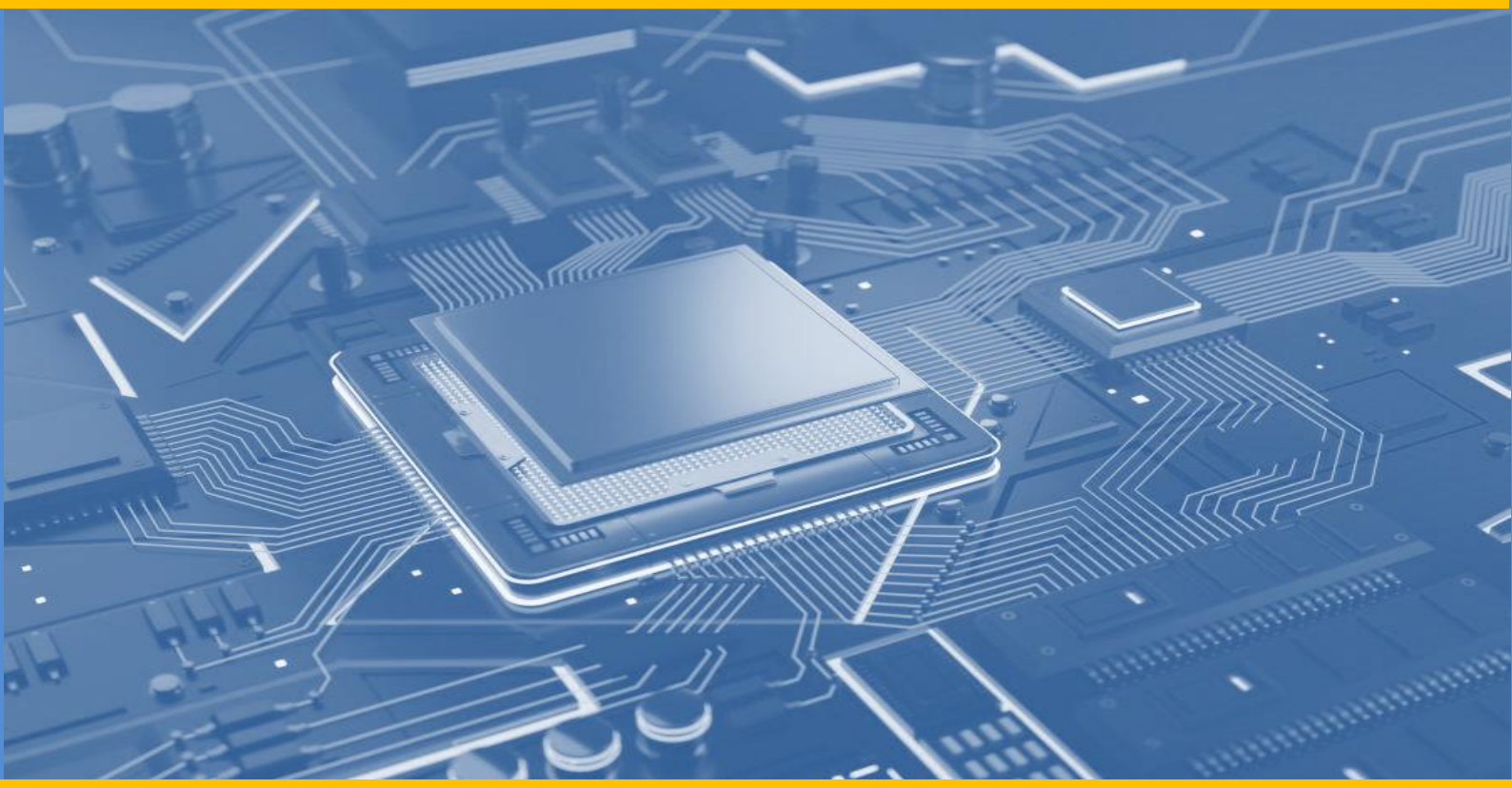
MIET
Mohamed Institute of Education & Technology
INSTITUTIONS
Since 1984

M.I.E.T. ENGINEERING COLLEGE

(Autonomous)
Tiruchirappalli-620007

Curriculum & Syllabus

(Regulations 2024)



M.E. VLSI Design

M.I.E.T. ENGINEERING COLLEGE

(AUTONOMOUS)

(Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai)
Accredited by NBA (CIVIL, CSE, ECE, EEE & MECH)
Accredited with 'A+' grade by NAAC
(An ISO 9001:2015 Certified Institution)
(Recognized by UGC under section 2(f) & 12(B) of UGC Act, 1956)
TRICHY - PUDUKKOTTAI MAIN ROAD, TRICHY - 620 007

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULUM AND SYLLABUS

M.E. VLSI DESIGN
(Regulations 2024)

Vision

To be a top-class technical hub in imparting knowledge in cutting edge areas of Electronics and Communication Engineering, providing pleasant learning environment, nurturing scholars of excellent proficiency to meet the global and socio-economic challenges of the country.

Mission

- To provide remarkable teaching and research environment through state-of-the-art facilities.
- To strengthen the soft as well as hard skills of students to achieve technical and academic excellence.
- To raise the students to become responsible citizens with good human values and encourage them to work for the well-being of society.
- To develop the skills of lifelong learning and professional growth of students through utilization of the high-standard infrastructure facilities.

Program Outcomes (POs)

1. An ability to independently carry out research/investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document.
3. 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.
4. Understand the fundamentals involved in the Designing and Testing of electronic circuits in the VLSI domain.
5. Provide solutions through research to socially relevant issues for modern Electronic Design Automation (EDA) tools with knowledge, techniques, skills and or the benefit of the society.
6. Interact effectively with the technical experts in industry and society.

Program Educational Objectives (PEO)

1. Graduates will be able to model, analyze, design, verify functionality, implement and test VLSI chips using relevant Electronic Design Automation Tool.
2. Graduates will be able to technically competent in design, development and implementation of electronics and VLSI design and extends into applications in the different thrust areas.
3. Graduates will be responsible member of society with ethics, eager to solve the real-world problem in VLSI technologies.

PO-PEO Mapping

Program Educational Objectives	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	2	1	2	3	1	1
PEO2	3	1	2	3	2	2
PEO3	3	1	1	3	3	3

1 - Low, 2 - Medium, 3 – High

CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABUS FOR SEMESTERS I TO IV

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24MA1101	Graph Theory and Optimization	FC	3	0	0	3	3
2.	24VL1101	Analog IC Design	PCC	3	0	0	3	3
3.	24VL1102	Digital CMOS VLSI Design	PCC	3	0	0	3	3
4.	24VL1103	Digital System Design using FPGA	PCC	3	0	0	3	3
5.	24VL1104	Semiconductor Devices and Modeling	PCC	3	0	0	3	3
6.	24VL13XX	Professional Elective I	PEC	3	0	0	3	3
7.	24VL1201	Digital System Design using FPGA Laboratory	PCC	0	0	4	4	2
8.	24VL1202	Analog IC Design Laboratory	PCC	0	0	4	4	2
							Total	**22**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24VL2101	Design of ASICs	PCC	3	0	0	3	3
2.	24VL2103	RFIC Design	PCC	3	0	0	3	3
3.	24VL2104	VLSI Testing	PCC	3	0	0	3	3
4.	24VL23XX	Professional Elective II	PEC	3	1	0	4	4
5.	24VL23XX	Professional Elective III	PEC	3	1	0	4	4
6.	24RE2101	Scientific Report Writing	RMC	2	0	0	2	2
7.	24VL2201	Design of ASIC using EDA tools	PCC	0	0	4	4	2
							Total	**21**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24VL3101	VLSI Structures for Signal Processing	PCC	3	0	0	3	3
2.	24VL33XX	Professional Elective IV	PEC	3	0	0	3	3
3.	24OEXXXX	Open Elective	OEC	3	0	0	3	3
4.	24RE3101	Research Methodology and IPR	RMC	2	0	0	2	2
5.	24VL3501	Project Work Phase I	EEC	0	0	12	12	6
6.	24RE3201	Research Article Review	RMC	0	0	4	4	2
							Total	**19**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
PRACTICAL								
1.	24VL4501	Project Work Phase II	EEC	0	0	24	24	12
							Total	**12**

FOUNDATION COURSE (FC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24MA1101	Graph Theory and Optimization	FC	3	0	0	3	3
							Total	**3**

PROFESSIONAL CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24VL1101	Analog IC Design	PCC	3	0	0	3	3
2.	24VL1102	Digital CMOS VLSI Design	PCC	3	0	0	3	3
3.	24VL1103	Digital System Design using FPGA	PCC	3	0	0	3	3
4.	24VL1104	Semiconductor Devices and Modeling	PCC	3	0	0	3	3
5.	24VL1201	Digital System Design using FPGA Laboratory	PCC	0	0	4	4	2
6.	24VL1202	Analog IC Design Laboratory	PCC	0	0	4	4	2
7.	24VL2101	Design of ASICs	PCC	3	0	0	3	3
8.	24VL2103	RFIC Design	PCC	3	0	0	3	3
9.	24VL2104	VLSI Testing	PCC	3	0	0	3	3
10.	24VL2201	Design of ASICs using EDA Tools	PCC	0	0	4	4	2
11.	24VL3101	VLSI Structures for Signal Processing	PCC	3	0	0	3	3
							Total	**30**

PROFESSIONAL ELECTIVES COURSES (PEC)
SEMESTER I & II, PROFESSIONAL ELECTIVE I, II & III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24VL1301	Opto Electronic Devices	PEC	3	1	0	4	4
2.	24VL1302	Electronic Design Automation using EDA Tools	PEC	3	1	0	4	4
3.	24VL1303	Electromagnetic Interference and Compatibility	PEC	3	1	0	4	4
4.	24VL2301	Data Converters	PEC	3	1	0	4	4
5.	24VL2302	Hardware Software Co-Design for FPGA	PEC	3	1	0	4	4
6.	24VL2303	Scripting Languages for Electronic Design Automation	PEC	3	1	0	4	4

7.	24VL2304	Low Power VLSI Design	PEC	3	1	0	4	4
8.	24VL2305	MEMS and NEMS	PEC	3	1	0	4	4
9.	24VL2306	Network on Chip	PEC	3	1	0	4	4
10.	24VL2307	Nanotechnology	PEC	3	1	0	4	4

SEMESTER III, PROFESSIONAL ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24VL3301	Evolvable Hardware	PEC	3	0	0	3	3
2.	24VL3302	Soft Computing and Optimization	PEC	3	0	0	3	3
3.	24VL3303	CAD for VLSI Design	PEC	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES(RMC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24RM2101	Scientific Report Writing	RMC	2	0	0	2	2
2.	24RM3201	Research Article Review	RMC	0	0	4	2	2
3.	24RE3101	Research Methodology and IPR	RMC	2	0	0	2	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24VL3501	Project Work Phase I	EEC	0	0	12	12	6
2.	24VL4501	Project Work Phase II	EEC	0	0	24	24	12

OPEN ELECTIVE COURSES (OEC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24OEMF01	Green Supply Chain Management	OEC	3	0	0	3	3
2.	24OEMF02	Renewable Energy Technologies	OEC	3	0	0	3	3

3.	24OEMF03	Medical Robotics	OEC	3	0	0	3	3
4.	24OEMF04	Textile Reinforced Composites	OEC	3	0	0	3	3
5.	24OEMF05	Nano Composite Materials	OEC	3	0	0	3	3
6.	24OEMF06	New Product Design and Development	OEC	3	0	0	3	3
7.	24OEPE01	Electric Vehicle Technology	OEC	3	0	0	3	3
8.	24OEPE02	Renewable Energy Systems	OEC	3	0	0	3	3
9.	24OEPE03	Power Semiconductor Devices	OEC	3	0	0	3	3
10.	24OEPE04	Energy Storage Technologies	OEC	3	0	0	3	3
11.	24OEPE05	Control System Design	OEC	3	0	0	3	3
12.	24OEPE06	Energy Management and Auditing	OEC	3	0	0	3	3
13.	24OECS01	Speech Signal Processing	OEC	3	0	0	3	3
14.	24OECS02	Digital Forensics	OEC	3	0	0	3	3
15.	24OECS03	IT & Agricultural System	OEC	3	0	0	3	3
16.	24OECS04	Machine Learning	OEC	3	0	0	3	3
17.	24OECS05	IoT for Smart Systems	OEC	3	0	0	3	3
18.	24OECS06	Software Testing and Automation	OEC	3	0	0	3	3
19.	24OEST01	Integrated Water Resources Management	OEC	3	0	0	3	3
20.	24OEST02	Water, Sanitation and Health	OEC	3	0	0	3	3
21.	24OEST03	Principles of Sustainable Development	OEC	3	0	0	3	3
22.	24OEST04	Environmental Impact Assessment	OEC	3	0	0	3	3
23.	24OEST05	Environmental Sustainability	OEC	3	0	0	3	3
24.	24OEST06	Green building design	OEC	3	0	0	3	3

SUMMARY

S.No.	Subject Area	Credits per Semester				Credits Total
		I	II	III	IV	
1.	Foundation Course (FC)	03	00	00	00	03
2.	Professional Core Courses (PCC)	16	11	03	00	30
3.	Professional Electives Courses (PEC)	03	08	03	00	14
4.	Research Methodology And Ipr Course(RMC)	00	02	04	00	06
5.	Open Elective Courses (OEC)	00	00	03	00	03
6.	Employability Enhancement Courses (EEC)	00	00	06	12	18
7.	Non Credit/Audit Course	00	00	00	00	00
Total Credit		**22**	**21**	**19**	**12**	**74**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75

24MA1101 GRAPH THEORY AND OPTIMIZATION **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To introduce graph as mathematical model to solve connectivity related problems.
- To introduce fundamental graph algorithms.
- To familiarize the students with the formulation and construction of a mathematical model for a linear programming problem in a real life situation.

UNIT I GRAPHS **9**

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

UNIT II GRAPH ALGORITHM **9**

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

UNIT III LINEAR PROGRAMMING **9**

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

UNIT IV NON-LINEAR PROGRAMMING **9**

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

UNIT V SIMULATION MODELLING **9**

Monte Carlo Simulation – Types of Simulation – Elements of Discrete Event Simulation – Generation of Random Numbers – Applications to Queuing system**s.**

TOTAL : 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Apply graph ideas is solving connectivity related problems.
CO2: Apply fundamental graph algorithms to solve certain optimization problems.
CO3: Formulate and construct mathematical models for linear programming problems and solve the transportation and assignment problems.
CO4: Model various real life situations as optimization problems and effect their solution through Non-linear programming.
CO5: Apply simulation modeling techniques to problems drawn from industry management and other engineering fields.

TEXT 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.

REFERENCE BOOKS

1. Douglas B. West, "Introduction to Graph Theory", Pearson Education, New Delhi, 2015.
2. Balakrishna R., Ranganathan. K., " A text book of Graph Theory", Springer science and Business Media, New Delhi, 2012.
3. Narasingh Deo, "Graph Theory with Applications to Engineering and Computer Science",Prentice Hall India,1997.
4. David avis "Graph Theory and Combinatorial Optimization", Springer-Verlag New York Inc,2010.
5. Krishnaiyan KT, Thulasiraman, Subramanian Arumugam,"Handbook of Graph theory, Combinatorial Optimization", Chapman & Hall 2016.

Mapping of COs and POs

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

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24VL1101 ANALOG IC DESIGN **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the basic principle of operation, the circuit choices and the trade offs involved in the MOS transistor level design.
- To develop the ability to design issues related to single and multistage voltage, current and differential amplifiers, their output and impedance issues, bandwidth, feedback and stability will be dealt with in detail.
- To develop the skills to design analog VLSI circuits for a given specification.

UNIT I CURRENT MIRRORS AND SINGLE STAGE AMPLIFIERS **9**

MOS Device Models, MOS Current Sources and sinks, CS, CG and Source Follower, Differential amplifier-Single ended and differential operation, Cascode and Folded Cascode configurations.

UNIT II FREQUENCY RESPONSE AND NOISE CHARACTERISTICS OF AMPLIFIERS **9**

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

UNIT III FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIERS 9

Properties and types of negative feedback circuits, effect of loading in feedback networks, operational amplifier performance parameters, single stage Op-Amps.

UNIT IV TWO STAGE OPAMPS AND FREQUENCY COMPENSATION 9

Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation.

UNIT V BAND GAP REFERENCES 9

Supply independent biasing, temperature independent references, PTAT and CTAT current generation, constant-gm biasing. Case study-Design of Two stage opamp amplifiers to meet specified SR, noise, gain, BW, ICMR and power dissipation, voltage swing, high gain amplifier structures. Design of sub-µW bandgap circuits.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Design current mirrors and amplifiers to meet user specifications.
CO2: Analyse the frequency and noise performance of amplifiers.
CO3: Design and analysis of feedback amplifiers and one stage op-amps.
CO4: Design and analyse two stage op amps.
CO5: Perform design and analysis of analog circuits for given specifications.

TEXT BOOKS

1. Behzad Razavi,"Design of Analog CMOS Integrated Circuits", TataMcgraw Hill, 2001.
2. Willey M.C.Sansen,"Analog Design Essentials",Springer,2006.
3. T.C.Carusone, D.A.Johns and K.W.Martin, "Analog Integrated Circuit Design," Second Edition, John WileyInc,2012.

REFERENCE BOOKS

1. Phillip E. Allen,Douglas R. Holberg,"CMOS Analog Circuit Design",OxfordUniversityPress,2nd,Edition,2002.
2. Paul. R. Gray and Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley, 5th Edition, 2009.
3. Jacob Baker, "CMOS: Circuit Design, Layout, And Simulation, Wiley IEEEPress,3rd ,Edition, 2010.
4. Behzad Razavi, "Design of Analog CMOS Integrated Circuits"MC Graw Hill Education,July 2015.
5. Carusone, David A. Johns, and Kenneth W. Martin, "ANalog Integrated Circuit Design",Wiley, 2013.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL1102 DIGITAL CMOS VLSI DESIGN **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To lay rigorous foundation in basic CMOS digital circuits.
- To build problem solving skills and creative circuit building capability.
- To learn all important issues related to size, speed and power consumption.

UNIT I MOS TRANSISTOR PRINCIPLES AND CMOS INVERTER **9**

MOSFET characteristic under static and dynamic conditions, MOSFET secondary effects, elmore constant , CMOS inverter-static characteristic, dynamic characteristic, power, energy, and energy delay parameters, stick diagram and layout diagrams.

UNIT II STATIC AND DYNAMIC LOGIC CIRCUITS **9**

Static CMOS design, different styles of logic circuits, logical effort of complex gates, static and dynamic properties of complex gates, dynamic logic gates design considerations, domino logic, interconnects.

UNIT III SEQUENTIAL CIRCUIT DESIGN AND TIMIMG ANALYSIS **9**

Static latches and registers, dynamic latches and registers, timing issues, pipelines, clocking strategies, nonbistable sequential circuits.

UNIT IV MEMORIES **9**

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

UNIT V ARITHMETIC BUILDING BLOCK **9**

Architectures for adders, accumulators, multipliers. Case study – Optimized design of adders, multipliers and barrels shifters for a given specification with special consideration to speed, power and area trade offs.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Design CMOS inverter with optimized power, area and timing.

CO2: Design optimized static and dynamic circuits using logical effort.

CO3: Understand timing constraints in latches flip-flops and clocking issues.

CO4: Design memories.

CO5: Design low power digital VLSI circuits.

TEXT BOOKS

1. N.Weste, K. Eshraghian, " Principles Of CMOS VLSI Design", Addision Wesley, 2nd Edition, 1993.
2. Jan Rabaey, Anantha Chandrakasan, B Nikolic, "Digital Integrated Circuits",Pearson,2016.
3. Perspective", Prentice Hall Of India, 2nd Edition, Feb2003. Samir Palnitkar, "Verilog HDL",SunSoft,1996.

REFERENCE BOOKS

1. T Pucknell and Eshraghian, "Basic VLSI Design", 3rd Edition, PHI, 1996.
2. Sung-MoKang & Yusuf Leblebici,"CMOS Digital Integrated Circuits Analysis and Design",Mcgraw-Hill,1998.
3. Neil Weste, David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective",3rd Edition, Pearson/Addison-Wesley, 2005.
4. Jan M. Rabaey,Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits", 2nd Edition, Pearson/Addison-Wesley,2003.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'-No correlation

24VL1103 DIGITAL SYSTEM DESIGN USING FPGA **L T P C**

3 0 0 3

COURSE OBJECTIVES

- Understand the various abstraction level in Verilog HDL and model the complex combinational and sequential circuits with Verilog HDL.
- Provide in depth understanding of state machine design and modeling using Verilog HDL.
- Understand about different FPGA Architecture like Xilinx and ALTERA.

UNIT I VERILOG HDL-STRUCTURAL AND BEHAVIORAL MODELING 9

Verilog Fundamentals-Operators-Gate Level Modeling -Data Flow Modeling-Test Bench-Behavioral Level Modeling -Procedural Assignment Statements-Blocking and Non Blocking Assignments-Tasks & Functions-System Tasks & Compiler Directives.

UNIT II DESIGN AND MODELING OF COMBINATIONAL AND SEQUENTIAL CIRCUITS 9

Ripple Carry Adders-Carry Look Ahead Adder- Unsigned Binary Multipliers.Synthesizable Coding Style for Combinational Circuits.FSM modeling of sequence detector-Serial adder-Vending machine. Synthesizable coding style for sequential circuits and FSM.

UNIT III MEMORY AND SYSTEM DESIGN 9

Synchrronous and Asychronous FIFO -Single port and Dual Port ROM and RAM. Traffic Light Controller, Real Time clock-Interfacing using FPGA:VGA,LCD,CAMERAS.

UNIT IV FPGA ARCHITECTURE 9

Types of programmable logic devices: PLA,PAL,CPLD-FPGA Architecture -Programming Technologies-Chip I/O Programmable Logic Blocks-Fabric and Architecture of FPGA-Xilinx/Intel/Actel FPGA Architecture.

UNIT VSOC ARCHITECTURE 9

An overview of System on Design -FPGA SoC Architecture Case Study:

1. Binary counter-Bus protocol.
2. Xilinx/Intel FPGA.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Analyse and design synchronous sequential circuits.

CO2: Analyse hazards and design asynchronous sequential circuits.

CO3: Knowledge on the testing procedure for combinational circuit and PLA.

CO4: Able to design PLD and ROM.

CO5: Design and use programming tools for implementing digital circuits of industry.

TEXT BOOKS

1. Michael D Ciletti, Advanced Digital Design with the Verilog HDL, 2017, Second Edition, Pearson Education.
2. Ming Bo Lin,Digital System Design and Practice:Using Verilog HDL andFPGAs,2015,Second Edition,Create Space Independent Publishing Platform.
3. Wayne Wolf, FPGA Based System Design, 2011,Prentices Hall Modern Semiconductor Design Series.

REFERENCE BOOKS

1. Charles H Roth Jr,Lizy Kurian John and Byeong Kil Lee,Digital Dystems Design using Verilog, 2016,First Edition,Cengage Learning.

2. Joseph Yu,System-on-Chip,Design with Arm Cortex-M Processors,2019,ARM Education Media.
3. By Cem Unsalan, Bora Tar, "Digital System Design with FPGA: Implementation Using Verilog and VHDL",MC Graw Hill,2017.
4. Ross K. Snider, "Advanced Digital System Design using SoC FPGAs",Springer, 2023.
5. Ian Grout, "Digital Systems Design with FPGAs and CPLDs",Elsevier, 2008.

Mapping of COs and 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	-
AVG	1	-	1	1	1.2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL1104 SEMICONDUCTOR DEVICES AND MODELING **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To acquire the fundamental knowledge and to expose to the field of semiconductor theory and devices and their applications.
- To gain adequate understanding of semiconductor device modelling aspects, designing devices for electronic applications.
- To acquire the fundamental knowledge of different semiconductor device modelling aspects.

UNIT I BIPOLAR DEVICES **9**

n–p–n Transistors, Basic Operation of a Bipolar Transistor, Modifying the Simple Diode Theory for Describing Bipolar Transistors, Ideal Current–Voltage Characteristics, Collector Current, Base Current, Current Gains, Ideal IC–VCE Characteristics, Characteristics of a Typical n–p–n Transistor, Effect of Emitter and Base Series Resistances, Effect of Base–Collector Voltage on Collector Current, Collector Current Falloff at High Currents, Nonideal Base Current at Low Currents, Bipolar Device Models for Circuit and Time.

UNIT II MOS CAPACITORS **9**

Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in an MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Nonequilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–Oxide Interface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche

Breakdown, Band-to-Band Tunneling, Injection of Hot Carriers from Silicon into Silicon Dioxide.

UNIT III MOSFET DEVICES **9**

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

UNIT IV CMOS DEVICE DESIGN **9**

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

UNIT V MOSFET ADVANCED TECHNOLOGIES **9**

Combinational Circuits. Interconnects – Electro static discharge (ESD) – Latch-up and its Prevention ,MOSFET structure evolution – High-k dielectrics,Metal Gate Electrodes, High mobility substrates (Strained Si, Ge), Elevated S/D.

Case study:

1. Reliability Analysis of High-k Dielectrics in MOSFETs.
2. Design and Optimization of ESD Protection Circuits.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Discuss the device level characteristics of BJT transistors.
CO2: Explore the properties of MOS capacitors.
CO3: Analyze the various characteristics of MOSFET devices.
CO4: Describe the various CMOS design parameters and their impact on performance.
CO5: Ability to analyse the transistor level circuits.

TEXT BOOKS

1. Yuan Taur and Tak H.Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2016.
2. A.B. Bhattacharyya “Compact MOSFET Models for VLSI Design”, John Wiley & Sons Ltd, 2009.
3. Ansgar Jungel, “Transport Equations for Semiconductors”, Springer, 2009.

REFERENCE BOOKS

1. Behzad Razavi, “Fundamentals of Microelectronics” Wiley Student Edition, 2nd Edition, 2014.

2. Sung-Mo Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits - Analysis and Design, Third Edition, Tata McGraw-Hill, 2003.
3. Neil H. E. Weste and David Money Harris, CMOS VLSI Design: A Circuits and Systems Perspective, Fourth Edition, Addison Wesley, 2010.
4. Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf, "Device Modeling for Analog and RF CMOS Circuit Design", John Wiley & Sons Ltd, 2004.
5. Selberherr, S., "Analysis and Simulation of Semiconductor Devices", Springer-Verlag., 1984.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL1201 DIGITAL SYSTEM DESIGN USING FPGA LABORATORY

L T P C
0 0 4 2

COURSE OBJECTIVES

- To help engineers read, understand, and maintain digital hardware models.
- To form strong foundation on conventional verification test benches written in Verilog and System Verilog.
- To provide a critical language foundation for more advanced training on System Verilog.

LIST OF EXPERIMENTS

1. Adder/ Subtractor and Multiplexer/ Demultiplexer.
2. Encoder/ Priority Encoder.
3. Code Converter ,Comparator.
4. Flip flop-Shift Register/ Universal Shift Register.
5. Up counter/ Down counter.
6. Design of 8-bit Carry Skip Adder and Carry Save Adder.
7. Design of 4-bit Array Multiplier with and without Pipelining.
8. Design of 4-tap FIR Filter with and without Pipelining.
9. Design of FIFO.
10. Design of Sequence Detector.
11. Design of 8-bit ALU.

12. Study of FPGA.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1: To learn the basic HDL functions.

CO2: Design and analyse the combinational and sequential circuits using Verilog HDL tools.

CO3: Perform FPGA Implementation for Verilog HDL designs on development.

CO4: Implement FIR algorithms in FPGA.

CO5: Implement ALU in FPGA.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL1202 ANALOG IC DESIGN LABORATORY **L T P C**
0 0 4 2

COURSE OBJECTIVES

- Analyze and design single ended and differential IC amplifiers.
- Understand the relationships between devices, circuits and systems.
- Emphasize the design of practical amplifiers, small systems and their design parameter trade-offs.

LIST OF EXPERIMENTS

1. Simulation of MOSFET IV characteristics, second order parameters.
2. Simulation of CMOS inverter-DC,AC.
3. Simulation of Transient Analysis.
4. Post layout simulation.
5. Design of basic single stage amplifiers(Common Source,Common Gate and Common Drain).
6. Analysis and Design of Simple current mirror and cascode current mirror.
7. Analysis and Design of differential amplifier with active load and current source load.
8. 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.

9. Design a differential amplifier with resistive load using transistors from CMOS process library that meets a given specification for the following parameter.
10. Analysis and Design of Two-Stage Opamp with Frequency Compensation.
11. To study layouts of CMOS combinational and sequential circuits.
12. To utilize switch-level and circuit-level simulators for the logic verification and timing simulation.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1: Introduce industry standard Analog IC design EDA tool.
CO2: Practical learning and understanding of Analog amplifiers, current mirrors etc.
CO3: Solve analog design problems by changing the design parameter of the circuit with the help of LTSpice.
CO4: Understand the working of oscillators and differential circuits.
CO5: Learn the art of designing power efficient opamps

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

24VL2101 DESIGN OF ASICS **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To deal with the entire FPGA and ASIC Design Flow from the Circuit and Layout Design Point of View.
- To give the student an understanding of basics of System on Chip design.
- To understand case study of Finite State Machine.

UNIT I ASIC DESIGN METHODOLOGY AND DESIGN FLOW **9**

Implementation strategies for digital ICs: Custom IC Design – Cell-based Design Methodology – Array based Implementation Approaches-Traditional and Physical Compiler based ASIC Flow.

UNIT II RTL SYNTHESIS **9**

RTL Synthesis Flow – Synthesis Design Environment and Constraints – Architecture of

Logic Synthesizer – Technology Library Basics – Components of Technology Library – Synthesis Optimization – Technology independent and dependent Synthesis – Data path Synthesis – Low power Synthesis.

UNIT III LOGIC SYNTHESIS, PLACEMENT AND ROUTING 9

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

UNIT IV SYSTEM ON CHIP DESIGN 9

SoC Design Flow, Platform-Based and IP Based SoC Designs, Basic Concepts of Bus-Based Communication Architectures, High Performance Filters using Delta-Sigma Modulators.

UNIT V CASE STUDY- FSM 9

Case study: FSM design, clock domain crossing, FIFOs. Core (ARM) and IOs (I2C, PWM, GPIO, SPI, NAND, Ethernet, USB, high speed serdes etc. are interconnected through AXI/APB buses (protocols and interconnects).

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1: Understand methodology and Design flow in ASICs.
CO2: Describe the issues involved in ASIC design.
CO3: Analyse to use Algorithms for Floor Planning and Placement of Cells.
CO4: Understand to analyse High Performance Algorithms.
CO5: Analyse to Finite State Machines.

TEXT BOOKS

1. H.Gerez, “Algorithms for VLSI Design Automation”, John Wiley, 1999.
2. M.J.S Smith, “Application Specific Integrated Circuits”, Pearson, 2003.
3. Jan.M.Rabaey et al, “Digital Integrated Circuit Design Perspective”, 2nd Edition, PHI 2003.

REFERENCE BOOKS

1. Hoi-Jun Yoo, Kangmin Lee and Jun Kyong Kim, “Low-Power NoC for High-Performance SoC Design”, CRC Press, 2008.
2. An Integrated Formal Verification solution DSM sign-off market trends”, www.cadence.com.
3. David A.Hodges, “Analysis and Design of Digital Integrated Circuits”, 3rd Edition, MGH 2004.
4. Khosrow Golshan, “Physical Design Essentials”, Springer,2007.
5. Keith Barr, “ASIC Design in the Silicon Sandbox: A Complete Guide to Building Mixed-Signal Integrated Circuits”,McGraw-Hill,2006.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL2103 RFIC DESIGN **L T P C**
3 0 0 3

COURSE OBJECTIVES

- Understand the Concept of RFIC Design.
- Understand the High Frequency Model of MOS and importance of Impendence Matching.
- Understand functional Design Aspects of Mixers, PLL, analyze and design of Transceivers.

UNIT I INTRODUCTION TO WIRELESS AND RF TECHNOLOGY **9**

Complexity design and Applications – Choice of Technology – basic Concepts in RF Design: Non Linearity – Time Variance – Intersymbol Interference - Random Processes – Noise. Definitions of Sensitivity – dynamic range- Conversion gain and Distortion.

UNIT II HIGH FREQUENCY MODEL OF RF TRANSISTORS AND MATCHING NETWORKS **9**

MOSFET behavior at RF Frequencies – Noise Performance and limitation of devices – Impedance matching networks – transformers and baluns.

UNIT III ACTIVE AND PASSIVE MIXERS **9**

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

UNIT IV PLL AND FREQUENCY SYNTHESIZERS **9**

Phase Detector/Charge Pump, Analog Phase Detectors, Digital Phase Detectors, Frequency

Dividers, Loop Filter Design, Phase Locked Loops, Phase Noise in PLL, Loop Bandwidth, Basic Integer-N Frequency Synthesizer, Basic Fractional-N Frequency Synthesizer.

UNIT V DESIGN OF TRANSCEIVER **9**

Case study: System level specification and design of Receiver , Transmitter and Frequency Synthesizer

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1: Understand the concept of RFIC Design.

CO2: Understand the High Frequency Model of MOS and Importance of Impedance Matching.

CO3: To analyze and design mixers.

CO4: Design PLL and frequency synthesizer.

CO5: Analyze and Design of Transceivers.

TEXT BOOKS

1. Hooman Darabi, "Radio Frequency Integrated Circuits and Systems", 2020, 2nd Edition, Cambridge University Press, NewYork, USA.
2. B Razavi, "RF Microelectronics", Prentice Hall, 1998.
3. Richard Chi-Hsi Li, "RF Circuit Design, 2nd Edition", Wiley,2012.

REFERENCE BOOKS

1. Jia-Sheng Hong, "Microstrip Filters for RF/Microwave Applications", Wiley, 2001.
2. Thomas H.Lee, "The Design of CMOS Radio –Frequency Integrated Circuits", Cambridge University Press, 2003.
3. Richard C. Li , "RF Circuit Design", Wiley,2008.
4. John W. M. Rogers, Calvin Plett, "Radio Frequency Integrated Circuit Design",Pearson 2003.
5. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" Mcgraw-Hill, 1999.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL2104 VLSI TESTING **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To introduce the concept of VLSI testing.
- To introduce logic and fault simulation and testability measures.
- To study the test generation for combinational and sequential circuits.

UNIT I INTRODUCTION TO VLSI TESTING **9**

Testing of VLSI Circuits– Fault Modeling – Equivalence and Dominance - Logic and Fault Simulation –Testability Measures – Combinational Circuit Test Generation – Redundancy Identification.

UNIT II LOGIC & FAULT SIMULATION & TESTABILITY MEASURES **9**

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

UNIT III TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS **9**

Testable Combinational Logic Circuit Design – Design of Testable Sequential Circuits– BIST Architectures –Random Logic Bist –Test-Per-Clock – Test-Per-Scan - BIST Systems – Memory BIST –At-speed Testing– Boundary Scan Architecture – JTAG Standards.

UNIT IV DESIGN FOR TESTABILITY **9**

Design for Testability Basics – Testability Analysis - Scan Cell Designs – Scan Architecture –DFT for Other Test Objectives.

UNIT V CASE STUDY ON TESTING **9**

Combinational Logic Circuit Design- Sequential Circuits design-Real time application.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1: Identify the various IC fabrication methods.
CO2: Express the Layout of simple MOS circuit using true value and fault simulation.
CO3: Apply the BIST Architectures design rules for subsystem design.
CO4: Differentiate various FPGA,scan architectures.
CO5: Design an real time application using VLSI testing.

TEXT BOOKS

1. M. L. Bushnell and V.D. Agrawal, Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits, Springer, 2005.
2. H. Fujiwara, Logic Testing and Design for Testability, MIT Press, 1985.
3. M. Abramovici, M. Breuer, and A. Friedman, Digital System Testing and Testable Design, IEEE Press, 1994.

REFERENCE BOOKS

1. M. Huth and M. Ryan, Logic in Computer Science, Cambridge Univ. Press, 2004.
2. T. Kropf, Introduction to Formal Hardware Verification, Springer Verlag, 2000.
3. D. Baik, K. K. Saluja and S. Kajihara, `Random Access Scan: a solution to test power, test data volume and test time`, International Conference on VLSI Design, Jan. 2004.
4. H. Fujiwara, `A new class of sequential circuits with combinational test generation complexity`, IEEE Trans. on Computers, Vol. 49, No. 5, Sep 2000, pp. 895-905.
5. S. Ohtake, T. Masuzawa, and H. Fujiwara, `A non-scan DfT method for controllers to achieve complete fault efficiency`, Proc. of the IEEE Asian Test Symposium (ATS) 1998, pp. 204-211.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No Correlation

24RE2101 SCIENTIFIC REPORT WRITING **L T P C**
2 0 0 2

COURSE OBJECTIVES

- To teach the basic paper writing process and learn how to collect relevant bibliography.
- To summarize the skills needed to study all the bibliography.
- To infer the skills needed when writing the title,abstract, conclusion etc. and prepare for quality paper at very first-time submission.

UNIT I INTRODUCTION TO SUBJECT SELECTION **9**

Selecting a subject-narrowing the subject into a topic - Stating an objective.

UNIT II PREPARATION FOR PAPER WRITING **9**

Preparing a working outline- Collecting the relevant bibliography (atleast 15 journal papers).

UNIT III LINKING OF PAPERS **9**

Studying the papers - understanding the authors contributions - analysing each paper- Linking the papers.

UNIT IV INTRODUCTION TO WRITING SKILLS **9**

Key skills are needed when writing a Title- key skills are needed when writing an Abstract-key skills are needed when writing an Introduction- Preparing conclusions based on the reading of all the papers.

UNIT V WRITING THE FINAL PAPER **9**

Writing the Final Paper -checking Plagiarism –case study: draft paper preparation-conference submission(national level)-journal publication.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1: Understand the basic paper writing skills .

CO2: Learn how to collect relevant papers and preparing the working outline.

CO3: Understand the skills needed when studying the relevant papers.

CO4: Understand the skills needed when writing the paper.

CO5: Ensure the good quality of paper at very first-time submission.

TEXT BOOKS

1. Adrian Wallwork , 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.
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006.
4.

REFERENCE BOOKS

1. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.
2. Sheela P. Turbek, Taylor M. Chock,Lauren G. Shoemaker, Lara Vimercati, "Scientific Writing Made Easy: A Step-by-Step Guide to Undergraduate Writing in the Biological Sciences",Bullet IN 2006.
3. Rafal Marszalek, "Scientific Reports", Nature Portfolio,2011.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No Correlation

24VL2201 DESIGN OF ASICS USING EDA TOOLS **L T P C**
0 0 4 2

COURSE OBJECTIVES

- To help engineers read, understand, and simulate digital hardware models.
- To perform conventional verification of test benches written in Verilog and System Verilog.
- To provide a critical language foundation for more advanced training on System Verilog.

LIST OF EXPERIMENTS

1. Adder/ Subtractor and Multiplexer/ Demultiplexer.
2. Encoder/ Priority Encoder.
3. Code Converter, Comparator.
4. Flip flop-Shift Register/ Universal Shift Register.
5. Up counter/ Down counter.
6. Design of 8-bit Carry Skip Adder and Carry Save Adder.
7. Design of 4-bit Array Multiplier with and without Pipelining.
8. Design of 4-tap FIR Filter with and without Pipelining.
9. Design of FIFO.
10. Design of Sequence Detector.
11. Design of 8-bit ALU.
12. Design of MAC unit using Verilog.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1: Familiarize with sophisticated VLSI CAD tools available in the lab.
CO2: Able to design and implement any ASIC designs using the latest VLSI CAD tools.
CO3: Perform full custom ASIC design of digital blocks.
CO4: Learn advanced features in physical design.
CO5: Perform a complete cycle of chip design from design to chip tape-out procedure.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No Correlation

24VL3101 VLSI STRUCTURES FOR SIGNAL PROCESSING **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To introduce techniques for altering existing DSP structures to suit VLSI implementations.
- To introduce efficient design of DSP architectures suitable for VLSI.
- To enhance the knowledge on the concepts of pipelining and bit level architecture.

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

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

UNIT II RETIMING, ALGORITHMIC STRENGTH REDUCTION **9**

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

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

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

UNIT IV BIT-LEVEL ARITHMETIC ARCHITECTURES **9**

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

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

Numerical strength reduction – sub-expression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge triggered single phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining - Bundled Dataversus Dual-Rail protocol.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Determine the parameters influencing the efficiency of DSP architectures.

CO2: Analyse and modify the design equations leading to efficient DSP architectures.

CO3: Speed up convolution process and develop fast and area efficient IIR structures.
CO4: Develop fast and area efficient multiplier architectures.
CO5: Analyse to reduce multiplications and build fast hardware for synchronous digital systems.

TEXT BOOKS

1. Keshab K. Parhi, "VLSI Digital Signal Processing Systems, Design and Implementation ", Wiley, Interscience, 2007.
2. Magdy A. Bayoumi, Earl E. Swartzlander, "VLSI Signal Processing Technology", Springer,1994.
3. J. D. Plummer, M. D. Deal and P. B. Griffin, Silicon VLSI Technology Fundamentals, Practice and Models, Prentice Hall, 2000.

REFERENCE BOOKS

1. U. Meyer – Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, 2nd Edition, 2004.
2. J.G. Proakis and D.G. Manolakis, Digital Signal Processing, Third Edition, Prentice Hall,2007.
3. Jose E. France, YannisTsividls, Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing' Prentice Hall, 1994.
4. Mohammed Ismail, Terri, Fiez, Analog VLSI Signal and Information Processing, McGraw Hill, 1994.
5. Kung. S.Y., H.J. While house T.Kailath, VLSI and Modern singal processing, Prentice Hall, 1985.

Mapping of COs and 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	-
AVG	1	-	2	2	1	-

1-Low, 2-Medium, 3-High, '-'- No Correlation

24RE3101 RESEARCH METHODOLOGY AND IPR **L T P C**
2 0 0 2

COURSE OBJECTIVES

- To arrange the conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose and ensure accuracy.
- To transform and model the collected data to discover useful information for decision- making.

- To create public awareness about the benefits of Intellectual property among students and provide legal certainty to inventors/ Patent applicants.

UNIT I RESEARCH DESIGN **6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES **6**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING **6**

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS **6**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS **6**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL:30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1:Arrange the conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose.

CO2:Gather information in a measured and systematic manner to ensure accuracy and data analysis.

CO3:Transform and model the collected data to discover useful information for decision-making.

CO4:Awareness about the benefits of Intellectual property.

CO5:Take up legal certainty while applying for Patent.

TEXT BOOKS

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. K R N Aswini, “Research Methodology & Intellectual Property Rights”, Pearson

2024.

REFERENCE BOOKS

1. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
2. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.
3. C.R.Kothari, "Research Methodology Methods and Techniques", New age international publishers,1990.
4. Dr. Santosh M Nejakar, Dr. Harish Bendigeri "Research Methodology and Intellectual Property Rights", ISBN 978-93-5987-928-4, Edition: 2023-24.
5. N.K.Acharya, "Intellectual Property Rights", Asia Law House 6th Edition. ISBN: 978-93-81849-30-9,2023.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No Correlation

24RE3201 RESEARCH ARTICLE REVIEW **L T P C**
0 0 4 2

COURSE OBJECTIVES

- Thorough review of an article.
- Proper planning and preparation of draft.
- Write a proper review of the article.

STAGES OF REVIEW

Stage-1	Collection of latest Research articles.
Stage-2	Read the entire article and take a note in his/her own words.
Stage-3	Summarize the literature in his/her own words.
Stage-4	Classify and arrange the literatures with template.
Stage-5	Preparation of review article.
Stage-6	Plagiarism checked by the department and it must be less than 10%.
Stage-7	Article must be communicated to the journal.

The students must do the above work individually by the guidance of faculty members and one coordinator is required to monitor the work progress. The evaluation will be done based on the following

a) Review of work after stage 3 10%
b) Review of work after stage 5 20%
c) Review of work after stage 7 20%
d) Final examination 50%

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1:Understand the technique to collect the literatures from various resources.
CO2:Apply the knowledge for collecting the required research data from the articles.
CO3:Formulate the research problem.
CO4:Analyze the research gap from various researchers work.
CO5:Create the new article to publish in the research journals.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL3501 PROJECT WORK PHASE I **L T P C**
0 0 12 6

COURSE OBJECTIVES

- To develop knowledge to formulate a real-world problem.
- To use different tools and techniques to arrive at a solution.
- To prepare a report and give a presentation.

Project Guidelines and Evaluation

- **Selection of a project topic:** It is a crucial and involves a literature survey and creative input, guided by a project supervisor. The topic should allow skill development in design, fabrication, analysis, testing, and research.
- **Literature survey**: Which helps to identify gaps and build on existing research. Initial project work should be completed during Dissertation I to lay the groundwork for further research.

- **Completed project work phase-I:** will be evaluated by internal and external examiners based on an oral presentation and the project report, which is submitted at the end of Dissertation-I. The evaluation follows the institution's credit system regulations.

ESSENTIALS

1. **ZEROTH REVIEW:** Confirmed project title, Print out of base paper, abstract, with minimum of **6 slides** of Power Point Presentation.

2. **FIRST REVIEW:** Reply for queries (if any) given in **ZEROTH REVIEW**, clear idea about existing and collection of clear literature survey (Minimum of 20 articles)from the reputed journals, with minimum of 15 slides. 25% of work should be completed.

3. **SECOND REVIEW:** Reply for queries (if any) given in **FIRST REVIEW,** collect and prepare the literatures (Minimum of 50 articles) with Literature template, minimum of **30 slides. 50%** of work should be completed.

4. **THIRD REVIEW:** Reply for queries (if any) given in **SECOND REVIEW, 90%** of work completion including Research Gap, Problem statement, Project Workflow Chart, Study of proposed work comparing with existing literatures Example: Calculation, Simulations, Analysis, optimization with minimum of **45 slides.**

TOTAL:180 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1:Design and analyze, an identified problem using scientific tools.
CO2:Simulation/ Theoretical analysis of a physical system.
CO3:Integrate various domain knowledge for a sustainable solution.
CO4:Set Goals, Targets, timeline, plan and execute activities of the project.
CO5:Disseminate work both in oral and written format.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL4501 PROJECT WORK PHASE II **L T P C**
0 0 24 12

COURSE OBJECTIVES

- To define the problem of the proposed research work.
- To enable students to apply any piece of theory and experiments which they have learned to a specific problem related to industry / research.
- To demonstrate and validate the results of the design concept.

ESSENTIALS

1. ZEROTH REVIEW: Confirmed project title, Print out of base paper, abstract, with minimum of **6 slides** of Power Point Presentation.

2. FIRST REVIEW: Reply for queries (if any) given in **ZEROTH REVIEW**, clear idea about existing and proposed project work, clear literature survey, with minimum of **15 slides**.

3. SECOND REVIEW: Reply for queries (if any) given in **FIRST REVIEW,** nearly **30%** of work completion including Project Workflow Chart, Design, Calculation with minimum of **20 slides.**

4. THIRD REVIEW: Reply for queries (if any) given in **SECOND REVIEW, 50%** of work completion including Project Workflow Chart, Design, Calculation, simulations, Fabrication, with minimum of **25 slides.**

TOTAL: 360 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1:Identify and formulate research problem.
CO2:Design and develop solution to the problem.
CO3:Analyze and solve the complex problems.
CO4:Plan, implement and execute the project.
CO5:Write effective technical report and demonstrate through presentation.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-' - No correlation

24VL1301 OPTOELECTRONIC DEVICES **L T P C**
3 1 0 4

COURSE OBJECTIVES

- To study the basics concepts of optical system, optoelectronic devices and materials.
- To learn the fundamental concepts in Semiconducting materials.
- To design the integrated optical active and passive components.

UNIT I INTRODUCTION TO OPTICAL SYSTEMS **12**

Introduction: Optical Systems and Fundamentals - Basics of Semi-conductor Optics: Elemental and Compound Semiconductors - Electronic and Optical Processes in Semiconductors; P-N Junctions LEDs, Photodetectors and Solar Cells.

UNIT II BASIC OPTOELECTRONIC DEVICES **12**

Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –excitonic state–Electro-optics and nonlinear optics: Modulators and switching devices – plasmonics.

UNIT III OPTICAL PROCESSES IN SEMICONDUCTORS **12**

Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells.

UNIT IV OPTICAL AND OPTOELECTRONIC MATERIALS **12**

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

UNIT V OPTICAL PASSIVE AND ACTIVE COMPONENTS **12**

Integrated Optical Passive and Active Components: Case Study on Tunable Filters, Delay-Lines and Switching Circuits in SOI Platform.

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1:Understand the basics concepts of optical system.
CO2:Describe the different optoelectronic devices.
CO3:Understand the fundamental concepts in Semiconducting materials.
CO4:Understand the different optoelectronic materials used.
CO5:Design the integrated optical active and passive components.

TOTAL: 60 PERIODS

TEXT BOOKS

1. C. Kittel, “Introduction to Solid State Physics”, 7th Edition, John Wiley & Sons,Singapore, (2006).
2. Jasprit Singh, “Semiconductor Optoelectronics: Physics and Technology”, McGraw-Hill Education (Indian Edition), 2019.

3. S.C.Gupta, “Optoelectronic Devices and Systems”, Second Edition,2015.

REFERENCE BOOKS

1. Mark Fox, “Optical Properties of Solids”, Oxford Univ.Press, 2001.
2. Pallab Bhattacharya, “Semiconductor Optoelectronic Devices”, Pearson Education,2017.
3. B. Saleh, New York, “Fundamentals of Photonics”, Wiley,1991.
4. R. A. Smith, “Semiconductors”, Cambridge, University Press, 1978.
5. E. Rosencher & B. Vinter, “Optoelectronics”, Cambridge, University Press,2002.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, ‘-’- No correlation

24VL1302 ELECTRONIC DESIGN AUTOMATION TOOLS **L T P C**
3 1 0 4

COURSE OBJECTIVES

- To extend the knowldege on PSpice code for electronics circuits.
- To learn synthesize Verilog and VHDL code and design circuits using verilog.
- To apply the concept of designing and testing in real world scenario.

UNIT I INTRODUCTION TO SCRIPTING LANGUAGE **12**

OS Architecture: System settings and configuration- Introduction to UNIX commands - Handling directories- Filters and Piping- Wildcards -Regular expression- Power Filters - Files Redirection. Working on Vi editor- Basic Shell Programming-TCL Scripting language.

UNIT II DESIGN AND ANALYSIS OF CIRCUITS USING SPICE **12**

Circuit simulation using Spice - circuit description. AC, DC and transient analysis. Advanced spice commands and analysis. Models for diodes, transistors and Opamp. Digital building blocks. A/D, D/A and sample and hold circuits. Design and analysis of mixed signal circuits.

UNIT III SYNTHESIS AND SIMULATION USING HDLS **12**

Synthesis and simulation using HDLs-Logic synthesis using Verilog. Memory and FSM

synthesis. Performance driven synthesis, Simulation- Types of simulation. Static timing analysis. Formal verification. Switch level and transistor level simulation.

UNIT IV INTRODUCTION TO VERILOG **12**

System Verilog- Introduction, Design hierarchy, Data types, Operators and language constructs. Functional coverage, Assertions, Interfaces and test bench structures. Analog/Mixed Signal Modelling and Verification: Analog/Mixed signal modelling using Verilog-A and Verilog-AMS.

UNIT V CASE STUDY USING EDA TOOLS **12**

Designing a High-Speed ADC with EDA Tools, Designing a System-on-Chip (SoC) for a Mobile Device.

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1:Write the scripting language for circuit design using EDA tool.

CO2:Write PSpice code for any electronics circuit and to perform monte-carlo analysis and sensitivity/worst case analysis.

CO3:Design synthesizable Verilog and VHDL code.

CO4:Analyze the designing of circuits using verilog.

CO5:Design and test in real world scenario using EDA tools.

TOTAL:60 PERIODS

TEXT BOOKS

1. H.Gerez, “Algorithms for VLSI Design Automation”, John Wiley, 1999.
2. Z. Dr Mark, “Digital System Design with System Verilog”, Pearson, 2010.
3. Luciano Lavagno, Igor L. Markov, Grant E. Martin, Louis K. Scheffer, “Electronic Design Automation for Integrated Circuits Handbook, Second Edition”, ISBN 9781032339986,2022.

REFERENCE BOOKS

1. Robert Ashby, “Designer's Guide to the Cypress PSoC,Newnes (An imprint of Elsevier)”, 2006.
2. S.Sutherland, S. Davidmann and P. Flake, “System Verilog for Design”, 2nd Edition, Springer, 2006.
3. M.J.S.Smith, “Application Specific Integrated Circuits”,Pearson, 2008.
4. M.H.Rashid, “Introduction to PSpice using OrCAD for circuits and electronics”, Pearson, 2004.
5. O.H. Bailey, “The Beginner's Guide to PSoC”, Express Timelines Industries Inc,2007.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL1303 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY L T P C
3 1 0 4

COURSE OBJECTIVES

- To gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility and electromagnetic shielding effectiveness.
- To understand ways of mitigating EMI by using shielding, grounding and filtering.
- To understand how EMI impacts wireless and broadband technologies.

UNIT I INTRODUCTION & SOURCES OF EM INTERFERENCE 12

Introduction - Classification of sources - Natural sources - Man-made sources - Survey of theelectromagnetic environment.

UNIT II EM SHIELDING 12

Introduction - Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency,magnetic field shielding - Effects of apertures.

UNIT III INTERFERENCE CONTROL TECHNIQUES 12

Equipment screening - Cable screening - grounding - Power-line filters - Isolation - Balancing -Signal-line filters - Nonlinear protective devices.

UNIT IV EMC STANDARDS, MEASUREMENTS AND TESTING 12

Need for standards - The international framework - Human exposure limits to EM fields -EMCmeasurement techniques - Measurement tools - Test environments.

UNIT V EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES 12

Efficient use of frequency spectrum - EMC, interoperability and coexistence - Specifications and alliances - Transmission of high-frequency signals over telephone and power networks – EMC and digital subscriber lines - EMC and power line telecommunications.

Case Study:

1. Investigate various case studies related to EMIC. Example: Chernobyl Disaster in 1986.

2. Develop some understanding about the design of EM shields in electronic system design and packaging.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1:Demonstrate knowledge of the various sources of electromagnetic interference.
CO2:Display an understanding of the effect of how electromagnetic fields.
CO3:Explain the EMI mitigation techniques of shielding and grounding.
CO4:Explain the need for standards and EMC measurement methods.
CO5:Discuss the impact of EMC on wireless and broadband technologies.

TEXTBOOKS

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press,Second Edition, Indian Edition, 2013.
2. Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, Second Edition,2008.
3. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition,2010.

REFERENCE BOOKS

1. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, Newyork,2009.
2. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Interscience Series, 1997.
3. Paolo Stefano Crovetti, "Electromagnetic Interference and Compatibility", Electronics,2021.
4. Reto B. Keller, "Design for Electromagnetic Compatibility--In a Nutshell", Springer,2023.
5. L. Ashok Kumar, Y. Uma Maheswari, "Electromagnetic Interference and Electromagnetic Compatibility Principles, Design, Simulation, and Applications", CRC Press,2024.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'-No Correlation

24VL2301 DATA CONVERTERS **L T P C**
3 1 0 4

COURSE OBJECTIVES

- To teach Analog to Digital and Digital to Analog Converters characteristics.
- To develop the skills to design of Switched Capacitor based Circuits.
- To train the students to design of Analog to Digital and Digital to Analog Converters.

UNIT I INTRODUCTION & CHARACTERISTICS OF AD/DA CONVERTER CHARACTERISTICS **12**

Evolution, Types and Applications of AD/DA Converter Characteristics, Issues in Sampling, Quantization and Reconstruction, Oversampling and Anti-aliasing Filters.

UNIT II SWITCH CAPACITOR CIRCUITS AND COMPARATORS **12**

Switched-Capacitor Amplifiers, Switched Capacitor Integrator, Switched Capacitor Common Mode Feedback. Single Stage Amplifier as Comparator, Cascaded Amplifier Stages as Comparator, Latched Comparators. Offset Cancellation, Op Amp Offset Cancellation, Calibration Techniques.

UNIT III TYPES OF D/A CONVERTERS **12**

Current Steering DACS, Capacitive DACS, Binary Weighted Vs. Thermometer DACS, Issues in Current Element Matching, Clock Feed Through, Zero Order Hold Circuits, DNL, INL and Other Performance Metrics of ADCS and DACS.

UNIT IV PIPELINE AND OTHER ADCS **12**

Performance Metrics, Flash Architecture, Pipelined Architecture, Successive Approximation Architecture, Time Interleaved Architecture.

UNIT V SIGMA DELTA CONVERTERS **12**

First Order and Second Order Sigma Delta Modulator Characteristics.

Case Study:

1. Analyze the architecture, function and application of Analog-Digital converters (A/D) Sigma-Delta showing some simulations using the Simulink software.
2. The use of Artificial Intelligence (AI) to manage the operation and improve the performance of Analog-to-Digital Converters (ADCs) based on Sigma-Delta Modulators.

TOTAL:60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to:

CO1:Analyse the various blocks associated with a typical CMOS AD or DA Converter.
CO2:Design and implement circuits using switched capacitor concepts.
CO3:Analyze and design D/A converters.

CO4:Discuss different types of A/Ds .
CO5:Analyze and design Sigma Delta converter.

TEXT BOOKS

1. Behzad Razavi, "Principles of Data Conversion System Design", IEEE Press,1995.
2. Rudy Van De Plassche, "CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters" Kluwer Acedamic Publishers, Boston, 2003.
3. Franco Maloberti, "Data Converters", Springer, 2007.

REFERENCE BOOKS

1. J. G. Proakis, D. G. Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Prentice Hall, 4th Edition, 2006.
2. Shanthi Pavan, Richard Schreier, Gabor C. Temes , "Understanding Delta-Sigma Data Converters", Willey –IEEE Press, 2nd Edition, 2017.
3. Franco Maloberti, "Data Converters", Springer Science & Business Media, 2007.
4. Walt Kester, Newnes, "The Data Conversion Handbook", Analog-Digital Conversion,2004.
5. Ahmed M. A. Ali, "High Speed Data Converters", ISBN:978-1-84919-938-4,2016.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No Correlation

24VL2302 HARDWARE SOFTWARE CO-DESIGN FOR FPGA **L T P C**
3 1 0 4

COURSE OBJECTIVES

- To acquire the knowledge about system specification and modelling.
- To learn the formulation of partitioning.
- To study the different technical aspects about prototyping and emulation.

UNIT I SYSTEM SPECIFICATION AND MODELLING **12**

Hardware/Software Co-Design, Co-Design for System Specification and Modeling, Co-Design for Heterogeneous Implementation - Processor Synthesis, Single-Processor Architectures with One ASIC, Single-Processor Architectures with Many ASICs.

UNIT II HARDWARE/SOFTWARE PARTITIONING **12**

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

UNIT III HARDWARE/SOFTWARE CO-SYNTHESIS **12**

The Co-Synthesis Problem, State-Transition Graph, Refinement and Controller Generation, Distributed System Co-Synthesis.

UNIT IV PROTOTYPING AND EMULATION **12**

Introduction, Prototyping and Emulation Techniques, Prototyping and Emulation Environments, Future Developments in Emulation and Prototyping, Target Architecture, Architecture Specialization Techniques, System Communication Infrastructure.

UNIT V DESIGN SPECIFICATION AND VERIFICATION **12**

Concurrency, Coordinating Concurrent Computations, Interfacing Components, Verification, Languages for System-Level Specification and Design System-Level Specification.

Case Study:

1. HW/SW Partitioning Based On Heuristic Scheduling and Genetic Algorithms.
2. Illustrate the design flow using single-chip codesign of an Internet video game.

TOTAL:60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Describe The Broad Range of System Architectures and Design Methodologies.
CO2: Discuss the Data flow Models as a State-of-the-Art Methodology.
CO3: Understand in Translating between Software and Hardware descriptions.
CO4: Understand the State-of-The-Art practices in developing Co-Design Solutions.
CO5: Understand the Concurrent Specification from an Algorithms.

TEXT 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. J. H. Reed, Software Radio, Pearson, 2002.

REFERENCE BOOKS

1. Jorgen Staunstrup, Wayne Wolf, "Hardware/Software Co-Design: Principles and Practice", Kluwer Academic Publisher,1997.
2. Giovanni De Micheli, Rolf Ernst Morgon, "Reading in Hardware/Software Co-Design", Kaufmann Publisher,2001.

3. Tsui, Digital Techniques for Wideband receivers, Artech House, 2001.
4. S. K. Mitra, Digital Signal processing, McGrawHill, 1998.
5. U. Meyer – Baese, Digital Signal Processing with FPGAs, Springer, 2004.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL2303 SCRIPTING LANGUAGES FOR ELECTRONIC DESIGN AUTOMATION **L T P C 3 1 0 4**

COURSE OBJECTIVES

- To write scripts in the LINUX environment.
- To study the principles of Scripting Languages like Perl,TCL and Python.
- To write the scripts for automation using the languages like Perl,TCL and Python.

UNIT I LINUX BASICS **12**

Introduction to Linux,File System of Linux,General usuage of Linux Kernel and Basic Commands,Linux users and group,Permissions for File,directory and users,Searching a file and directory,zipping and unzipping concepts.

UNIT II PERL BASICS **12**

History and concepts of PERL,Scalar data,Arrays and List Data,Control Structures,Hashes,Basics I/O,Regular Expressions,Functions,Miscellaneous Control Structures,Formats.

UNIT III TCL BASICS **12**

An overview of TCL and Tk,TCL Language syntax,Variables,Expressions,Lists,Control flow,procedures,Errors and Exceptions,String manipulations.

UNIT IV ADVANCED TOPICS IN PERL **12**

Directory Acesses,File and Directory Manipulation,Process Manipulation,Packages and Modules,Applications of PERL Scripts to Electronic Design Automation.

UNIT V ADVANCED TOPICS IN TCL **12**

Acessing Files and Processes.

Case Study:

1. A Case Study on TCL Language.
2. To study more features of TCL to identify if they strengthen or weaker original design principles.

TOTAL:60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1:Explain and apply commands in LINUX Environment.

CO2:Develop and execute PERL scripts.

CO3:Analyze and handle files, directories and manage process using PERL. CO4:Build TCL scripts to handle files, directories and manage process.

CO5:Develop Python scripts to interpret files and directories.

TEXT BOOKS

1. Guido van Rossum Fred L.Drake,Jr.,editor,Python Tutorial Release 3.2.3,2012,Python Software Foundation.
2. Henry Frankland, "Linux RHEL 6 and above; windows 10", EDA solutions ,2021.
3. Laung-Terng Wang, Yao-Wen Chang and Kwang-Ting (Tim) Cheng, "Electronic Design Automation",Science direct,2009

REFERENCE BOOKS

1. Mark Lutz,Learning Python,2013,5th Edition,O'Reilly Media,Inc.
2. Suman Lata Tripathi, Abhishek Kumar, Jyotirmoy Pathak , "Programming and GUI Fundamentals: TCL-TK for Electronic Design Automation (EDA)", Wiley,2022.
3. Kirti Sikri Desai, "EDA tools and Programming Languages, and Tcl", 1945.
4. Konrad Zuse, "first high-level programming language",1942.
5. Corrado Böhm, "first high-level language to have an associated compiler", 1951.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL2304 LOW POWER VLSI DESIGN **L T P C**
3 1 0 4

COURSE OBJECTIVES

- To provide a comprehensive idea about different sources of power dissipation in VLSI circuits.
- To introduce power estimation methods, understand different power optimization methods and challenges.
- To design a system with multiple supply and threshold voltages applicable for various applications.

UNIT I VARIOUS SOURCES OF POWER DISSIPATION **12**

Importance of Low Power Consumption – Design for Low Power – Deep Submicron and Nanometer MOS Transistors and Models – Sources of Static and Dynamic Power Consumption in MOS Devices New Device Technologies for Reducing Leakage Current – Basics of Power and Energy.

UNIT II ESTIMATE THE POWER OF GIVEN CIRCUIT **12**

Power Optimization during Design Cycle – Architecture – Algorithm and System Levels – Power Optimization of Interconnects and Clocks – Dynamic Voltage Scaling – Clock Distribution – RTL power estimation and optimization – Model granularity – Model parameters – Model semantics – Model storage and Model construction.

UNIT III DESIGN OF LOW POWER DIGITAL VLSI CIRCUIT **12**

Power Optimization in Memories – Power in Cell Arrays – Power for Read and Write Accesses – Low Power Memory Technologies – Standby Power Optimization of Circuits and Systems – Power Optimization of Circuits and Systems during Operation – Low Power Design Methodologies and Flows Power Characterization and Modeling – Low Power Clock – Data and Power Gating – Power Integrity.

UNIT IV LEAKAGE POWER REDUCTION **12**

Leakage power reduction technique- stacking technique, sleepy keeper technique, super cutoff CMOS,VTCMOS, MTCMOS, DTCMOS, - energy constrained and delay constrained. Sleep Transistor design Switch efficiency, area efficiency, IR drop, normal Vs reverse body bias, Inrush current and current Latency, Power gating – course grain and fine grain. Isolation, retention, power down and wake up methods.

UNIT V CASE STUDY- LOW POWER TECHNIQUE AUTOMATION **12**

Low power design techniques automation levels, Power-Aware design flow, Unified power format (UPF): Necessity, UPF Tutorial, Case study:Low power design examples using UPF, Design flow modification with UPF.

TOTAL:60 PERIODS

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1:Understanding about various sources of power dissipation.

CO2:Estimate the power for given circuits.

CO3:Design low power digital VLSI circuits.

CO4:Apply various circuit techniques to optimize the power consumption.

CO5:Analyze and explore the usage of sleep transistors and IP Design for low power.

TEXT BOOKS

1. Jan M. Rabaey, Low Power Design Essentials, Springer, 2009. Christian Piguet, Low-Power CMOS Circuits: Technology, Logic Design a, CRC Press, Taylor and Francis, 2006.
2. RakeshChadha and J. Bhaskar, An ASIC Low Power Primer, Analysis, Techniques and Specification, Springer,2013.
3. Ajit Pal, "Low-Power VLSI Circuits and Systems", Springer 2015.

REFERENCE BOOKS

1. Michael Keating, David Flynn, Robert Aitken, Alan Gibbons and Kaijian Shi,2006.
2. Methodology Manualfor System on Chip,Springer, 2007.
3. Gary K. Yeap, Farid N. Najm, "Low Power Vlsi Design and Technology", World Scientific, 1996.
4. Shilpi Birla, Shashi Kant Dargar, Neha Singh, P. Sivakumar, "Low Power Designs in Nanodevices and Circuits for Emerging Applications", ISBN 9781032412771,2014.
5. Abdellatif Bellaouar,Mohamed I. Elmasry University of Waterloo, "Low-Power Digital Vlsi Design Circuits and Systems",Springer,1995.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL2305 MEMS AND NEMS **L T P C**
3 1 0 4

COURSE OBJECTIVES

- To introduce the concepts of Micro Electro Mechanical devices and fabrication process of microsystems.
- To know the design concepts of micro sensors and micro actuators.
- To familiarize concepts of Quantum Mechanics and Nano systems.

UNIT I OVERVIEW **12**

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

UNIT II MEMS FABRICATION TECHNOLOGIES **12**

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

UNIT III MICRO SENSORS **12**

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

UNIT IV MICRO ACTUATORS **12**

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

UNIT V NANOSYSTEMS AND QUANTUM MECHANICS **12**

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

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1:Discuss micro sensors.
CO2:Explain micro actuators.
CO3:Outline nanosystems and Quantum mechanics.
CO4:Design micro actuators for different applications.
CO5:Analyze atomic structures.

TEXT BOOKS

1. Chang Liu, "Foundations of MEMS", Pearson Education India Limited, 2006.
2. Marc Madou, "Fundamentals of Microfabrication", CRC Press 1997.
3. Stephen D. Senturia," Micro System Design", Kluwer Academic Publishers,2001.

REFERENCE BOOKS

1. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2002.
2. Tai Ran Hsu ,"MEMS and Microsystems Design and Manufacture" ,Tata Mcraw Hill, 2002.
3. Deilang chan, "Nems/Mems technology devices", Scientific.Net,2011.
4. Cornelius T. Leondes, "Mems and Nems handbook techmolgies and applications", Springer,2006.
5. Zhuoqing Yang, "Advanced MEMS/NEMS Fabrication and Sensors", Springer,2022.

Mapping of COs and 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	-	-
AVG	1	-	2	1	2	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL2306 NETWORK ON CHIP **L T P C**
3 1 0 4

COURSE OBJECTIVES

- Understand the concept of Network - on - Chip.
- Learn router architecture designs.
- Study fault tolerance Network - on – Chip.

UNIT I INTRODUCTION TO NOC **12**

Introduction to NOC – OSI Layer Rules in NOC - Interconnection Networks in Network-On-Chip Network Topologies - Switching Techniques - Routing Strategies - Flow Control

Protocol Quality- of-Service Support.

UNIT II ARCHITECTURE DESIGN **12**

Switching Techniques and Packet Format - Asynchronous FIFO Design - GALS Style of Communication - Wormhole Router Architecture Design - VC Router Architecture Design - Adaptive Router Architecture Design.

UNIT III ROUTING ALGORITHM **12**

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

UNIT IV TEST AND FAULT TOLERANCE OF NOC **12**

Design-Security in Networks-On-Chips-Formal Verification of Communications in Networks-On Chips-Test and Fault Tolerance For Networks-On-Chip Infrastructures-Monitoring Services For Networks-On-Chips.

UNIT V THREE-DIMENSIONAL INTEGRATION OF NETWORK-ON-CHIP **12**

Three-Dimensional Networks-On-Chips Architectures – A Novel Dimensionally-Decomposed Router for On-Chip Communication in 3D Architectures - Resource Allocation For QOS On-Chip Communication – Networks-On-Chip Protocols-On-Chip Processor Traffic Modeling For Networks-On-Chip.

TOTAL:60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1:Compare different architecture design.
CO2:Discuss different routing algorithms.
CO3:Explain three dimensional Networks on Chip architectures.
CO4:Test and design fault tolerant NOC.
CO5:Design three dimensional architectures of NOC.

TEXT BOOKS

1. Chrysosto MOSnicopoulos, Vijaykrishnan Narayanan, Chita R.Das “Networks-On - Chip Architectures Holistic Design Exploration”, Springer.
2. Fayezgebali, Haythamelmiligi, Hqhahedwatheq E1-Kharashi “Networks-On-Chips Theory and Practice CRC Press.
3. Kundu, Santanu, Chattopadhyay, Santanu, “Network-on-Chip”, Taylor & Francis,2014.

REFERENCES BOOKS

1. Konstantinos Tatas and Kostas Siozios "Designing 2D and 3D Network-On- Chip Architectures” 2013.
2. Palesi, Maurizio, Masoud “Routing Algorithms in Networks-On-Chip” 2014.
3. Natalie Enright Jerger , Li-Shiuan Peh, “On-Chip Networks”, Springer,2009.

4. Fayez Gebali, "Networks-on-Chips: Theory and Practice", CRC Press, 2011.
5. Subodha Charles, "Design Of Secure And Trustworthy Network-On-Chip Architectures", University Of Florida,2020.

Mapping of COs and 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	-	-
AVG	1	-	1	1	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL2307 NANO TECHNOLOGY **L T P C**
3 1 0 4

COURSE OBJECTIVES

- Provides knowledge of various industrial applications of Nanotechnology.
- Imparting the state of art of nanotechnology to the society and to the environmental implication.
- To exercise the students' knowledge and imagination of Nanoscience and nanotechnology toward engineering applications coupled with detailed justifications.

UNIT I NANOTECHNOLOGY **12**

Background, what is Nanotechnology, types of Nanotechnology and Nano-machines, top down and bottom up techniques, atomic manipulation-Nanodots, semi-conductor quantum dots, self- assembly monolayers, simple details of characterization tools- SEM, TEM, STM, AFM.

UNIT II NANOMATERIALS **12**

Nanomaterials, Preparation of Nanomaterials- solid state reaction method, Chemical Vapor Deposition, SOL-GELS techniques, electrodeposition, ball milling, introduction to lithography, Pulse Laser Deposition (PLD), applications of Nanomaterials.

UNIT III CARBON TUBES **12**

New forms of carbon, carbon tubes-types of Nanotubes, formation of Nanotubes, assemblies, purification of carbon Nanotubes, properties of Nanotubes, applications of Nanotubes.

UNIT IV OPTICS, PHOTONICS AND SOLAR ENERGY **12**

Light and Nanotechnology, interaction of light and Nanotechnology, Nanoholes and photons, solarcells, optically useful Nanostructured polymers, photonic crystals.

UNIT V FUTURE APPLICATIONS **12**

MEMS, Nanomachines, Nanodevices, Quantum Computers, Opto-electronic Devices, Quantum Electronic devices, environmental and biological applications.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students should will be able to:

CO1:Understand the bases for introduction to Nanotechnology.

CO2:Understand the synthesis of Nanomaterials and their application and the impacts.

CO3:Acquire knowledge about various kind of Nano materials.

CO4:Understand the Nanotechnology devices used and their structures.

CO5:Understand and improve the application of Nanotechnology.

TEXT BOOKS

1. Mick Wilson, Kamali Kannangra Geoff Smith, Michelle Simons and Burkhard Raguse,"Nanotechnology-Basic Science and Emerging Technologies", Overseas Press, 2002.
2. Mark Ratner and Daniel Ratner, "Nanotechnology-a Gentle Introduction to The Next Big Idea",Prentice Hall,2003.
3. Bhushan, ""Handbook of Nanotechnology", Springer,2017.

REFERENCE BOOKS

1. Rebecca L Johnson,"Nanotechnology", Lerner Publications,2003.
2. Charles P. Poole Jr., "Introduction to Nanotechnogy", Chapman and Hall/CRS, 2003.
3. Jeremy.J.Remsdon, "Nanotechnology An Introduction", Pearson,2010.
4. Goodard William A, Donald W Brenner, "Handbook of Nanoscience, Engineering, and Technology", CRC Press,2007.
5. Yasir Waheed ,"Core Concept of Nanotechnology with application spectrum", Spectram books,2007.

Mapping of COs and 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	-	-
AVG	1	-	1	1	-	-

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL3301 EVOLVABLE HARDWARE **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To study about the evolvable systems algorithms, multi-objective utility functions.
- Understand the concepts of reliability, design-in redundancy, fault tolerance and defect tolerance.
- Design of evolvable systems using Programmable Logic Devices (like FPGAs) and modular subsystems with identical components and generalized controller algorithms.

UNIT I INTRODUCTION **9**

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

UNIT II EVOLUTIONARY COMPUTATION **9**

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

UNIT III RECONFIGURABLE DIGITAL DEVICES **9**

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

UNIT IV RECONFIGURABLE ANALOG DEVICES **9**

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

UNIT V APPLICATIONS OF EHW **9**

Synthesis vs. Adaptation, designing self-adaptive systems, fault-tolerant systems, real-time systems, intrinsic reconfiguration for online systems, EHW based fault recovery and future work.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students should will be able to

CO1:Understand the fundamentals of computational models and computers.

CO2:Understand the principles of bio-inspired and unconventional computational systems.

CO3:Discuss about the reconfigurable digital architectures and its computational intelligence techniques.

CO4:Discuss about the reconfigurable analog architectures and its computational intelligence techniques.

CO5:Discuss about the typical applications of bio-inspired and other unconventional techniques in the phase of design, implementation and runtime of a computational device.

TEXT BOOKS

1. Garrison W. Greenwood and Andrew M. Tyhrrell, “Introduction to Evolvable Hardware: a Practical Guide for Designing Self- Adaptive Systems”, Wiley-Ieee Press, 2006.
2. Tetsuya Higuchi, Xin Yao and Yong Liu, “Evolvable Hardware”, Springer-Verlag, 2004.
3. David R. W. Smith, "Evolvable Hardware: From Theory to Practice",Springer,2010.

REFERENCE BOOKS

1. Lukas Sekanina, “Evolvable Components: From Theory to Hardware Implementations”, Springer, 2004.
2. Timothy G. W. Gordon, “ Evolving Hardware”, Springer 2005.
3. Martin A. Trefzer , Andy M. Tyrrell, “Evolvable Hardware from Practice to Application”, Springer 2015.
4. Tetsuya Higuchi, Yong Liu, Xin Yao, “Evolvable Hardware”, Spinger,2006.
5. André Macário Barros, Heitor Silvério Lopes, “Encyclopedia of Information Science and Technology, Third Edition”, IGI Global,2015.

Mapping of COs and 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	-	-
AVG	1	-	1	1	-	-

1-Low, 2-Medium, 3-High, ‘-’- No correlation

24VL3302 SOFT COMPUTING AND OPTIMIZATION **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To classify various soft computing frame works.
- To be familiar with the design of neural networks, fuzzy logic, and fuzzy systems.
- To learn mathematical background for optimized genetic programming and be exposed to neuro-fuzzy hybrid systems and its applications.

UNIT I FUZZY LOGIC **9**

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

UNIT II ARTIFICIAL NEURAL NETWORKS **9**

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

UNIT III GENETIC ALGORITHM **9**

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

UNIT IV NEURO-FUZZY MODELING **9**

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

UNIT V CONVENTIONAL OPTIMIZATION TECHNIQUES **9**

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

TOTAL :45 PERIODS

COURSE OUTCOMES

On successive completion of this course, the students will be able to

CO1:Develop application on different soft computing techniques.

CO2:Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.

CO3:Implement machine learning through Neural networks.
CO4:Model Neuro Fuzzy system for clustering and classification.
CO5:Use the optimization techniques to solve the real world problems.

TEXT BOOKS

1. J.S.R.Jang, C.T. Sun and E.Mizutani, Neuro-Fuzzy and Soft Computing, PHI / Pearson Education 2004.
2. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison wesley, 2009.
3. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Applications, Prentice Hall, 1995.

REFERENCE BOOKS

1. Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall, 1998.
2. Simon Haykins, Neural Networks: A Comprehensive Foundation, Prentice Hall International Inc, 1999.
3. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997.
4. James A. Freeman , Neural Networks Algorithms, Applications, Pearson Edn., 2003.
5. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2003.

Mapping of COs and POs

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

1-Low, 2-Medium, 3-High, '-'- No correlation

24VL3303 CAD FOR VLSI DESIGN **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To introduce the VLSI design methodologies, data structures and algorithms required for VLSI design.
- To study algorithms for partitioning, placement, floor planning and routing.
- To study algorithms for modelling, simulation and synthesis.

UNIT I INTRODUCTION **9**

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

UNIT II DATA STRUCTURES AND BASIC ALGORITHMS **9**

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

UNIT III ALGORITHMS FOR PARTITIONING AND PLACEMENT **9**

Layout Compaction – Problem Formulation – Algorithms for Constraint Graph Compaction –Partitioning – Placement – Placement Algorithms.

UNIT IV ALGORITHMS FOR FLOORPLANNING AND ROUTIN **9**

Floor planning – Problem Formulation – Floor planning Algorithms – Routing – Area Routing –Global Routing – Detailed Routing.

UNIT V MODELLING, SIMULATION AND SYNTHESIS **9**

Simulation – Gate Level Modeling and Simulation – Logic Synthesis and Verification – Binary Decision Diagrams – High Level Synthesis.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successive completion of this course, the students should be able to

CO1:Use various VLSI design methodologies.
CO2:Understand different data structures and algorithms required for VLSI design.
CO3:Develop algorithms for partitioning and placement.
CO4:Develop algorithms for floor planning and routing.
CO5:Design algorithms for modelling, simulation and synthesis.

TEXT BOOKS

1. Sabih H. Gerez, “Algorithms for VLSI Design Automation”, Second Edition, Wiley-India, 2017.
2. Naveed a. Sherwani, “Algorithms for VLSI Physical Design Automation”, 3rd Edition, Springer, 2017.
3. R.H. Katz, “Contemporary logic design”, Addison-Wesley Pub. Co., 1993.

REFERENCE BOOKS

1. Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, “Handbook of Algorithms for Physical Design Automation, CRC Press, 1st Edition,
2. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.
3. Ramachandran, “Digital VLSI systems design”, Springer, 2007.

4. M. Sarrafzadeh and C.K. Wong, An introduction to physical design McGraw Hill, 1996.
5. J. Bhasker, Verilog VHDL synthesis: a practical primer, B S Publications, 1998.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	0	1	2	-	-
CO2	1	0	1	2	-	-
CO3	1	0	1	2	2	-
CO4	1	0	1	2	2	1
CO5	1	0	1	2	2	1
AVG	1	0	1	2	2	1

1-Low, 2-Medium, 3-High, '-'- No correlation

24OEMF01 GREEN SUPPLY CHAIN MANAGEMENT **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce the concept and significance of Green Supply Chain Management.
- To equip learners with the knowledge of environmental management practices.
- To develop analytical and strategic skills.

UNIT I INTRODUCTION **9**

Concept and importance of Green Supply Chain Management - Evolution of GSCM: Traditional Supply Chains vs. Green Supply Chains. Environmental Impact, Key Drivers and Challenges in GSCM. Green Procurement and Eco-friendly Sourcing - Life Cycle Assessment (LCA) and its role in GSCM.

UNIT II ENVIRONMENTAL MANAGEMENT IN SUPPLY CHAIN **9**

Environmental Policies and Regulations Impacting Supply Chains - Green Manufacturing. Role of Technology and Innovation in Reducing Environmental Footprints - Eco-labeling and Certifications in Supply Chains - Reverse Logistics and Recycling - Waste Management and Circular Economy Principles - Carbon Footprint Calculation and Reduction Strategies in SCM.

UNIT III GREEN LOGISTICS AND TRANSPORTATION MANAGEMENT **9**

Sustainable Transportation Practices and Eco-friendly Logistics - Green Packaging: Materials, Design, and Processes - Optimizing Distribution and Transportation Networks for Sustainability - Carbon Emissions in Logistics - Energy Efficiency in Transportation - Role of ICT in Greening Transportation Networks - Urban Logistics and Green Infrastructure.

UNIT IV SUSTAINABLE SUPPLY CHAIN DESIGN AND STRATEGY 9

Sustainable Supply Chain Network Design - Supplier Selection and Collaboration for Sustainability. Risk Management - Sustainable Product Design and Eco-innovation. Green Supply Chain Metrics and Performance Indicators - Integration of Environmental and Social Considerations into SCM Strategy - Case Studies.

UNIT V GREEN SUPPLY CHAIN ANALYTICS AND PERFORMANCE MANAGEMENT 9

Data Analytics for Green Supply Chain Management - Tools and Techniques for Evaluating Sustainability in SCM - Environmental and Economic Performance Evaluation in GSCM - Benchmarking and Best Practices in Green SCM - Use of Green Certifications and Standards for Supply Chain Performance - Reporting and Communicating Sustainability in the Supply Chain - Challenges in Monitoring and Managing Green Supply Chains.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students can able to

CO1: Explain the key drivers, challenges, and environmental policies.
CO2: Apply green procurement strategies and life cycle assessment.
CO3: Implement sustainable practices in logistics and transportation.
CO4: Design and manage sustainable supply chain networks.
CO5: Analyze and monitor green supply chain performance.

TEXT BOOKS

1. Wang, Hsiao-Fan & Gupta, Surendra M. Green Supply Chain Management: Product Life Cycle Approach, McGraw-Hill Professional, 2011.
2. Sarkis, Joseph & Dou, Yijie, Green Supply Chain Management: A Concise Introduction, Routledge, 2017.
3. Khan, Mehmood; Hussain, Matloub; Ajmal, Mian M. Green Supply Chain Management for Sustainable Business Practice, IGI Global, 2017.

REFERENCE BOOKS

1. Johnsen, Thomas E.; Howard, Mickey; Miemczyk, Joe, Purchasing and Supply Chain Management: A Sustainability Perspective, Routledge, 2018.
2. Bouchery, Yann; Corbett, Charles J.; Fransoo, Jan C.; Tan, Sustainable Supply Chains: A Research-Based Textbook on Operations and Strategy Springer, 2017.
3. Khan, Syed Abdul Rehman (Ed.), Green Practices and Strategies in Supply Chain Management, Intech Open, 2019.
4. Esty, Daniel C.; Winston, Andrew S. Yale University Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage, Press, 2006.
5. Sarkis, Joseph (Ed.), Handbook of Green Supply Chain Management, CRC Press, 2012.

24OEMF02 RENEWABLE ENERGY TECHNOLOGIES **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the fundamentals and classification of renewable energy sources, their environmental impact, and the current scenario in India.
- To analyze the working principles and characteristics of solar photovoltaic and wind energy systems, including system design and performance factors.
- To explore various alternative renewable energy technologies such as biomass, ocean, hydrogen, fuel cells, and geothermal systems.

UNIT I INTRODUCTION **9**

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

UNIT II SOLAR PHOTOVOLTAICS **9**

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

UNIT III PHOTOVOLTAIC SYSTEM DESIGN **9**

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

UNIT IV WIND ENERGY CONVERSION SYSTEMS **9**

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

UNIT V OTHER RENEWABLE ENERGY SOURCES **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the student will be able to:

CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources.

TEXT BOOKS

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
3. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 2012.

REFERENCE BOOKS

1. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
2. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
3. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
4. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013
5. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.

24OEMF03 MEDICAL ROBOTICS **L T P C**
3 0 0 3

COURSE OBJECTIVES

- Identify and describe different types of medical robots and their potential applications.
- Know basic concepts in kinematics, Dynamics, and control relevant to Medical Robotics.
- Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image guided interventions.

UNIT I INTRODUCTION **9**

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – Stateof art of robotics in the field of healthcare-DICOM.

UNIT II LOCALIZATION AND TRACKING **9**

Position sensors requirements - Tracking - Mechanical linkages - Optical – Sound based - Electromagnetic - Impedance-based - In-bore MRI tracking-Video matching - Fiber optic tracking systems - Hybrid systems.

UNIT III DESIGN OF MEDICAL ROBOTS **9**

Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security.

UNIT IV SURGICAL ROBOTICS **9**

Minimally invasive surgery and robotic integration - surgical robotic sub systems – synergistic control - Control Modes - Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging -Cardiac Surgery – Neurosurgery - case studies.

UNIT V ROBOTS I REHABILITATION AND MEDICAL CARE **9**

Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - Assistive robots – Robots in Physiotherapy - case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the student will be able to:

CO1: Identify various medical robots and their potential applications.
CO2: Recognize the position tracking and hybrid systems.
CO3: Apply Robotics and its concepts in Medical field.
CO4: Simulate a MIS procedure and be aware of the state of art in surgical and oncology robotics.
CO5: Design a medical robotic system given the specific requirements for Rehabilitation and medical care.

TEXT BOOKS

1. Achim Ernst Floris Schweikard, "Medical Robotics", Springer, 2016.
2. Paula Gomes, "Medical robotics Minimally invasive surgery", Woodhead, 2013.
3. Russell H. Taylor, Paolo Dario, Gabor Fichtinger, "Medical Robotics", Springer, 2022.

REFERENCE BOOKS

1. Jaydev P Desai, Rajni V Patel, Antoine Ferreira; Sunil Kumar Agrawal, "The
2. Encyclopedia of Medical Robotics", World Scientific Publishing Co. Pvt. Ltd, 2019.
3. Jocelyne Troccaz , "Medical Robotics", John Wiley & Sons Incorporated, 2013.
4. Vanja Bonzovic , "Medical Robotics", I-tech Education publishing, Austria, 2008.
5. Farid Gharagozloo "Robotic Surgery", Springer, 2022.

24OEMF04 TEXTILE REINFORCED COMPOSITES **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- Describe the role and properties of reinforcements in composite materials.
- Explain the difference between thermoset and thermoplastic matrices in composites.
- List and briefly explain two mechanical tests used for evaluating composite materials.

UNIT I REINFORCEMENTS **9**

Introduction – composites –classification and application; reinforcements- fibres and its

properties; preparation of reinforced materials and quality evaluation; preforms for various composites.

UNIT II MATRICES **9**

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices.

UNIT III COMPOSITE MANUFACTURING **9**

Classification; methods of composites manufacturing for both thermoplastics and hermosetsHand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post rocessing of composites and composite design requirements.

UNIT IV TESTING **9**

Fibre volume and weight fraction, specif ic gravity of composites, tensile, f lexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS **9**

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical Lamination theory, failure theories and prediction of inter laminar stresses using at ware.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the student will be able to:

CO1: Compare the different types of textile reinforcements.
CO2: Explain the different types of matrices.
CO3: Explore the manufacturing of composites.
CO4: Evaluation of the properties of thermoset and thermoplastic composite.
CO5: Discuss the mechanics of composites failure.

TEXT BOOKS

1. Bor Z.Jang,“Advanced Polymer composites”,ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., “Experimental Characterization of advanced composite Materials”,Second Edition,CRCPress,NewJersey,1996.
3. K. K. Chawla, "Composite Materials: Science and Engineering", Springer, 2012.

REFERENCE BOOKS

1. George LubinandStanley T.Peters, “Handbook of Composites”, Springer Publications,1998.
2. Mel. M. Schwartz, “Composite Materials”, Vol. 1 &2, Prentice Hall PTR, New Jersey, 1997.
3. RichardM.Christensen, “Mechanicsof compositematerials”, Dover Publications, 2005.

4. Sanjay K. Mazumdar, “Composites Manufacturing: Materials, Product, and Process Engineering”, CRC Press,2001.
5. Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, 2005.

24OEMF05 NANO COMPOSITE MATERIALS **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To explore the difficulties, fabrication technologies and properties of nano composite materials.
- To gain knowledge on Nano materials.
- To get familiarize in synthesis of nano materials.

UNIT I CERAMIC-BASED NANOCOMPOSITES **9**

Composites – nomenclature, properties; classification of ceramic nanocomposites; challenges with bulk nanoceramics/Nano ceramic composites; problems associated with synthesis of nanosize powders – chemical /physical methods of synthesis of nanoscaled ceramic powders, challenges posed by the typical properties of nanoscaled powders, Challenges faced during processing/ sintering; various processing techniques, spark plasma sintering; properties of nanoceramics – hardness, tensile; superplasticity – superplastic forming applications; superhard nanocomposites – properties, bottle neck, industrial applications.

UNIT II METAL-BASED NANOCOMPOSITES **9**

Processing of metal-matrix nanocomposites – liquid metallurgy processing techniques, thermal spray techniques, cold spray, powder metallurgy (PM) techniques, difficulties, applications of metal matrix nanocomposites – Cu–Ni alloy nanocomposites, magnesium metal–matrix nanocomposites- implants, titanium nanocomposites; fractal-based glass-metal nanocomposites, its designing and fractal dimension analysis; core–shell structured nanocomposites; bio-medical imaging, environmental remediation applications, semiconductor core–shell nanomaterials, heterojunction photo catalyst.

UNIT III POLYMER-BASED NANOCOMPOSITES **9**

Block copolymer nanocomposites – features, advantage over homopolymer composites; fundamentals of block copolymer; nanoparticle co-assembly; particle–polymer enthalpic interactions; particle surface chemistry – grafting suitable polymeric ligands, entropic interactions, mechanism of nanoparticle incorporation; applications of block copolymers nanocomposites – Textile fabric, bulk heterojunction (BHJ) organic photovoltaic (solar cell) devices, drug delivery; polymer and carbon nanotube–based composites, their mechanical properties, and industrial possibilities.

UNIT IV BIOMEDICAL NANOCOMPOSITES **9**

Natural nanocomposite systems – spider silk, bones, shells; ceramic nanocomposites – biomedical applications; toughening mechanisms; alumina and zirconia ceramics, alumina–zirconia nanocomposites; tooth nanocomposites and dental implants; organic–inorganic

nanocomposite formation through self-assembly; biomimetic synthesis of nanocomposites material.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures – preparation and applications; nanotechnology in textiles and cosmetics; nano-fillers embedded polypropylene fibers – soil repellency, lotus effect; nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame-retardant finishes); sun-screen dispersions for UV protection using titanium oxide – colour cosmetics; nanotechnology in food technology – nanopackaging for enhanced shelf life, smart/intelligent packaging.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the student will be able to:

CO1: Explain the fabrication technologies, properties and drawbacks of ceramic nanocomposites.

CO2: Explain the fabrication technologies, properties and drawbacks of metal matrix nanocomposites.

CO3: Explain the fabrication technologies, properties and drawbacks of block copolymer Nano composites.

CO4: Comprehend biomimicry and evaluate them in load bearing arena for bone tissue engineering.

CO5: Design nanocomposite materials for engineering applications.

TEXT BOOKS

1. Twardowski T.E., “Introduction to nanocomposite materials: properties, processing, characterization”, DES Tech Publications, USA, 2007.
2. Ajayan P.M., Schadler L.S. and Braun P.V., “Nanocomposites science and technology”, 2006.
3. Tsuji, Nobuo, "Nano Structured Metals and Alloys: Processing, Microstructure, Mechanical Properties and Applications", Woodhead Publishing, 2011.

REFERENCE BOOKS

1. Sadasivuni K.K., Ponnamma D., Rajan M., Ahmed B. and Al-Maadeed M.A.S.A., “Polymer nanocomposites in biomedical engineering”, Springer Nature, Switzerland, 2019.
2. Basu B. and Balani K., “Advanced structural ceramics”, John Wiley & Sons, 2011.
3. Brown P. and Stevens K., “Nanofibers and nanotechnology in textiles”, Woodhead publication, London, 2006.
4. Rakesh K. Gupta, "Polymer and Composite Nanotechnology: Synthesis and Applications", DEStech Publications, 2012.
5. Sabu Thomas, Shaijumon Manayil Jacob, Deepalekshmi Ponnamma, "Nanocomposite Materials: Synthesis, Properties and Applications", Wiley-VCH, 2020.

24OEMF06 NEW PRODUCT DESIGN AND DEVELOPMENT **L T P C**
3 0 0 3

COURSE OBJECTIVE

- The course aims at providing the basic concepts of product design, product features.
- Architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.
- To gain knowledge for business opportunity.

UNIT I INTRODUCTION **9**

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

UNIT II CONCEPT GENERATION AND SELECTION **9**

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT III PRODUCT ARCHITECTURE **9**

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

UNIT IV INDUSTRIAL DESIGN **9**

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT **9**

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the student will be able to:

CO1: Explain the significance of product development and the integration of customer, designer, supplier, and process planner in IPPD.
CO2: Apply structured methods to generate, explore, and evaluate innovative product concepts effectively.
CO3: Analyze product architecture and its impact on design, manufacturability, variety, and system-level interactions.
CO4: Evaluate the role of industrial design in product development, integrating tools and customer needs to enhance usability and performance.
CO5: Demonstrate principles of design for manufacturing, cost estimation, prototyping, and economic analysis to ensure efficient product development.

TEXT BOOK

1. Kari T.Ulrich and Steven D.Eppinger, ”Product Design and Development”, McGraw-Hill International Edns. 1999.
2. Kevin Otto, Kristin Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Pearson Education, 2001.
3. Anil Mital, Anoop Desai, Anand Subramanian, Aashi Mital, "Product Development: A Structured Approach to Design and Manufacture", Elsevier, 2008

REFERENCE BOOKS

1. Kemnneth Crow, “Concurrent Engg./Integrated Product Development”, DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal, “Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh, “Tool Design –Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, New york, NY.
4. Michael Luchs, Scott Swan, Abbie Griffin, "Design Thinking: New Product Development Essentials from the PDMA", Wiley, 2015.
5. Don Norman, "The Design of Everyday Things", Basic Books, 2013.

24OEPE01 ELECTRIC VEHICLE TECHNOLOGY **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the architecture and social importance of Electric Vehicles.
- To develop the knowledge about batteries used in Electric Vehicles.
- To design the motor and converters for Electric Vehicles.

UNIT I NEED FOR ELECTRIC VEHICLES **9**

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges.

UNIT II ELECTRIC VEHICLE ARCHITECHTURE **9**

Electric vehicle types, layout and power delivery, performance – traction motor characteristics,tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts ofhybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits anddemerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electricvehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE **9**

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries,electrochemical reactions, thermodynamic voltage, specific energy, specific power, energyefficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel.

UNIT IV ELECTRIC DRIVES AND CONTROL **9**

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DCmotor drives and control, Induction motor drives and control, PMSM and brushless DC motor -drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency –Inverters – DC and AC motor speed controllers.

UNIT V DESIGN OF ELECTRIC VEHICLES **9**

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing,

component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equationof vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance,rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safetyand challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, andRenault Zoe cars.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Explain the basic of electric vehicle history and components.
CO2: Explore the properties of batteries.
CO3: Enumerate the electrical machine properties and classifications.
CO4: Explain the properties of electric vehicle drives systems.
CO5: Design the motor sizing of hybrid electric vehicles.

TEXT BOOKS

1. A.K. Babu, Khanna Publishing House, Electric & Hybrid Vehicles New Delhi, 2018.
2. Iqbal Hussain, Electric & Hybrid Vehicles – Design Fundamentals , Second Edition, CRCPress, 2011.
3. Electric Vehicle Battery Systems – Sandeep Dhameja, Newnes, 2000.

REFERENCE BOOKS

1. Deshpande.M. V. PHI Learning Pvt. Ltd., 2010, Design and Testing of Electrical Machines.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric AndFuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory AndDesign", CRC Press, 2005.
5. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals – Mehrdad Ehsani,Yimin Gao, Ali Emadi, CRC Press, 2010.

24OEPE02 RENEWABLE ENERGY SYSTEMS **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To understand the different types of renewable energy technologies.
- To explain Standalone operation, grid connected operation of renewable energy systems.
- To design the structure of PV system.

UNIT I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS **9**

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

UNIT II SOLAR PHOTOVOLTAICS **9**

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

UNIT III DESIGN OF PV SYSTEM **9**

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

UNIT IV WIND ENERGY CONVERSION SYSTEMS **9**

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Verticalaxis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-

Solidity-Blade Count-Powercurve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type Cand Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG basedWECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources.

TEXT BOOKS

1. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
2. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
3. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013

REFERENCE BOOKS

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford UniversityPress,2009.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and
5. Applications”, PHI Learning Private Limited, 2012.
6. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006.

24OEPE03 POWER SEMICONDUCTOR DEVICES **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the function of Power switching devices.
- To analyze characteristics of current controlled and voltage-controlled devices.
- To design the protection circuits.

UNIT I INTRODUCTION **9**

Power switching devices overview – Attributes of an ideal switch, application requirements ,circuit symbols; Power handling capability – (SOA); Power diodes – Types,

forward and reverse characteristics, switching characteristics – rating. Features and Brief History of Silicon Carbide-Promise and Demonstration of SiC Power Devices- Physical Properties of Silicon Carbide devices–Unipolar and Bipolar Diodes- GaN Technology Overview.

UNIT II CURRENT CONTROLLED DEVICES **9**

BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and second breakdown; - Thyristors – Construction, working, static and transient characteristics, types, series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT &Thyristor- Basics of GTO, SiC based Bipolar devices-Applications- Building a GaN Transistor – GaN Transistor Electrical Characteristics.

UNIT III VOLTAGE CONTROLLED DEVICES **9**

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs –and IGCT. New semiconductor materials for devices – Intelligent power modules - study of moduleslikeAPTGT100TL170G, MSCSM70TAM05TPAG. Integrated gate commutated thyristor (IGCT) –SiC based unipolar devices-applications.

UNIT IV DEVICE SELECTION, DRIVING AND PROTECTING CIRCUITS **9**

Device selection strategy – On-state and switching losses – EMI due to switching. Necessity of isolation, pulse transformer, optocoupler – Gate drive integrated circuit: Study of Driver IC – IRS2110/2113. SCR, MOSFET, IGBTs and base driving for power BJT. – Over voltage, over currentand gate protections; Design of snubbers.

UNIT V THERMAL PROTECTION **9**

Heat transfer – conduction, convection and radiation; Cooling – liquid liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance –Electrical analogy of thermal components, heat sink types and design – Mounting types- switching loss calculation for power device.

TOTAL : 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Identify suitable device for the application and to learn the characteristics of voltage and current controlled power devices.

CO2: Explore the significance of Silicon Carbide devices and Galium Nitride devices.

CO3: Explain the principles and characteristics of Silicon devices, Silicon Carbide devices and Galium Nitride devices.

CO4: Design proper driving circuits and protection circuits.

CO5: Construct a proper thermal protective devices for power semiconductor devices.

TEXT BOOKS

1. Biswanath Paul, "Power Electronics", Universities Press 2019.

2. L. Umanand, “Power Electronics Essentials and Applications”, Wiley India Ltd., 2009.
3. Muhammad H. Rashid , “Power Electronics Handbook”, Elsevier, 3rd ed., 2011.

REFERENCE BOOKS

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications “, Pearson, Fourth Edition, 2021.
2. Ned Mohan, Undeland and Robins, “Power Electronics: Converters Applications and
3. Design”, Media Enhanced Third Edition, Wiley, 2007.
4. Tsunenobu Kimoto and James A. Cooper, “Fundamentals of Silicon Carbide Technology: Growth, Characterization, Devices, and Applications”, First Edition, 2014 John Wiley & Sons, Singapore Pte Ltd.
5. Alex Lidow, Johan Strydom, Michael de Rooij, David Reusch, “GaN Transistors for efficient power conversion”, Second Edition, Wiley, 2015.

24OEPE04 ENERGY STORAGE TECHNOLOGIES **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To understand the various types of energy storage Technologies.
- To develop the design of thermal storage system.
- To understand the thermodynamics of Fuel Cell.

UNIT I INTRODUCTION **9**

Necessity of energy storage – types of energy storage –energy storage technologies – Applications.

UNIT II THERMAL STORAGE SYSTEM **9**

Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – Pressurized water storage system – Modelling of phase change storage system – Simple units, Packed bed storage units - Modelling using porous medium approach.

UNIT III ELECTRICAL ENERGY STORAGE **9**

Fundamental concept of batteries – Measuring of battery performance, charging and dis charging of a battery, storage density, energy density, and safety issues - Types of batteries: – Lead Acid, Nickel-Cadmium, Zinc-Manganese dioxide - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT IV FUEL CELL **9**

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types: Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, Alkaline fuel cell -Detailed analysis – Advantages and disadvantages –Fuel Cell Thermodynamics.

UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES **9**

Flywheel, Super capacitors, Principles& Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Explore of various storage technologies.
CO2: Discuss the mechanical storage system.
CO3: Analysis analysis of Various Battery Energy Storage System.
CO4: Analyze the operation of fuel cell.
CO5: Compare various types of alternate storage technologies.

TEXT BOOKS

1. Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011).
2. Ralph Zito, Energy storage: A new approach, Wiley (2010).
3. Robert A. Huggins, Energy storage, Springer Science & Business Media (2010).

REFERENCE BOOKS

1. David Linden, Thomas B.Reddy, "Handbook of Batteries", Third Edition, Tata Mc-Graw Hill,2002.
2. James Larminie, Andrew Dicks, "Fuel cell Systems Explained", Third Edition, Wiley, 2018.
3. Ru-Shi Liu, Lei Zhang and Xueliang Sun, "Electrochemical Technologies for Energy Storage and Conversion", First Edition, Wiley, 2012.
4. P.Jayarama Reddy, "Principles of Energy Storage Systems", BS Publications, Hyderabad,First Edition, 2022.
5. G.D.Rai, "Non-Conventional Energy Sources", VI Edition Khanna Publishes, First Edition, 2017.

24OEPE05 CONTROL SYSTEM DESIGN **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To analyze the models of various linear systems.
- To design the compensators and controllers for SISO systems.
- To design state space forms to continuous and discrete systems.

UNIT I ANALYSIS OF LINEAR SYSTEMS **9**

Review of system models –Transfer function and state space form– Time and Frequency Response – stability- Discretization –Need for Discretization –Sample and Hold devices – Effect of sampling on transfer function and state models – Analysis – Test for controllability and Observability.

UNIT II DESIGN OF SISO SYSTEM **9**

Design Specifications –In continuous domain – Limitations – Controller Structure –

Multiple degrees of freedom – PID controllers and Lag-lead compensators-Design – Discretization and direct discrete design - Design in continuous and discrete domain.

UNIT III STATE SPACE DESIGN **9**

Pole assignment design – State and Output Feedback – observers – Estimated State Feedback – Design Examples (Continuous and Discrete).

UNIT IV OPTIMAL CONTROL **9**

Introduction: Classical control and optimization, formulation of optimal control problem, Typical performance measures – Linear quadratic regulator problem – solution – Application examples.

UNIT V OPTIMAL FILTERING **9**

Filtering – Linear system and estimation – System noise smoothing and prediction – Kalman Filter –Recursive estimation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Analyze controllers for linear systems defined in transfer function and state space forms.

CO2: Design controllers for sisco systems defined in transfer function and state space forms.

CO3: Apply state space forms to continuous and discrete systems.

CO4: Apply optimal control to linear systems in continuous and discrete systems

CO5: Apply filtering concepts to linear systems in continuous and discrete systems.

TEXT BOOKS

1. M.Gopal, "Digital Control and State Variable Methods", 4th edition, McGraw Hill India,2012.
2. K. Ogata, 'Modern Control Engineering', 5th Edition, Pearson, 2012.
3. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.

REFERENCE BOOKS

1. M.Gopal, Modern Control System Theory, 3rd edition, New Age International Publishers, 2014.
2. William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Taylor and Francis Group, 2011.
3. AshishTewari, 'Modern Control Design with Matlab and Simulink', John Wiley, New Delhi, 2002.
4. T. Glad and L. Ljung, "Control Theory –Multivariable and Non-Linear Methods", Taylor & Francis, 2002.

5. M. Chidambaram and R. Padma Sree, “Control of Unstable Single and Multim Variable Systems”,Narosa Publishing, 2017.

24OEPE06 ENERGY MANAGEMENT AND AUDITING **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To study the concepts behind economic analysis and load management.
- To emphasize the energy management of various electrical equipment and metering.
- To illustrate the concept of energy management technologies.

UNIT I ENERGY SCENARIO **9**

Basics of Energy and its various forms - Conventional and non-conventional sources – Energy policy - Energy conservation act 2001, Amedments (India) in 2010 - Need for energy management- Designing and starting an energy management program - Energy managers and energy auditors - Roles and responsibilities of energy managers - Energy labelling and energy standards.

UNIT II ENERGY COST AND LOAD MANAGEMENT **9**

Important concepts in an economic analysis - Economic models-Time value of money-Utility rate structures- Cost of electricity-Loss evaluation- Load management: Demand control techniques-Utility monitoring and control system-HVAC and energy management-Economic justification.

UNIT III ENERGY MANAGEMENT **9**

Demand side management (DSM)– DSM planning – DSM techniques – Load management as a DSM strategy – Energy conservation – Tariff options for DSM.

UNIT IV ENERGY AUDITING **9**

Definition – Energy audit methodology: audit preparation, execution and reporting – Financial analysis – Sensitivity analysis – Project financing options - Instruments for energy audit – Energy audit for generation, distribution and utilization systems – Economic analysis.

UNIT V ENERGY EFFICIENT TECHNOLOGIES **9**

Energy saving opportunities in electric motors - Power factor improvement benefit and techniques-Shunt capacitor, Synchronous Condenser and Phase Advancer - Energy conservation in industrial drives, electric furnaces, ovens and boilers - Lighting techniques: Natural, CFL, LED lighting sources and fittings.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Explore the present energy scenario and role of energy managers.
CO2: Comprehend the Economic Models for cost and load management.
CO3: Configure the Demand side energy management through its control.
CO4: Discuss the process of energy auditing.
CO5: Analyse the energy level of industrial electrical systems.

TEXT BOOKS

1. Anil Kumar, Om Prakash, Prashant Singh Chauhan "Energy Management: Conservation and Audits, CRC Press, 2020.
2. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy Management", CRC press, Taylor & Francis group, Eighth Edition, 2016.
3. S.C. Bhatia and Sarvesh Devraj, "Energy Conservation", Woodhead Publishing India Pvt. Ltd, 2016.

REFERENCE BOOKS

1. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy Management", CRC press, Taylor & Francis group, Eighth Edition, 2016.
2. https://prsindia.org/files/bills_acts/bills_parliament/2010/The_Energy_Conservation_Amendment_Bill_2010.pdf.
3. Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1990.
4. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
5. Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003. https://www.eeeguide.com/power-factor-improvement.

24OECS01 SPEECH SIGNAL PROCESSING **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals of the speech processing.
- Gather knowledge about the phonetics and pronunciation processing.
- To understand the concepts of speech recognition.

UNITI INTRODUCTION **9**

Introduction - Knowledge in Speech and Language Processing - Ambiguity - Models and Algorithms - Language - Thought - Understanding - Regular Expression and Automata - Words & Transducers — N grams.

UNIT II SPEECH MODELING **9**

Word Classes and Part of Speech Tagging — Hidden Markov Model — Computing Likelihood: The Forward Algorithm – Training Hidden Markov Model – Maximum Entropy Model – Transformation - Based Tagging – Evaluation and Error Analysis – Issues in Part of Speech Tagging – Noisy Channel Model for Spelling.

UNIT III SPEECH PRONUNCIATION AND SIGNAL PROCESSING **9**

Phonetics - Speech Sounds and Phonetic Transcription - Articulatory Phonetics – Phonological Categories and Pronunciation Variation - Acoustic Phonetics and Signals - Phonetic Resources - Articulatory and Gestural Phonology.

UNIT IV SPEECH IDENTIFICATION **9**

Speech Synthesis - Text Normalization - Phonetic Analysis - Prosodic Analysis – Diphone Wave Form Synthesis Unit Selection Waveform Synthesis – Evaluation.

UNIT V SPEECH RECOGNITION **9**

Automatic Speech Recognition - Architecture - Applying Hidden Markov Model - Feature Extraction: MFCC Vectors - Computing Acoustic Likelihoods - Search and Decoding - Embedded Training – Multi-pass Decoding: N-Best Lists and Lattices- a* (_stack) Decoding - Context-Dependent Acoustic Models: Triphones - Discriminative Training - Speech Recognition by Humans.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Create new algorithms with speech processing.
CO2: Derive new speech models.
CO3: Perform various language phonetic analysis.
CO4: Create a new speech identification system.
CO5: Generate a new speech recognition system.

TEXT BOOKS

1. Daniel Jurafsky and James H. Martin, ― Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition‖, Person education,2013.
2. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition 2/e Paperback – 1 January 2013 by Jurafsky / Martin (Author).
3. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice (Prentice-Hall Signal Processing Series) 2001.

REFERENCE BOOKS

1. Kai-Fu Lee, ―Automatic Speech Recognition‖, The Springer International Series in Engineering and Computer Science, 1999.
2. Himanshu Chaurasiya, ―Soft Computing Implementation of Automatic Speech Recognition‖, LAP Lambert Academic Publishing, 2010.
3. Claudio Becchetti, Klucio Prina Ricotti, ―Speech Recognition: Theory and C++ implementation‖, Wiley publications 2008.
4. Ikrami Eldirawy , Wesam Ashour, ―Visual Speech Recognition‖, Wiley publications , 2011.
5. Discrete-Time Speech Signal Processing: Principles And Practice Paperback – 1 January 2003 By Quatieri.

24OECS02 DIGITAL FORENSICS **L T P C**
3 0 0 3

COURSE OBJECTIVES

- Understand the basics of wireless technologies and security.
- Learn the methods of investigation using digital forensic techniques.
- Identify and explain at least three current issues in the practice of digital forensic investigations.

UNIT I INTRODUCTION **9**

Overview of wireless technologies and security: Personal Area Networks, Wireless Local Area Networks, Metropolitan Area Networks, Wide Area Networks. Wireless Threats, Vulnerabilities and Security: Wireless LANs, War Driving, Warchalking, War Flying, Common Wi-fi Security Recommendations, PDA Security, Cell Phones and Security, Wireless DoS attacks, GPS Jamming, Identity Theft.

UNIT II CONFIDENTIALITY, INTEGRITY, AVAILABILITY TRIAD IN MOBILE **9**

Confidentiality, Integrity, Availability (CIA) TRIAD in Mobile Phones-Voice, SMS and Identification Data Interception in GSM: Introduction, Practical Setup and Tools, Implementation- Software and Hardware Mobile Phone Tricks: Net Monitor, GSM Network Service Codes, Mobile Phone Codes, Catalog Tricks and AT Command Set- SMS Security Issues.

UNIT III MOBILE PHONE FORENSICS **9**

Mobile Phone Forensics: Crime And Mobile Phones, Evidences, Forensic Procedures, Files Present in Sim Card, Device Data, External Memory Dump, Evidences in Memory Card, Operator Systems- Android Forensics: Procedures for Handling an Android Device, Imaging Android USB Mass Storage Devices, Logical and Physical Techniques.

UNIT IV DIGITAL FORENSICS **9**

Digital Forensics: Introduction – Evidential Potential of Digital Devices: Closed vs. Open Systems, Evaluating Digital Evidence Potential- Device Handling: Seizure issues, Device Identification, Networked Devices and Contamination.

UNIT V DIGITAL FORENSICS EXAMINATION PRINCIPLES **9**

Digital Forensics Examination Principles: Previewing, Imaging, Continuity, Hashing and Evidence Locations- Seven Element Security Model- Developmental Model of Digital Systems- Audit and Logs Evidence Interpretation: Data Content and Context.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explore the basics of mobile and digital security.
CO2: Explain mobile phone forensics and android forensics.
CO3: Analyze issues in Digital forensics.
CO4: Analyze the common data privacy techniques.
CO5: Examine and analyze Digital forensics techniques.

TEXT BOOKS

1. Gregory Kipper, "Wireless Crime and Forensic Investigation", Auerbach Publications, 2007.
2. Iosif I. And Roulidakis, "Mobile Phone Security and Forensics: A Practical Approach", Springer publications, Second Edition, 2016.
3. Andrew Hoog, "Android Forensics: Investigation, Analysis and Mobile Security for Google Android", Elsevier publications, 2011.

REFERENCE BOOKS

1. Digital Forensics, Andre Arnes, John Wiley and Sons U.S.A. 2017.
2. The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics Paperback – Import, April 2012 by John Sammons (Author).
3. Cyber Forensics Paperback – 1 June 2018 by Dejey (Author), Murugan (Author).
4. Hand book of Digital Forensics and Investigation Book, 2010.
5. Digital Forensics Dr. Jeetendra Pande, Dr. Ajay Prasad, Uttarakhand Open University, 2016.

24OECS03 IT AND AGRICULTURAL SYSTEM **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To introduce the students to areas of agricultural systems in which IT and computers play a major role.
- To also expose the students to IT applications in precision farming, environmental control systems, agricultural systems management and weather prediction models.
- To enable students with the intense knowledge of sustainable production system without damaging environment.

UNIT I PRECISION FARMING **9**

Precision Agriculture and Agricultural Management – Ground Based Sensors, Remote Sensing, GPS, GIS and Mapping Software, Yield Mapping Systems, Crop Production Modeling.

UNIT II ENVIRONMENT CONTROL SYSTEMS **9**

Artificial Light Systems, Management of Crop Growth in Greenhouses, Simulation of CO_2 Consumption in Greenhouses, On-Line Measurement of Plant Growth in the Greenhouse, Models of Plant Productionand Expert Systems in Horticulture.

UNIT III AGRICULTURAL SYSTEMS MANAGEMENT **9**

Agricultural Systems - Managerial Overview, Reliability of Agricultural Systems, Simulation of Crop Growth and Field Operations, Optimizing the Use of Resources, Linear Programming, Project Scheduling, Artificial Intelligence and Decision Support Systems.

UNIT IV WEATHER PREDICTION MODELS **9**

Importance of climate variability and seasonal forecasting, Understanding and Predicting World's Climate System, Global Climatic Models and Their Potential for Seasonal Climate Forecasting, General Systems Approach to Applying Seasonal Climate Forecasts.

UNIT V E-GOVERNANCE IN AGRICULTURAL SYSTEMS **9**

Expert Systems, Decision Support Systems, Agricultural and Biological Databases, E-Commerce, E- Business Systems & Applications, Technology Enhanced Learning Systems and Solutions, E-Learning,Rural Development and Information Society.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1:Apply IT in remote sensing applications such as Drones etc.
CO2:Explore the greenhouse automation and its advantages.
CO3:Apply IT principles and concepts for management of field.
CO4:Explore about weather models, their inputs and applications.
CO5:Apply IT in e-governance in agriculture.

TEXTBOOKS

1. National Research Council, "Precision Agriculture in the 21st Century", National AcademiesPress, Canada, 1997.
2. H. Krug, Liebig, H.P. "International Symposium on Models for Plant Growth, EnvironmentalControl and Farm Management in Protected Cultivation", 1989.
3. Peart, R.M., and Shoup, W. D., "Agricultural Systems Management", Marcel Dekker, NewYork, 2004.

REFERENCE BOOKS

1. Hammer, G.L., Nicholls, N., and Mitchell, C., "Applications of Seasonal Climate", Springer, Germany, 2000.
2. Agricultural Systems, Agroecology and Rural Innovation for Development Book - Second Edition - 2017.
3. It In Agricultural System, Dr. C.R. Balamurugan, N. Ramadevi, Dr. S. Sathya.
4. An Introduction to Agricultural Systems Springer; 2nd ed. 1988. Softcover reprint of the original 2nd ed. 1988 edition (12 February 2012); 01149344934.
5. IT in Agricultural System by Pranjali S. Bahalkar (Author), Dr. Mithra Venkatesan (Author), Dr. Shubhangi Suryavanshi (Author).

24OECS04 MACHINE LEARNING **L T P C**

3 0 0 3

COURSE OBJECTIVES

- Understand fundamental concepts of machine learning and its applications.
- Learn various supervised and unsupervised learning algorithms.
- Explore emerging trends and ethical considerations in machine learning.

UNIT I INTRODUCTION TO MACHINE LEARNING **9**

Definition and Types of Learning – Supervised, Unsupervised, Semi-supervised and Reinforcement Learning – Applications of Machine Learning – Steps in Developing ML Models – Hypothesis Space and Inductive Bias – Performance Evaluation Metrics: Confusion Matrix, Accuracy, Precision, Recall, F1 Score, ROC-AUC.

UNIT II SUPERVISED LEARNING ALGORITHMS **9**

Linear Regression – Gradient Descent – Logistic Regression – k-Nearest Neighbors – Decision Trees – Random Forest – Support Vector Machines – Bias-Variance Tradeoff – Overfitting and Underfitting – Cross-validation.

UNIT III UNSUPERVISED LEARNING **9**

Clustering: k-Means, Hierarchical Clustering, DBSCAN – Dimensionality Reduction: PCA, t-SNE – Association Rule Mining: Apriori, FP-Growth – Evaluation of clustering: Silhouette Score, Davies–Bouldin index.

NIT IV NEURAL NETWORKS AND DEEP LEARNING BASICS **9**

Perceptron – Multilayer Perceptron (MLP) – Activation functions – Backpropagation – Basics of Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) – Applications in image and sequence data.

UNIT V ADVANCED TOPICS AND APPLICATIONS **9**

Ensemble Learning: Bagging, Boosting, AdaBoost, Gradient Boosting – Introduction to Reinforcement Learning – Basics of Natural Language Processing (NLP) – Model Deployment concepts – Introduction to MLOps – Ethics and fairness in ML.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Evaluate ML models and demonstrate ethical awareness in deploying AI systems
CO2: Explain the basic concepts, types and applications of machine learning.
CO3: Apply appropriate supervised learning techniques to solve Classification/regression problems.
CO4: Implement and interpret unsupervised algorithms for clustering and pattern discovery.
CO5: Design simple neural network models and understand their applications.

TEXT BOOKS:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill Education.
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly, 2nd Edition.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.

REFERENCE BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press.
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press.
3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.
4. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms, Publisher: Cambridge University Press.
5. Andriy Burkov, The Hundred-Page Machine Learning Book,Publisher: Andriy Burkov Publications / Amazon Kindle Direct Publishing.

24OECS05 IoT FOR SMART SYSTEMS **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To study about Internet of Things technologies and its role in real time applications.
- To familiarize the accessories and communication techniques for IoT.
- To provide insight about the embedded processor and sensors required for IoT.

UNIT I INTRODUCTION TO INTERNET OF THINGS **9**

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE **9**

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

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. Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth / Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary Systems-Recent trends.

UNIT IV IOT PROCESSORS **9**

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability. Embedded processors for IOT: Introduction to Python programming - Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES **9**

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT.
CO3: Explain different protocols and communication technologies used in IoT.
CO4: Analyze the big data analytic and programming of IoT.
CO5: Implement IoT solutions for smart applications.

TEXTBOOKS

1. Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley, 2016.
2. Samuel Greengard, "The Internet of Things", The MIT press, 2015.
3. Adrian McEwen and Hakim Cassimally"Designing the Internet of Things "Wiley,2014.

REFERENCE BOOKS:

1. ArshdeepBahga and VijaiMadisetti: A Hands-on Approach "Internet of Things",Universities Press 2015.
2. Adrian McEwen and Hakim Cassimally"Designing the Internet of Things "Wiley,2014.
3. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
4. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device.
5. Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
6. Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010.

24OECS06 SOFTWARE TESTING AND AUTOMATION **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the basics of software testing.
- To focus on wide aspects of testing and understanding multiple facets of testing.
- To get an insight about test automation and the tools used for test automation.

UNIT I FOUNDATIONS OF SOFTWARE TESTING **9**

Why do we test Software?, Black-Box Testing and White-Box Testing, Software Testing Life Cycle, V-model of Software Testing, Program Correctness and Verification, Reliability versus Safety, Failures, Errors and Faults (Defects), Software Testing Principles, Program Inspections, Stages of Testing: Unit Testing, Integration Testing, System Testing.

UNIT II TEST PLANNING **9**

The Goal of Test Planning, High Level Expectations, Intergroup Responsibilities, Test Phases, Test Strategy, Resource Requirements, Tester Assignments, Test Schedule, Test Cases, Bug

Reporting, Metrics and Statistics.

UNIT III TEST DESIGN AND EXECUTION **9**

Test Objective Identification, Test Design Factors, Requirement identification, Testable Requirements, Modeling a Test Design Process, Modeling Test Results, Boundary Value Testing, Equivalence Class Testing, Path Testing, Data Flow Testing, Test Design Preparedness Metrics, Test Case Design Effectiveness, Model-Driven Test Design, Test Procedures, Test Case Organization and Tracking, Bug Reporting, Bug Life Cycle.

UNIT IV ADVANCED TESTING CONCEPTS **9**

Performance Testing: Load Testing, Stress Testing, Volume Testing, Fail-Over Testing, Recovery Testing, Configuration Testing, Compatibility Testing, Usability Testing, Testing the Documentation, Security testing, Testing in the Agile Environment, Testing Web and Mobile Applications.

UNIT V TEST AUTOMATION AND TOOLS **9**

Automated Software Testing, Automate Testing of Web Applications, Selenium: Introducing Web Driver and Web Elements, Locating Web Elements, Actions on Web Elements, Different Web Drivers, Understanding Web Driver Events, Testing: Understanding Testing.xml, Adding Classes, Packages, Methods to Test, Test Reports.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Explain the basic concepts of software testing and the need for software testing.
CO2: Design Test planning and different activities involved in test planning.
CO3: Design effective test cases that can uncover critical defects in the application.
CO4: Carry out advanced types of testing.
- CO5: Automate the software testing using Selenium and Test.

TEXTBOOKS

1. Yogesh Singh, “Software Testing”, Cambridge University Press, 2012.
2. Unmesh Gundecha, Satya Avasarala, "Selenium WebDriver 3 Practical Guide" - Second Edition 2018.
3. Glenford J. Myers, Corey Sandler, Tom Badgett, The Art of Software Testing, 3rd Edition, 2012, John Wiley & Sons, Inc.

REFERENCES

1. Ron Patton, Software testing, 2nd Edition, 2006, Sams Publishing.
2. Paul C. Jorgensen, Software Testing: A Craftsman’s Approach, Fourth Edition, 2014, Taylor & Francis Group.
3. Carl Cocchiaro, Selenium Framework Design in Data-Driven Testing, 2018, Packt Publishing.
4. Elfriede Dustin, Thom Garrett, Bernie Gaurf, Implementing Automated Software Testing, 2009, Pearson Education, Inc.
5. Satya Avasarala, Selenium WebDriver Practical Guide, 2014, Packt Publishing.

24OEST01 INTEGRATED WATER RESOURCES MANAGEMENT **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the principles, key elements, and global challenges of Integrated Water Resources Management.
- To examine the economic, legal, health, and agricultural dimensions of water management within the IWRM framework.
- To learn global practices, case studies, and policy instruments for effective implementation of IWRM.

UNIT I CONTEXT FOR IWRM **9**

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS **9**

Economic view of water issues: economic characteristics of water good and services – Nonmarket monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS **9**

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT **9**

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM **9**

Origin of groundwater - Classification and types - Properties of aquifers - Darcy's law - Governing equations – Artificial recharge - RWH in rural and urban areas - Irrigation modernization – Rehabilitation – Command Area Development - Participatory Irrigation Management – Water Users' Association - Economic aspects of irrigation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of the course, the student will be able to

CO1: Identify and explain the global challenges related to water resources and the need for Integrated Water Resources Management (IWRM).

CO2: Apply economic principles and valuation methods to assess water as an economic good and evaluate water pricing and PPP models.
CO3: Interpret and analyze legal and regulatory frameworks, including international water laws, for sustainable water governance.
CO4: Evaluate the interconnections between water and health, and apply health impact assessment tools in water-related projects.
CO5: Assess the role of water in agriculture, including concepts like virtual water, water footprint, and irrigation efficiency within the IWRM context.

TEXT BOOKS

1. Gupta, R.S., Hydrology and Hydraulic Systems, 4th Edition, Standard Publishers, 2021.
2. Biswas, A.K., Integrated Water Resources Management: A Reassessment, Routledge, 2004.
3. Subramanya, K., Engineering Hydrology, 5th Edition, McGraw Hill, 2020.

REFERENCE BOOKS

1. Batchelor, C., Water Governance and IWRM, Stockholm Environment Institute, 2007.
2. David Keith Todd and Larry W. Mays, "Groundwater Hydrology", 3rd Third Edition, John Wiley & Sons, 2004.
3. Molden, D. (Ed.), Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture, Earthscan, 2007.
4. UN-Water, The United Nations World Water Development Report 2023: Partnerships and Cooperation for Water, UNESCO, 2023.
5. Chatterjee, R. and Ray, P., Groundwater Governance and Management in India, CRC Press, 2020.

24OEST02 WATER, SANITATION AND HEALTH **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals of WASH, including the links between water, sanitation, health, hygiene, equity, and sustainability.
- To examine the challenges, impacts, and management issues related to WASH, with focus on social, economic, environmental, and political factors.
- To explore governance strategies, development initiatives, and case studies, highlighting policies, community participation, and sustainable solutions at local and global levels.

UNIT I FUNDAMENTALS WASH **9**

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues - Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH.

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT **9**

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases- Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT **9**

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation: - Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE **9**

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP) Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance.

UNIT V INITIATIVES **9**

Management vs Development -Accelerating Development- Development Indicators Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets – Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Describe the basic concepts of water, sanitation, health, hygiene, and their importance in sustainable development.

CO2: Identify the social, economic, environmental, and political factors affecting WASH in developing contexts.

CO3: Recognize common challenges in WASH management and suggest possible solutions considering community and equity aspects.

CO4: Understand governance frameworks, policies, and institutional approaches related to WASH implementation.

CO5: Analyze global and national WASH initiatives, development plans, and case studies to propose sustainable strategies.

TEXTBOOKS

1. Bonitha R., Beaglehole R., Kjellstrom T. (2006), Basic Epidemiology, 2nd Edition, World Health Organization.

2. National Research Council (2009), Global Issues in Water, Sanitation, and Health: Workshop Summary, The National Academies Press, Washington, DC.
3. Howard, G. and Bartram, J. (2003), Domestic Water Quantity, Service Level and Health, World Health Organization.

REFERENCE BOOKS

1. Van Note Chism, N. and Bickford, D. J. (2002), Improving the Environment for Learning: An Expanded Agenda, New Directions for Teaching and Learning, 2002:
2. Sen, Amartya. (1997), On Economic Inequality, Enlarged Edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press.
3. World Bank (2000), Intersectoral Water Allocation Planning and Management, World Bank Publishers.
4. UNICEF/WHO Joint Monitoring Programme (JMP) – Progress Reports on Drinking Water, Sanitation and Hygiene, Multiple Editions.
5. Third World Network, Policy Briefs and Research Articles.

24OEST03 PRINCIPLES OF SUSTAINABLE DEVOLOPMENT **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To understand the meaning of sustainability and major development challenges.
- To learn about international frameworks, goals, and actions for sustainable development.
- To explore sustainable living methods, resource protection, and progress measurement tools.

UNITI SUSTAINABILITY AND DEVELOPMENT CHALLEGES **9**

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development- millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation - climate change – desertification.

UNITII PRINCIPLES AND FRAME WORK **9**

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step- peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas.

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING **9**

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 9

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change – Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms.

UNIT V ASSESSING PROGRESS AND WAY FORWARD 9

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On Successful completion of this course, the student will be able to

CO1: Explain the concept of sustainability and recognize major global issues such as pollution, climate change, and resource degradation.

CO2: Explain global goals and agreements like the UN Sustainable Development Goals and related principles.

CO3: Describe the importance of health, education, and poverty reduction in sustainable development.

CO4: Discuss sustainable practices in agriculture, energy, water, cities, and environmental protection.

CO5: Identify tools and indicators used to measure sustainability and suggest steps for future improvement.

TEXT BOOKS

1. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
2. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012.

3. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.

REFERENCE BOOKS

1. The New Global Frontier - Urbanization, Poverty and Environment in the 21st Century George Martine, Gordon McGranahan, Mark Montgomery and Rogelio Fernández-Castilla, IIED and UNFPA, Earthscan, UK, 2008.
2. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006.
3. A guide to SDG interactions: from science to implementation, International Council for Science, Paris,2017.
4. Jeffrey D. Sachs, The Age of Sustainable Development, Columbia University Press, 2015.
5. K. Mather, Environmental Management, New Age International Publishers, India, Reprint 2012.

24OEST04 ENVIRONMENTAL IMPACT ASSESSMENT **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To make the students to understand environmental clearance.
- To provide knowledge on overall methodology of EIA, prediction tools and models.
- To Understand environmental management plan and case studies.

UNIT I INTRODUCTION **9**

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION **9**

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment.

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT **9**

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation.

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN **9**

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment.

UNIT V CASE STUDIES **9**

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explain need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles.

CO2: Explore various impact identification methodologies, prediction techniques and model of impacts on various environments.

CO3: Relate social impacts and change in community due to development activities and rehabilitation methods.

CO4: Document the EIA findings and prepare environmental management and monitoring plan.

CO5: Identify, predict and assess impacts of similar projects based on case studies.

TEXT BOOKS

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996.
2. Van Note Chism, N. and Bickford, D. J., Improving the environment for learning, 2002.
3. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003.

REFERENCE BOOKS

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India.
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India.
3. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey.
4. World Bank –Source book on EIA ,1999.
5. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

24OEST05 ENVIRONMENTAL SUSTAINABILITY **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To understand the concept of environmental sustainability.
- To understand the significance of biodiversity.
- To understand environmental economics.

UNIT I INTRODUCTION **9**

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems.

UNIT II CONCEPT OF SUSTAINABILITY **9**

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture.

UNIT III SIGNIFICANCE OF BIODIVERSITY **9**

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation.

UNIT IV POLLUTION IMPACTS **9**

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS **9**

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Explain the concept of environmental problems.
CO2: Enumerate the sustainability concept.
CO3: Explain Significance of biodiversity.
CO4: Explain the impacts of population.
CO5: Assess impacts of Environmental economics.

TEXT BOOKS

1. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016.
2. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020.
3. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019.

REFERENCE BOOKS

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press.

3. George C. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey, 2000.
4. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India, 2005.
5. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India.

24OEST06 GREEN BUILDING DESIGN **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To learn the fundamentals of sustainable and energy-efficient building design.
- To familiarize students with building envelopes, operational energy reduction and net zero building concepts.
- To expose the students to passive house standards and building rating systems.

UNIT I INTRODUCTION **9**

Embodied energy, Operational energy in Building and Life cycle energy. Ecological footprint, Bio-capacity and calculation of planet equivalent.

UNIT II ROLE OF MATERIAL **9**

Carbon from Cement, alternative cements and cementitious material - Sustainability issues for concrete – Green steel.

UNIT III OPERATIONAL ENERGY IN BUILDING **9**

Role of materials and thermal conductivity - Building envelopes - Building systems and operations (HVAC, lighting, water supply, sewage, garbage disposal, recycling and composting) Clean & renewable energy in buildings - Rainwater harvesting - Effects of trees and microclimatic modification through greening.

UNIT IV RECYCLE AND REUSE METHODS OF BUILDING DESIGN **9**

Recycling of industrial and other waste for concrete production – reuse of steel members for new buildings – case studies.

UNIT V SMART BUILDINGS **9**

Smart buildings -Sensing and control systems.Net Zero buildings, Passive house standards and Building Rating systems.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Discuss the embodied energy and operational energy in buildings.
CO2: Explain the role of building materials in sustainable design.
CO3: Enumerate the operational energy in building design.
CO4: Evaluate recycling and reuse strategies in sustainable building design
CO5: Identify the building rating systems.

TEXT BOOKS

1. J Newman, B S Choo, Advanced Concrete Technology-Processes, 1st Edition, Elsevier, 2003.
2. S Kubba, LEED Practices, Certification, and Accreditation Hand book, 1st ed. Elsevier, 2010.
3. Energy Conservation Building Code, Revised Version, Ministry of Power, Bureau of Energy Efficiency, 2018.

REFERENCE BOOKS

1. Building Envelope Stringency Analysis, Architectural Energy Corporation, International Institute for Energy Conservation, 2004.
2. Practical Handbook on Energy Conservation in Buildings, Indian Building Congress, 1st edition, Nabhi Publication, 2008.
3. F C McQuiston, J D Parker, Heating, Ventilating, and Air Conditioning, Analysis and Design, Fourth Ed. John Wiley & Sons, 1994.
4. A H Buchanan, G Brian, Energy and carbon dioxide implications of building construction, Energy and Buildings, 1994.
5. C J Kibert, Sustainable Construction: Green Building Design and Delivery, 3rd edition, Wiley, 2022.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