ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. VLSI DESIGN

REGULATIONS – 2021
CHOICE BASED CREDIT SYSTEM

1. **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

- To critically analyse and understand the principles involved in the designing and testing of electronic circuits relevant to industry and society.
- To appreciate the concepts in the working of electronic circuits.
- To take up socially relevant and challenging projects and to provide Innovative solutions through research for the benefit of the society with latest hardware & software related to VLSI and also to develop the capacity to protect Intellectual Property.
- To Progress and Develop with Ethics and Communicate effectively.
- To become entrepreneurs to develop indigenous solutions.

2. **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 for the benefit of the society

6. Interact effectively with the technical experts in industry and society

PEO/PO Mapping:

PEO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
I.	✓	✓	✓	✓	✓	✓
II.	✓	✓	✓	✓	·	·
III.	✓	·	✓	·	✓	✓
IV.	·	✓	·	·	·	✓
V.	✓	✓	✓	✓	✓	✓

(3-High, 2- Medium, 1- Low)

MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEMESTER I	Graph Theory and Optimization Techniques	2	0	1	1	0	0
		Research Methodology and IPR	2	2	-	-	2	-
		Analog IC Design	1	1	2	1	2	0
		Digital CMOS VLSI Design	1	0	1.4	1	0	0
		Advanced Digital System Design	1	0	1	1	1.2	0
		Semiconductor Devices and Modeling	2	0	1.4	1	2	0
		FPGA Laboratory	1	1	1	1	1	1
		Analog IC Design Laboratory	1	1	1	1	2	1
	SEMESTER II	Design for Verification using UVM	1	0	1	1	2.5	0
		Low Power VLSI Design	1.6	0	2	2.4	2.2	0
		RFIC Design	1.6	0	2	2.2	2	0
		VLSI Testing	1.6	0	2	2.4	2.4	1
		Professional Elective I						
		Professional Elective II						
		Verification using UVM Laboratory	1	3	1	1	1	3
		Term Paper and Seminar	1	1	1	1	1	1
YEAR II	SEMESTER III	VLSI Signal Processing	1	0	1	1	0	0
		Professional Elective III						
		Professional Elective IV						
		Open Elective						
		Project Work I						
	SEMESTER IV	Project Work II						

PROFESSIONAL ELECTIVE COURSES [PEC]

S. NO.	COURSE TITLE	PO1	PO2	PO3	PO4	PO5	PO6
1.	ASIC Design	1	0	2	2	1	0
2.	Embedded System Design	1	0	2	2	3	1
3.	Electromagnetic Interference and Compatibility	2.5		1	2	1	1
4.	Data Converters	1	0	2	2	0	0
5.	Hardware Software Co-Design for FPGA	1	0	2	2	0.8	0
6.	Pattern Recognition	3	0	2	3	1	1
7.	DSP Structures for VLSI	1	0	1	1	0	0
8.	Power Management and Clock Distribution Circuits	1	0	2	2	0	0
9	Reconfigurable Architectures	1.2	0	2	1.2	0	0
10.	Advanced Wireless Sensor Networks	3	0	2	1	3	0
11.	Signal Integrity for High Speed Design	1	0	2	2.2	1	0
12.	System On Chip	1	0	2	1	0	0
13.	MEMS and NEMS	1	0	2	1	2	0
14.	Network on Chip	1	0	2	1	3	0
16.	Nanotechnology	1	0	1	1	0	0
17.	Evolvable Hardware	1	0	2.2	1.2	0	0
18.	Soft Computing and Optimization Techniques	1	0	2	1	2	0
19.	CAD for VLSI Design	1	0	1	2	2	1
20.	VLSI Architectures for Image Processing	1	0	1	1	1	0
21.	System Verilog	1	0	2	2	2	1
22.	Adaptive Signal Processing	1.6	1	1.6	1.2	1	1
23.	Machine Learning	3	0	2	3	1	1
24.	Digital Image and Video Processing	3	0	2	2	2	2

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I TO IV SEMESTERS CURRICULA AND 1st SEMESTER SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	VL4153	Graph Theory and Optimization Techniques	FC	3	1	0	4	4
2.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
3.	VL4151	Analog IC Design	PCC	3	0	0	3	3
4.	VL4152	Digital CMOS VLSI Design	PCC	3	0	0	3	3
5.	AP4152	Advanced Digital System Design	PCC	3	0	2	5	4
6.	AP4153	Semiconductor Devices and Modeling	PCC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	VL4111	FPGA Laboratory	PCC	0	0	4	4	2
9.	VL4112	Analog IC Design Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**10**	**30**	**23**

*Audit course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	VL4251	Design for Verification using UVM	PCC	3	0	0	3	3
2.	VL4291	Low Power VLSI Design	PCC	3	0	0	3	3
3.	VL4292	RFIC Design	PCC	3	0	0	3	3
4.	VL4252	VLSI Testing	PCC	3	0	0	3	3
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	VL4211	Verification using UVM Laboratory	PCC	0	0	4	4	2
9.	VL4212	Term Paper Writing and Seminar	EEC	0	0	2	2	1
			TOTAL	**20**	**0**	**6**	**26**	**21**

*Audit course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	VL4351	VLSI Signal Processing	PCC	3	0	0	3	3
2.		Professional Elective III	PEC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	2	5	4
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	VL4311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**14**	**26**	**19**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	VL4411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 75

PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVE I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL4071	ASIC Design	PEC	3	0	0	3	3
2.	VE4152	Embedded System Design	PEC	3	0	0	3	3
3.	EL4071	Electromagnetic Interference and Compatibility	PEC	3	0	0	3	3
4.	VL4001	Data Converters	PEC	3	0	0	3	3
5.	VL4002	Hardware Software Co-Design for FPGA	PEC	3	0	0	3	3
6.	IF4094	Pattern Recognition	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL4003	DSP Structures for VLSI	PEC	3	0	0	3	3
2.	VL4004	Power Management and Clock Distribution Circuits	PEC	3	0	0	3	3
3.	VL4005	Reconfigurable Architectures	PEC	3	0	0	3	3
4.	VL4006	Advanced Wireless Sensor Networks	PEC	3	0	0	3	3
5.	AP4095	Signal Integrity for High Speed Design	PEC	3	0	0	3	3
6.	II4092	System On Chip	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL4073	MEMS and NEMS	PEC	3	0	0	3	3
2.	VL4091	Network on Chip	PEC	3	0	0	3	3
3.	VL4074	Nanotechnology	PEC	3	0	0	3	3
4.	VL4007	Evolvable Hardware	PEC	3	0	0	3	3
5.	VL4092	Soft Computing and Optimization Techniques	PEC	3	0	0	3	3
6.	VL4072	CAD for VLSI Design	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL4009	VLSI Architectures for Image Processing	PEC	3	0	2	5	4
2.	VL4010	System Verilog	PEC	3	0	2	5	4
3.	VL4011	Adaptive Signal Processing	PEC	3	0	2	5	4
4.	CP4252	Machine Learning	PEC	3	0	2	5	4
5.	DS4151	Digital Image and Video Processing	PEC	3	0	2	5	4

AUDIT COURSES (AC)
Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OME431	Vibration and Noise Control Strategies	3	0	0	3
8.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
9.	OME433	Additive Manufacturing	3	0	0	3
10.	OME434	Electric Vehicle Technology	3	0	0	3
11.	OME435	New Product Development	3	0	0	3
12.	OBA431	Sustainable Management	3	0	0	3
13.	OBA432	Micro and Small Business Management	3	0	0	3
14.	OBA433	Intellectual Property Rights	3	0	0	3
15.	OBA434	Ethical Management	3	0	0	3
16.	ET4251	IoT for Smart Systems	3	0	0	3
17.	ET4072	Machine Learning and Deep Learning	3	0	0	3
18.	PX4012	Renewable Energy Technology	3	0	0	3
19.	PS4093	Smart Grid	3	0	0	3
20.	CP4391	Security Practices	3	0	0	3
21.	MP4251	Cloud Computing Technologies	3	0	0	3
22.	IF4072	Design Thinking	3	0	0	3
23.	MU4153	Principles of Multimedia	3	0	0	3
24.	CX4016	Environmental Sustainability	3	0	0	3
25.	TX4092	Textile Reinforced Composites	3	0	0	3
26.	NT4002	Nanocomposite Materials	3	0	0	3
27.	BY4016	IPR, Biosafety and Entrepreneurship	3	0	0	3

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	VL4153	Graph Theory and Optimization Techniques	3	1	0	4	I

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	VL4151	Analog IC Design	3	0	0	3	I
2.	VL4152	Digital CMOS VLSI Design	3	0	0	3	I
3.	AP4152	Advanced Digital System	3	0	2	4	I
4.	AP4153	Semiconductor Devices and Modeling	3	0	0	3	I
5.	VL4111	FPGA Laboratory	0	0	4	2	I
6.	VL4112	Analog IC Design Laboratory	0	0	4	2	I
7.	VL4251	Design for Verification using UVM	3	0	0	3	II
8.	VL4291	Low Power VLSI Design	3	0	0	3	II
9.	VL4292	RFIC Design	3	0	0	3	II
10.	VL4252	VLSI Testing	3	0	0	3	II
11.	VL4211	Verification using UVM Laboratory	0	0	4	2	II
12.	VL4351	VLSI Signal Processing	3	0	0	3	III

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	VL4212	Mini Project with seminar	0	0	2	1	II
2.	VL 4311	Project Work I	0	0	12	6	III
3.	VL 4411	Project Work II	0	0	24	12	IV

SUMMARY

Sl. No.	NAME OF THE PROGRAMME: M.E.VLSI DESIGN					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	17	14	03	00	34
3.	PEC	00	06	07	00	13
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	01	06	12	19
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	**TOTAL CREDIT**	**23**	**21**	**19**	**12**	**75**

VL4153 GRAPH THEORY AND OPTIMIZATION TECHNIQUES L T P C
3 1 0 4

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.
- To provide knowledge and training using non-linear programming under limited resources for engineering and business problems.
- To understand the applications of simulation modelling in engineering problems.

UNIT I GRAPHS 12

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 12

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 12

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

UNIT IV NON-LINEAR PROGRAMMING 12

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

UNIT V SIMULATION MODELLING 12

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

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

- apply graph ideas is solving connectivity related problems.
- apply fundamental graph algorithms to solve certain optimization problems.
- formulate and construct mathematical models for linear programming problems and solve the transportation and assignment problems.
- model various real life situations as optimization problems and effect their solution through Non-linear programming.
- 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.
4. Douglas B. West, “Introduction to Graph Theory”, Pearson Education, New Delhi, 2015.
5. Balakrishna R., Ranganathan. K., “ A text book of Graph Theory”, Springer Science and Business Media, New Delhi, 2012.
6. Narasingh Deo, “Graph Theory with Applications to Engineering and Computer Science”, Prentice Hall India,1997.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	0	1	1	0	0
2	2	0	1	1	0	0
3	2	0	1	1	0	0
4	2	0	1	1	0	0
5	2	0	1	1	0	0
Avg	(10/5)=2	0	(5/5)=1	(5/5)=1	0	0

RM4151 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
- To gather information in a measured and systematic manner to ensure accuracy and facilitate data analysis
- 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
- To 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:

- Ability to arrange the conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose
- Ability to gather information in a measured and systematic manner to ensure accuracy and facilitate data analysis
- Ability to transform and model the collected data to discover useful information for decision-making
- Ability to awareness about the benefits of Intellectual property
- Ability to take up legal certainty while applying for Patent

REFERENCES:

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. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	3	2	-	-	2	-
2	3	3	-	-	1	-
3	2	3	-	-	1	-
4	1	1	-	-	3	-
5	1	1	-	-	3	-
Avg	**2**	**2**	**-**	**-**	**2**	**-**

VL4151 **ANALOG IC DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Analog Circuits play a very crucial role in all electronic systems and due to continued

miniaturization, many of the analog blocks are not getting realized in CMOS technology. The most important building blocks of all CMOS analog IC will be the topic of study in this course.

- The basic principle of operation, the circuit choices and the tradeoffs involved in the MOS transistor level design common to all analog CMOS ICs will be discussed in this course.
- The specific 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.

UNIT I SINGLE STAGE AMPLIFIERS 9

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

UNIT II HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS 9

Miller effect, association of poles with nodes, frequency response of CS, CG and Source Follower, Cascode 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, two-stage Op Amps, input range limitations, gain boosting, slew rate, power supply rejection, noise in Op Amps.

UNIT IV STABILITY AND FREQUENCY COMPENSATION OF TWO STAGE AMPLIFIER 9

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

UNIT V BANDGAP REFERENCES 9

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

COURSE OUTCOMES:

At the end of this course, the students should will be able to:

CO1: Design amplifiers to meet user specifications
CO2: Analyse the frequency and noise performance of amplifiers
CO3: Design and analyse feedback amplifiers and one stage op amps
CO4: Design and analyse two stage op amps
CO5: Design and analyse current mirrors and current sinks with mos devices

TOTAL: 45 PERIODS

REFERENCES

1. Behzad Razavi, “Design Of Analog Cmos Integrated Circuits”, Tata Mcgraw Hill, 2001.

2. Willey M.C. Sansen, “Analog Design Essentials”, Springer, 2006.
3. Grebene, “Bipolar And Mos Analog Integrated Circuit Design”, John Wiley & Sons,Inc.,2003.
4. Phillip E.Allen, Douglas R .Holberg, “Cmos Analog Circuit Design”, Oxford University Press, 2nd Edition, 2002.
5. Recorded Lecture Available at http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
6. Jacob Baker “CMOS: Circuit Design, Layout, And Simulation, Wiley IEEE Press, 3rd Edition, 2010.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	2	1		
2	1		2	1		
3	1		2	1	2	
4	1		2	1	2	
5	1		2	1	2	
Avg	(5/5)=1	(1/1)=1	(10/5)=2	(5/5)=1	(6/3)=2	

VL4152 DIGITAL CMOS VLSI DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the transistor level design of all digital building blocks common to all cmos microprocessors, network processors, digital backend of all wireless systems etc.
- To introduce the principles and design methodology in terms of the dominant circuit choices, constraints and performance measures
- To learn all important issues related to size, speed and power consumption

UNIT I MOS TRANSISTOR PRINCIPLES AND CMOS INVERTER 12

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 COMBINATIONAL LOGIC CIRCUITS 9

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

UNIT III SEQUENTIAL LOGIC CIRCUITS 9

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

UNIT IV ARITHMETIC BUILDING BLOCKS 9

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

UNIT V MEMORY ARCHITECTURES 6

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be able to:

CO1: Use mathematical methods and circuit analysis models in analysis of CMOS digital circuits

CO2: Create models of moderately sized static CMOS combinational circuits that realize specified digital functions and to optimize combinational circuit delay using RC delay models and logical effort

CO3: Design sequential logic at the transistor level and compare the tradeoffs of sequencing elements including flip-flops, transparent latches

CO4: Understand design methodology of arithmetic building blocks

CO5: Design functional units including ROM and SRAM

REFERENCES:

1. N.Weste, K. Eshraghian, " Principles Of Cmos VLSI Design", Addision Wesley, 2nd Edition, 1993
2. M J Smith, "Application Specific Integrated Circuits", Addisson Wesley, 1997
3. Sung-Mo Kang & Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis And Design", Mcgraw-Hill, 1998
4. Jan Rabaey, Anantha Chandrakasan, B Nikolic, " Digital Integrated Circuits: A Design Perspective", Prentice Hall Of India, 2nd Edition, Feb 2003

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	1	0	0
2	1	0	2	1	0	0
3	1	0	1	1	0	0
4	1	0	2	1	0	0
5	1	0	1	1	0	0
Avg	(5/5)=1	0	(7/5)=1.4	(5/5)=1	0	0

AP4152 ADVANCED DIGITAL SYSTEM DESIGN L T P C

3 0 2 4

COURSE OBJECTIVES:

- To design asynchronous sequential circuits.
- To learn about hazards in asynchronous sequential circuits.
- To study the fault testing procedure for digital circuits.
- To understand the architecture of programmable devices.
- To design and implement digital circuits using programming tools.

UNIT I SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Clocked Synchronous Sequential Circuits and Modelling- State Diagram, State Table, State Table Assignment and Reduction-Design of Synchronous Sequential Circuits Design of Iterative Circuits-ASM Chart and Realization using ASM.

UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

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

UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9

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

UNIT IV SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES 9

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

UNIT V SYSTEM DESIGN USING VERILOG 9

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

45 PERIODS

SUGGESTED ACTIVITIES:

1: Design asynchronous sequential circuits.
2: Design synchronous sequential circuits using PLA/PAL.
3: Simulation of digital circuits in FPGA.
4: Design digital systems with System Verilog.

PRACTICAL EXERCISES: 30 PERIODS

1. Design of Registers by Verilog HDL.
2. Design of Counters by Verilog HDL.
3. Design of Sequential Machines by Verilog HDL.
4. Design of Serial Adders , Multiplier and Divider by Verilog HDL.
5. Design of a simple Microprocessor by Verilog HDL.

COURSE OUTCOMES:

At the end 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 standards.

TOTAL:75 PERIODS

REFERENCES:

1. Charles H.Roth jr., “Fundamentals of Logic Design” Thomson Learning,2013.
2. M.D.Ciletti , Modeling, Synthesis and Rapid Prototyping with the Verilog HDL, Prentice Hall, 1999
3. M.G.Arnold, Verilog Digital – Computer Design, Prentice Hall (PTR), 1999.
4. Nripendra N Biswas “Logic Design Theory” Prentice Hall of India,2001.
5. Paragk.Lala “Fault Tolerant and Fault Testable Hardware Design” B S Publications,2002
6. Paragk.Lala “Digital System Design Using PLD” B S Publications,2003.
7. Palnitkar , Verilog HDL – A Guide to Digital Design and Synthesis, Pearson , 2003.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	1	1	0
2	1	0	1	1	1	0
3	1	0	1	1	1	0
4	1	0	1	1	2	0
5	1	0	1	1	1	0
Avg	(5/5)=1	0	(5/5)=1	(5/5)=1	(6/5)=1.2	0

AP4153 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 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–OxideInterface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown.

UNIT II MOSFET DEVICES 9

Long-Channel MOSFETs, Drain-Current Model, MOSFET I–V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET

Channel Mobility, MOSFET Capacitances and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields

UNIT III CMOS DEVICE DESIGN 9

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, Physical Meaning of Effective Channel Length, Extraction of Channel Length by C–V Measurements.

UNIT IV 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-Dependent Analyses Basic dc Model, Basic ac Model, Small-Signal Equivalent-Circuit Model, Emitter Diffusion Capacitance, Charge-Control Analysis, Breakdown Voltages, Common-Base Current Gain in the Presence of Base–Collector Junction Avalanche, Saturation Currents in a Transistor.

UNIT V MATHEMATICAL TECHNIQUES FOR DEVICE SIMULATIONS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1: Explore the properties of MOS capacitors.

CO2: Analyze the various characteristics of MOSFET devices.

CO3: Describe the various CMOS design parameters and their impact on performance of the device.

CO4: Discuss the device level characteristics of BJT transistors.

CO5: Identify the suitable mathematical technique for simulation.

REFERENCES:

1. Yuan Taur and Tak H.Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2016.
2. A.B. Bhattacharyya “Compact MOSFET Models for VLSI Design”, John Wiley & Sons Ltd, 2009.
3. Ansgar Jungel, “Transport Equations for Semiconductors”, Springer, 2009
4. Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf, “Device Modeling for Analog and RF CMOS Circuit Design”, John Wiley & Sons Ltd, 2004
5. Selberherr, S., “Analysis and Simulation of Semiconductor Devices”, Springer-Verlag., 1984
6. Behzad Razavi, “Fundamentals of Microelectronics” Wiley Student Edition, 2nd Edition, 2014

7. J P Collinge, C A Collinge, “Physics of Semiconductor devices” Springer, 2002.
8. S.M.Sze, Kwok.K. NG, “Physics of Semiconductor devices”, Springer, 2006.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2		1	1		
2	2		1	1		
3	2		2	1		
4	2		1	1		
5	2		2	1	2	
Avg	(10/5)=2		(7/5)=1.4	(5/5)=1	(2/1)=2	

VL4111 FPGA LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Understand and use the System Verilog RTL design and synthesis features, including new data types, literals, procedural blocks, statements, and operators, relaxation of Verilog language rules, fixes for synthesis issues, enhancements to tasks and functions, new hierarchy and connectivity features, and interfaces.

CO2: Appreciate and apply the System Verilog verification features, including classes, constrained random stimulus, coverage, strings, queues and dynamic arrays, and learn how to utilize these features for more effective and efficient verification.

CO3: The implementation of higher level of abstraction to design and verification

CO4: Develop Verilog test environments of significant capability and complexity.
CO5: Integrate scoreboards, multichannel sequencers and Register Models

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
Avg	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1

VL4112 ANALOG IC DESIGN LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- Carry out a detailed analog circuit design starting with transistor characterization and finally realizing an IA design.
- At various stages of design, exposure to state of art CAD VLSI tool in various phases of experiments designed to bring out the key aspects of each important module in the CAD tool including the simulation, layout, LVS and parasitic extracted simulation.

LIST OF EXPERIMENTS

1. Extraction of process parameters of CMOS process transistors
   a. Plot I_D vs. V_{GS} at different drain voltages for NMOS, PMOS.
   b. Plot I_D vs. V_{GS} at particular drain voltage for NMOS, PMOS and determine Vt.
   c. Plot log I_D vs. VGS at particular gate voltage for NMOS, PMOS and determine I_{OFF} and sub-threshold slope.
   d. Plot I_D vs. V_{DS} at different gate voltages for NMOS, PMOS and determine Channel length modulation factor.
   e. Extract V_{th} of NMOS/PMOS transistors (short channel and long channel). Use V_{DS} of appropriate voltage To extract V_{th} use the following procedure.
      i. Plot g_m vs V_{GS} using SPICE and obtain peak g_m point.
      ii. Plot $y=I_D/(g_m)$ as a function of VGS using SPICE.
      iii. Use SPICE to plot tangent line passing through peak gm point in y (V_{GS}) plane and determine V_{th}.
   f. Plot I_D vs. V_{DS} at different drain voltages for NMOS, PMOS, plot DC load line and calculate gm, gds, gm/gds, and unity gain frequency. Tabulate result according to technologies and comment on it.

2. CMOS inverter design and performance analysis
   a. i. Plot VTC curve for CMOS inverter and thereon plot dV_{out} vs. dV_{in} and determine transition voltage and gain g. Calculate V_{IL}, V_{IH}, NM_H, NM_L for the inverter.
      ii. Plot VTC for CMOS inverter with varying V_{DD}.

iii. Plot VTC for CMOS inverter with varying device ratio.

b. Perform transient analysis of CMOS inverter with no load and with load and determine propagation delay t_{pHL}, t_{pLH}, 20%-to-80% rise time t_r and 80%-to-20% fall time t_f.

c. Perform AC analysis of CMOS inverter with fanout 0 and fanout 1.

3. Use spice to build a three stage and five stage ring oscillator circuit and compare its frequencies. Use FFT and verify the amplitude and frequency components in the spectrum.

4. Single stage amplifier design and performance analysis

a. Plot small signal voltage gain of the minimum-size inverter in the technology chosen as a function of input DC voltage. Determine the small signal voltage gain at the switching point using spice and compare the values for two different process transistors.

b. Consider a simple CS amplifier with active load, with NMOS transistor as driver and PMOS transistor as load.

i. Establish a test bench to achieve $V_{DSQ}=V_{DD}/2$.
ii. Calculate input bias voltage for a given bias current.
iii. Use spice and obtain the bias current. Compare with the theoretical value
iv. Determine small signal voltage gain, -3dB BW and GBW of the amplifier
v. using small signal analysis in spice, considering load capacitance.
vi. Plot step response of the amplifier with a specific input pulse amplitude.
vii. Derive time constant of the output and compare it with the time constant
viii. resulted from -3dB Band Width.
ix. Use spice to determine input voltage range of the amplifier

5. Three OPAMP Instrumentation Amplifier (INA).

Use proper values of resistors to get a three OPAMP INA with differential-mode voltage gain=10. Consider voltage gain=2 for the first stage and voltage gain=5 for the second stage.

i. Draw the schematic of op-amp macro model.
ii. Draw the schematic of INA.
iii. Obtain parameters of the op-amp macro model such that it meets a given specification for:

i.low-frequency voltage gain,

ii.unity gain BW (fu),

iii.input capacitance,

iv.output resistance,

v.CMRR

d. Draw schematic diagram of CMRR simulation setup.

e. Simulate CMRR of INA using AC analysis (it's expected to be around 6dB below CMRR of OPAMP).

f. Plot CMRR of the INA versus resistor mismatches (for resistors of second stage only) changing from -5% to +5% (use AC analysis). Generate a separate plot for mismatch in each resistor pair. Explain how CMRR of OPAMP changes with resistor mismatches.

g. Repeat (iii) to (vi) by considering CMRR of all OPAMPs with another low frequency gain setting.

6. Use Layout editor.

a. Draw layout of a minimum size inverter using transistors from CMOS process library. Use Metal 1 as interconnect line between inverters.

b. Run DRC, LVS and RC extraction. Make sure there is no DRC error.
c. Extract the netlist. Use extracted netlist and obtain $t_{PHL}t_{PLH}$ for the inverter using Spice.
d. Use a specific interconnect length and connect and connect three inverters in a chain.
e. Extract the new netlist and obtain t_{PHL} and t_{PLH} of the middle inverter.
f. Compare new values of delay times with corresponding values obtained in part 'c'.

7. Design a differential amplifier with resistive load using transistors from CMOS process library that meets a given specification for the following parameter
    a. low-frequency voltage gain,
    b. unity gain BW (fu),
    c. Power dissipation

i. Perform DC analysis and determine input common mode range and compare with the theoretical values.
ii. Perform time domain simulation and verify low frequency gain.
iii. Perform AC analysis and verify.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
On successful completion of this course, students will be able to
CO1: Design digital and analog Circuit using CMOS given a design specification.
CO2: Design and carry out time domain and frequency domain simulations of simple analog building blocks, study the pole zero behaviors and compute the input/output impedances
CO3: Use EDA tools for Circuit Design

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
Avg	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1

VL4251 DESIGN FOR VERIFICATION USING UVM L T P C
3 0 0 3

COURSE OBJECTIVES:
- To provide the students complete understanding on UVM testing
- To become proficient at UVM verification,
- To provide an experience on self checking UVM testbenches

UNIT I INTRODUCTION **9**

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

UNIT II DEVELOPING REUSABLE VERIFICATION COMPONENTS **9**

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

UNIT III UVM USING VERIFICATION COMPONENTS **9**

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

UNIT IV UVM USING THE REGISTER LAYER CLASSES **9**

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

UNIT V ASSIGNMENT IN TESTBENCHES **9**

Assignment, APB: Protocol, Test bench Architecture, Driver and Sequencer, Monitor, Agent and Env; Creating Sequences, Building Test, Design and Testing of Top Module.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1:understand the basic concepts of two methodologies UVM

CO2:build actual verification components.

CO3:generate the register layer classes.

CO4:code testbenches using UVM.

CO5:understand advanced peripheral bus testbenches.

REFERENCES

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	1	2	0
2	1	0	1	1	2	0
3	1	0	1	1	2	0
4	1	0	1	1	2	1
5	1	0	1	1	2	1
Avg	(5/5)=1	(0/0)=0	(5/5)=1	(5/5)=1	(10/5)=2	(2/2)=1

VL4291 LOW POWER VLSI DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

- identify sources of power in an IC.
- identify the power reduction techniques based on technology independent and technology dependent methods
- identify suitable techniques to reduce the power dissipation
- estimate power dissipation of various MOS logic circuits
- develop algorithms for low power dissipation

UNIT I POWER DISSIPATION IN CMOS 9

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

UNIT II POWER OPTIMIZATION 9

Logic Level Power Optimization – Circuit Level Low Power Design – Gate Level Low Power Design –Architecture Level Low Power Design – VLSI Subsystem Design of Adders, Multipliers, PLL, Low Power Design

UNIT III DESIGN OF LOW POWER CMOS CIRCUITS 9

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

UNIT IV POWER ESTIMATION 9

Power Estimation Techniques, Circuit Level, Gate Level, Architecture Level, Behavioral Level, – Logic Power Estimation – Simulation Power Analysis –Probabilistic Power Analysis

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

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should will be able to:

CO1: able to find the power dissipation of MOS circuits

CO2: design and analyze various MOS logic circuits

CO3 :apply low power techniques for low power dissipation

CO4: able to estimate the power dissipation of ICs

CO5: able to develop algorithms to reduce power dissipation by software tools.

REFERENCES

1. Kaushik Roy and S.C.Prasad, "Low Power CMOS VLSI Circuit Design", Wiley, 2000
2. J.B.Kulo and J.H Lou, "Low Voltage CMOS VLSI Circuits", Wiley 1999.
3. James B.Kulo, Shih-Chia Lin, "Low Voltage SOI CMOS VLSI Devices and Circuits", John Wiley and Sons, Inc. 2001
4. J.Rabaey, "Low Power Design Essentials (Integrated Circuits and Systems)", Springer, 2009

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	0	2	3	2	0
2	2	0	2	2	2	0
3	1	0	2	2	2	0
4	1	0	2	3	2	0
5	2	0	2	2	3	0
Avg	(8/5)=1.6	(0/0)=0	(10/5)=2	(12/5)=2.4	(11/5)=2.2	(0/0)=0

VL4292 RFIC DESIGN L T P C

3 0 0 3

COURSE OBJECTIVES:

- to study the various impedance matching techniques used in RF circuit design.
- to understand the functional design aspects of LNAs, Mixers, PLLs and VCOs.
- to understand frequency synthesis.

UNIT I IMPEDANCE MATCHING IN AMPLIFIERS 9

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

UNIT II AMPLIFIER DESIGN 9

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

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 OSCILLATORS 9

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

UNIT V 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

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be able to:

CO1: to understand the principles of operation of an RF receiver front end

CO2: to design and apply constraints for LNAs, Mixers and frequency synthesizers

CO3: to analyze and design mixers

CO4: to design different types of oscillators and perform noise analysis

CO5: to design PLL and frequency synthesizer

REFERENCES

1. B.Razavi ,"RF Microelectronics" , Prentice-Hall ,1998
2. Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2002
3. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" Mcgraw-Hill, 1999
4. Jia-Sheng Hong, "Microstrip Filters for RF/Microwave Applications", Wiley, 2001
5. Thomas H.Lee, "The Design of CMOS Radio –Frequency Integrated Circuits', Cambridge University Press ,2003

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	0	2	2	2	0
2	2	0	2	2	2	0
3	1	0	2	2	2	0
4	1	0	2	3	2	0
5	2	0	2	2	2	0
Avg	(8/5)=1.6	(0/0)=0	(10/5)=2	(11/5)=2.2	(10/5)=2	(0/0)=0

VL4252 **VLSI TESTING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- to introduce the VLSI testing.
- to introduce logic and fault simulation and testability measures
- to study the test generation for combinational and sequential circuits
- to study the design for testability.
- to study the fault diagnosis

UNIT I INTRODUCTION TO TESTING **9**

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

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**

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

UNIT IV DESIGN FOR TESTABILITY **9**

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

UNIT V FAULT DIAGNOSIS **9**

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be able to:

CO1: Understand VLSI Testing Process
CO2: Develop Logic Simulation and Fault Simulation
CO3:Develop Test for Combinational and Sequential Circuits
CO4: Understand the Design for Testability
CO5:Perform Fault Diagnosis.

REFERENCES

1. Laung-Terng Wang, Cheng-Wen Wu and Xiaoqing Wen, “VLSI Test Principles and Architectures”, Elsevier, 2017
2. Michael L. Bushnell and Vishwani D. Agrawal, “Essentials of Electronic Testing for Digital, Memory & Mixed-Signal VLSI Circuits” , Kluwer Academic Publishers, 2017.
3. Niraj K. Jha and Sandeep Gupta, “Testing of Digital Systems”, Cambridge University Press, 2017.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2	0	2	3	3	1
2	2	0	2	2	3	1
3	1	0	2	2	3	1
4	1	0	2	3	2	1
5	2	0	2	2	1	1
Avg	(8/5)=1.6	(0/0)=0	(10/5)=2	(12/5)=2.4	(12/5)=2.4	(5/5)=1

VL4211 VERIFICATION USING UVM LABORATORY

L T P C
0 0 4 2

COURSE OBJECTIVES:

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

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: understand the features and capabilities of the UVM class library for system Verilog

CO2: combine multiple UVCs into a complete verification environment

CO3:create and configure reusable, scalable, and robust UVM verification components (UVCs)

CO4: create a UVM testbench structure using the UVM library base classes and the UVM factory

CO5:develop a register model for your DUT and use the model for initialization and accessing DUT registers

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	1	1	1	3
2	1	3	1	1	1	3

3	1	3	1	1	1	3
4	1	3	1	1	1	3
5	1	3	1	1	1	3
Avg	(5/5)=1	(15/5)=3	(5/5)=1	(5/5)=1	(5/5)=1	(15/5)=3

VL4212 TERM PAPER WRITING AND SEMINAR L T P C
0 0 2 1

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.
Activities to be carried out

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area	3rd week	**3%** (the selected information must be area specific and of international and national standard)

	7. Attach a call for papers (CFP) from your area.		
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people's survey paper), • Favour more recent papers, • Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered	4th week	**6%** (the list of standard papers and reason for selection)
Reading and notes for first 5 papers	• Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research?	5th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)

	• What did the author say were the important directions for future research? • Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)		
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	**8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	**8%** (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	**6%** (Clarity, purpose and conclusion) **6%** Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	**5%** (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11thweek	**10%** (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	**5%** (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	**10%** (formatting, English, Clarity and linking) **4%** Plagiarism Check

			Report
Seminar	A brief 15 slides on your paper	14th & 15th week	**10%** (based on presentation and Viva-voce)

TOTAL: 30 PERIODS

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
Avg	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1

VL4351 VLSI 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.

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 strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even, Merge-Sort architecture, parallel rank-order filters.

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

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 Data versus Dual-Rail protocol.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Ability to determine the parameters influencing the efficiency of DSP architectures and apply pipelining and parallel processing techniques to alter FIR structures for efficiency

CO2: Ability to analyse and modify the design equations leading to efficient DSP architectures for transforms apply low power techniques for low power dissipation

CO3: Ability to speed up convolution process and develop fast and area efficient IIR structures

CO4: Ability to develop fast and area efficient multiplier architectures

CO5: Ability to reduce multiplications and build fast hardware for synchronous digital systems

REFERENCES

1. Keshab K. Parhi, " VLSI Digital Signal Processing Systems, Design and Implementation ", Wiley, Interscience, 2007

2. U. Meyer – Baese, " Digital Signal Processing with Field Programmable Gate Arrays", Springer, 2nd Edition, 2004.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	2	2	1	0
2	1	0	2	2	1	0
3	1	0	2	2	1	0
4	1	0	2	2	1	0
5	1	0	2	2	1	0
Avg	(5/5)=1	(0/0)=0	(10/5)=2	(10/5)=2	(5/5)=1	(0/0)=0

VL4071	ASIC DESIGN	L T P C
		3 0 0 3

COURSE OBJECTIVES:

- To Focus on the Semi-Custom IC Design and introduces the Principles of Design Logic Cells, I/O Cells and Interconnect Architecture, with Equal Importance given to FPGA and ASIC styles.
- To deal with the entire FPGA and ASIC Design Flow from the Circuit and Layout Design Point of View

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

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

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

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

UNIT III PROGRAMMABLE ASIC ARCHITECTURE 9

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

UNIT IV 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 V 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. Case Studies: Digital Camera, SDRAM, High Speed Data standards.

TOTAL :45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be

CO1: able to apply Logical Effort Technique for predicting Delay, Delay Minimization and FPGA Architectures

CO2: able to Design Logic Cells and I/O Cells

CO3: able to analyze the various resources of recent FPGAs

CO4: able to use Algorithms for Floor Planning and Placement of Cells and to Apply Routing Algorithms for Optimization of Length and Speed.

CO5: able to analyze High Performance Algorithms Available for ASICs

REFERENCES

1. M.J.S.Smith, "Application Specific Integrated Circuits", Pearson, 2003.
2. Steve Kilts, “Advanced FPGA Design,” Wiley Inter-Science,2006
3. Roger Woods, John Mcallister, Dr. Ying Yi, Gaye Lightbod, “FPGA-Based Implementation of Signal Processing Systems”, Wiley, 2008.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	2	3	1
2	1	0	1	2	3	1
3	1	0	1	2	3	1
4	1	0	1	2	3	1
5	1	0	1	2	3	1
Avg	(5/5)=1	(0/0)=0	(5/5)=1	(10/5)=2	(15/5)=3	(5/5)=1

VE4152 EMBEDDED SYSTEM DESIGN L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the design challenges in embedded systems.
- To program the Application Specific Instruction Set Processors.
- To understand the bus structures and protocols.
- To model processes using a state – machine model.
- To design a real time embedded system.

UNIT I EMBEDDED SYSTEM OVERVIEW 9

Embedded System Overview, Design Challenges – Optimizing Design Metrics, Design Methodology, RT-Level Combinational and Sequential Components, Optimizing Custom Components, Optimizing Custom Single-Purpose Processors.

UNIT II GENERAL AND SINGLE PURPOSE PROCESSOR 9

Basic Architecture, Pipelining, Superscalar and VLIW Architectures, Programmer’s View, Development Environment, Application-Specific Instruction-Set Processors (ASIPS) Microcontrollers, Timers, Counters and Watchdog Timer, UART, LCD Controllers and Analog-to-Digital Converters, Memory Concepts.

UNIT III BUS STRUCTURES 9

Basic Protocol Concepts, Microprocessor Interfacing – I/O Addressing, Port and Bus - based I/O, Arbitration, Serial Protocols, I2C, CAN and USB, Parallel Protocols – PCI and ARM bus, Wireless Protocols – IRDA, Bluetooth, IEEE 802.11.

UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS 9

Basic State Machine Model, Finite-State Machine with Data path Model, Capturing State Machine

in Sequential Programming Language, Program-State Machine Model, Concurrent Process Model, Communication among Processes, Synchronization among processes, RTOS – System design using RTOS.

UNIT V SYSTEM DESIGN **9**

Burglar alarm system-Design goals -Development strategy-Software development-Relevance to more complex designs- Need for emulation -Digital echo unit-Creating echo and reverb-Design requirements-Designing the codecs -The overall system design

SUGGESTED ACTIVITIES:

1: Do microcontroller based design experiments.
2: Create program –state models for different embedded applications.
3: Design and develop embedded solutions for real world problems.

COURSE OUTCOMES:

CO1: Knowledge of different protocols
CO2: Apply state machine techniques and design process models.
CO3: Apply knowledge of embedded sotware development tools and RTOS
CO4: Apply networking principles in embedded devices.
CO5: Design suitable embedded systems for real world applications.

TOTAL:45 PERIODS

REFERENCES:

1. Frank Vahid and Tony Gwargie, “Embedded System Design”, John Wiley & Sons, 2009.
2. Steve Heath, “Embedded System Design”, Elsevier, Second Edition, 2004.
3. Bruce Powel Douglas, “Real Time UML, Second Edition: Developing Efficient Objects for Embedded Systems”, 3rd Edition 2004, Pearson Education
4. Daniel W.Lewis, “Fundamentals of Embedded Software where C and Assembly Meet”, Pearson Education, 2004
5. Bruce Powel Douglas, “Real Time UML; Second Edition: Developing Efficient Objects for Embedded Systems”, 3rd Edition 1999, Pearson Education.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	2	2	3	1
2	1	0	2	2	3	1
3	1	0	2	2	3	1
4	1	0	2	2	3	1
5	1	0	2	2	3	1
Avg	(5/5)=1	(0/0)=0	(10/5)=2	(10/5)=2	(15/5)=3	(5/5)=1

EL4071 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility
- To develop a theoretical understanding of electromagnetic shielding effectiveness
- To understand ways of mitigating EMI by using shielding, grounding and filtering
- To understand the need for standards and to appreciate measurement methods
- To understand how EMI impacts wireless and broadband technologies

UNIT I INTRODUCTION & SOURCES OF EM INTERFERENCE 9

Introduction - Classification of sources - Natural sources - Man-made sources - Survey of the electromagnetic environment.

UNIT II EM SHIELDING 9

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

UNIT III INTERFERENCE CONTROL TECHNIQUES 9

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

UNIT IV EMC STANDARDS, MEASUREMENTS AND TESTING 9

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

UNIT V EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES 9

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.

SUGGESTED ACTIVITIES:

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.

COURSE OUTCOMES:

Upon 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 couple through apertures, and solve simple problems based on that understanding
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

TOTAL:45 PERIODS

REFERENCES

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Second Edition, Indian Edition, 2013.

2. Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, Second Edition,2008.
3. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition,2010.
4. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, Newyork,2009.
5. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Interscience Series, 1997.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	2		1	2	1	1
2	3		1	2	1	1
3	2		1	2	1	1
4	2		1	2	1	1
5	2		1	2	1	1
Avg	2.5		1	2	1	1

VL4001 DATA CONVERTERS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To teach Analog to Digital and Digital to Analog Converters characteristics
- To teach the design of Switched Capacitor based Circuits
- To teach the design of Analog to Digital and Digital to Analog Converters

UNIT I INTRODUCTION & CHARACTERISTICS OF AD/DA CONVERTER CHARACTERISTICS 9

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 9

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 NYQUIST RATE D/A CONVERTERS 9

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 **9**

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

UNIT V SIGMA DELTA CONVERTERS **9**

STF, NTF, First Order and Second Order Sigma Delta Modulator Characteristics, Estimating The Maximum Stable Amplitude, CTDSMs, Op amp Nonlinearities

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be

CO1:able to carry out the design calculations for developing the various blocks associated with a typical CMOS AD or DA Converter.

CO2: able to design and implement circuits using Switched Capacitor Concepts

CO3: able to analyze and design D/A Converters

CO4: able to design different types of A/Ds

CO5: able to analyze and design Sigma Delta converter

REFERENCES

1. Behzad Razavi, “Principles of Data Conversion System Design”, IEEE Press, 1995.
2. M. Pelgrom, “Analog-to-Digital Conversion”, Springer, 2010.
3. Rudy Van De Plassche, “CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters” Kluwer Acedamic Publishers, Boston, 2003.
4. J. G. Proakis, D. G. Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Prentice Hall, 4th Edition, 2006.
5. Shanthi Pavan, Richard Schreier, Gabor C. Temes , “Understanding Delta-Sigma Data Converters”, Willey –IEEE Press, 2nd Edition, 2017.

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	1	0	2	2	0	0
2	1	0	2	2	0	0
3	1	0	2	2	0	0
4	1	0	2	2	0	0
5	1	0	2	2	0	0
Avg	(5/5)=1	(0/0)=0	(10/5)=2	(10/5)=2	(0/0)=0	(0/0)=0

VL4002 HARDWARE SOFTWARE CO-DESIGN FOR FPGA **L T P C 3 0 0 3**

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 9

Embedded Systems, 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, Multi-Processor Architectures, Comparison of Co-Design Approaches, Models of Computation, Requirements for Embedded System Specification

UNIT II HARDWARE/SOFTWARE PARTITIONING 9

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 9

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

UNIT IV PROTOTYPING AND EMULATION 9

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

UNIT V DESIGN SPECIFICATION AND VERIFICATION 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be able to

CO1: Describe The Broad Range of System Architectures and Design Methodologies that currently exist and define their fundamental attributes.

CO2: Discuss the Dataflow Models as a State-of-the-Art Methodology to Solve Co-Design Problems and to Optimize the balance between Software and Hardware.

CO3: Understand in Translating between Software and Hardware Descriptions through Co-Design Methodologies.

CO4: Understand the State-of-The-Art practices in developing Co-Design Solutions to problems using modern Hardware/Software Tools for building prototypes.

CO5: Understand the Concurrent Specification from an Algorithm, Analyze its behavior and partition the Specification into Software (C Code) and Hardware (HDL) Components

REFERENCES

1. Patrick Schaumont, “A Practical Introduction to Hardware/Software Co-design”, Springer,2010.
2. Ralf Niemann, “Hardware/Software Co-Design for Data Flow Dominated Embedded Systems”, Kluwer Academic Publisher, 1998.
3. Jorgen Staunstrup, Wayne Wolf, “Hardware/Software Co-Design: Principles and Practice”, Kluwer Academic Publisher,1997.

4. Giovanni De Micheli, Rolf Ernst Morgon, “Reading in Hardware/Software Co-Design”, Kaufmann Publisher,2001.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	2	2	0	0
2	1	0	2	2	0	0
3	1	0	2	2	0	0
4	1	0	2	2	2	0
5	1	0	2	2	2	0
Avg	(5/5)=1	(0/0)=0	(10/5)=2	(10/5)=2	(4/5)=0.8	(0/0)=0

IF4094 PATTERN RECOGNITION L T P C
3 0 0 3

COURSE OBJECTIVES:

- Understand the in-depth concept of Pattern Recognition
- Implement Bayes Decision Theory
- Understand the in-depth concept of Perception and related Concepts
- Understand the concept of ML Pattern Classification
- Understand the concept of DL Pattern Recognition

UNIT I PATTERN RECOGNITION 8

Induction Algorithms. Rule Induction. Decision Trees. BayesianMethods. Overview. NaiveBayes. The Basic Na¨ıve Bayes Classifier. Naive Bayes Induction for Numeric Attributes. Correction to the Probability Estimation. Laplace Correction. No Match. Other Bayesian Methods. Other Induction Methods. Neural Networks. Genetic Algorithms. Instance-based Learning. Support Vector Machines.

UNIT II STATISTICAL PATTERN RECOGNITION 8

About Statistical Pattern Recognition. Classification and regression. Features, Feature Vectors, and Classifiers. Pre-processing and feature extraction. The curse of dimensionality. Polynomial curve fitting. Model complexity. Multivariate non-linear functions. Bayes' theorem. Decision boundaries. Parametric methods. Sequential parameter estimation. Linear discriminant functions. Fisher's linear discriminant. Feed-forward network mappings.

UNIT III BAYES DECISION THEORY CLASSIFIERS 11

Bayes Decision Theory. Discriminant Functions and Decision Surfaces. The Gaussian Probability Density Function. The Bayesian Classifier for Normally Distributed Classes. Exact interpolation. Radial basis function networks. Network training. Regularization theory. Noisy interpolation theory. Relation to kernel regression. Radial basis function networks for classification. Comparison with the multi-layer perceptron. Basis function optimization.

UNIT IV LINEAR DISCRIMINANT FUNCTIONS 9

Linear Discriminant Functions and Decision Surfaces. The Two-Category Case. The Multicategory Case. The Perceptron Criterion Function. Batch Perceptron. Perceptron Algorithm Convergence. The Pocket Algorithm. Mean Square Error Estimation. Stochastic Approximation and the LMS Algorithm. Convergence Proof for Single-Sample Correction. Fixed increment descent. Some Direct Generalizations. Fixed increment descent. Batch variable increment Perceptron. Balanced Winnow algorithm. Relaxation Procedures. The Descent Algorithm

UNIT V NONLINEAR CLASSIFIERS 9

The Two Layer Perception. The Three Layer Perception. Algorithms Based On Exact Classification Of The Training Set. Feedforward operation and classification. General feedforward operation. Expressive power of multilayer networks. Backpropagation algorithm. Network learning. Training protocols. Stochastic Backpropagation. Batch Backpropagation. Radial basis function networks (RBF). Special bases. Time delay neural networks (TDNN). Recurrent networks. Counter propagation. Cascade-Correlation. Cascade-correlation. Neocognitron

TOTAL : 45 PERIODS

SUGGESTED ACTIVITIES:

1: Car Sales Pattern Classification using Support Vector Classifier
2: Avocado Sales Pattern Recognition using Linear regression
3: Tracking Movements by implementing Pattern Recognition
4: Detecting Lanes by implementing Pattern Recognition
5: Pattern Detection in SAR Images

COURSE OUTCOMES:

CO1: Discover imaging, and interpretation of temporal patterns
CO2: Identify Structural Data Patterns
CO3: Implement Pattern Classification using Machine Learning Classifiers
CO4: Implement Pattern Recognition using Deep Learning Models
CO5: Implement Image Pattern Recognition

REFERENCES

1. Pattern Classification, 2nd Edition, Richard O. Duda, Peter E. Hart, and David G. Stork. Wiley, 2000
2. Pattern Recognition, Jürgen Beyerer, Matthias Richter, and Matthias Nagel. 2018
3. Pattern Recognition and Machine Learning, Christopher M. Bishop. Springer, 2010
4. Pattern Recognition and Classification, Dougherty, and Geoff. Springer, 2013
5. Practical Machine Learning and Image Processing, Himanshu Singh. Apress, 2019

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3		2	3	1	1
2	3		2	3	1	1
3	3		2	3	1	1
4	3		2	3	1	1
5	3		2	3	1	1

Avg	(15/5)=3		(10/5)=2	(15/5)=3	(5/5)=1	(5/5)=1

VL4003 DSP STRUCTURES FOR VLSI L T P C
3 0 0 3

COURSE OBJECTIVES:

- to understand the fundamentals of DSP
- to learn various DSP structures and their implementation.
- to know designing constraints of various filters
- design and optimize VLSI architectures for basic DSP algorithms
- to enable students to design VLSI system with high speed and low power.
-

UNIT I INTRODUCTION TO DIGITAL SIGNAL PROCESSING 9

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

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

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

UNIT III RETIMING, UNFOLDING AND FOLDING 9

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

UNIT IV FAST CONVOLUTION 9

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

UNIT V ARITHMETIC STRENGTH REDUCTION IN FILTERS 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course student will be able

CO1: acquired knowledge about fundamentals of DSP processors.

CO2: improve the overall performance of DSP system through various transformation and optimization techniques.

CO3: to understand the need of different types of instructions for DSP.

CO4: optimize design in terms of computation complexity and speed.

CO5: understand clock based issues and design asynchronous and wave pipelined systems**.**

REFERENCES

1. K.K Parhi: “VLSI Digital Signal Processing”, John-Wiley, 2nd Edition Reprint, 2008.
2. John G.Proakis, Dimitris G.Manolakis, “Digital Signal Processing”, Prentice Hall of India, 1st Edition, 2009.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	1	0	0
2	1	0	1	1	0	0
3	1	0	1	1	0	0
4	1	0	1	1	0	0
5	1	0	1	1	0	0
Avg	(5/5)=1	(0/0)=0	(5/5)=1	(5/5)=1	(0/0)=0	(0/0)=0

VL4004 POWER MANAGEMENT AND CLOCK DISTRIBUTION CIRCUITS L T P C
3 0 0 3

COURSE OBJECTIVES:

- to design ~~of~~ reference circuits and low dropout regulators for desired specifications
- to understand oscillators choice and requirements for clock generation circuits
- to design clock generation and recovery in the context of high speed systems

UNIT I VOLTAGE AND CURRENT REFERENCES 9

Current mirrors, self biased current reference, startup circuits, VBE based current reference, VT based current reference, band gap reference , supply independent biasing, temperature independent biasing, PTAT current generation, constant Gm biasing.

UNIT II LOW DROP OUT REGULATORS 9

Analog building blocks, negative feedback, performance metrics, AC design, stability, internal and external compensation, PSRR – internal and external compensation circuits

UNIT III OSCILLATOR FUNDAMENTALS 9

General considerations, ring oscillators, LC oscillators, Colpitts oscillator, jitter and phase noise in ring oscillators, impulse sensitivity function for LC & ring oscillators, phase noise in differential LC oscillators.

UNIT IV CLOCK DISTRIBUTION CIRCUITS 9

PLL fundamental, PLL stability, noise performance, charge-pump PLL topology, CPPLL building blocks, jitter and phase noise performance, DLL fundamentals.

UNIT V CLOCK AND DATA RECOVERY CIRCUITS 9

CDR architectures, transimpedance amplifiers and limiters, CMOS interface, linear half rate CMOS CDR circuits, wide capture range CDR circuits.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be able to:

CO1:design band gap reference circuits and low drop out regulator for a given specification.

CO2: understand specification related to supply and clock generation circuits of IC

CO3: choose oscillator topology and design meeting the requirement of clock generation circuits.

CO4: design clock generation circuits in the context of high speed I/Os, high speed broad band communication circuits and data conversion circuits.

CO5: Design clock distribution circuits

REFERENCES

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

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	2	2	0	0
2	1	0	2	2	0	0
3	1	0	2	2	0	0
4	1	0	2	2	0	0
5	1	0	2	2	0	0
Avg	(5/5)=1	(0/0)=0	(10/5)=2	(10/5)=2	(0/0)=0	(0/0)=0

VL4005 RECONFIGURABLE ARCHITECTURES L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT - I INTRODUCTION 9

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

UNIT - II IMPLEMENTATION, SYNTHESIS AND PLACEMENT 9

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

UNIT – III COMMUNICATION AND SOPC 9

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

UNIT – IV RECONFIGURATION MANAGEMENT 9

Reconfiguration – configuration architectures – managing the reconfiguration process – reducing configuration transfer time – configuration security.

UNIT – V APPLICATIONS 9

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

TOTAL :45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should will be able to:

CO1: analyze the different architecture principles relevant to reconfigurable computing systems
CO2: compare the tradeoffs that are necessary to meet the area, power and timing criteria of reconfigurable systems
CO3: analyze the algorithms related to placement and partitioning
CO4:analyze the communication techniques and system on programmable chip for reconfigurable architectures
CO5: analyze the principles of Network and System on a Programmable Chip

REFERENCES

1. Christophe Bobda, “Introduction to Reconfigurable Computing: Architectures, Algorithms and Applications”, Springer 2007.
2. Scott Hauck and Andre Dehon, “Reconfigurable Computing: The Theory and Practice of FPGA Based Computation”, Elsevier 2008
3. M. Gokhale and P. Graham, “Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays”, Springer, 2005.
4. Nikoloas Voros Et Al. “Applied Reconfigurable Computing: Architectures, Tools and Applications” Springer, 2018.
5. Koen Bertels, João M.P. Cardoso, Stamatis Vassiliadis, “Reconfigurable Computing: Architectures and Applications”, Springer 2006.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	2	1	0	0
2	2	0	2	2	0	0
3	1	0	2	1	0	0
4	1	0	2	1	0	0
5	1	0	2	1	0	0
Avg	(6/5)=1.2	(0/0)=0	(10/5)=2	(6/5)=1.2	(0/0)=0	(0/0)=0

VL4006 ADVANCED WIRELESS SENSOR NETWORKS L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I OVERVIEW OF WIRELESS SENSOR NETWORKS 9

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

UNIT II ARCHITECTURES 9

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

UNIT III MAC AND ROUTING 9

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

UNIT IV INFRASTRUCTURE ESTABLISHMENT 9

Topology control, clustering, time synchronization, localization and positioning, sensor tasking and control.

UNIT V DATA MANAGEMENT AND SECURITY 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be able to:

CO1: design and implement simple wireless network concepts
CO2: design, analyze and implement different network architectures
CO3: implement MAC layer and routing protocols
CO4: deal with timing and control issues in wireless sensor networks
CO5: analyze and design secured wireless sensor networks

REFERENCES

1. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks" , John Wiley, 2005.
2. Erdal Çayirci , Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks-S Technology, Protocols, and Applications”, John Wiley, 2007.
4. Yingshu Li, My T. Thai,Weili Wu, “Wireless Sensor Networks and Applications”, Springer, 2008.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	0	0	3	1	3	0
2	0	0	2	1	3	0
3	3	0	1	1	3	0

4	3	0	2	1	0	0
5	3	0	2	1	3	0
Avg	(9/3)=3	(0/0)=0	(10/5)=2	(5/5)=1	(12/4)=3	(0/0)=0

AP4095 SIGNAL INTEGRITY FOR HIGH SPEED DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics

UNIT I SIGNAL PROPAGATION ON TRANSMISSION LINES 9

Transmission line equations, wave solution, wave *vs*. circuits, initial wave, delay time, Characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

UNIT II MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK 9

Multi-conductor transmission-lines, coupling physics, per unit length parameters ,Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) Differential signalling, termination, balanced circuits ,S-parameters, Lossy and Lossless models.

UNIT III NON-IDEAL EFFECTS 9

Non-ideal signal return paths – gaps, BGA fields, via transitions , Parasitic inductance and capacitance , Transmission line losses – Rs, tanδ , routing parasitic, Common-mode current, differential-mode current , Connectors.

UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9

SSN/SSO , DC power bus design , layer stack up, SMT decoupling ,, Logic families, power consumption, and system power delivery , Logic families and speed Package types and parasitic ,SPICE, IBIS models ,Bit streams, PRBS and filtering functions of link-path components , Eye diagrams , jitter , inter-symbol interference Bit-error rate ,Timing analysis.

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to

CO1: identify sources affecting the speed of digital circuits.

CO2:identify methods to improve the signal transmission characteristics

CO3: characterise and model multiconductor transmission line

CO4: analyse clock distribution system and understand its design parameters
CO5: analyse nonideal effects of transmission line

REFERENCES

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

TOOLS REQUIRED

1. SPICE, source - http://www-cad.eecs.berkeley.edu/Software/software.html
2. HSPICE from synopsis, www.synopsys.com/products/ mixedsignal/hspice/hspice.html
3. **SPECTRAQUEST** from Cadence, http://www.specctraquest.com **or any equivalent open source tool**

CO-PO Mapping

CO	POs					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
1	1	0	2	3	1	0
2	1	0	2	3	1	0
3	1	0	2	3	1	0
4	1	0	2	1	1	0
5	1	0	2	1	1	0
Avg	(5/5)=1	(0/0)=0	(10/5)=2	(11/5)=2.2	(5/5)=1	(0/0)=0

II4092 **SYSTEM ON CHIP** **L T P C**
3 0 0 3

COURSE OBJECTIVE:

- To introduce architecture and design concepts underlying system on chips.
- Students can gain knowledge of designing SoCs.
- To impart knowledge about the hardware-software design of a modest complexity chip allthe way from specifications, modeling, synthesis and physical design.

UNIT I SYSTEM ARCHITECTURE: OVERVIEW **9**

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

UNIT II PROCESSOR SELECTION FOR SOC 9

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

UNIT III MEMORY DESIGN 9

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

UNIT IV INTERCONNECT ARCHITECTURES AND SOC CUSTOMIZATION 9

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

UNIT V FPGA BASED EMBEDDED PROCESSOR 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the program the students shall

CO1: Explain all important components of a System-on-Chip and an embedded system, i.e.
CO2: digital hardware and embedded software;
CO3: Outline the major design flows for digital hardware and embedded software;
CO4: Discuss the major architectures and trade-offs concerning performance, cost and power
CO5: consumption of single chip and embedded systems;

REFERENCES:

1. Wayne Wolf, “Modern VLSI Design – System – on – Chip Design”, Prentice Hall, 3rd Edition, 2008.
2. Wayne Wolf , “Modern VLSI Design – IP based Design”, Prentice Hall, 4th Edition, 2008

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	2	1	0	0
2	1	0	2	1	0	0
3	1	0	2	1	0	0
4	1	0	2	1	0	0
5	1	0	2	1	0	0

Avg	(5/5)=1	(0/0)=0	(10/5)=2	(5/5)=1	(0/0)=0	(0/0)=0

VL4073 **MEMS AND NEMS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- to introduce the concepts of Micro Electro Mechanical devices.
- to know the 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 **9**

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

UNIT II MEMS FABRICATION TECHNOLOGIES **9**

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

UNIT III MICRO SENSORS **9**

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 **9**

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

UNIT V NANOSYSTEMS AND QUANTUM MECHANICS **9**

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:45 PERIODS

COURSE OUTCOMES:

At the end 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

REFERENCES

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
4. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures” CRC Press, 2002.
5. Tai Ran Hsu ,”MEMS and Microsystems Design and Manufacture” ,Tata Mcraw Hill, 2002.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1		2	1		
2	1		2	1		
3	1		2	1		
4	1		2	1	2	
5	1		2	1		
Avg	(5/5)=1		(10/5)=2	(5/5)=1	(2/1)=2	

VL4091 NETWORK ON CHIP L T P C
3 0 0 3

COURSE OBJECTIVES:

The students should be made to:

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

UNIT I INTRODUCTION TO NOC 9

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 9

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 9

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 and Adaptive Routing Algorithms

UNIT IV TEST AND FAULT TOLERANCE OF NOC 9

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 9

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:45 PERIODS

COURSE OUTCOMES:

At the end 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

REFERENCES

1. ChrysostoMOSnicopoulos, 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. Konstantinos Tatas and Kostas Siozios "Designing 2D and 3D Network-On-Chip Architectures" 2013
4. Palesi, Maurizio, Daneshtalab, Masoud "Routing Algorithms in Networks-On-Chip" 2014

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	3	0	0
2	1	0	1	3	0	0
3	1	0	1	3	0	0
4	1	0	1	1	0	0
5	1	0	1	1	0	0
Avg	(5/5)=1	(0/0)=0	(5/5)=1	(11/5)=2.2	(0/0)=0	(0/0)=0

VL4074 **NANO TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Provides knowledge of various industrial applications of Nanotechnology
- Introduces the theory and practice on Nanomaterials
- 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 9

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 9

What are 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 9

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 9

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

UNIT V FUTURE APPLICATIONS 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end 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 impact of Nanomaterials on environment

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

REFERENCES

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. Rebecca L Johnson,"Nanotechnology", Lerner Publications,2003
4. Charles P. Poole Jr., "Introduction to Nanotechnogy",Chapman and Hall/CRS,2003

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	1	0	0
2	1	0	1	1	0	0
3	1	0	1	1	0	0
4	1	0	1	1	0	0
5	1	0	1	1	0	0
Avg	(5/5)=1	0	(5/5)=1	(5/5)=1	0	0

VL4007 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:

At the end of this course, the students should will be able to:

CO1: understand the fundamentals of computational models and computers which have appeared at the intersection of hardware and artificial intelligence to solve hard computational problems.

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.

REFERENCES

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. Lukas Sekanina, "Evolvable Components: From Theory to Hardware Implementations", Springer, 2004

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	3	1	0	0
2	1	0	3	1	0	0
3	1	0	3	2	0	0
4	1	0	1	1	0	0
5	1	0	1	1	0	0
Avg	(5/5)=1	0	(11/5)=2.2	(6/5)=1.2	0	0

VL4092 SOFT COMPUTING AND OPTIMIZATION TECHNIQUES L T P C

3 0 0 3

COURSE OBJECTIVE:

- 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.
- Be exposed to neuro-fuzzy hybrid systems and its applications.
- To understand the various evolutionary optimization techniques.

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- Fuzzy logic 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:

Upon Completion of the course, the students will be able to:

CO1: Develop application on different soft computing techniques like Fuzzy, GA and Neural network

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: Able to use the optimization techniques to solve the real world problems

REFERENCES:

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.
4. James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Edn., 2003.
5. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2003.
6. Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall, 1998.
7. Simon Haykins, Neural Networks: A Comprehensive Foundation, Prentice Hall International Inc, 1999.

8. Timothy J.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1997.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	2	1	2	0
2	1	0	2	1	2	0
3	1	0	2	1	2	0
4	1	0	2	1	2	0
5	1	0	2	1	0	0
Avg	(5/5)=1	0	(10/5)=2	(5/5)=1	(8/4)=2	0

VL4072 CAD FOR VLSI DESIGN L T P C
3 0 2 4

COURSE OBJECTIVES:

- to introduce the VLSI design methodologies and design methods.
- to introduce data structures and algorithms required for VLSI design.
- to study algorithms for partitioning and placement.
- to study algorithms for 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 ROUTING 9

Floorplanning – Problem Formulation – Floorplanning 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:

At the end 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 floorplanning and routing.

CO5: design algorithms for modelling, simulation and synthesis.

REFERENCES

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. Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, “Handbook of Algorithms for Physical Design Automation, CRC Press, 1st Edition, 2.
4. N.a. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	2		
2	1	0	1	2		
3	1	0	1	2	2	
4	1	0	1	2	2	1
5	1	0	1	2	2	1
Avg	(5/5)=1	0	(5/5)=1	(10/5)=2	(6/3)=2	(2/2)=1

VL4009 VLSI ARCHITECTURES FOR IMAGE PROCESSING L T P C

3 0 2 4

COURSE OBJECTIVES:

- The students will be able to acquire knowledge on image and video processing algorithms
- The students will be able to acquire knowledge on design of VLSI architectures.

UNIT I IMAGE PROCESSING ALGORITHMS AND ARCHITECTURES 9

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

UNIT II 3D IMAGE PROCESSING 9

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

UNIT III 3D BINARY IMAGE PROCESSING 9

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

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

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

UNIT V VLSI SYSTEMS FOR IMAGE PROCESSING 9

Concurrent Systems for Image Analysis- VLSI Wavefront Arrays for Image Processing-Curve Detection in VLSI-Design of VLSI Based Multicomputer Architecture for Dynamic Scene Analysis-VLSI-Based Image Resampling for Electronic Publishing

TOTAL:45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Convert a 2D Image to 3D Image.
2. Perform Urinary, Binary Image Operations and Monotonic, Shift, Point, Shift-Invariant Operators for 2D Image.
3. Obtain a CT Scan Image , Perform The Following
   a. Smooth Filter
   b. Detection Filter
   c. Morphological Filter
   d. Region Growing
4. Perform Surface Thinning and Axis Thinning, Distance Transformation and Skeleton, Voronoi Division of a Digitized Image

TOTAL:30+45=75 PERIODS

COURSE OUTCOMES:

Upon Completion of The Course, Students Will Be Able to Demonstrate An Ability to

CO1: Analyze Various Architectures to Realize Image Processing Algorithms and Explain The 3D Image Processing Algorithms

CO2: Explore Various Processing Techniques of Image and Design Different Architectures for Image Processing.

CO3: Analyze various pipelined hardware architecture for 2D and 3D Image processing

CO4: Realize binary image processing algorithm in VLSI systems

CO5: Implement filter techniques in 2D and 3D image.

REFERENCES

1. Pieter Jonker, "Morphological Image Processing: Architecture and VLSI Design", Springer, First Edition, 1992.
2. Junichiro Toriwaki · Hiroyuki Yoshida, "Fundamentals of Three-Dimensional Digital Image Processing", Springer 2009.
3. King-Sun Fu, "VLSI for Pattern Recognition and Image Processing", Springer-Verlag, 1984.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	1	1	0
2	1	0	1	1	1	0
3	1	0	1	1	1	0
4	1	0	1	1	1	0
5	1	0	1	1	1	0
Avg	(5/5)=1	0	(5/5)=1	(5/5)=1	(5/5)=1	0

VL4010 **SYSTEM VERILOG** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- Insight to Apply System Verilog Concepts to Do Synthesis, Analysis and Architecture Design.
- Understanding of System Verilog and SVA for Verification and Understand The Improvements in Verification Efficiency.
- Understand Advanced Verification Features, Such As The Practical Use of Classes, Randomization, Checking, and Coverage.
- Knowledge to Communicate The Purpose and Results of a Design Experiment in Written and Oral
- Understand The Purpose of Hardware-Software Verification

UNIT I VERIFICATION METHODOLOGY **9**

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

UNIT II SYSTEM VERILOG BASICS AND CONCEPTS **9**

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

UNIT III OOPS **9**

Introduction-Where to Define a Class- OOPS Terminology -Creating New Objects -Object Deallocation- Using Objects -Static Variables Vs. Global Variables -Class Routines -Defining Routines Outside of The Class - Scoping Rules -Using One Class Inside Another - Understanding Dynamic Objects -Copying Objects -Public Vs. Private -Straying Off Course - Building a Testbench

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

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

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

System Verilog ATM Example, Data Abstraction, Interface Encapsulation, Design Top Level Squat, Receivers and Transmitters, Test Bench for ATM.

TOTAL:45 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Design a Testbench for 2x1 Mux Using Gates
2. Implementation of a Mailbox By Allocating Memory
3. Implementation and Testing of Semaphore for a Simple DUT
4. Implementation of Scoreboard for a Simple DUT

TOTAL:45+30=45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students should demonstrate the ability to

CO1: use system 63erilog to create correct, efficient, and re-usable models for digital designs
CO2: use system 63erilog to create testbenches for digital designs
CO3: understand and effectively exploit new constructs in System Verilog for verification
CO4: understand the communication between modules
CO5: designing a complete system model using Verilog

REFERENCES

1. System Verilog for Verification: a Guide to Learning The Testbench Language Features, Chris Spear,Springer 2006
2. Writing Testbenches: Functional Verification of HDL Models, Second Edition, Janick Bergeron, Kluwer Academic Publishers, 2003.
3. System Verilog for Design: a Guide to Using System Verilog for Hardware Design and Modeling, 2nd Edition, Stuart Sutherland, Simon Davidman and Peter Flake, Springer
4. Open Verification Methodology Cookbook, Mark Glasser, Springer, 2009
5. Assertion-Based Design, 2nd Edition, Harry D. Foster, Adam C. Krolnik, David J. Lacey, Kluwer Academic Publishers, 2004

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6

1	1	0	2	2	2	1
2	1	0	2	2	2	1
3	1	0	2	2	2	1
4	1	0	2	2	2	1
5	1	0	2	2	2	1
Avg	(5/5)=1	0	(10/5)=2	(10/5)=2	(10/5)=2	(5/5)=1

VL4011 ADAPTIVE SIGNAL PROCESSING L T P C
3 0 2 4

COURSE OBJECTIVES:

- to understand the basic principles of discrete random signal processing
- to understand the principles of spectral estimation
- to learn about the weiner and adaptive filters
- to understand the different signal detection and estimation methods
- to acquire skills to design synchronization methods for proper functioning of the system

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

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

UNIT II SPECTRAL ESTIMATION 9

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

UNIT III WEINER AND ADAPTIVE FILTERS 9

Weiner Filter: FIR Wiener Filter, IIR Wiener Filter, Adaptive Filter: FIR Adaptive Filters – Steepest Descent Method- LMS Algorithm, RLS Adaptive Algorithm, Applications.

UNIT IV DETECTION AND ESTIMATION 9

Bayes Detection Techniques, Map, Ml,– Detection of M-Ary Signals, Neymanpearson, Minimax Decision Criteria. Kalman Filter- Discrete Kalman Filter, The Extended Kalman Filter, Application.

UNIT V SYNCHRONIZATION 9

Signal Parameter Estimation, Carrier Phase Estimation, Symbol Timing Estimator, Joint Estimation of Carrier Phase and Symbol Timing.

TOTAL: 45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Design of Non- Parametric and Parametric for Spectral Estimation
2. Design of Linear Prediction Filter Using Matlab
3. Design of LMS Filter Using Matlab
4. Design of RLS Filter Using Matlab
5. Design of Extended Kalman Filter Using Matlab

COURSE OUTCOMES:

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

CO1: Analyze the basic principles of discrete random signal processing

CO2:Analyze the principles of spectral estimation

CO3:Analyze the Weiner and Adaptive filters

CO4:Analyze the different signal detection and estimation methods

CO5:Design the synchronization methods for proper functioning of the system

REFERENCES

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 2009.
2. John G. Proakis., "Digital Communication", 4th Edition, McGraw Hill Publications, 2001.
3. Simon Haykin, "Adaptive Filter Theory", Pearson Education, Fourth Edition, 2003
4. Bernard Sklar and Pabitra Kumar Roy, "Digital Communications: Fundamentals and Applications", 2/E, Pearson Education India, 2009
5. Paulo S. R. Diniz, "Adaptive Filtering Algorithms and Practical Implementation", Springer, 2011

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	0	1	1	1	1
2	1	1	2	1	1	1
3	2	0	2	1	1	1
4	2	0	1	1	1	1
5	2	1	2	2	1	1
Avg	(8/5)=1.6	(2/2)=1	(8/5)=1.6	(6/5)=1.2	(5/5)=1	(5/5)=1

CP4252 MACHINE LEARNING L T P C

3 0 2 4

COURSE OBJECTIVES:

- To understand the concepts and mathematical foundations of machine learning and types of problems tackled by machine learning
- To explore the different supervised learning techniques including ensemble methods
- To learn different aspects of unsupervised learning and reinforcement learning
- To learn the role of probabilistic methods for machine learning
- To understand the basic concepts of neural networks and deep learning

UNIT I INTRODUCTION AND MATHEMATICAL FOUNDATIONS 9

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

UNIT II SUPERVISED LEARNING 9

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

UNIT III UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING 9

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

UNIT IV PROBABILISTIC METHODS FOR LEARNING- 9

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

UNIT V NEURAL NETWORKS AND DEEP LEARNING 9

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

45 PERIODS

SUGGESTED ACTIVITIES:

1. Give an example from our daily life for each type of machine learning problem
2. Study at least 3 Tools available for Machine Learning and discuss pros & cons of each
3. Take an example of a classification problem. Draw different decision trees for the example and explain the pros and cons of each decision variable at each level of the tree
4. Outline 10 machine learning applications in healthcare
5. Give 5 examples where sequential models are suitable.
6. Give at least 5 recent applications of CNN

PRACTICAL EXERCISES: 30 PERIODS

1. Implement a Linear Regression with a Real Dataset (https://www.kaggle.com/harrywang/housing). Experiment with different features in building a model. Tune the model's hyperparameters.
2. Implement a binary classification model. That is, answers a binary question such as "Are houses in this neighborhood above a certain price?"(use data from exercise 1). Modify the classification threshold and determine how that modification influences the model. Experiment with different classification metrics to determine your model's effectiveness.
3. Classification with Nearest Neighbours. In this question, you will use the scikit-learn's KNN classifer to classify real vs. fake news headlines. The aim of this question is for you to read the

scikit-learn API and get comfortable with training/validation splits. Use California Housing Dataset

4. In this exercise, you'll experiment with validation sets and test sets using the dataset. Split a training set into a smaller training set and a validation set. Analyze deltas between training set and validation set results. Test the trained model with a test set to determine whether your trained model is overfitting. Detect and fix a common training problem.
5. Implement the k-means algorithm using https://archive.ics.uci.edu/ml/datasets/Codon+usage dataset
6. Implement the Naïve Bayes Classifier using https://archive.ics.uci.edu/ml/datasets/Gait+Classification dataset
7. Project - (in Pairs) Your project must implement one or more machine learning algorithms and apply them to some data.
    a. Your project may be a comparison of several existing algorithms, or it may propose a new algorithm in which case you still must compare it to at least one other approach.
    b. You can either pick a project of your own design, or you can choose from the set of pre-defined projects.
    c. You are free to use any third-party ideas or code that you wish as long as it is publicly available.
    d. You must properly provide references to any work that is not your own in the write-up.
    e. Project proposal You must turn in a brief project proposal. Your project proposal should describe the idea behind your project. You should also briefly describe software you will need to write, and papers (2-3) you plan to read.

List of Projects (datasets available)

1. Sentiment Analysis of Product Reviews
2. Stock Prediction
3. Sales Forecasting
4. Music Recommendation
5. Handwriting Digit Classification
6. Fake News Detection
7. Sports Prediction
8. Object Detection
9. Disease Prediction

COURSE OUTCOMES:

Upon the completion of course, students will be able to

CO1: Understand and outline problems for each type of machine learning

CO2: Design a Decision tree and Random forest for an application

CO3: Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.

CO4: Use a tool to implement typical Clustering algorithms for different types of applications.

CO5: Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification.

TOTAL:75 PERIODS

REFERENCES

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

4. Tom M Mitchell, “Machine Learning”, McGraw Hill Education, 2013.
5. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012.
6. Shai Shalev-Shwartz and Shai Ben-David, “Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2015
7. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
8. Hal Daumé III, “A Course in Machine Learning”, 2017 (freely available online)
9. Trevor Hastie, Robert Tibshirani, Jerome Friedman, “The Elements of Statistical Learning”, Springer, 2009 (freely available online)
10. Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3		2	3	1	1
2	3		2	3	1	1
3	3		2	3	1	1
4	3		2	3	1	1
5	3		2	3	1	1
Avg	(15/5)=3		(10/5)=2	(15/5)=3	(5/5)=1	(5/5)=1

DS4151 DIGITAL IMAGE AND VIDEO PROCESSING L T P C
3 0 2 4

COURSE OBJECTIVES:

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

UNIT I FUNDAMENTALS OF IMAGE PROCESSING AND TRANSFORMS 9

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

UNIT II ENHANCEMENT AND RESTORATION 9

Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Introduction to Image restoration, Image degradation,

Image restoration model, Linear and Nonlinear image restoration techniques, Blind deconvolution. Color image enhancement.

UNIT III SEGMENTATION AND RECOGNITION 9

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

UNIT IV BASIC STEPS OF VIDEO PROCESSING 9

Analog Video, Digital Video. Time-Varying Image Formation models:Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation,Sampling of Videosignals, Filtering operations

UNIT V 2-D MOTION ESTIMATION 9

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

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Histogram Equalization
2. Image Filtering (spatial-domain)
3. Image Filtering (frequency-domain)
4. Image Segmentation
5. Familiarization with Video Processing tools
6. Denoising video
7. Video resizing
8. Background subtraction
9. Interpolation methods for re-sampling
10. Adaptive unsharp masking based interpolation for video up-sampling
11. Gaussian mixture model (GMM) based background subtraction
12. Video encoding

COURSE OUTCOMES:

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

CO1: Analyze the digital image, representation of digital image and digital images in transform Domain.

CO2: Analyze the detection of point, line and edges in images and understand the redundancy in images, various image compression techniques.

CO3: Analyze the video technology from analog color TV systems to digital video systems, how video signal is sampled and filtering operations in video processing.

CO4: Obtain knowledge in general methodologies for 2D motion estimation, various coding used in video processing.

CO5: Design image and video processing systems.

TOTAL:75 PERIODS

REFERENCES:

1. Digital Image Processing – Gonzalez and Woods, 3rd Ed., Pearson, 2016
2. Handbook of Image and Video processing, Academic press, 2010

3. K.R.Castelman, Digital Image processing, Prentice Hall, 1996
4. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition, 2002
5. R C Gonzalez, R E Woods and S L Eddins, Digital Image Processing Using Matlab, Pearson Education , 2006

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3		2	2	2	2
2	3		2	2	2	2
3	3		2	2	2	2
4	3		2	2	2	2
5	3		2	2	2	2
Avg	3		2	2	2	2

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING **L T P C**
2 0 0 0

COURSE OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING **6**

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

UNIT II PRESENTATION SKILLS **6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS **6**

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

UNIT IV RESULT WRITING SKILLS **6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS **6**

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:

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. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	3	-	-	2	-
2	1	3	-	-	2	-
3	1	3	-	-	2	-
4	1	3	-	-	2	-
5	1	3	-	-	2	-
Avg	1	3	-	-	2	-

AX4092 DISASTER MANAGEMENT **L T P C**
2 0 0 0

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION **6**

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

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

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

UNIT III DISASTER PRONE AREAS IN INDIA 6

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

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

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

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

CO-PO Mapping

CO	POs

	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	-	-	2	-
2	3	1	-	-	2	-
3	3	1	-	-	2	-
4	3	1	-	-	2	-
5	3	1	-	-	2	-
Avg	3	1	-	-	2	-

AX4093 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

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

UNIT IV ORGANS OF GOVERNANCE

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

UNIT V LOCAL ADMINISTRATION

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

UNIT VI ELECTION COMMISSION

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

5. CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1				
2			2			
3			1			
4						
5						2
Avg	1	1	1.5			2

AX4094 **நற்றமிழ் இலக்கியம்** **L T P C**
2 0 0 0

UNIT I சங்க இலக்கியம் **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்

3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

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

UNIT III **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்

ஆகியவை பற்றிய செய்திகள்

UNIT V **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,

- நாடகம்,

2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

CO-PO Mapping

CO	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
Avg	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1	(5/5)=1

OPEN ELECTIVES

OCE431 INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

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 – Non-market 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

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1	Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2	Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3	Apply law and governance in the context of IWRM.
CO4	Discuss the linkages between water-health; develop a HIA framework.
CO5	Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.

2. Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.
5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

OCE432 WATER, SANITATION AND HEALTH L T P C
3 0 0 3

OBJECTIVES:

- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

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

OUTCOMES:

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.

CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.
2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary***.** Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I 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.

UNIT II 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 10

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 8

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

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla,* IIED and UNFPA, Earthscan, UK, 2008

5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006

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

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C
3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, 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 10

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 8

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

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between 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

REFERENCES:

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. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996

4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003

5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey

6. World Bank –Source book on EIA ,1999

7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OIC431 BLOCKCHAIN TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

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

UNIT II BITCOIN AND CRYPTOCURRENCY 9

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

UNIT III INTRODUCTION TO ETHEREUM 9

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

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

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

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand and explore the working of Blockchain technology

CO2: Analyze the working of Smart Contracts

CO3: Understand and analyze the working of Hyperledger

CO4: Apply the learning of solidity to build de-centralized apps on Ethereum

CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.

2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016

3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .

4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.

5. D. Drescher, Blockchain Basics. Apress, 2017.

OIC432 DEEP LEARNING L T P C

3 0 0 3

COURSE OBJECTIVES:

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

UNIT I DEEP LEARNING CONCEPTS 6

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

UNIT II NEURAL NETWORKS **9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK **10**

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

UNIT VI NATURAL LANGUAGE PROCESSING USING RNN **10**

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

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING **10**

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

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data

CO2: Implement Image Segmentation and Instance Segmentation in Images

CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)

CO4: Traffic Information analysis using Twitter Data

CO5: Autoencoder for Classification & Feature Extraction

TOTAL : 45 PERIODS

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT- I BASICS OF VIBRATION 9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT- II BASICS OF NOISE 9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT- V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.

5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.
2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

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3	0	0	3

COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO 9

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING 9

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV 9

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS 9

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES 9

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors

   (Could be downloaded from www.energymanagertraining.com)
6. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
7. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
8. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433 ADDITIVE MANUFACTURING L T P C

3 0 0 3

UNIT I INTRODUCTION 9

Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION 9

Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9

Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-– Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters - Materials -Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

OME434 ELECTRIC VEHICLE TECHNOLOGY L T P C

3 0 0 3

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 of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, 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, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL 9

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor 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 equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance, Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel 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 and Design”, CRC Press, 2005

OME435	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.

2. Identfying opportunity and planning for new product design and development.

3. Conducting customer need analysis; and setting product specification for new product design

and development.

4. Generating, selecting, and testing the concepts for new product design and development.

5. Appling the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCTDESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.

2. Identify opportunity and plan for new product design and development.

3. Conduct customer need analysis; and set product specification for new product design and development.

4. Generate, select, and test the concepts for new product design and development.

5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development “McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill, 2010.

2. Rosenthal S.,“Effective Product Design and Development”, Business One Orwin,Homewood, 1992,ISBN1-55623-603-4.

3. Pugh.S,“Total Design Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing,1991,ISBN0-202-41639-5.

4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.

5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

OBA431 SUSTAINABLE MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman’s stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance-sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS 9

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.

2. Intellectual Property rights and copyrights, EssEss Publications.

3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.

4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.

5. WIPO Intellectual Property Hand book.

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY 9

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.

2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.

3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251 IoT FOR SMART SYSTEMS LT P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, 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 9

PROTOCOLS:

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:

At the end of this course, the students will have the ability 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

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.

2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.

3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.

4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.

5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.

6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.

7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.

8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072 MACHINE LEARNING AND DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

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

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

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

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

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

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

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

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text,

Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

To impart knowledge on

- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy 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 - CO_2 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

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

REFERENCES:

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 Applications", PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006
6. Gray, L. Johnson, "Wind energy system", prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093 **SMART GRID** **L T P C**
3 0 0 3

COURSE OBJECTIVES

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

UNIT I INTRODUCTION TO SMART GRID 9

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

UNIT II SMART GRID TECHNOLOGIES 9

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

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

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

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

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

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.

CO2: Explain the function of Smart Grid.

CO3: Experiment the issues of Power Quality in Smart Grid.

CO4: Analyze the performance of Smart Grid.

CO5**:** Recommend suitable communication networks for smart grid applications

REFERENCES

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

CP4391 SECURITY PRACTICES L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I SYSTEM SECURITY 9

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

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

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

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

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

UNIT V PRIVACY AND STORAGE SECURITY 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017

2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022

3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019

4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0

5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012

6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.

7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

MP4251 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

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

UNIT II CLOUD PLATFORM ARCHITECTURE 12

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

UNIT III AWS CLOUD PLATFORM - IAAS 9

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

UNIT IV PAAS CLOUD PLATFORM 9

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

UNIT V PROGRAMMING MODEL 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.

2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.

3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.

4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing ,

MCGraw Hill Education (India) Pvt. Ltd., 2013.

5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guide‖, McGraw-Hill Osborne Media, 2009.

6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.

7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.

8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.

9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072 **DESIGN THINKING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I **UX LIFECYCLE TEMPLATE** **8**

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

UNIT II **CONTEXTUAL INQUIRY** **10**

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

UNIT III **DESIGN THINKING, IDEATION, AND SKETCHING** **9**

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

UNIT IV **UX GOALS, METRICS, AND TARGETS** **8**

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user

experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

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

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application
CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018

2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012

3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018

4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016

5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 PRINCIPLES OF MULTIMEDIA L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.

- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT II ELEMENTS OF MULTIMEDIA 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT III MULTIMEDIA TOOLS 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT IV MULTIMEDIA SYSTEMS 9

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

Suggested Activities:

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

Suggested Evaluation Methods:

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

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

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

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)
4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

CX4016 ENVIRONMENTAL SUSTAINABILITY L T P C
3 0 0 3

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

REFERENCES

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, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

TX4092 TEXTILE REINFORCED COMPOSITES L T P C
3 0 0 3

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 thermosets-

Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing 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

REFERENCES

1. BorZ.Jang,"Advanced Polymer composites",ASM International,USA,1994.

2. Carlsson L.A. and Pipes R.B., "Experimental Characterization of advanced composite Materials",SecondEdition,CRCPress,NewJersey,1996.

3. George LubinandStanley T.Peters, "Handbook of Composites", Springer Publications,1998.

4. Mel. M. Schwartz, "Composite Materials", Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.

5. RichardM.Christensen,"Mechanics of compositematerials",DoverPublications,2005.

6. Sanjay K. Mazumdar, "Composites Manufacturing: Materials, Product, and Process Engineering",CRCPress,2001

NT4002 NANOCOMPOSITE MATERIALS L T P C
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UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of

synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, 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

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

BY4016 IPR, BIOSAFETY AND ENTREPRENEURSHIP L T P C
3 0 0 3

UNIT I IPR 9

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY 9

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety

guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS 9

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT 9

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) - Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL : 45 PERIODS

REFERENCES

1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.

2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.

3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.

4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.

5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.

6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.