PROGRAM CURRICULUM

VLSI DESIGN

for

M. TECH. TWO YEAR DEGREE PROGRAM

(Applicable for the batches admitted from A.Y 2024-25)

Aditya Nagar, ADB Road, Surampalem - 533 437

VISION & MISSION OF THE UNIVERSITY

VISION:

Aditya University aspires to be a globally recognised academic institution dedicated to quality education, cutting-edge research, and technological service to our country, and envisions itself as a beacon of holistic advancement and long-term impact, remaining dynamic in the ever-changing worlds of society, ecology, and economics..

MISSION:

- Aditya University pushes boundaries to design high-quality curricula and to provide students with a vibrant and relevant education that prepares them for a changing world. Our industry insights and creative teaching methods attempt to equip our students to be lifelong learners.
- Aditya University's learning environment encourages intellectual curiosity, critical thinking, and cooperation, with the goal of providing students with an immersive education that fosters creativity and innovation. Our cutting-edge facilities, interactive classrooms, and supportive faculty aim to motivate students to realise their full potential and contribute to society.
- Aditya University promotes cross-disciplinary inquiry and discovery and leads cutting-edge research and innovation. Through strategic partnerships, research grants, and a dedicated faculty, we aim to advance science, technology, and social sciences and empower students and faculty to conduct transformative research that solves real-world problems and elevates our institution globally.
- Aditya University is committed to producing world-changing bu entrepreneurs through its emphasis on entrepreneurship, mento incubation programmes.

Department of Electronics and Communication Engineering

Vision:

To become a center of excellence in Electronics and Communication Engineering, fostering technological capability, professional commitment, and social responsibility through cutting-edge education, innovative research and sustainable solutions towards global technological advancement for the betterment of society.

Mission:

M1: To provide quality education supported by well-equipped laboratory facilities and strong industry collaboration for professional success and technological leadership.

M2: To promote cutting-edge technologies and foster innovative research Engineering to serve the needs of the society, industry, and scientific community.

M3: To inculcate professional ethics and personality development skills, empowering students with the values and interpersonal abilities required to succeed in diverse, global environments.

PROGRAM OUTCOMES (POs)

After successful completion of the program, the graduates will be able to

PO 1	Independently carry out research /investigation and development work to solve practical problems
PO 2	Write and present a substantial technical report/document
PO 3	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.
PO 4	Learn, keep up with contemporary technologies and ways of working.
PO 5	Communicate effectively as an individual or a team leader in diverse and multidisciplinary groups.
PO 6	Use the principles of project management such as scheduling, work breakdown structure and be conversant with the principles of finance for profitable project management.

PROGRAM SPECIFIC OUTCOMES (PSO's)

After successful completion of the program, the graduates will be able to

PSO1	Acquire competency in areas of VLSI including IC Fabrication, Design, Testing, Verification and prototype development focusing on applications.
PSO2	Design, implement, analyze and interpretation of VLSI projects using CAD & EDA tools: Cadence-Spice, Xilinx ISE, MATLAB, Mentor graphics, micro wind, DSCH
PSO3	Integrate multiple sub-systems to develop System On Chip, optimize its performance and excel in industry sectors related to VLSI domain.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the Program will

PEO 1	Post-Graduates will develop a strong foundation in VLSI design principles and techniques, enabling them to solve complex engineering problems, lead projects in the electronics sector, and contribute effectively to multi-disciplinary teams in both industry and academia.
PEO 2	Post-Graduates will engage in continuous learning and research in VLSI and related areas, utilizing emerging technologies and innovative approaches to design efficient systems and contribute to advancements in semiconductor technology.
PEO3	Post-Graduates will demonstrate ethical responsibility, professional integrity, and leadership in their careers by making significant contributions to societal and technological growth while adhering to sustainable practices in the electronics and communication industry.

ADITYA UNIVERSITY

Department of Electronics and Communication Engineering

Master of Technology in VLSI Design (VLSID)

Program Curriculum-2024

Credit Division:

S.No	Broad Category of Course	Credit Division
1	Program Core Courses (PCC)	30
2	Program Elective Courses (PEC)	15
3	University Elective Courses (UEC)	03
4	Technical Paper Publication (TPP)	02
5	Summer Internship (SI)	02
6	Project-Part I&II (PROJ)	28
7	Audit Course (AUC)	0
Total		**80**

Program Core Courses (PCC):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242EC001	Analog IC Design	2	0	1	3	50	50	100	-
242EC002	Digital IC design	2	0	1	3	50	50	100	-
242EC003	Mixed Signal and RF IC Design	2	0	1	3	50	50	100	-
242EC004	Verification using System Verilog and UVM	2	0	1	3	50	50	100	-
242EC005	VLSI fabrication Technology	2	1	0	3	50	50	100	-
242EC006	Physical Design Automation	2	0	1	3	50	50	100	-
242EC007	VLSI Testing and Validation	2	0	1	3	50	50	100	VUVM
242EC008	Microelectronics Device Modelling	2	1	0	3	50	50	100	AICD&DICD
242EC009	Nano-Electronics	3	0	0	3	50	50	100	AICD
242EC010	Scripting Languages	2	0	1	3	50	50	100	-

Program Elective Courses (PEC):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242EC011	FPGA based System Design	2	0	1	3	50	50	100	DICD
242EC012	M/NEMS Technology	3	0	0	3	50	50	100	NE
242EC013	Nanomaterials and Nanotechnology	2	1	0	3	50	50	100	NE
242EC014	Network Security and Cryptography	3	0	0	3	50	50	100	VLSITV
242EC015	Low Power VLSI circuit Design	2	1	0	3	50	50	100	MSD
242EC016	VLSI Signal Processing	2	1	0	3	50	50	100	AICD&D ICD
242EC017	SOC Design	2	1	0	3	50	50	100	DICD
242EC018	Hardware Software co-design	2	1	0	3	50	50	100	FPGASD
242EC019	Photonics	3	0	0	3	50	50	100	-
242EC020	Sensors and Sensor Circuit Design	2	1	0	3	50	50	100	MNT
242EC021	ASIC Design	3	0	0	3	50	50	100	DICD
242EC022	DSP algorithms for VLSI	2	1	0	3	50	50	100	VLSI SP
242EC023	VLSI Architectures	2	1	0	3	50	50	100	FPGASD
242EC024	VLSI Solid State Circuits	3	0	0	3	50	50	100	MDM
242EC025	Machine Learning for VLSI Design	3	0	0	3	50	50	100	-

University Elective Courses (UEC):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242CE028	Metro Rail Transportation Design and Construction (L&T EduTech)**	3	0	0	3	50	50	100	-
242CE029	Building Information Modelling in Architecture, Engineering and Construction (L&T EduTech) **	3	0	0	3	50	50	100	-
242CE030	Basic Concrete Technology	3	0	0	3	50	50	100	-
242CE031	Repair & Rehabilitation of Structures	3	0	0	3	50	50	100	-
242EE028	Neural Networks and Fuzzy Logic	3	0	0	3	50	50	100	-
242EE029	Hybrid Electric Vehicles	3	0	0	3	50	50	100	-
242EE030	Electrical Power Distribution and Automation (L&T EduTech) **	3	0	0	3	50	50	100	-
242EE031	Renewable Energy & Power Evacuation (L&T EduTech) **	3	0	0	3	50	50	100	-
242ME028	Design of fire and life safety systems(L&T EduTech) **	3	0	0	3	50	50	100	-
242ME029	Green Engineering Systems	3	0	0	3	50	50	100	-
242ME030	I.C. Engines	3	0	0	3	50	50	100	-
242EC028	CAD Tools for VLSI Design	3	0	0	3	50	50	100	-
242EC029	FPGA Design for Embedded Systems	3	0	0	3	50	50	100	-
242CS030	Artificial Intelligence	3	0	0	3	50	50	100	-
242CS031	Machine Learning techniques	3	0	0	3	50	50	100	-

**The syllabus for the industry partner courses will be released in the department as and when required

Technical Paper Publication (TPP):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242EC026	Technical Paper Publication	0	0	2	2	100	-	100	-

Summer Internship (SI):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242EC027	Summer Internship	0	0	2	2	100	-	100	-

Project-Part I&II (PROJ):

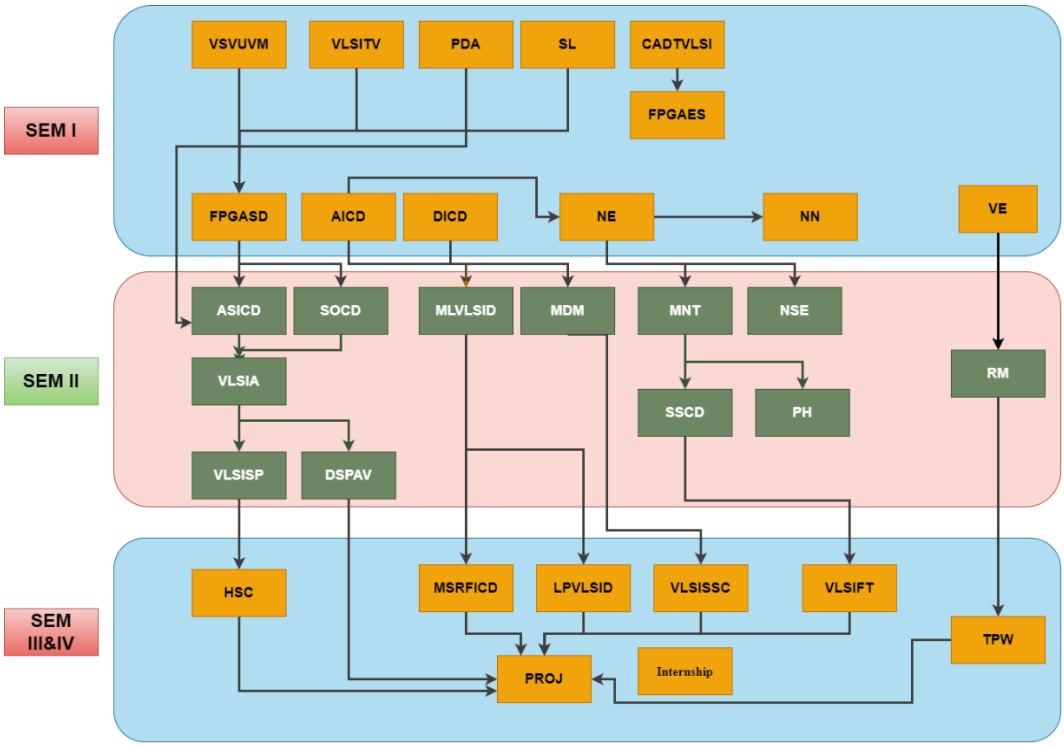
Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242EC030	Project-Part I (PROJ)	0	0	10	10	100	-	100	-
242EC031	Project-Part II (PROJ)	0	0	18	18	50	50	100	-

Audit Courses (AUC):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242AC001	Value Education	2	0	0	0	100	-	100	-
242AC002	Research Methodology	2	0	0	0	100	-	100	-

2024 M. Tech (VLSI DESIGN) CURRICULUM

PRE-REQUISITE FLOW CHART



Suggestive Semester-wise Curriculum

I Semester

Course Code	Course Title	Course Category	Credits				Total Hours
			L	T	P	Total	
242EC001	Analog IC Design	PCC	2	0	1	3	4
242EC002	Digital IC design	PCC	2	0	1	3	4
242EC004	Verification using System Verilog and UVM	PCC	2	1	0	3	3
242EC010	Scripting Languages	PCC	2	1	0	3	3
242EC009	Nano-Electronics	PCC	3	0	0	3	3
-	Program Elective Courses-1	PEC	-	-	-	3	3
-	Program Elective Courses-2	PEC	-	-	-	3	3
242AC001	Value Education	AUC	2	0	0	0	2
		Total	**13**	**2**	**2**	**21**	**25**

II Semester

Course Code	Course Title	Course Category	Credits				Total Hours
			L	T	P	Total	
242EC003	Mixed Signal & RF IC Design	PCC	2	0	1	3	**4**
242EC005	VLSI fabrication Technology	PCC	2	1	0	3	**3**
242EC006	Physical Design Automation	PCC	2	0	1	3	**4**
242EC008	Microelectronics Device Modelling	PCC	2	1	0	3	**3**
242EC007	VLSI Testing and Validation	PCC	2	1	0	3	3
-	Program Elective Courses-3	PEC	-	-	-	3	**3**
-	Program Elective Courses-4	PEC	-	-	-	3	**3**
242AC002	Research Methodology	AUC	2	0	0	0	**2**
		Total	**12**	**3**	**2**	**21**	**25**

III Semester

Course Code	Course Title	Course	Credits				Total Hours
		Category	L	T	P	Total	
----	Program Elective Course -V	PEC	3	0	0	3	3
----	University Elective Courses	UEC	3	0	0	3	3
242EC027	Summer Internship	SI	0	0	2	2	-
242EC030	Project Part-I	PROJ	0	0	10	10	18
		Total	**6**	**0**	**12**	**18**	**24**

IV Semester

Course Code	Course Title	Course	Credits				Total Hours
		Category	L	T	P	Total	
242EC026	Technical Paper Publication	TPP	0	0	2	2	6
242EC031	Project Part-II	PROJ	0	0	18	18	34
		Total	**0**	**0**	**20**	**20**	**40**

Program Elective Course-I		
S.NO	**Course code**	**Course name**
1	242EC011	FPGA based System Design
2	242EC017	SOC Design
3	242EC021	ASIC Design

Program Elective Course-II		
S.NO	**Course code**	**Course name**
1	242EC012	M/NEMS Technology
2	242EC015	Low Power VLSI circuit Design
3	242EC022	DSP algorithms for VLSI

Program Elective Course-III		
S.NO	**Course code**	**Course name**
1	242EC013	Nanomaterials and Nanotechnology
2	242EC016	VLSI Signal Processing
3	242EC018	Hardware Software co-design

Program Elective Course-IV		
S.NO	**Course code**	**Course name**
1	242EC014	Network Security & Cryptography
2	242EC019	Photonics
3	242EC023	VLSI Architectures

Program Elective Course-V		
S.NO	**Course code**	**Course name**
1	242EC020	Sensors and Sensor Circuit Design
2	242EC024	VLSI Solid State Circuits
3	242EC025	Machine Learning for VLSI Design

ANALOG IC DESIGN

	L	T	P	C
Course Code:242EC001	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Design basic building blocks of CMOS analog ICs.
CO2: Analyze the characteristics of different CMOS circuits.
CO3: Compare performance metrics of CMOS amplifiers.
CO4: Develop the two stage CMOS operational amplifiers.
CO5: Analyze the basic comparator and different performance parameters of comparator.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	1	1	2	-
CO2:	2	2	1	1	2	-
CO3:	2	2	2	1	2	-
CO4:	2	3	1	1	2	-
CO5:	2	2	2	2	2	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	1	2	-
CO2:	1	2	-
CO3:	1	2	-
CO4:	1	2	-
CO5:	1	2	-

UNIT – I

MOS Devices and Modeling: The MOS Transistor, Passive Components- Capacitor & Resistor, Integrated circuit Layout, CMOS Device Modeling - Simple MOS Large-Signal Model, Other Model Parameters, Small-Signal Model for the MOS Transistor, Computer Simulation Models, Sub-threshold MOS Model.

Practice:

1. Simulation of MOS Device Characterization and parametric analysis.
2. CMOS Inverter - DC, AC, Transient Analysis.

UNIT – II

Analog CMOS Sub-Circuits: MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Current Mirrors-Current mirror with Beta Helper, Degeneration, Cas code current Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference.

Practice:

1. Analysis and Design of Common Source Amplifier with Diode Connected Load.
2. Analysis and Design of Common Gate Amplifier with Resistive load and Current Source load.

UNIT – III

CMOS Amplifiers: Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures.

Practice:

1. Analysis and Design of Simple Current Mirror and Suggest a circuit to minimize the error in the output current.
2. Analysis and Design of Differential Amplifier with Active load and Current Source Load.

UNIT – IV

CMOS Operational Amplifiers: Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power- Supply Rejection Ratio of Two-Stage Op Amps, Cascode Op Amps, Measurement Techniques of OP Amp.

Practice:

1. Analysis and Design of Cascode Amplifier and Suggest a Circuit to overcome Voltage Headroom Limitation.
2. Analysis and Design of Two-Stage Op-Amp with Frequency Compensation.

UNIT – V

Comparators: Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete Time Comparators

Practice:

1. Analysis and Design of open loop comparator.

Text Books:

1	CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, International Second Edition/Indian Edition, ISBN Number- 0195116445
2	Analysis and Design of Analog Integrated Circuits- Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer, Wiley India, Fifth Edition, ISBN Number- 0470245999

Reference Books:

1	Analog Integrated Circuit Design- David A.Johns, Ken Martin, Wiley Student Edition, ISBN Number- 9788126543939
2	Design of Analog CMOS Integrated Circuits- Behzad Razavi, TMH Edition, ISBN Number- 938706784X

Web Links:

1	http://www.aicdesign.org/OnLineLectures.html
2	http://nptel.ac.in/courses/117106030/
3	www.mentor.com
4	www.cadence.com

DIGITAL IC DESIGN

	L	T	P	C
Course Code:242EC002	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Infer the functionality of MOS circuits.
CO2: Analyze various combinational circuits designs in CMOS
CO3: Analyze sequential logic gates designs in CMOS
CO4: Infer the functionality of arithmetic building blocks.
CO5: Analyze different semiconductor memories

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	1	1	1	2	1
CO2:	2	3	1	1	2	1
CO3:	2	2	3	1	2	1
CO4:	2	3	1	1	2	1
CO5:	2	2	3	2	2	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	1	2	3
CO2:	1	2	3
CO3:	1	2	3
CO4:	1	3	2
CO5:	1	3	2

UNIT – I
MOS Design:
Pseudo NMOS Logic: Inverter, Inverter threshold voltage, Output high voltage, Output Low voltage, Gain at gate threshold voltage, Transient response, Rise time, Fall time, Pseudo NMOS logic gates, Transistor equivalency, CMOS Inverter logic.
Practice:
1. Inverter Characteristics.
2. NAND and NOR Gate

UNIT – II
Combinational MOS Logic Circuits:MOS logic circuits with NMOS loads, Primitive CMOS logic gates – NOR & NAND gate, Complex Logic circuits design – Realizing Boolean expressions using NMOSgates and CMOS gates, AOI and OIA gates, CMOS full adder, CMOS transmission gates, Designing with Transmission gates.
Practice:
1. XOR and XNOR Gate
2. Full Adder

UNIT – III

Sequential MOS Logic Circuits:Behavior of bistable elements, SR Latch, Clocked latch and flip flop circuits, CMOS D latch and edge triggered flip-flop.

Practice:

1. RS-Latch
2. Ring Oscillator

UNIT – IV

Dynamic Logic Circuits:Basic principle, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, High performance Dynamic CMOS circuits, Dynamic logic vs Domino logic.

Practice:

1. Clock Divider
2. Synchronous Counter

UNIT – V

Semiconductor Memories:Types, RAM array organization, DRAM – Types, Operation, Leakage currents in DRAM cell and refresh operation, SRAM operation Leakage currents in SRAM cells, Flash Memory- NOR flash and NAND flash.

Practice:

1. Asynchronous Counter
2. 1-Bit RAM

Text Books:

1. CMOS Digital Integrated Circuits Analysis and Design, Sung-Mo Kang, Yusuf Leblebici, TMH, 3rd Ed, ISBN Number- 0072460539.
2. Digital Integrated Circuits, Jan M Rabaey, Pearson Education, 2nd Edition, ISBN Number- 9385152343

Reference Books:

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective, Ming - BO Lin, CRC Press, ISBN Number- 143986859X
2. Digital Integrated Circuits –A Design Perspective, JanM.Rabaey, Anantha Chandrakasan, Borivoje Nikolic, PHI, 2nd Ed, ISBN Number- 0130909963

Web Links:

1. https://subodhtripathi.files.wordpress.com/2012/01/0072460539cmos1.pdf
2. https://highered.mheducation.com/sites/0072460539/index.html
3. https://www.scribd.com/doc/102546275/CMOS-Digital-Integrated-Circuits- Sung-Mo-Kang-Leblebici
4. https://infoscience.epfl.ch/Infoscience

MIXED SIGNAL and RF IC DESIGN

	L	T	P	C
Course Code:242EC003	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Comprehend the fundamental components used in analog and digital circuit design.
CO2: Explore the applications of data converters in various fields.
CO3: Analyze the stability and performance of PLL.
CO4: Infer bottlenecks specific to RF IC design.
CO5: Interpret RF Transceiver Architecture.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	1	1	1	2	-
CO2:	2	3	1	1	2	-
CO3:	2	2	2	1	2	-
CO4:	2	3	1	1	2	-
CO5:	2	2	2	1	2	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	1	2	-
CO2:	1	2	-
CO3:	1	2	-
CO4:	1	2	-
CO5:	1	3	-

UNIT – I

Basic Building Blocks, Op-Amp, Capacitors, Switches, Non-overlapping Clocks,Basic Operation and Analysis, Resistor Equivalence of a Switched Capacitor,Parasitic-Sensitive Integrator, Parasitic-Insensitive Integrators, Signal-Flow-GraphAnalysis, Noise in Switched-Capacitor Circuit.

Practice:

1. Fully compensated op-amp with resistor and miller compensation
2. Parasitic sensitive integrator switched capacitor circuits

UNIT – II

Ideal D/A Converter, Ideal A/D Converter, Quantization Noise, DeterministicApproach, Stochastic Approach, Signed Codes, Performance Limitations, Resolution, Offset and Gain Error, Accuracy and Linearity Integrating Converters, Successive Approximation Converters, DAC-Based Successive Approximation, ChargeRedistribution A/D, Resistor-Capacitor Hybrid, Speed Estimate for ChargeRedistribution Converters, Error Correction in Successive-Approximation Converter.

Practice:

1. Parasitic insensitive integrator switched capacitor circuits
2. Design two stage cross coupled clamped comparator.

UNIT – III

Basic Phase-Locked Loop Architecture, Voltage Controlled Oscillator, Divider Phase Detector, Loop Filer, The PLL in Lock, Linearized Small-Signal Analysis, SecondOrder PLL Model, Limitations of the Second-Order Small-Signal Model, PLLDesign Example, Jitter and Phase Noise, Period Jitter , P-Cycle Jitter, AdjacentPeriod Jitter, other Spectral Representations of Jitter, Probability Density Functionof Jitter, Ring Oscillators , LC Oscillators , phase Noise of Oscillators, jitter andPhase Noise in PLLS.

Practice:

1. Design Strobed Flip-flop comparator.
2. Design of PLL

UNIT – IV

INTRODUCTION TO RF AND WIRELESS TECHNOLOGY: Complexitycomparison, Design bottle necks, Applications, Analog and digital systems, Choiceof Technology.

BASICCONCEPTS IN RF DESIGN: Nonlinearity and timevariance, ISI, Random process and noise, sensitivity and dynamic range, passive impedance transformation.

Practice:

1. Design of VCO
2. Band gap reference circuit

UNIT – V

Multiple Access: Techniques and wireless standards, mobile RF communication, FDMA, TDMA, CDMA, Wireless standards.

Transceiver Architectures: Generalconsiderations, receiver architecture, Transmitter Architecture, transceiver performance tests, case studies.

Amplifiers, Mixers And Oscillators: LNAs, down conversion mixers, Cascaded Stages, oscillators, Frequency synthesizers.

Practice:

1. Implement a PLL based frequency synthesizer.

Text Books:

1. David A Johns, Ken Martin: Analog IC design, Wiley, ISBN Number- 9788126543939
2. R Gregorian and G C Temes: Analog MOS integrated circuits for signal processing, Wiley, ISBN Number- 9788126517978

Reference Books:

1. Roubik Gregorian: Introduction to CMOS Op-amps and comparators, Wiley, ISBN Number- 0471317780
2. Behzad Razavi, RF Microelectronics Prentice Hall of India, ISBN Number- 0137134738

Web Links:

1. https://home.iitk.ac.in/~ashwinrs/2022_EE698I.html
2. https://onlinecourses.nptel.ac.in/noc24_ee75
3. https://onlinecourses.nptel.ac.in/noc24_ee13

VERIFICATION USING SYSTEM VERILOG AND UVM

	L	T	P	C
Course Code:242EC004	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Interpret the concepts of verification methodologies and data types.
CO2: Summarize the concepts of procedural statements, routines and assertions
CO3: Illustrate the concepts of OOP terminology
CO4: Explain the randomization in System Verilog.
CO5: Analyze the concepts of functional coverage.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	-	3	2	-	-
CO2:	1	-	3	2	-	-
CO3:	1	-	2	3	-	-
CO4:	1	-	3	2	-	-
CO5:	2	-	3	2	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	2	2	-
CO2:	1	2	-
CO3:	1	2	-
CO4:	1	2	-
CO5:	1	2	-

UNIT – I

Verification Using System Verilog: What is the Functional Verification, What is the Assertion based Verification,Why use System Verilog for Verification, OOP concept for System Verilog,Layered approach for Verification, Designing with OOP, OOP classes, OOP connections, Block level testing using OOP, Chip Level Testing, FunctionalCoverage, Assertion Based verification, Interfacing with C

Practice:

1. Basic Testbench in SystemVerilog
2. Building a Simple Environment

UNIT – II

Universal Verification Methodology, UnderstandingVerification Component Overview, Transaction Level Modeling (TLM),Developing Reusable Verification Component, Using Verificationcomponent, Using Register Layer Class

Practice:

1. Randomized Testing with UVM

UNIT – III

Low Power Verification Techniques (CPF/UPF): Need of Power Aware Simulation,Understanding Unified Power Format file,Writing CPF/UPF, Assertions checking for the low power Simulation

Practice:

1. Scoreboarding in UVM
2. Implementing Functional Coverage in UVM

UNIT – IV

Verification of SOC with ARM/MIPS Processor, ARM architecture as covered in Embedded classes, Development ofARM/MIPS BFM, Writing C test case on ARM, Using ARMCC and ARMSScompiler and linking it with simulator

Practice:

1. Assertion-Based Verification using SystemVerilog Assertions (SVA)
2. Protocol Verification using UVM

UNIT – V

Verification Environment build and Automation.Use of Make file, Perl & TCL script in running the test, Running Regressionof the test suit for the Device Under test, Automatic regression resultsgeneration, Merging of the code & functional coverage, Ranking of the test suit.

Practice:

1. Integrating a UVM-based Testbench with a SystemC Model
2. Low-Power Verification using UVM

Text Books:

1. Hardware Verification with System Verilog- Mike Mintz & Robert, Ekendahl System Verilog forVerification – Chris Spear, ISBN Number- 0-387717382
2. IEEE Standard for SystemVerilog--Unified Hardware Design, Specification, and Verification Language, ISBN Number- 1504445104

Reference Books:

1. UVM user Manual

Web links:

1. https://www.udemy.com/course/uvm-for-verification-part-2-projects/?utm_source=adwords&utm_medium=udemyads&utm_campaign=Search_DSA_Beta_Prof_la.EN_cc.INDIA&campaigntype=Search&portfolio=India&language=EN&product=Course&test=&audience=DSA&topic=&priority=Beta&utm_content=deal4584&utm_term=_._ag_160270535665_._ad_696202838340_._kw__._de_c_._dm__._pl__._ti_dsa-1677053911888_._li_9147583_._pd__._&matchtype=&gad_source=1&gclid=CjwKCAjwnqK1BhBvEiwAi7o0Xyj21cvFN97-KGpQbnyHVxUHRk6YsxUkWaYMefK8G4fucWJFzXicMxoCLOwQAvD_BwE
2. https://iisc.talentsprint.com/micro-electronics-and-semiconductor-technologies/mobile/?utm_source=g_search&utm_medium=paid_google&utm_campaign=iisc-mest-g_search-performance-lower_funnel&utm_content=iisc-mest-g_search-performance-lower_funnel-audience&utm_term=verilog%20course&placement=&matchtype=b&device=c&net

work=g&gad_source=1&gclid=CjwKCAjwnqK1BhBvEiwAi7o0XznNmhPCp4msgOwCxRqsq0XNSyS-hyIEOwuMWi0NDoaNEj6jQ4s75RoC8_0QAvD_BwE

3. https://www.maven-silicon.com/best-vlsi-courses/online-vlsi-course-march/?utm_source=Google_Search_Online&campaignid=16685447008&gad_source=1&gclid=CjwKCAjwnqK1BhBvEiwAi7o0X-k33iGbPiuXc0s77-XaIFvyCWOGNYZUTECkwy3QzP9wHI2t1nR6CxoC8e8QAvD_BwE

VLSI FABRICATION TECHNOLOGY

	L	T	P	C
Course Code:242EC005	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Summarize Clean Room Environment and Wafer Preparation
CO2: Outline Oxidation, Diffusion, and Implantation
CO3: Identify Epitaxial Growth methodologies
CO4: Analyze various Lithography Process
CO5: Outline the Fabrication and Packaging technique

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	-	2	-	-	-	-
CO2:	-	2	2	-	-	-
CO3:	-	3	2	-	-	-
CO4:	-	3	2	-	-	-
CO5:	-	2	2	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	-
CO2:	-	2	-
CO3:	-	2	-
CO4:	-	2	-
CO5:	-	2	-

UNIT – I

Clean Room Environment and Wafer Preparation: Crystal Structure of a solid, Defects in material. Types of clean room, Contamination in clean room, Electronic Grade Silicon Czochralski crystal growing, Silicon Shaping, Wafer cleaning processes and wet chemical etching techniques.

UNIT – II

Oxidation, Diffusion, and Implantation: Kinetics of Silicon dioxide growth both for thick, thin, and ultrathin films; Oxidation Techniques and Systems Models of Diffusion in Solids, Defects due to oxidation, Solid State diffusion modeling and technology, Implantation Equipment, Principles, techniques and applications, removal of implant damage.

UNIT – III

Epitaxial Growth: Metallization's and MBE, Defects in Epitaxial Layer Dielectric Deposition, PECVD and Rapid Thermal Annealing, E-beam evaporation, Sputtering, Thermal Evaporation, Dry Etching

UNIT – IV

Lithography: Optical Lithography, E-beam lithography, X-ray, and Other Lithography techniques

UNIT – V

Fabrication and Packaging: Fabrication of MOSFET, Process to Package a chip (Dicing, Attaching, wire bonding, Chip package header), Fabrications of other devices.

Text Books:

1. S.M. Sze, "VLSI Technology", McGraw Hill, 2nd Edition, ISBN Number-0070582912.
2. G. S. May, S. M. Sze, Fundamentals of Semiconductor Fabrication, Wiley, ISBN Number- 0471232793

Reference Books:

1. James D Plummer, Michael D. Deal, Peter Griffin, "Silicon VLSI Technology: fundamentals practice and Modeling", Prentice Hall India, ISBN Number-0130850373
2. Wai Kai Chen, "VLSI Technology" CRC press, ISBN Number- 084931738X

Web Links:

1. https://nptel.ac.in/courses/117106093
2. https://chipedge.com/fabrication-process-in-vlsi/

PHYSICAL DESIGN AUTOMATION

	L	T	P	C
Course Code:242EC006	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Summarize the relationship between design automation algorithms and various constraints in VLSI fabrication and design technology.
CO2: Make use of the design algorithms to meet the critical design parameters.
CO3: Identify layout optimization techniques and map them to the algorithms
CO4: Develop proto-type EDA tool and test its efficacy
CO5: Distingush the different partitioning algorithms and its evolution.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	-	-	3	1	-	-
CO2:	3	-	2	-	-	-
CO3:	2	-	2	3	-	-
CO4:	3	-	1	-	-	-
CO5:	2	-	2	3	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	2	2	-
CO2:	2	2	1
CO3:	2	2	-
CO4:	2	2	1
CO5:	2	2	-

UNIT – I

VLSI design Cycle, Physical Design Cycle, Design Rules, Layout of Basic Devices, and Additional Fabrication, Design styles: full custom, standard cell, gate arrays, field programmable gate arrays, sea of gates and comparison, system packaging styles, multi-chip modules. Design rules, layout of basic devices, fabrication process and its impact on physical design, interconnect delay, noise and cross talk, yield and fabrication cost.

Practice:

1) Graph algorithms
a) Graph search algorithms
i. Depth first search
ii. Breadth first search
b) Spanning tree algorithm
i. Kruskal‟s algorithm
c) Shortest path algorithm
i. Dijkstra algorithm
ii. Floyd- Warshall algorithm
d) Steiner tree algorithm

2) Computational geometry algorithm
a) Line sweep method
b) Extended line sweep method

UNIT – II

Factors, Complexity Issues and NP-hard Problems, Basic Algorithms (Graph and Computational Geometry): graph search algorithms, spanning tree algorithms, shortest path algorithms, matching algorithms, min-cut and max-cut algorithms, Steiner tree algorithms

Practice:

1) Partitioning algorithms
I) Group migration algorithms
a) Kernighan –Lin algorithm
b) Extensions of Kernighan-Lin algorithm
i) Fiduccias –Mattheyses algorithm
ii) Goldberg and Burstein algorithm
II) Simulated annealing and evolution algorithms
a) Simulated annealing algorithm
b) Simulated evolution algorithm
III) Metric allocation method

UNIT – III

Basic Data Structures, atomic operations for layout editors, linked list of blocks, bin based methods, neighbor pointers, corner stitching, multi-layer operations.

UNIT – IV

Graph algorithms for physical design: classes of graphs, graphs related to a set of lines, graphs related to set of rectangles, graph problems in physical design, maximum clique and minimum coloring, maximum k-independent set algorithm, algorithms for circle graphs.

Practice:

1) Floor planning algorithms
i) Constraint based methods
ii) Integer programming based methods
iii) Rectangular dualization based methods
iv) Hierarchical tree based methods
v) Simulated evolution algorithms
vi) Time driven Floor planning algorithms

UNIT – V

Partitioning algorithms: design style specific partitioning problems, group migrated algorithms, simulated annealing and evolution, and Floor planning and pin assignment, Routing and placement algorithms.

Practice:

1) Routing algorithms
I) Two terminal algorithms
a) Maze routing algorithms
i) Lee‟s algorithm
ii) Souk up‟s algorithm
iii) Hadlock algorithm
b) Line-Probe algorithm
c) Shortest path based algorithm

II) Multi terminal algorithm
a) Stenier tree based algorithm
i) SMST algorithm
ii) Z-RST algorithm

Text Books:

1. Naveed Shervani, Algorithms for VLSI Physical Design Automation, 3rd Edition, Kluwer Academic, ISBN Number- 0792383931
2. Charles J Alpert, Dinesh P Mehta, Sachin S Sapatnekar, Handbook of Algorithms for Physical Design Automation, CRC Press, ISBN Number- 0849372429

Reference Books:

1. Algorithms for VLSI Physical Design Automation Hardcover, Naveed A. Sherwani, ISBN Number- 0792383931

Web Links:

1. https://nptel.ac.in/courses/106105161/
2. https://eecs.wsu.edu/~daehyun/teaching/2014_EE582/
3. http://users.ece.utexas.edu/~dpan/PDA_syllabus.pdf

VLSI TESTING AND VALIDATION

	L	T	P	C
Course Code:242EC007	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Analyze the basic faults that occur in digital systems

CO2: Testing of stuck at faults for digital circuits, Design for testability.

CO3: Analyse testing issues in the field of digital system design critically for conducting research

CO4: Solve engineering problems by modelling different faults for fault free simulation in digital circuits

CO5: Apply appropriate research methodologies and techniques to develop new testing strategies for digital and mixed signal circuits and systems

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	1	3	1	-	-
CO2:	1	1	3	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	2	2	1	-	-
CO5:	3	2	2	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	2	-	-
CO2:	2	-	-
CO3:	2	2	2
CO4:	2	2	2
CO5:	2	2	2

UNIT – I

Introduction to Testing:

Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends affecting Testing, Types of Testing, Fault Modeling: Defects, Errors and Faults, Functional Versus Structural Testing, Levels of Fault Models, Single Stuck-at Fault.

Practice:

1. Introduction to test bench architecture.
2. Combinational Circuit Testing (adder and multiplier)

UNIT – II

Logic and Fault Simulation:

Simulation for Design Verification and Test Evaluation, Modeling Circuits for Simulation, Algorithms for True value Simulation, Algorithms for Fault Simulation.

Practice:

1. Analysis of code coverages and write development of functional coverage.

UNIT – III

Testability Measures:

SCOAP Controllability and Observability, High Level Testability Measures, Digital DFT and Scan Design: Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan.

UNIT – IV

Built-In Self-Test:

The Economic Case for BIST, Random Logic BIST: Definitions, BIST Process, Pattern Generation, Response Compaction, Built-In Logic Block Observers, Test-Per- Clock, Test-Per-Scan BIST Systems, Circular Self-Test Path System, Memory BIST, Delay Fault BIST.

Practice:

1. Design for Test and Automatic Test pattern Generation for a 4-bit counter.
2. Design for Test and Automatic Test pattern Generation for a 4-bit counter.

UNIT – V

Boundary Scan Standard:

Motivation, System Configuration with Boundary Scan: TAP Controller and Port, Boundary Scan Test Instructions, Pin Constraints of the Standard, Boundary Scan Description Language: BDSL Description Components, Pin Descriptions.

Practice:

1. Perform the logic equivalence (formal verification).

Text Books:

1. Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits - M.L. Bushnell, V. D. Agrawal, Kluwer Academic Pulishers, ISBN Number-4330981722
2. Digital Systems and Testable Design - M. Abramovici, M.A.Breuer and A.D Friedman, Jaico Publishing House, ISBN Number- 8172248911

Reference Books:

1. Digital Circuits Testing and Testability - P.K. Lala, Academic Press, ISBN Number-0124343309

Web Links:

1. https://www.slideshare.net/labishettybhanu/trends-and-challenges-in-vlsi
2. http://www.engr.uconn.edu/~tehrani/teaching/test
3. http://nptel.ac.in/courses/106103116/34
4. http://eesemi.com/bist.html
5. http://slideplayer.com/slide/6546550/

MICROELECTRONICS DEVICE MODELLING

	L	T	P	C
Course Code:242EC008	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Understand the physics of 2-terminal MOS operation and its characteristics.
CO2: Understand the physics of 4-terminal MOSFET operation and its characteristics.
CO3: Analyze the SOI MOSFET electrical characteristics.
CO4: Interpret various MOSFET models.
CO5: Analyse various high k dielectrics

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	-	1	-	2	2	-
CO2:	-	1	-	-	2	-
CO3:	-	3	-	-	3	-
CO4:	-	3	-	-	3	-
CO5:	-	3	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	-
CO2:	-	2	-
CO3:	-	2	-
CO4:	-	2	-
CO5:	-	3	-

UNIT – I
2-terminal MOS device: threshold voltage modelling (ideal case as well as considering the effects of Qf, Φms and Dit.).

UNIT – II
C-V characteristics (ideal case as well as taking into account the effects of Qf, Φms and Dit); MOS capacitor as a diagnostic tool (measurement of non-uniform doping profile, estimation of Qf, Φms and Dit).

UNIT – III
4-terminal MOSFET: threshold voltage (considering the substrate bias); above threshold I-V modelling (SPICE level 1,2,3 and 4).

UNIT – IV

Sub threshold current model; scaling; effect of threshold tailoring implant (analytical modelling of threshold voltage using box approximation); buried channel MOSFET. Short channel, DIBL and narrow width effects; small signal analysis of MOSFETs (Meyer "s model).

UNIT – V

SOI MOSFET: basic structure; threshold voltage modelling Advanced topics: hot carriers in channel; EEPROMs; CCDs; high-K gate dielectrics.

Text Books:

1. D.G. Ong, "Modern MOS Technology: Processes, Devices and Design", Mc Graw Hill,1984, ISBN Number- 0070477094
2. Y. Taur and T.H. Ning, "Fundamentals of modern VLSI Devices" Cambridge Univ. Press,1998, ISBN Number- 1107635713

Reference Books:

1. Physics of Semiconductor Devices, S.M. Sze, Wiley, ISBN Number- 8126517026

Web Links:

1. https://nptel.ac.in/courses/117106033/
2. https://www.sciencedirect.com/topics/materials-science/device-modeling

NANO-ELECTRONICS

	L	T	P	C
Course Code:242EC009	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Demonstrate challenges due to scaling on CMOS devices.
CO2: Analyse and explain working of novel MOS based silicon devices and various multi gate devices.
CO3: Analyse working of spin electronic devices
CO4: Summarize nano electronics systems and building blocks such as: low dimensional semiconductors, hetero structures, carbon nano tubes, quantum dots, nanowires etc.
CO5: Develop nano electronics systems and building blocks such as: carbon nanotubes, quantum dots, nanowires etc.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	-	1	-	2	-	-
CO2:	-	3	2	2	-	-
CO3:	2	2	-	3	-	-
CO4:	-	3	2	-	-	-
CO5:	-	2	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	-
CO2:	-	2	-
CO3:	-	2	-
CO4:	-	2	-
CO5:	-	2	-

UNIT – I
Properties of Individual Nano particles: Introduction, Metal Nano Clusters, Semiconducting Nanoparticles, Rare Gas and Molecular Clusters, Methods of Synthesis.

UNIT – II
The nanoscale MOSFET, Fin FETs, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.), Resonant Tunneling Transistors.
Carbon Nano Structures: Introduction, Carbon Molecules, Carbon Clusters, Carbon Nano Tubes, Application of Carbon Nanotubes.

UNIT – III
Carbon Nanotubes for Data Processing–Introduction, Electronic Properties, Synthesis of Carbon Nanotubes, Carbon Nanotube Interconnects, Carbon Nanotubes Field Effect Transistors (CNTFETs), Nanotubes for Memory Applications, Prospects of an All- CNT

Nanoelectronics.
Neuro electronic Interfacing: Semiconductor Chips with Ion Channels, Nerve Cells, and Brain: Introduction, Ion-Electronic Interface, Neuron-Silicon Circuits, Brain- Silicon Chips.

UNIT – IV

Optical3-DTime-of-Flight Imaging System: Introduction, Taxonomy of Optical3-DTechniques, CMOS Imaging, CMOS 3-D Time-of-Flight Image Sensor, Application Examples
Pyroelectric Detector Arrays for IR Imaging: Introduction, Operation Principle of Pyro electric IR Detectors, Pyroelectric Materials, Realized Devices, Characterization, and Processing Issues

UNIT – V

Electronic Noses: Introduction, Operating Principles of Gas Sensor Elements, Electronic Noses, Signal Evaluation, Dedicated Examples.2- DTactileSensorsandTactileSensorArrays: Introduction, Definitions and Classifications, Resistive Touch screens, Ultrasonic Touchscreens, Robot Tactile Sensors, Fingerprint Sensors.

Text Books:

1. Introduction to Nanotechnology, C.P. Poole Jr., F.J. Owens, Wiley, ISBN Number-0471079359
2. Nano electronics and Information Technology (Advanced Electronic Materials and Novel Devices), Waser Ranier, Wiley-VCH, ISBN Number- 3527409270

Reference Books:

1. Nano systems, K.E. Drexler, Wiley, ISBN Number- 9780471575184
2. The Physics of Low-Dimensional Semiconductors, John H.Davies, “Cambridge University Press, ISBN Number- 052148491X

Web Links:

1 https://www.nano.gov/html/facts/faqs.html
2 https://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_003.pdf
3 http://www.nanobuildings.com/

SCRIPTING LANGUAGES

	L	T	P	C
Course Code:242EC010	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Identify Programming Languages with Syntaxes
CO2: Contrast the fluency in programming with scripting languages
CO3: Create and run scripts using PERL/ TCL/ PYTHON in CAD Tools.
CO4: Identify the use of PERL/PYTHON/ TCL in optimizing the system performance.
CO5: Analyze methods for Libraries and Packages.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	1	1	2	3	2
CO2:	1	3	2	2	2	1
CO3:	1	2	1	3	1	2
CO4:	2	3	2	1	2	1
CO5:	1	2	1	1	2	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	1	2	1
CO2:	2	3	1
CO3:	-	3	2
CO4:	-	2	1
CO5:	-	2	1

UNIT – I

Introduction to Scripts and Scripting:

Basics of Linux, Origin of Scripting languages, scripting today, Characteristics and uses of scripting languages.

PERL: Introduction to PERL, Names and values, Variables and assignment, Scalar expressions, Control structures, Built-in functions, Collections of Data, working with arrays, Lists and hashes, Simple input and output, Strings, Patterns and regular expressions, Subroutines, Scripts with arguments.

Practice:

1. Write a Ruby script to create a new string which is n copies of a given string where n is a nonnegative integer
2. Write a Ruby script to print odd numbers from 10 to 1

UNIT – II

Advanced PERL:

Finer points of Looping, Subroutines, Using Pack and Unpack, working with files, Type globs, Eval, References, Data structures, Packages, Libraries and modules, Objects, Objects and modules in action, tied variables, interfacing to the operating systems, Security issues.

Practice:

1. Write a Ruby scirpt to check two integers and return true if one of them is 20 otherwise return their sum

UNIT – III

TCL:

The TCL phenomena, Philosophy, Structure, Syntax, Parser, Variables and data in TCL, Control flow, Data structures, Simple input/output, Procedures, Working with Strings, Patterns, Files and Pipes, Example code.

Practice:

1. Write a TCL script to find the factorial of a number
2. Write a TCL script that multiplies the numbers from 1 to 10

UNIT – IV

Advanced TCL:

The eval, source, exec and up-level commands, Libraries and packages, Namespaces, trapping errors, Event-driven programs, Making applications 'Internet aware', 'Nuts- and-bolts' internet programming, Security issues, TCL and TK integration.

Practice:

1. Write a TCL script for Sorting a list using a comparison function
2. Write a TCL script to comparing the file modified times.

UNIT – V

PYTHON:

Introduction to PYTHON language, PYTHON-syntax, statements, functions, Built-in functions and Methods, Modules in PYTHON, Exception Handling.

Practice:

1. Arithmetic Operations
2. Logical Operations

Text Books:

1. The World of Scripting Languages- David Barron, Wiley Student Edition, ISBN Number- 0471998869
2. PYTHON Web Programming, Steve Holden and David Beazley, New Riders Publications, ISBN Number- 0735710902

Reference Books:

1. TCL/TK: A Developer's Guide- Clif Flynt, Morgan Kaufmann Series, ISBN Number- 9780123847171
2. Core PYTHON Programming, Chun, Pearson Education, ISBN Number- 0132269937

Web Links:

1 https://www.geeksforgeeks.org/perl-programming-language/
2 https://www.udemy.com/course/perl-by-digiflax/

FPGA BASED SYSTEM DESIGN

	L	T	P	C
Course Code:242EC011	**2**	**0**	**1**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Identify different types of programmable logic devices.
CO2: Compare the performance of different FPGAs and their programming Technologies
CO3: Analyze different SRAM programmable FPGA architectures
CO4: Analyze different Anti-Fuse Programmed FPGA architectures
CO5: Develop digital circuits with ACT architectures

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	2	-	-	-
CO2:	3	2	3	-	-	-
CO3:	3	3	3	-	-	-
CO4:	3	3	3	-	-	-
CO5:	3	3	3	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	-
CO2:	-	2	1
CO3:	-	2	1
CO4:	-	2	-
CO5:	-	2	-

UNIT – I

Introduction to Programmable Logic Devices:

Introduction, Simple Programmable Logic Devices - Read Only Memories, Programmable Logic Arrays, Programmable Array Logic, Programmable Logic Devices/Generic Array Logic; Complex Programmable Logic Devices – Architecture of Xilinx Cool Runner XCR3064XL,CPLD, CPLD Implementation of a Parallel Adder with Accumulation.

Practice:

1. Implementation of simple combinational design in Xilinx
2. Design of A Counter Using the On Board Clock

UNIT – II

Field Programmable Gate Arrays:

Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, Programmable I/O blocks in FPGAs, Dedicated Specialized Components of FPGAs, Applications of FPGAs.

Practice:

1. Design and implement a traffic light control circuit
2. FPGA System design Using IP Integrator

UNIT – III

Programming FPGAs:

SRAM Programmable FPGAs, Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 and XC4000 Architectures.

Practice:

1. Hardware Debugging using VIO

UNIT – IV

ACT FPGA Architectures:

Anti-Fuse Programmed FPGAs, Introduction, Programming Technology, Device Architecture, TheActel ACT1, ACT2 and ACT3 Architectures

Practice:

1. Design of an ALU and hardware debugging using VIO

UNIT – V

Applications:

Design Applications, General Design Issues, Counter Examples, A Fast Video Controller, A Position Tracker for a Robot Manipulator, A Fast DMA Controller, Designing Counters with ACT devices, Designing Adders and Accumulators with the ACT Architecture.

Practice:

1. Integrated logic analyzer (ILA) core for hardware debugging

Text Books:

1. Field Programmable Gate Array Technology, Stephen M. Trimberger, Springer International Edition, ISBN Number- 0792394194.
2. Digital Systems Design, Charles H. Roth Jr, LizyKurian John, Cengage Learning, ISBN Number- 813150574X.

Reference Books:

1. Digital Systems Design with FPGAs and CPLDs, Ian Grout, Elsevier, Newnes, ISBN Number- 075068397X
2. Digital Design Using Field Programmable Gate Arrays, Pak K. Chan/Samiha Mourad, Pearson Low Price Edition, ISBN Number- 8131724409

Web Links:

1. www.cs.umd.edu/class/sum2003/cmsc311/Notes/Comb/pla.html
2. www.eng.ucy.ac.cy/theocharides/Courses/ECE664/L5.pdf
3. www.soc.napier.ac.uk/~bill/pdf/ICD_C09.PDF
4. https://en.wikipedia.org/wiki/Complex_programmable_logic_device.

M/NEMS TECHNOLOGY

	L	T	P	C
Course Code:242EC012	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the fundamental concepts, materials, and applications of Micro-Electro-Mechanical Systems (MEMS) and Nano-Electro-Mechanical Systems (NEMS).

CO2: Describe the various fabrication technologies for MEMS, including photolithography, thin film deposition, etching techniques, micromachining, and packaging.

CO3: Design and analyze different types of MEMS sensors, understanding the engineering mechanics behind their operation.

CO4: Design and evaluate micro actuators using various actuation mechanisms such as thermal forces, shape memory alloys, piezoelectric crystals, and electrostatic forces.

CO5: Apply the principles of quantum mechanics and molecular dynamics to understand and design nanosystems and molecular electronics.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	3	1	2	1
CO2:	3	3	2	1	1	2
CO3:	3	2	3	1	2	2
CO4:	3	2	3	1	2	2
CO5:	3	2	3	2	1	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	2	1	1
CO2:	3	1	1
CO3:	2	1	1
CO4:	2	1	1
CO5:	1	1	1

UNIT – I

OVERVIEW AND INTRODUCTION

New trends in Engineering and Science: Micro and Nano scale systems Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of Micro and Nano electro mechanical systems, Micro electromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, silicon compounds, polymers, metals.

UNIT – II

MEMS FABRICATION TECHNOLOGIES

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
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
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
Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Shrodinger Equation and Wavefunction Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

Text Books:

1. Marc Madou, “Fundamentals of Micro fabrication”, CRC press, ISBN Number-08493945112
2. Stephen D. Senturia,” Micro system Design”, Kluwer Academic Publishers, ISBN Number- 0792372468

Reference Books:

1. Tai Ran Hsu,” MEMS and Microsystems Design and Manufacture”, Tata McGraw Hill, ISBN Number- 007048709X
2. Chang Liu, “Foundations of MEMS”, Pearson education India limited, ISBN Number-0132497360

Web Links:

1. https://en.wikipedia.org/wiki/Nanoelectromechanical_systems
2. https://www.sciencedirect.com/topics/nursing-and-health-professions/nanoelectromechanical-system

NANOMATERIALS AND NANOTECHNOLOGY

	L	T	P	C
Course Code:242EC013	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Understand the basic science behind the design and fabrication of nano scale systems.
CO2: Understand and formulate new engineering solutions for current problems and competing technologies for future applications.
CO3: Develop the inter disciplinary projects applicable to wide areas by clearing and fixing the boundaries in system development
CO4: Gather detailed knowledge of the operation of fabrication and characterization
CO5: An ability to apply knowledge of science and Engineering

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	-	1	-	2	-	-
CO2:	-	3	2	2	-	-
CO3:	-	2	-	3	-	-
CO4:	-	3	2	-	-	-
CO5:	-	2	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	-
CO2:	-	2	-
CO3:	-	2	2
CO4:	-	2	-
CO5:	-	2	2

UNIT – I

Introduction of nano materials and nanotechnologies, Features of nanostructures, Applications of nano materials and technologies. Nano dimensional Materials 0D, 1D, 2D structures – Size Effects – Fraction of Surface Atoms –Specific Surface Energy and Surface Stress – Effect on the Lattice Parameter – Phonon Density of States – the General Methods available for the Synthesis of Nanostructures – precipitate – reactive– hydrothermal/solvo thermal methods – suitability of such methods for scaling – potential Uses.

UNIT – II

Fundamentals of nano materials, Classification, Zero-dimensional nano materials, One-dimensional nano materials, Two-dimensional nano materials, Three dimensional nano materials. Low-Dimensional Nano materials and its Applications, Synthesis, Properties, and Applications of Low-Dimensional Carbon- Related Nano materials.

UNIT – III

Micro- and Nanolithography Techniques, Emerging Applications Introduction to Micro electromechanical Systems (MEMS), Advantages and Challenges of MEMS, Fabrication Technologies, Surface Micromachining, Bulk Micromachining, Molding. Introduction to Nano Photonics.

UNIT – IV

Introduction, Synthesis of CNTs - Arc-discharge, Laser-ablation, Catalytic growth, Growth mechanisms of CNT‟s - Multi-walled nano tubes, Single-walled nano tubes Optical properties of CNT‟s, Electrical transport in perfect nano tubes, Applications as case studies. Synthesis and Applications of CNT's.

UNIT – V

Ferroelectric materials, coating, molecular electronics and nano electronics, biological and environmental, membrane based application, polymer based application.

Text Books:

1. Kenneth J. Klabunde and Ryan M. Richards, “Nanoscale Materials in Chemistry”, 2nd edition, John Wiley and Sons, ISBN Number- 0470222700
2. I Gusev and A A Rempel, “Nanocrystalline Materials”, Cambridge International Science Publishing, 1st Indian edition by Viva Books Pvt. Ltd, ISBN Number- 1898326266

Reference Books:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath, James Murday, “Nanoscience and Nanotechnology”, Tata McGraw Hill Education, ISBN Number- 978-3-642-28030-6
2. Bharat Bhushan, “Springer Handbook of Nanotechnology”, Springer, 3rd edition, ISBN Number- 3642025242

Web Links:

1. https://nptel.ac.in/courses/118104008
2. https://en.wikipedia.org/wiki/Nanotechnology

NETWORK SECURITY AND CRYPTOGRAPHY

	L	T	P	C
Course Code:242EC014	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain basic concepts of encryption techniques.
CO2: Identify and utilize different forms of cryptography techniques
CO3: Illustrate authentication requirements with algorithms.
CO4: Apply authentication and security in the network applications.
CO5: Compare different types of threats to the system and handle the same.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	3	3	-	3	-
CO2:	3	1	-	-	2	-
CO3:	3	3	2	-	-	-
CO4:	2	1	1	-	2	-
CO5:	3	3	2	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	-
CO2:	-	2	1
CO3:	-	2	1
CO4:	-	2	-
CO5:	-	3	-

UNIT – I
Security & Number Theory
Need, security services, Attacks, OSI Security Architecture, one time passwords, Model for Network security, Classical Encryption Techniques like substitution ciphers, Transposition ciphers, Cryptanalysis of Classical Encryption Techniques. Introduction, Fermat's and Euler's Theorem, The Chinese Remainder Theorem, Euclidean Algorithm, Extended Euclidean Algorithm, and Modular Arithmetic.

UNIT – II
Private-Key(Symmetric)Cryptography
Block Ciphers, Stream Ciphers, RC4 Stream cipher, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Triple DES, RC5, IDEA, Linear and Differential Cryptanalysis.

UNIT – III
RSA, Key Distribution and Management, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography, Message Authentication Code, hash functions, message digest algorithms: MD4 MD5, Secure Hash algorithm, RIPEMD-160, HMAC.

UNIT – IV

Authentication:

IP and Web Security Digital Signatures, Digital Signature Standards, Authentication Protocols, Kerberos, IP security Architecture, Encapsulating Security Payload, Key Management, Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction.

UNIT – V

SystemSecurity:

Intruders, Intrusion Detection, Password Management, Worms, viruses, Trojans, Virus Countermeasures, Firewalls, Firewall Design Principles, Trusted Systems.

Text Books:

1. Cryptography and Network Security, Behrouz A. Forouzan and Debdeep Mukhopadhay, Tata McGrawHill, 2010, ISBN Number-007070208X
2. William Stallings, "Cryptography and Network Security, Principles and Practices", Pearson Education, 3rd Edition, ISBN Number- 0131873164

Reference Books:

1. CharlieKaufman,RadiaPerlmanandMikeSpeciner,"NetworkSecurity,Private Communication in a Public World", Prentice Hall, 2nd Edition, ISBN Number-0130460192
2. CryptographyandNetworkSecurity:PrinciplesandPractice,WilliamStallings, William Stallings, Pearson Education, 5th Edition, ISBN Number- 0136097049

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs16
2. https://www.cs.vsb.cz/ochodkova/courses/kpb/cryptography-and-network-security_-principles-and-practice-7th-global-edition.pdf

LOW POWER VLSI CIRCUIT DESIGN

	L	T	P	C
Course Code:242EC015	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Make use of the Low-Power Design Approaches incomplex systems design.
CO2: Contrast different Low-Voltage and Low-Power design approaches for atarget design.
CO3: Inspect the low power methods to get the circuits for Capacitance power reduction.
CO4: Choose the suitable design among the list of Low-Voltage Low-PowerAdders or Multipliers
CO5: Extend the knowledge of power management strategies in powerefficient Designs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	2	2	1	1
CO2:	3	2	3	2	1	1
CO3:	3	3	3	2	1	1
CO4:	3	3	3	2	1	1
CO5:	3	3	3	2	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	1	2	3
CO2:	1	2	3
CO3:	1	3	2
CO4:	1	2	3
CO5:	1	2	3

UNIT – I

Fundamentals of Low Power VLSI Design:

Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and PunchThrough, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

UNIT – II

Low-Power Design Approaches:

Low-Power Design through Voltage Scaling: VTCMOS circuits, MTCMOS circuits, Voltage Scaling Using High-Level Transformations: Multilevel Voltage Scaling, Challenges in MVS Voltage Scaling Interfaces, Static Timing Analysis Dynamic Voltage and Frequency Scaling. Architectural Level Approach –Pipelining and Parallel Processing Approaches.

UNIT – III

Switched Capacitance Minimization:

Probabilistic Power Analysis: Random logic signals, probability and frequency, probabilistic power analysis techniques, signal entropy, Bus Encoding: Gray Coding, One-Hot Coding, Bus-Inversion, T0 Coding, Clock Gating, Gated-Clock FSMs FSM State Encoding, FSM Partitioning, Pre computation, Glitching Power Minimization.

UNIT – IV

Low-Voltage Low-Power Adders and Multipliers:

Introduction, Standard Adder Cells, CMOS Adder's Architectures – Ripple Carry Adders, Carry Look-Ahead Adders, Carry Select Adders, Carry Save Adders, Low- Voltage Low-Power Design Techniques –Trends of Technology and Power Supply Voltage, Low Voltage Low-Power Logic Styles.

UNIT – V

Low power clock distribution:

Low power clock distribution: Power dissipation in clock distribution, single driver versus distributed buffers, Zero Skew versus tolerable skew, chip and package co design for clock network.

Text Books:

1. Low-Voltage, Low-Power VLSI Subsystems – Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering, ISBN Number- 007143786X.
2. Low-Power VLSI Circuits and Systems, AjitPal, SPRINGER PUBLISHERS, ISBN Number- 9788132219361.

Reference Books:

1. Practical Low Power Digital Vlsi Design, Gary Yeap Motorola, Springer Science Business Media, LLC, ISBN Number- 0792380096.
2. Low Power CMOS Design– Anantha Chandrakasan, IEEE Press/ Wiley International, ISBN Number- 0780334299

Web Links:

1. https://archive.nptel.ac.in/courses/106/105/106105034/
2. https://chipedge.com/what-is-low-power-vlsi-design/#:~:text=The%20aim%20of%20low%20power,makes%20up%20the%20static%20power.

VLSI SIGNAL PROCESSING

	L	T	P	C
Course Code:242EC016	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain parallel and pipelining processing techniques.
CO2: Identify applications for unfolding algorithm.
CO3: Analyse Systolic Design for Space Representations containing Delays.
CO4: Explain Cook-Toom Algorithm, Fast Convolution algorithm by Inspection method.
CO5: Analyse Power Reduction techniques and Power Estimation techniques.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	1	2	1	2	1
CO2:	3	1	2	1	2	1
CO3:	3	2	3	1	1	2
CO4:	2	3	2	1	1	1
CO5:	3	2	3	2	1	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	2	2	1
CO2:	2	2	1
CO3:	3	3	2
CO4:	2	2	1
CO5:	3	2	3

UNIT – I
Introduction to DSP:
Typical DSP algorithms, DSP algorithms benefits, Representation of DSP algorithms Pipelining and Parallel Processing Introduction, Pipelining of FIR Digital filters, Parallel Processing, Pipelining and Parallel Processing for Low Power Retiming Introduction, Definition sand Properties, Solving System of Inequalities, Retiming Techniques.

UNIT – II
Folding-introduction, Folding Transform, Register minimization Techniques, Register minimization in folded architectures, folding of Multi rate systems Unfolding- Introduction, An Algorithm for Unfolding, Properties of Unfolding, critical Path, Unfolding and Retiming, Applications of Unfolding.

UNIT – III

Systolic Architecture Design:

Introduction, Systolic Array Design Methodology, FIR systolic Arays, Selection of Scheduling Vector, Matrix Multiplication and 2D Systolic Array Design, Systolic Design for Space Representations contain Delays.

UNIT – IV

Fast Convolution:

Introduction–Cook-Toom Algorithm–Wino gard algorithm–Iterated Convolution– Cyclic Convolution– Design of Fast Convolution algorithm by Inspection.

UNIT – V

Digital lattice filter structures, bit level arithmetic, architecture, redundant arithmetic. Numerical strength reduction, synchronous, wave and asynchronous pipe lines, low power design. Low Power Design: Scaling Vs Power Consumption, Power Analysis, Power Reduction techniques, Power Estimation Approaches.

Text Books:

1. KeshabK. Parthi[A1], VLSI Digital signal processing systems, design and Implementation [A2], Wiley, Inter Science, ISBN Number- 0471241865
2. Mohammad Isamail and Terri Fiez, Analog VLSI signal and information processing, McGraw Hill ISBN Number- 0070323860

Reference Books:

1. S.Y. Kung, H.J. White House, T. Kailath, VLSI and Modern Signal Processing, Prentice Hall, ISBN Number- 013942699X

Web Links:

1. https://archive.nptel.ac.in/courses/108/105/108105157/
2. https://ee.iitpkd.ac.in/node/61

SOC DESIGN

	L	T	P	C
Course Code:242EC017	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Exaplain about SoC
CO2: Illustrate the design of different embeddedmemories.
CO3: Summarize the validation and Testing Concepts.
CO4: Identify new techniques for future systems.
CO5: Explain the examples of applications and systems developed using a co-design approach.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	-	-	3	-	-	-
CO2:	2	-	3	2	-	-
CO3:	-	-	3	2	-	-
CO4:	3	-	2	2	-	-
CO5:	3	-	2	2	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	-	2
CO2:	-	-	2
CO3:	-	-	2
CO4:	-	-	2
CO5:	-	-	2

UNIT – I
Introduction- System tradeoffs and evolution of ASIC Technology- System on chip concepts and methodology– SoC design issues -SoC challenges and components.

UNIT – II
Design Methodological For Logic Cores- SoC Design Flow – On-chip buses –Design process for hard cores –Soft and firm cores – Core and SoC design examples.

UNIT – III
Design Methodology for Memory and Analog Cores- Embedded memories –Simulation modes Specification ofanalog circuits – A to D converter –Phase locked loops –High I/O.

UNIT – IV
Design Validation- Core level validation –Test benches –SoC design validation – Co simulation – hardware/Software co-verification. Case Study: Validation and test of systems on chip.

UNIT – V

SoC Testing- SoC Test Issues –Cores with boundary scan –Test methodology for design reuse– Testing ofmicroprocessor cores – Built in self-method –testing of embedded memories.

Text Books:

1. Rochit Rajsunah, System-on-a-chip:Design and Test, ArtechHouse. Prakash Raslinkar, Peter Paterson & Leena Singh, ISBN Number- 978-1475774689
2. System-on-a-chip verification: Methodology and Techniques, Kluwer Academic Publishers, ISBN Number- 0792372794

Reference Books:

1. M.Keating, D.Flynn, R.Aitken, A, GibbonsShi, Low Power Methodology Manual for System-on- Chip Design Series: Integrated Circuits and Systems, Springer, ISBN Number-0387718184
2. Validation and test of systems on chip, IEEE conference on ASIC/SOC, L.Balado, E.Lupon, ISBN Number- 0-7803-5632-2

Web Links:

1. https://nanohub.org/courses/ECE695R/o1a/outline/unit1introductionandbackground/l15overviewofsocdesignflow?time=00:07:37
2. https://www.synopsys.com/blogs/chip-design/system-on-chip-design.html

HARDWARE SOFTWARE CO-DESIGN

	L	T	P	C
Course Code:242EC018	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Analyze embedded system's hardware and software design issues.
CO2: Develop the applications on 8051, ADSP2106 and TMS320C60 processors.
CO3: Demonstrate modern embedded architectures and compilation technologies.
CO4: Interpret the Design and co-design by using design verification tools.
CO5: Build the system from system level specification languages

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	1	2	1	1	-
CO2:	1	1	1	1	1	-
CO3:	2	2	2	1	1	-
CO4:	2	2	2	1	1	-
CO5:	3	2	2	1	1	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	2
CO2:	-	2	2
CO3:	-	2	2
CO4:	-	2	2
CO5:	-	2	2

UNIT – I
Co- Design Issues:
Co- Design Models, Architectures, Languages, A Generic Co-design Methodology.
Co- Synthesis Algorithms: Hardware software synthesis algorithms: hardware, software partitioning distributed system co synthesis.

UNIT – II
Prototyping and Emulation:
Prototyping and emulation techniques, prototyping and emulation environments, future developments in emulation and prototyping architecture specialization techniques, system communication infrastructure
Target Architectures: Architecture Specialization techniques, System Communication infrastructure, Target Architecture and Application System classes, Architecture for control dominated systems (8051-Architectures for High performance control), Architecture for Data dominated systems (ADSP21060, TMS320C60), Mixed Systems.

UNIT – III

Compilation Techniques and Tools for Embedded Processor Architectures:

Modern embedded architectures, embedded software development needs, compilation technologies, practical consideration in a compiler development environment.

UNIT – IV

Design Specification and Verification:

Design, co-design, the co-design computational model, concurrency coordinating concurrent computations, interfacing components, design verification, implementation verification, verification tools, interface verification

UNIT – V

Languages for System – Level Specification and Design-I:

System – level specification, design representation for system level synthesis, system level specification languages.

Languages for System-Level Specification and Design-II:

Heterogeneous specifications and multi-language co-simulation, the cosyma system and lycos system.

Text Books:

1. Hardware / Software Co- Design Principles and Practice, Jorgen Staunstrup, Wayne Wolf, Springer, ISBN Number- 8181286847
2. Hardware / Software Co- Design, Giovanni DeMicheli, Mariagiovanna Sami, Kluwer Academic Publishers, ISBN Number- 0792338839

Reference Books:

1. A Practical Introduction to Hardware/Software Co-design, Patrick R. Schaumont, Springer Publications, ISBN Number- 1489990607

Web Links:

1. https://embedded.eecs.berkeley.edu/Research/hsc/abstract.html
2. http://ieeexplore.ieee.org/document/6172642/
3. http://www.tik.ee.ethz.ch/education/lectures/hswcd/
4. http://ieeexplore.ieee.org/document/715400/

PHOTONICS

	L	T	P	C
Course Code:242EC019	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Classify the Optical sources and detectors and to discuss their principle
CO2: Infer the Design considerations of fiber optic systems.
CO3: Analyse the basic methodologies behind the manufacturing of differentLED materials
CO4: Apply the principles of atomic physics to materials used in optics andphotonics.
CO5: Use the tools, methodologies, language and conventions of physics to testand communicate ideas and explanations

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	-	2	-	-	-	-
CO2:	-	2	1	-	-	-
CO3:	-	3	1	-	-	-
CO4:	-	1	-	-	-	-
CO5:	-	2	3	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	-
CO2:	-	2	-
CO3:	-	2	-
CO4:	-	2	-
CO5:	-	2	-

UNIT – I

Laser Systems:

General description, Laser structure, Single mode laser theory, Excitation mechanism and working of: CO2, Nitrogen, Argonion, Excimer, X-ray, Free-electron, Dye, Nd: YAG, Alexanderite and Ti: sapphire lasers, Diode pumped solid state laser, Optical parametric oscillator (OPO) lasers. Optical amplifiers-Semiconductor opticalamplifiers, Erbium doped waveguide optical amplifiers, Raman amplifiers, Fiber Lasers. Laser Applications-Lasers in Isotope separation, Laser interferometry and speckle metrology, Velocity measurements.

UNIT – II

Properties of laser Radiation:

Introduction, Laser line width ,Laser frequency stabilization, Beam divergence, Beam coherence, Brightness ,Focusing properties of laser radiation, Q-switching ,Methods of Q-switching: Rotating-mirror method ,Electro- optic Q-switching, Acoustic- optic Q- switching and Passive Q-switching, Mode locking, Methods of mode locking: Active and passive mode locking techniques, Frequency doubling and Phase conjugation.

UNIT – III

Opto -Electronic Devices-I:

Introduction, P-N junction diode, Carrier recombination and diffusion in P-N junction, Injection efficiency, Internal quantum efficiency, Hetero-junction, Double hetero- junction, Quantum well, Quantum dot and Super lattices; LED materials, Device configuration and efficiency.

UNIT – IV

Opto-Electronic Devices-II:

Light extraction from LEDs, LED structures-single hetero structures, double heteros structures, Device performances and applications, Quantum well lasers; Photodiode and Avalanche photodiodes (APDs), Laser Diodes-Amplification, Feedback and oscillation, Power and efficiency, Spectral and spatial characteristics.

UNIT – V

Modulation of Light:

Introduction, Birefringence, Electro-optic effect, Pockets and Kerr effects, Electro- optic Phase modulation, Electro-optic amplitude modulation, Electro-optic modulators: scanning and switching, Acousto-optic effect, Acousto-optic modulation, Raman-Nath and Bragg modulators: deflectors and spectrum analyzer, Magneto-optic effect, Faraday rotator and optical isolator. Advantages of optical modulation.

Text Books:

1. Lasers: Principles and applications by J.Wilson And J.F.B.Hawkes, Prentice, Hall of India, New Delhi, ISBN Number- 0135236975
2. Laser fundamentals, W.T.Silfvast, Foundation books, New Delhi, ISBN Number- 1139855573

Reference Books:

1. Semiconductor opto electronics devices, P. Bhattacharya, Prentice– Hall of India, New Delhi, ISBN Number- 9789332587410
2. Optical fiber communications, John M. Senior, Prentice-Hall of India, New Delhi, ISBN Number- 9332535787

Web Links:

1. EDx course on “Optical Devices and Materials
   url: https://www.edx.org/course/optical-materials-devices-mitx-3-15-2x-0
2. NPTEL Course on “Introduction to Photonics” url:
   https://nptel.ac.in/courses/108106135/
3. University of Colarado course on “Photonics and Optics”
   url: https://www.colorado.edu/ecee/msee/curriculum/photonics-and-optics
4. Coursera on “LED’s and LASERS”
   url: https://www.coursera.org/learn/leds-semiconductor-lasers

SENSORS AND SENSOR CIRCUIT DESIGN

	L	T	P	C
Course Code:242EC020	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the basic concepts of op-amp and filters for sensor circuits
CO2: Clasify various sensor circuit performances along with application
CO3: Summarize the performance of sensors using various circuits
CO4: Illustrate the basic concepts of signal conditioning circuits
CO5: Develop circuits using sensors for measuring corresponsing parameters

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	-	3	-	-	-
CO2:	2	-	2	3	-	-
CO3:	-	-	3	2	-	-
CO4:	-	-	2	3	-	-
CO5:	3	-	2	2	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	-	2
CO2:	-	-	2
CO3:	-	-	2
CO4:	-	-	2
CO5:	-	-	2

UNIT – I
Review of Measurements and instrumentation:
Review of Static characteristics of Instrument systems, dynamic characteristics of Instrument systems, Review of Op-Amp Circuit, passive-, and active-filters.

UNIT – II
Analog Signal Conditioning:
Principles of analog signal conditioning, Signal-Level and Bias Changes, Linearization, Conversions, Filtering and Impedance Matching, Concept of Loading, PASSIVE CIRCUITS: Voltage Divider, Bridge Circuits, Bridge Resolution , Bridge Applications

UNIT – III
Digital Signal Conditioning:
Review of Digital Electronics: Digital Information, Fractional Binary Numbers, Boolean Algebra, Digital Electronics Circuits: comparator, converter, Digital-to-Analog Converters (DACs), Analog-to-Digital Converters (ADCs) : Flash-, SAR, Dual Slope, Sensor-to-Frequency Conversion, Data-Acquisition Systems: Hardware and Software of Data Aquisition System (DAS) , Characteristics of digital data: Digitized Value, Sampled Data Systems, Linearization,

UNIT – IV

Definition of Temperature: Thermal Energy, absolute and relative Temperature, Metal resistance versus temperature devices: Resistance versus Temperature Approximations, Resistance-Temperature Detectors (RTD), Other thermal sensor: Bimetal Strips, Gas Thermometers, Vapor-Pressure Thermometers, Liquid-Expansion Thermometers, Solid-State Temperature Sensors, Design considerations

UNIT – V

Optical Sensors: Fundamentals of em radiation, Characteristics of Light, Photometry, photodetectors

Text Books:

1. Process Control Instrumentation Technology, 6th Edition, Author: Curtis D. Johnson, Publisher: Prentice Hall International Edition, ISBN Number- 0139382003
2. Measurement, Instrumentation, and Sensors Handbook, Author/Chief Editor: John G. Webster., Publisher: CRC – Press – Taylor and Francis Group, ISBN Number-084932145X

Reference Books:

1. Introduction to Instrumentation and Measurement, 3rd Edition", Authors: Robert B. Northrop, Publisher: CRC – Press – Taylor and Francis Group, ISBN Number-1466596775

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_ee32
2. https://www.colorado.edu/ecee/academics/online-programs/ms-ee-coursera/curriculum/embedded-systems/ecea-5340-sensor-and-sensor

ASIC DESIGN

	L	T	P	C
Course Code:242EC021	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Illustrate VLSI tool-flow and appreciate FPGA architecture
CO2: Explain the issues involved in ASIC design slow
CO3: Summarize thealgorithms used for ASIC construction.
CO4: Outline the basics of System on Chip& On-chip communication architectures
CO5: Identify high performance algorithms available for ASICs IC

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	-	-	3	-	-	-
CO2:	1	-	3	1	-	-
CO3:	2	-	2	3	-	-
CO4:	-	-	3	-	-	-
CO5:	1	-	3	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	2	2	-
CO2:	2	2	-
CO3:	2	2	-
CO4:	2	2	-
CO5:	2	2	-

UNIT – I
Types of ASICs, VLSI Design flow, Programmable ASICs - Antifuse, SRAM, EPROM, EEPROMbased ASICs. Programmable ASIC logic cells and I/O cells. Programmable interconnects. LatestVersion - FPGAs and CPLDs and Soft-core processors.

UNIT – II
Trade off issues at System Level: Optimization with regard to speed, area and power, asynchronousand low power system design. ASIC physical design issues, System Partitioning, Power Dissipation,Partitioning Methods. Trade off issues at System Level: Optimization with regard to speed, area and power, asynchronousand low power system design. ASIC physical design issues, System Partitioning, Power Dissipation,Partitioning Methods.

UNIT – III
ASIC floor planning, Placement and Routing.

UNIT – IV

System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, BasicConcepts of Bus-Based Communication Architectures, On-Chip Communication ArchitectureStandards, Low-Power SoC Design.

UNIT – V

High performance algorithms for ASICS/ SoCs as case studies – Canonic Signed Digit Arithmetic,KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC, USBcontrollers, OMAP

Text Books:

1. M.J.S. Smith,"ApplicationSpecific Integrated Circuits", Pearson, ISBN Number-9788177584080
2. H.Gerez, "Algorithms for VLSI Design Automation", John Wiley, ISBN Number-0471984892

Reference Books:

1. J..M.Rabaey, A. Chandrakasan, and B.Nikolic, "Digital IntegratedCircuit Design Perspective (2/e)", ISBN Number- 9385152343
2. D.A.Hodges,"AnalysisandDesignofDigitalIntegratedCircuits(3/e)",MGH, ISBN Number-0070291535

Web Links:

1. https://www.ansys.com/en-in/simulation-topics/what-is-asic-design
2. https://www.arm.com/glossary/asic

DSP ALGORITHMS FOR VLSI

	L	T	P	C
Course Code:242EC022	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Summarize the concepts of Digital Siganl pProcessing
CO2: Illustrate the architectural features of Programmable digital signal processors.
CO3: Infer the TMS320C54XX processor architecture details, addressing modes and on-Chip peripherals.
CO4: Develop algorithms using Instruction set of TMS320C54XX
CO5: Implement basic DSP algorithms for filters.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	1	-	2	-	-
CO2:	1	3	-	2	-	-
CO3:	1	2	-	3	-	-
CO4:	2	3	-	-	-	-
CO5:	1	2	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	1	1
CO2:	-	1	1
CO3:	-	1	1
CO4:	-	1	1
CO5:	-	1	1

UNIT – I

INTRODUCTION TO DIGITAL SIGNAL PROCESSING: Introduction, A Digital SignalProcessing System, The Sampling Process, Discrete Time Sequences, Discrete Fourier Transform(DFT) and Fast Fourier Transform (FFT), Linear Time-Invariant Systems, Digital Filters, Decimationand Interpolation

UNIT – II

ARCHITECTURES FOR PROGRAMMABLE DIGITAL SIGNAL PROCESSORS: Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture andMemory, Data Addressing Capabilities, Address Generation Unit, Programmability and ProgramExecution, Features for External Interfacing.

UNIT – III

PROGRAMMABLE DIGITAL SIGNAL PROCESSORS: Introduction, Commercial digital Signal-processing Devices, Data Addressing Modes of TMS32OC54xx., Memory Space ofTMS32OC54xx Processors, Program Control.

UNIT – IV

Detail Study of TMS320C54X & 54xx Instructions and Programming, On-Chip peripherals, Interruptsof TMS32OC54XX Processors, Pipeline Operation of TMS32OC54xx Processor.

UNIT – V

IMPLEMENTATION OF BASIC DSP ALGORITHMS: Introduction, The Q-notation, FIR Filters,IIR Filters, Interpolation and Decimation Filters (one example in each case).

Text Books:

1. Digital Signal Processing, Avatar Singh and S. Srinivasan, Thomson Learning, ISBN Number- 9788131500347
2. Digital Signal Processing: A practical approach, Ifeachor E. C., Jervis B. W PearsonEducation, PHI, ISBN Number- 0201596199

Reference Books:

1. Digital Signal Processors, B Venkataramani and M Bhaskar TMH, ISBN Number-9780070702561
2. Architectures for Digital Signal Processing, Peter Pirsch John Weily, ISBN Number-8126523034

Web Links:

1. https://onlinecourses.nptel.ac.in/noc20_ee44/
2. https://www.oreilly.com/library/view/vlsi-digital-signal/9780471241867/sec-1.2.html

VLSI ARCHITECTURES

	L	T	P	C
Course Code:242EC023	**2**	**1**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Discuss the basic architecture of VLSI
CO2: Analysing various algorithms of for VLSI architectures
CO3: Analyzing the optimized architectures
CO4: Interpret the clocking mechanism of VLSI architectures
CO5: Interpret the data processing of various VLSI architectures

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	1	-	2	-	-
CO2:	1	3	2	2	-	-
CO3:	1	2	-	3	-	-
CO4:	2	3	2	-	-	-
CO5:	1	2	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	2
CO2:	-	2	2
CO3:	-	2	2
CO4:	-	2	2
CO5:	-	2	2

UNIT – I
Introduction: Review of VLSI Design flow. Goals of VLSI Design: Optimization of speed, power dissipation, cost and reliability.

UNIT – II
Algorithm to architecture transformation: Architectural antipodes, transform approach to VLSI architectures, graph based formalism for describing processing algorithms, isomorphic architecture.
Equivalence transforms for combinational computations: Common assumptions, pipelining, replication, time sharing, associatively transform and other algebraic transforms.

UNIT – III
Architectural Synthesis and Optimization: Circuit specifications for architectural synthesis,fundamental architectural synthesis problems, temporal domain-scheduling, spatial domainbinding, sequencing graphs, hierarchical models, synchronization problem, area and performanceestimation, data path and control unit synthesis, constrained and unconstrained scheduling,scheduling of pipelined circuits.

UNIT – IV

Clocking of synchronous circuits: single-phase and two-phase clocking, wave pipelining, collective clock buffer design, distributed clock buffer trees, hybrid clock distribution networksand impact of clock distribution delay on I/O timing.

UNIT – V

Asynchronous data processing architectures: data consistency problem of vectored acquisition-plain bit parallel synchronization, unit distance coding, suppression of cross patterns,handshaking, partial handshaking, data consistency problem of scalar acquisition-synchronizationat single place, synchronization at multiple places, synchronization from a slow clock, metastable synchronizer behavior.

Text Books:

1. Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication, Hubert Kaeslin, Cambridge University Press, ISBN Number- 0521882672
2. Synthesis and Optimization of Digital Circuits, Giovanni De Micheli, McGraw Hill, ISBN Number- 780070163331

Reference Books:

1. VLSI Array Processors, S.Y. Kung, Prentice Hall, ISBN Number- 013942749X
2. Clock generators for SoC processors: Circuits and Architectures, KluwerAcademic Publishers, ISBN Number- 1402080794

Web Links:

1. https://archive.nptel.ac.in/courses/108/105/108105118/
2. http://cva.stanford.edu/publications/1999/arvlsi99.pdf

VLSI SOLID STATE CIRCUITS

	L	T	P	C
Course Code:242EC024	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Interpret important parameters governing the high speed performance of devices and circuits
CO2: Model the properties of hetero junctions from the energy band diagram point of view
CO3: Model the physics and operation and modeling of MESFETs
CO4: : Interpret the operation and performance parameters of HEMT, HBTs
CO5: Interpret the operation and performance of Optoelectronics Devices

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	-	1	-	2	-	-
CO2:	-	2	2	2	-	-
CO3:	-	2	-	3	-	-
CO4:	-	3	2	-	-	-
CO5:	-	2	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	-
CO2:	-	2	-
CO3:	-	2	-
CO4:	-	2	-
CO5:	-	2	-

UNIT – I
Basic Properties of Compound Semiconductors
Important parameters governing the high speed performance of devices and circuits: Transit time of charge carriers,junction capacitances, ON-resistances and their dependence on the device geometry and size, carrier mobility,doping concentration and temperature - Materials properties: Merits of III –V binary and ternary compoundsemiconductors (GaAs, InP, InGaAs, AlGaAs, SiC, GaN etc.), different SiC structures, silicon-germanium alloysand silicon carbide for high speed devices, as compared to silicon based devices - Band diagrams, homo and heterojunctions.

UNIT – II
Metal Semiconductor related parameters and devices
Metal semiconductor contacts and Metal Insulator Semiconductor and MOS devices: Native oxides of Compoundsemiconductors for MOS devices and the interface state density related issues

UNIT – III
Metal semiconductor Field EffectTransistors (MESFETs): Basic features, Pinch off voltage

and threshold voltage.

UNIT – IV

HEMT, HBTs and Optoelectronics Devices

High Electron Mobility Transistors (HEMT): The generic Modulation Doped FET (MODFET) structure for highelectron mobility realization, Principle of operation and the unique features of HEMT. Hetero junction Bipolartransistors (HBTs)

UNIT – V

Principle of operation and the benefits of hetero junction BJT for high speed applications.
Optoelectronic Devices: Basic working principles and performance parameters of LED, Photodetectors and SolarCell.

Text Books:

1. B. J. Baliga, Gallium Nitride and Silicon Carbide Power Devices, World Scientific, ISBN Number- 9813109408
2. Sandip Tiwari, Compound Semiconductor Device Physics, Academic Press, ISBN Number- 012691740X

Reference Books:

1. Robert F. Pierret, Semiconductor Device Fundamentals, Addison-Wesley, ISBN Number- 0201543931
2. S. M. Sze, High-Speed Semiconductor Devices, Wiley, ISBN Number- 0471623075

Web Links:

1. https://in.video.search.yahoo.com/search/video?fr=mcafee&p=VLSI+SOLID+STATE+CIRCUITS+NPTEL&type=E210IN826G91832#id=5&vid=00729441fd52c602f8aa240ce1358c68&action=click
2. https://ceat.okstate.edu/ece/research/ece-old-files/vlsi-solid-state.html

MACHINE LEARNING FOR VLSI DESIGN

	L	T	P	C
Course Code:242EC025	**3**	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Identify the goals, applications, types and design issues of machine learning techniques.
CO2: Analyse different machine learning algorithms.
CO3: Discuss the suport vector machines and neural network models.
CO4: Demonstrate ensemble learing and clustering techniques.
CO5: Identyfying various methodes to incorporate in VLSI with machine learing

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	1	2	-	-	-
CO2:	1	1	2	-	-	-
CO3:	1	2	3	-	-	-
CO4:	1	2	3	-	-	-
CO5:	2	2	3	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	-	2	-
CO2:	-	2	-
CO3:	-	2	-
CO4:	-	2	-
CO5:	-	2	-

UNIT – I
Introduction: Aims and applications of machine learning, learning systems,various aspects of developing a learning system,overfitting, underfiting, bias-variance tradeoff

UNIT – II
Instance based learning: Instance based learning, Feature reduction,Collaborative filtering-based recommendation, Bayesian learning: Probability and Bayes learning, Linear regression, Decision trees,

UNIT – III
Logistic Regression: Logistic Regression, Support Vector Machine, Kernel, Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network

UNIT – IV

Computational learning: Computational learning theory, PAC learning model,Sample complexity, VC Dimension, Ensemble learning, Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model

UNIT – V

Machine Learning in VLSI Design: A Taxonomy for Machine Learning in VLSI Design, Machine Learning for Lithographic Process Models: Masks, and Physical Design, Yield Enhancements, Machine Learning based Aging Analysis, Machine Learning Hardware: Energy-Efficient Design of Advanced Machine Learning Hardware

Text Books:

1. Bishop, C. Pattern Recognition and Machine Learning. Berlin: Springer-Verlag, ISBN Number- 0241973376
2. Ethem Alpaydin, Introduction to Machine Learning, PHI, ISBN Number- 8120341600

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning DataMining,Inference,and Prediction, ISBN Number- 0387848576
2. Elfadel, Ibrahim M., Duane S. Boning, and Xin Li, eds. Machine Learning in VLSI Computer-AidedDesign. Springer, ISBN Number- 3030046656

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs24/
2. https://chipedge.com/role-of-machine-learning-in-vlsi-design/

BASIC CONCRETE TECHNOLOGY

Course Code: 242CE030

L	T	P	C
3	0	0	3

Course Outcomes:
At the end of the Course, Student will be able to:

CO 1: Understand the chemical composition, hydration, and physical properties of Portland cement.
CO 2: Evaluate the effects of mineral and chemical admixtures on concrete performance.
CO 3: Classify and assess aggregates based on mechanical properties, grading, and thermal behavior.
CO 4: Analyze workability and setting characteristics of fresh concrete, including relevant testing methods.
CO 5: Design and proportion concrete mixes using BIS and ACI methods, ensuring quality control.

Mapping of course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	1	-	-	-
CO2	2	1	3	-	-	-
CO3	2	1	3	-	-	-
CO4	2	1	3	-	-	-
CO5	2	2	3	-	-	-

Mapping of course outcomes with program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT – I

Cement: Portland cement – chemical composition – Hydration, Setting of cement – Structure of hydrate cement – Test on physical properties – Different grades of cement. Admixtures: Types of admixtures – mineral and chemical admixtures.

UNIT - II

Aggregates: Classification of aggregate – Particle shape & texture –, strength & other mechanical properties of aggregate – Specific gravity, Bulk density, porosity, adsorption &moisture content of aggregate – Bulking of sand – Deleterious substance in aggregate – Soundness of aggregate – Alkali aggregate reaction – Thermal properties – Sieve analysis – Fineness modulus – Grading curves – Grading of fine & coarse Aggregates – Gap graded aggregate – Maximum aggregate size.

UNIT – III

Fresh Concrete: Workability – Factors affecting workability – Measurement of workability by different tests – Setting times of concrete – Effect of time and temperature on workability – Segregation & bleeding – Mixing and vibration of concrete – Steps in manufacture of concrete – Quality of mixing water.

UNIT - IV

Hardened Concrete : Water / Cement ratio – Abram's Law – Gelspaoe ratio – Nature of strength of concrete – Maturity concept – Strength in tension & compression – Factors affecting strength – Relation between compressive & tensile strength - Curing. Testing Of Hardened Concrete: Compression tests – Tension tests– Flexure tests – Splitting tests – Pull-out test, Non-destructive testing methods – codal provisions for NDT. Elasticity, Creep & Shrinkage – Modulus of elasticity – Dynamic modulus of elasticity – Poisson's ratio – Creep of concrete – Factors influencing creep.

UNIT – V

Mix Design: Factors in the choice of mix proportions – Durability of concrete – Quality Control of concrete – Statistical methods – Acceptance criteria – Proportioning of concrete mixes by IS codes mix design. Special Concretes: Introduction to light weight concrete – Cellular concrete

Text Books:

1. Properties of Concrete by A. M. Neville Pearson 5th edition Education ltd. (ISBN: 9780273755807)
2. Concrete Technology by M. S. Shetty. – S. Chand & Co. (ISBN: 9788121900034)
3. Concrete Technology by Job Thomas -Cengage learning India Pvt Ltd.(ISBN: 9788131521099)

Reference Books:

1. Concrete Technology by M.L. Gambhir. – Tata Mc. Graw Hill Publishers, New Delhi. (ISBN: 9780070141100)
2. Concrete: Microstructure, Properties and Materials – P. K. Mehta and J. M. Monteiro, McGraw Hill Publishers. (ISBN: 9780071797870)

Web Links:

1. www.Nptel.Ac.In/Courses/105102012/
2. www.archive.nptel.ac.in/noc/courses/noc15/SEM1/noc15-ce01
3. https://archive.nptel.ac.in/courses/105/102/105102012/

REPAIR AND REHABILITATION OF STRUCTURES

CourseCode:242CE031

L	T	P	C
3	0	0	3

Course Outcomes:
At the end of the Course, Student will be able to

CO 1: Identify the causes of deterioration of concrete structures.
CO 2: Illustrate the various materials for repair and rehabilitation techniques.
CO 3: Construct the various strengthening and stabilization techniques.
CO 4: Determine various repair techniques of damaged structures.
CO 5: Evaluate the usage of different types of concretes and durability aspects.
CO 6: Classify the usage of high performance concretes for repairing works.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	-
CO2	3	2	2	2	2	-
CO3	3	2	2	2	2	-
CO4	3	2	2	2	2	-
CO5	2	2	1	2	1	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT-I
Materials for Repair and Rehabilitation:
Admixtures- types of admixtures- purposes of using admixtures- chemical composition- Natural admixtures- Fibers- wraps- Glass and Carbon fiber wraps- Steel Plates-Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects – Visual investigation- Acoustical emission methods-Corrosion activity measurement-chloridecontent– Depth of carbonation- Impact echo methods- Ultrasound pulse velocity methods- Pull out tests.

UNIT-II
Strengthening and Stabilization:
Techniques- design considerations-Beam shear capacity strengthening- Shear Transfer strengthening-stress reduction techniques- Column strengthening-flexural strengthening-

Connection stabilization and strengthening, Crack stabilization.

UNIT–III

Bonded Installation Techniques:

Externally bonded FRP- Wet layup sheet, bolted plate, near surface mounted FRP, fundamental debonding mechanisms-intermediate crack debonding- CDC debonding- plate end debonding- strengthening of floor of structures.

UNIT-IV

Fibre Reinforced Concrete:

Properties of constituent materials- Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes-Light weight concrete- properties of light weight concrete-No fines concrete-design of light weight concrete- Flyash concrete- Introduction- classification of flyash- properties and reaction mechanism of flyash- Properties of flyash concrete in fresh state and hardened state-Durability of flyash concretes.

UNIT-V

High Performance Concrete:

Introduction- Development of high performance concretes-Materials of high performance concretes-Properties of high performance concretes - Self Consolidating concrete-properties-qualifications.

Text Books:

1. Concrete repair and maintenance illustrated-Peter Emmons, published by Brandon W. Emmons.(ISBN: 9780876291916)
2. Experimental Techniques and Instrumentation, Dr.M.Sreenivasa Reddy, Dr.S.Govindarajan and Dr.S.Pachaiappan, Charulatha Publications, 2022.

Reference Books:

1. Rehabilitation of Concrete Structures, Dr. B. Vidivelli, Standard Publishers Distributors. (ISBN: 978-8180140276)
2. Concrete technology, M S Shetty, S. Chand Publications.(ISBN: 9788121900034)
3. Concrete technology, Neville & Brooks, pearson education ltd.(ISBN: 9788131708384)

Web Links:

1. http://nptel.ac.in/courses/112101095/38
2. http://www.nptel.ac.in/courses/105105041/module%206.pdf
3. https://www.youtube.com/watch?v=N4KrZ_DczrE

NEURAL NETWORKS AND FUZZY LOGIC

	L	T	P	C
Course Code: 242EE028	3	0	0	3

Course Outcomes:
At the end of the Course, Student will be able to:

CO 1: Explain artificial neuron models.
CO 2: Explain various learning methods of ANN.
CO 3: Apply different algorithms of ANN.
CO 4: Distinguish between Classical and Fuzzy Sets.
CO 5: Apply application of fuzzy logic control to real time systems.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	1	-	-
CO2	3	-	1	1	-	-
CO3	3	-	1	1	-	-
CO4	3	-	1	1	-	-
CO5	3	-	1	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT-I: Introduction to Neural Networks
Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Applications of ANN.

UNIT-II: Essentials of Artificial Neural Networks
Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN, Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application.

UNIT-III: Multilayer feed forward Neural Networks

Credit Assignment Problem, Generalized Delta Rule, Derivation of Back propagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements, Radial Basis Function (RBF) Neural Network – Kohonen Self Organising feature Map (KSOM).

UNIT-IV: Classical & Fuzzy Sets

Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.

UNIT-V: Fuzzy Logic Modules

Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

Text Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI Publication. (ISBN: 9788120353343)
2. Introduction to Neural Networks using MATLAB 6.0 - S.N.Sivanandam, S.Sumathi, S.N.Deepa, TMH. (ISBN: 9780070591127)

Reference Books:

1. Neural Networks, James A Freeman and Davis Skapura, Pearson Education. (ISBN: 9780201513769)
2. Fuzzy sets University and information, J.Klin and T.A.Folger, Prentice Hall. (ISBN: 9789353065782)
3. Introduction to artificial neural systems, J.M.Zurada, Jaico Publication house.(ISBN: 9780314933911)

Web Links:

1. http://nptel.ac.in/courses/108104049/16
2. www.archive.nptel.ac.in/courses/127/105/127105006/
3. www.geeksforgeeks.org/fuzzy-logic-introduction/

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HYBRID ELECTRIC VEHICLES

	L	T	P	C
Course Code: 242EE029	3	0	0	3

Course Outcomes:
At the end of the Course, Student will be able to:

CO 1: Analyze the architectures of HEVs with various components.
CO 2: Illustrate the concept of Electric Vehicle and Hybrid Electric Vehicles.
CO 3: Explain the Plan concept of Plug-in Electrical Vehicles.
CO 4: Analyze the power electronics converters for HEVs.
CO 5: Apply various energy storage technologies in Hybrid Vehicles.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	3	2	-	-
CO2	1	-	3	2	-	-
CO3	1	-	3	2	-	-
CO4	1	-	3	2	-	-
CO5	1	-	3	2	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT-I: Introduction
Introduction to Electric Vehicles: History of electric vehicles, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies- Challenges and Key Technologies of EVs – Challenges for EV Industry in India

UNIT-II: Hybridization of Automobile
Fundamentals of vehicle, components of conventional vehicle and propulsion load, Drive cycles and drive terrain, Concept of electric vehicle and hybrid electric vehicle, Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.

UNIT-III: Plug-in Hybrid Electric Vehicle

PHEVs and EREVs, PHEV Architectures, equivalent electric range of blended PHEVs, Fuel economy and power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology, battery charging.

UNIT-IV: Power Electronics in HEVs

Rectifiers and Buck converter used in HEVs, isolated and non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter, current source inverter, PWM rectifier in HEVs, EV and PHEV battery chargers.

UNIT-V: Battery and Storage Systems:

Energy Storage Parameters; Lead–Acid Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource.

Text Books:

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press.(ISBN: 9781138072855)
2. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press. (ISBN: 9780367693930)

Reference Books:

1. Introduction to Hybrid Vehicle System Modeling and Control, Wei Liu, Wiley.(ISBN: 9788126556205)
2. Electric and Hybrid Vehicles Technologies, Modelling and Control: A Mechatronic Approach", Amir Khajepour, Saber Fallahand Avesta Goodarzi, John Wiley & Sons Ltd. (ISBN: 9781118341513)

Web Links:

1 https://archive.nptel.ac.in/courses/108/103/108103009/

2. https://ndl.iitkgp.ac.in/he_document/nptel/nptel/IN__N__1_E_E__12391_I_t_H_a_E_V__14024_D_o_H_E_v__14030_14031

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GREEN ENGINEERING SYSTEMS

Course Code: 242ME029	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Distinguish the various solar energy collection methods and measuring instruments.
- **CO2:** Explain the different methods of solar energy storage and their applications.
- **CO3:** Illustrate the various types of wind mills and performance characteristics.
- **CO4:** Explain the principle of Biomass production, Geothermal energy sources and Ocean thermal energy conversion
- **CO5:** Illustrate the various types of electrical systems and mechanical systems.
- **CO6:** Compare the various energy efficient process.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-
CO6:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	3
CO2:	-	3
CO3:	-	3
CO4:	-	3
CO5:	-	3

UNIT – I

Introduction: Solar Radiation: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems. Photo voltaic energy conversion – types of PV cells, I-V characteristics

Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT – II

Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

UNIT – III

Bio-Mass: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India.

Ocean Energy: OTEC, Principles of utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

UNIT – IV

Electrical Systems: Energy efficient motors, energy efficient lighting and control, selection of luminaire, variable voltage variable frequency drives (adjustable speed drives), controls for HVAC (heating, ventilation and air conditioning), demand site management.

Mechanical Systems: Fuel cells- principle, thermodynamic aspects, selection of fuels & working of various types of fuel cells, Environmentally friendly and Energy efficient compressors and pumps.

UNIT – V

Energy Efficient Processes: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of efficient and sustainable green production systems with examples like environmentally friendly machining, vegetable based cutting fluids, alternate casting and joining techniques, zero waste manufacturing.

Green Buildings: Definition, features and benefits. Sustainable site selection and planning of building for maximum comfort. Environmentally friendly building materials like bamboo, timber, rammed earth, hollow blocks, lime & lime pozzolana cement, agro materials and industrial waste.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K. Nayak/ TMH.
2. Non-Conventional Energy Resources/ Khan B.H/ Tata McGraw Hill, New Delhi,

Reference Books:

1. Renewable Energy Technologies /Ramesh & Kumar /Narosa.
2. Renewable Energy Resources-2 Edition/ J. Twidell and T. Weir/ BSP Books Pvt. Ltd.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc17_me33
2. https://nptel.ac.in/courses/105107176/20

I.C.ENGINES

	L	T	P	C
Course Code: 242ME030	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Summarize the finite element methods
CO2: Analyse one-dimensional problems in trusses and beams
CO3: Solve structural problems using CST and axis - symmetric formulation
CO4: Apply finite elements to higher order, Iso-parametric elements, and one-dimensional heat transfer analysis.
CO5: Apply finite element methods to dynamic analysis.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	2	1	1	1	-	-
CO2	2	2	1	1	-	-
CO3	2	2	2	1	-	-
CO4	2	1	-	1	-	-
CO5	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT – I: Gas Exchange Processes
Inlet and exhaust processes in the four stroke cycle volumetric efficiency quasi static effects combined quasi static and dynamic effects variation with speed and valve area and timing-flow through valves poppet valve geometry and timing flow rate and discharge efficient, residual gas fraction exhaust gas flow rate and temperature variation, scavenging in wnike eyelid engines, scavenging parameters and mdeluctual scavenging processes. Flow through parts supercharging and turbo changing methods of power buying abusive relationships compressors, turbines wave compression devices.

UNIT – II: Charge Motion Within The Cylinder
Intake Jet Flow, Mean velocity and turbulence characteristics definitions application to engine velocity data swirl swirl measurement, swirl generation during induction swit modification within the cylinder squish pre chamber engine flow crevice flows and blowby News nerated

by piston-cylinder wall interaction

UNIT – III: Combustion In S.I And C.I Engines
Review of normal and abnormal combustion in SI and Ci engine cyclic variation in combustion of St engine analysis of cylindrical pressure data in SI and CI engine. EMP Flix SI engines common rail fuel injection system in Ci engines fuel spray behavior in CI engine

UNIT – IV: Electric Vehicles
Introduction Limitations of IC Engines as prime mover. History of EV, components of EV. and AC electric machines: Introduction and basic structure, Electric vehicle drive train, advantages and limitations Permanent magnet and switched reluctance motors.

UNIT – V: Hybrid Vehicles
Configurations of hybrid, Series and parallel, advantages and limitations, Hybrid drive trains, sizing of components Initial acceleration, rated vehicle velocity, Maximum velocity and maximum gradeability, Hydrogen: Production, Hydrogen storage systems, reformrs.
Fuel Cell Vehicles: Introduction, Fuel cell characteristics, Thermodynamics of Fuel cells, Fuell cell types; emphasis on PEM fuel cell.

Text Books:

1 Internal Combustion Engine Fundamentals, J.B. Heywood, Mc Graw Hill Co, (ISBN: 978-1259002076)
2 Build your own electric vehicle, Seth Leitman and Bob Brant. McGraw Hill, Co, 3 rd edition, **(**ISBN: 978-0071770569

Reference Books:

1 Engineering Fundamentals of IC Engine, H.N. Gupta, 2nd edition PHI Pvt. Ltd. (ISBN: 9788120346802)
2 PEM Fuel Cells-Theory and Practice, F. Barbir Elsevier Academic Press, (ISBN: 9780128102398)

Web Links:

1 http://nptel.ac.in/courses/112101097/
2 www.thermopedia.com/content/786

CAD TOOLS FOR VLSI DESIGN

Course Code:242EC028	L	T	P	C
	3	0	0	3

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Comprehend the insight of CAD Tools in modern design.
CO2: Develop combinational logic circuits by using CAD tools
CO3: Build sequential logic circuits using Verilog HDL operators
CO4: Analyze the performance of logic schematics using CAD simulation tools
CO5: Infer the performance of logic circuits in terms of DRC, LVS and PEX.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	3	1	2	2	1
CO2:	2	3	1	2	1	2
CO3:	2	2	3	2	2	1
CO4:	2	3	1	2	2	1
CO5:	2	3	2	2	2	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	2	3	1
CO2:	2	3	1
CO3:	2	3	1
CO4:	2	3	1
CO5:	2	3	1

UNIT – I
Understanding the working platform with Xilinx Vivado and its device, family and package Selection. Design and Implementation of Combinational Circuits Priority Encoder and Comparatorusing data flow & structural style.

UNIT – II
Design and Implementation of Sequential Circuits to detect a given sequence using with and without overlapping (mealy & Moore machines). Design and Implementation of a traffic light controller in three road & four road junctions.

UNIT – III
Exercise on Concatenation, Replication operators, Reduction and Conditional operators in Verilog HDL. Performance characteristics of an n-channel and p-channel MOSFET.

UNIT – IV

Working with Schematic for Ring Oscillator with variable amounts of Pull up to pull down ratios. Design a full adder by instantiating the logic gates. Make a comment on design style on its performance.

UNIT – V

Design a NAND gate by using NMOS, PMOS and CMOS technologies and make a comment on its performance. Design a Schematic, stick and layout for given logic.

Text Books:

1. S. M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits : Analysis and Design, Third Edition, MH, (ISBN Number-0072460539)
2. Plummer, Deal , Griffin "Silicon VLSI Technology: Fundamentals, Practice &Modeling"PH, (ISBN Number-0130850373)

Reference Books:

1. P. VanZant , "Microchip Fabrication", 5th Edition, MH, (ISBN Number-6053901308)
2. R. J. Baker, H. W. Li and D. E. Boyce, CMOS Circuit Design, Layout and Simulation, PH, (ISBN Number-1119481511)

Web Links:

1. https://themosisservice.com/university-support
2. https://youtu.be/OF3Zwfu6Ngc
3. https://newsroom.ibm.com/2021-05-06-IBM-Unveils-Worlds-First-2-

FPGA DESIGN FOR EMBEDDED SYSTEMS

	L	T	P	C
Course Code: 242EC029	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Outline the concepts of Embedded System and Hardware Description Languages
CO2: Develop an embedded system using FPGA
CO3: Explain FPGA platforms and cross development tools.
CO4: Illustrate Parallelism and scheduling concepts
CO5: Interpret the parallelism with in FPGA hardware core.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	1	3	1	-	-
CO2:	3	-	2	-	-	-
CO3:	1	-	2	-	-	-
CO4:	1	-	2	-	-	-
CO5:	1	-	2	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2	PSO3
CO1:	1	2	-
CO2:	-	2	2
CO3:	-	2	2
CO4:	2	-	2
CO5:	2	-	2

UNIT – I: Embedded System Overview & Hardware Description Languages
H/W-FPGA-Embedded SoC and use of VLSI circuit technology-platform FPGA's-Altera, Cyclone, Hardware Description Languages - VHDL , Verilog , Other High-Level HDLs, From HDL to Configuration Bit-stream

UNIT – II: System Design using FPGA:
Principles of system design-Design quality, Modules and interfaces, Abstraction and state, Cohesion and coupling, Designing and Reuse, Control flow graph, Design-Origins of platform FPGA designs.

UNIT – III: FPGA Platform
Components, adding to platform FPGA systems, assembling custom compute cores. Software Design-System Software Options, Root File system, Cross-Development Tools, Monitors and Boot-loader.

UNIT – IV: Partitioning, Scheduling & Communication

Overview of Partitioning Problem, Analytical Solution to Partitioning-Basic definitions, expected performance gain, resource considerations, Analytical Approach, Communication-Invocation/Coordination, Transfer of State, Practical Issues- Profiling Issues, Data Structures Manipulate Feature Size.

UNIT – V: Spatial Design

Principles of Parallelism-Identifying Parallelism - Spatial Parallelism with Platform FPGAs Parallelism within FPGA Hardware Cores, Parallelism within FPGA Designs

Text Books:

1. Embedded Systems Design with Platform FPGAs, Ron Sass, Andrew G Schmidt Principles and Practices, First Edition, Tata McGraw Hill, India, ISBN Number-0123743338
2. Digital Systems design using VHDL, Charles H Roth. Jr, Re-Print, PWS publishing company (Thomson Books), USA, ISBN Number-9788131518304

Reference Books:

1. Design with VHDL,V A. Padroni Circuit First Edition, MIT Press Cambridge, England, ISBN Number-0262162245
2. FPGA Based System Design, Wayne Wolf, First Edition, Prentices Hall Modern Semiconductor Design Series, USA, ISBN Number-0131424610

Web Links:

1. https://www.coursera.org/learn/intro-fpga-design-embedded-systems
2. https://www.colorado.edu/ali/fpga-design-embedded-systems-specialization

ARTIFICIAL INTELLIGENCE

	L	T	P	C
Course Code: 242CS030	**3**	**0**	**0**	**3**

Course Outcomes:
At the end of the Course, Student will be able to:

CO 1: Describe fundamentals of Artificial Intelligence and its applications
CO 2: Solve basic AI based problems and construct logical building blocks for problem Formulation
CO 3: Apply various logical systems inferencing different logical problems.
CO 4: Illustrate knowledge representation using predicate logic and predicate rules.
CO 5: Design expert systems that leverage domain knowledge effectively.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	-	1	-
CO2	2	1	2	-	1	-
CO3	2	1	2	2	1	2
CO4	2	1	2		1	-
CO5	2	1	-	-	1	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT – I: Introduction to Artificial Intelligence:
Introduction, History, Intelligent Systems, Foundations of AI, Applications, Tic-Tac-Toe Game playing, Development of AI Languages, Current trends in AI

UNIT – II: Problem Solving: State-Space Search And Control Strategies:
Introduction, General Problem Solving, Characteristics of problem, Exhaustive Searches, Heuristic Search Techniques, Iterative- Deepening A*, Constraint Satisfaction.

Problem Reduction and Game Playing: Problem Reduction, Game Playing, Minimax algorithm, Alpha- Beta Pruning, Two-player perfect information games.

UNIT – III: Logic Concepts

Introduction, Propositional calculus, Proportional logic, Representing facts in logic, functions and predicates, Axiomatic System, Semantic Tableau System in Proportional logic, Resolution Refutation in proportional logic, predicate logic.

UNIT – IV: **Knowledge Representation**

Knowledge Representation Using Predicate logic, Knowledge Representation using Semantic Network, Knowledge Representation using Frames.

Representing Knowledge Using Rules: Procedural Versus Declarative knowledge, Logic Programming, Forward versus Backward Reasoning

UNIT – V: Expert System

Representing and using Domain Knowledge, Reasoning with knowledge, Expert System Shells, Support for explanation examples, Knowledge acquisition-examples.

Text Books:

1. Artificial Intelligence- Saroj Kaushik, 1st edition CENGAGE Learning, (ISBN: 9789355730428).
2. Artificial intelligence, A modern Approach, Stuart Russel, Peter Norvig, Pearson Education Ltd, 2nd ed, (ISBN: 97881203238)
3. Artificial Intelligence- Elaine Rich, Kevin Knight, Shivashankar B Nair, 3rd ed, McGraw Hill Education, (ISBN-13. 9780070087705)

Reference Books:

1. Artificial intelligence structures and strategies for complex problem solving, George F Lugar, 5th Edition, Addison Wesley. ISBN-13: 978-0321263186

Web Links:

1. **https://www.tutorialspoint.com/artificial_intelligence/index.htm/**
2. **https://www.slideshare.net/slideshow/logic-in-ai/5005940//**
3. **https://www.slideshare.net/slideshow/artificial-intelligence-3638681/3638681/**

MACHINE LEARNING TECHNIQUES

Course Code: 242CS031

L	T	P	C
3	0	0	3

Course Outcomes:
At the end of the Course, Student will be able to:

CO1: Describe the need for AI and ML, and the types of ML algorithms.
CO2: Apply regression techniques and dimensionality reduction methods.
CO3: Implement and evaluate various classification techniques.
CO4: Describe and implement Artificial Neural Networks.
CO5: Utilize unsupervised learning methods for clustering and dimensionality reduction

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	-	-	-
CO2	2	1	2	-	-	-
CO3	2	1	2	2	-	2
CO4	2	1	2	-	-	-
CO5	2	1	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT – I
Introduction: Understanding the need for AI and Machine Learning (ML), AI & Data, Types of ML Algorithms: Supervised, Unsupervised Learning and semi supervised learning, reinforcement learning, evolutionary computation ML Model development life cycle Deep Learning for Human Like Learning

UNIT – II
Regression Techniques: Regression for prediction, Gradient Descent and Ascent, Learning with Momentum, Loss Functions, Over fitting and under fitting, Model evaluation techniques Types of Regression: Linear Regression,

UNIT – III

Classification Techniques: Naïve Bayes Classification: Bayesian Learning, Naïve Bayes Classification, MAP, Bayesian Belief Networks, Decision Tree, K-Nearest Neighbors Support Vector Machines: Hard Margin and Soft Margin, Kernels and Kernel Trick, EvaluationMeasures for Classification Techniques

UNIT – IV

Classification Techniques: Naïve Bayes Classification: Bayesian Learning, Naïve Bayes Classification, MAP, Bayesian Belief Networks Decision Tree K-Nearest Neighbors Support Vector Machines: Hard Margin and Soft Margin, Kernels and Kernel Trick, Evaluation Measures for Classification Techniques

UNIT – V

Unsupervised Learning: Uses in Clustering, associations and dimensionality reduction Clustering, Hierarchical Agglomerative Clustering, k-means Algorithm

Text Books:

1. Machine Learning, Tom Mitchell, McGraw-Hill international editions, TMH, (ISBN: 0071154671)
2. Pattern Recognition and Machine Learning C. Bishop, Springer, (ISBN: 9781493938438)
3. Elements of Artificial Neural Networks , Kishan Mehrotra, Chilukuri Mohan and Sanjay Ranka, Penram International, (ISBN: 9780262133289).

Reference Books:

1. Pattern Recognition, Techniques and Applications , Rajjan Shinghal, OXFORD Higher Education , (ISBN:9780195676853)
2. Andrew Kelleher, Adam Kelleher, Applied Machine Learning for Data Scientist and Software engineers, Addison-Wesley Professional, (ISBN:9780134116549)

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs24/preview/
2. https://www.udemy.com/course/machinelearning/

VALUE EDUCATION

L	T	P	C
2	0	0	0

Course Code: 242AC001

Course Outcomes:
At the end of the Course, Student will be able to:

CO 1: Understand value of education and self- development.
CO 2: Explain the need of good values in students.
CO 3: Developing the overall personality.
CO 4: Explain the need of character in a student.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	-	2	-
CO2	3	2	1	1	3	-
CO3	3	3	2	2	2	-
CO4	2	1	1	1	2	-
CO5	3	2	2	2	2	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT – I
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism, Moral and non- moral valuation. Standards and principles, Value judgements.

UNIT – II
Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration. Truthfulness, Cleanliness, Honesty, Humanity. Power of faith, National Unity, Patriotism. Love for nature, Discipline

UNIT – III
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship.

UNIT – IV

Happiness Vs suffering, love for truth, Aware of self- destructive habits, Association and Cooperation, Doing best for saving nature.

UNIT – V

Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively.

Text Books:

1. Chakrborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi. (ISBN: 9780195643077)

Reference Books:

1. Value Education and Professional Ethics by R.P. Shukla, **ISBN**: 978-8183560995
2. Value Education: A Textbook for Schools by Dr. N. Venkataiah, **ISBN**: 978-8120731965
3. Value Education: Theory and Practice by G. Rajagopal, **ISBN**: 978-8182475191

Web Links:

1. https://nptel.ac.in/courses/109/104/109104068/
2. https://nptel.ac.in/courses/109/105/109105116/
3. https://nptel.ac.in/courses/109/104/109104107/

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RESEARCH METHODOLOGY

	L	T	P	C
Course Code: 242AC002	**2**	**0**	**0**	**0**

Course Outcomes:
At the end of the Course, Student will be able to:

CO 1: Explain the characteristics and process of research.
CO 2: Choose the research problem by applying problem identification techniques.
CO 3: Develop and execute research design process.
CO 4: Show the results of research process adhering to professional ethics.
CO 5: Analyze the results of research using statistical measures of central tendency & coefficient of variation, correlation and regression

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	-	-	2	-
CO2	3	2	1	1	3	-
CO3	3	3	2	2	2	-
CO4	2	1	1	1	2	-
CO5	3	2	2	2	2	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT – I: Meaning of Research
Function of Research - Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research –Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature review.

UNIT – II: Identification of Research Problem

Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem.

UNIT – III: Research Design

Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design.

UNIT – IV: Interpretation and Report Writing

Meaning and Technique of interpretation – Precautions in interpretation, Significance of report writing – Different steps in writing a report – Layout of a Research report.

UNIT – V: Statistical Techniques and Tools

Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete serious and continuous serious) – Correlation – Regression.

Text Books:

1. Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers (ISBN: 9789386649225).
2. A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMMVidyalaya press.(ISBN: 9780367135720)

Reference Books:

1. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd.(ISBN: 9780471339274)
2. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi. (ISBN: 9788120343818)
3. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi.(ISBN: 9788180545283)

Web Links:

1. https://nptel.ac.in/courses/127106227
2. https://www.coursera.org/learn/research-methodologies