Proposed Course Structure & Scheme

For

Master of Technology

In

Microelectronics

Electronics Engineering Department
Institute of Engineering and Technology
AKTU Technical University, Lucknow - 226 021
www.ietlucknow.edu*, *www.aktu.ac.in

Eligibility Condition

1. B.Tech/B.E in Electronics & Communication/Electronics and Instrumentation/ Electrical and Electronics Engineering/ or equivalent degree with 60% marks.

Admission Procedure

Post Graduate admissions norms decided by AKTU

Admission Intake per batch

Total of 15 students per batch

2023-24

PROPOSED M.TECH MICROELECTRONICS CURRICULUM

SCHEME OF EXAMINATION 2023-24

M. Tech. (Microelectronics)

First Year: First Semester

Course Code	Subject Name	Credit	Periods			Evaluation Scheme					Subject Total
						Theory			Practical		
			L	T	P	CT	TA	ESE	TA	ESE	
MAMC-101	Core-I	4	4	0	0	20	10	70	-	-	100
MAMC-102	Core-II	4	4	0	0	20	10	70	-	-	100
MAMC-01X	Elective - I	4	4	0	0	20	10	70	-	-	100
MARM101	Research Process & Methodology	4	4	0	0	20	10	70	-	-	100
MAMC-151	Core Lab- I	2	0	0	3	-	-	-	50	50	100
MAMC-152	Core Lab - II	2	0	0	3	-	-	-	50	50	100
Total		**20**									**600**
Total Contact Hour 22			**Total Credit 20**								

SCHEME OF EXAMINATION

M. Tech. (Microelectronics)

First Year: Second Semester

Course Code	Subject Name	Credit	Periods			Evaluation Scheme					Subject Total
						Theory			Practical		
			L	T	P	CT	TA	ESE	TA	ESE	
MAMC-201	Core-III	4	4	0	0	20	10	70	-	-	100
MAMC-202	Core-IV	4	4	0	0	20	10	70	-	-	100
MAMC-02X	Elective - II	4	4	0	0	20	10	70	-	-	100
MAMC-03X	Elective - II1	4	4	0	0	20	10	70	-	-	100
MAMC-251	Core Lab -III	2	0	0	3	-	-	-	50	50	100
MAMC252	Seminar-1	2	0	0	3	-	-	-	50	50	100
Total		**20**									**600**
Total Contact Hour 22			**Total Credit 20**								

PROPOSED M.TECH MICROELECTRONICS CURRICULUM

M. Tech. (Microelectronics) 2023-24

Second Year: Third Semester

Course Code	Subject Name	Credit	Periods			Evaluation Scheme					Subject Total
						Theory			Practical		
			L	T	P	CT	TA	ESE	TA	ESE	
MAMC-04X	Elective - IV	4	4	0	0	20	10	70	-	-	100
MAMC-351	Dissertation-I	10	0	0	15	-	-	-	100	200	300
MAMC352	Seminar II	2		0	3	20	10	70	100	-	100
Total		**16**									**500**
Total Contact Hour 22			**Total Credit 16**								

Second Year: Fourth Semester

Course Code	Subject Name	Credit	Periods			Evaluation Scheme					Subject Total
						Theory			Practical		
			L	T	P	CT	TA	ESE	TA	ESE	
MAMC-451	Dissertation-II	16	0	0	32	-	-	-	150	350	500
Total		**16**	**0**	**0**	**32**						**500**
Total Contact Hour 32			**Total Credit 16**								

NOTE:

1. The total number of credits of the Program = 72.
2. The grand total of program = 2200
3. Each student shall be required to appear for examination in all courses.
4. Elective course will be offered only if 40% students will opt for a particular course.

Table (a) Program curriculum grouping based on course components

Course Component	**Curriculum Content (% of total Credits of the program)**	**Total number of credits**
Program Core	36.11	26
Program Electives	22.22	16
Seminar (S)	5.55	4
Industrial training/ Minor Project		
Dissertation (D)	36.11	26
	Total	72

Table (b) Program curriculum grouping based on course components as per semester:

Sem	**Program Core**		**Program Electives**		**Labs/Seminar**		**Ind. Training/ Minor project**		**Dissertation**		**Total**
	Credits	No.	Credits	No.	Credit	No.	Credit	No.	Credit	No.	Credit
I	12	3	4	1	4	2					**20**
II	8	2	8	2	4	2					**20**
III			4	1	2	1			10	1	**16**
IV									16	1	**16**
Tot	**26**	**8**	**16**	**4**	**4**	**2**			**26**	**2**	**72**

SUBJECT	**CODE**	**PRESENT**
CORE I	MAMC 101	Analog CMOS Circuit Design
CORE II	MAMC 102	VLSI Circuit Design
CORE III	MAMC 201	VLSI Testing & Verification
CORE IV	MAMC 202	Designing with ASICS
ELECTIVE I	MAMC 01X	MAMC 011: Physical Electronics MAMC 012: Digital Techniques for High Speed Design MAMC 013: VLSI Algorithms for VLSI Design Automation MAMC 014: Nano-Electronics Devices and Materials
ELECTIVE II	MAMC 02X	MAMC 021: Advance Embedded System Design MAMC 022: RF Integrated Circuits MAMC 023: VLSI Technology MAMC 024: Device Modeling & Circuit simulation
ELECTIVE III	MAMC 03X	MAMC 031: Advanced Microcontroller & System MAMC 032: Analog Signal Processing MAMC 033: CMOS Mixed-Signal VLSI Design MAMC 034: MEMS & Micro Sensor Design
ELECTIVE IV	MAMC 04X	MAMC 041: Advanced Computer Architecture MAMC 042: Microwave Integrated Circuits MAMC 043: Embedded System for Wireless & Mobile Communication MAMC 044: Semiconductor Memory Design
LAB I	MAMC 151	Analog CMOS Circuit Design Lab
LAB II	MAMC 152	VLSI Circuit Design Lab
LAB III	MAMC 251	Advanced VLSI sub system Design Lab
Seminar I	MAMC 252	Embedded System Lab CAD Lab Advanced Communication Network

VISION AND MISSION OF THE DEPARTMENT

VISION

To produce manpower in the field of Electronics and Communication Engineering, capable to compete with that elsewhere and to make the department a center of excellence in the field of Signal Processing and Microelectronics.

MISSION

M1: To develop the ability among students and understand concepts of core graduate electronics and communication engineering.

M2: To create center of Excellence to meet global research and development challenges.

M3: To build student community with professional and ethical standards in thrust areas so as to meet industry requirements.

VISION AND MISSION OF THE INSTITUTE

VISION

To effectively contribute towards the national endeavor of producing world class manpower and to usher in technology driven economic development of the country in order to enrich the quality of life of its citizen by promoting innovative technologies and optimal utilization of resources for sustainable development.

MISSION

M1. To establish global state-of-art facilities and resources that will prepare and enrich the human resource by promoting all-inclusive research and developments.

M2. To inculcate entrepreneurship skills in the students in order to optimize resources to achieve the economic growth by improving the quality of life of the citizens.

M3. To instill problem-solving skills for overcoming real life challenges by imparting values based professional education.

Program Educational Objectives (PEOs)

Program graduates, within three years from their graduation will

PEO1 Graduates of the programme will have an educational experience that inspires them to exhibit leadership and team building skills and have successful careers in their chosen technical or professional domain

PEO2 Graduates of the programme will continue to learn and adapt in a constantly evolving society and contribute to the society in a professional and ethical manner.

PEO3 Graduates of the programme will inculcate good technical and professional knowledge according to requirements of industries and higher studies.

PE04 To inculcate the spirit of innovation / creativity, independent thinking, risk taking ability, entrepreneurship and attitude to approach challenges with confidence.

MAMC-101	ANALOG CMOS CIRCUIT DESIGN	L: 4	T: 0	P: 0	Credits : 4

Course Objective: Students undergoing this course are expected to:

1. Understand fundamental concepts and principles for the analysis and design of CMOS circuits.
2. Acquire a comprehensive understanding of current mirror and differential amplifier circuits using CMOS technology, facilitating the understanding of their operations and characteristics.
3. Acquire the skills to design operational amplifiers, two-stage operational amplifiers, and operational transconductance amplifiers using CMOS technology, considering performance requirements and design constraints.
4. Explain the principles and functionality of comparators, allowing for a clear understanding of different comparator architectures and their applications in various contexts.
5. Understand the concept of switched capacitor techniques and their application in data converters within CMOS technologies

Syllabus:

Unit	Topics	Lectures
I	Introduction to Analog VLSI, Analog integrated circuit design, Circuit design consideration for MOS challenges in analog circuit design, recent trends in analog VLSI circuits, Analog MOSFET Modeling MOS transistor, Low frequency MOSFET Models, Small Signal Model of the MOSFET in Saturation, High frequency MOSFET Models, Variation of Transconductance with frequency, temperature effects in MOSFET, Noise in MOSFET.	8
II	Current Source, Sinks and References, MOS Diode/Active resistor, Simple current sinks and mirror, Basic current mirrors, advance current mirror, Current and Voltage references, Voltage Dividers: The Resistor-MOSFET Divider, The MOSFET-Only Voltage Divider, Current Source Self-Biasing: Threshold Voltage Referenced Self-Biasing, Diode Refrenced Self-Biasing, Thermal Voltage Referenced Self-Biasing, bandgap references, Beta Multiplier Referenced Voltage Self Biasing.	8
III	CMOS Differential Amplifier, Differential signaling, source coupled pair, Current source load, Common mode rejection ratio, Noise, Matching Considerations, CMOS Differential amplifier with current mirror load, Differential to single ended conversion, Noise and Distortion in Amplifier.	8
IV	CMOS Operational amplifier, Block diagram of Op-amplifier, Ideal characteristics of Op-Amplifier, Design of two stage Op-Amplifier, Compensation of Op-Amplifier, Frequency response of Op-Amplifier, Operational Transconductance Amplifier (OTA), Wide-Swing OTA, The	8

	Folded-Cascode Input Op-AMP, The Folded-Cascode OTA, Analog Multipliers.	
V	CMOS Comparator, Characteristic of a comparator, Two stage open loop comparator, Special purpose comparator, Regenerative comparator, High output current amplifier, High speed comparator, Switched Capacitor Circuits, Switched capacitor circuits, Switched capacitor amplifiers, Switch capacitor integrators, Data converter Fundamentals, Analog Versus Discrete Time Signals, Sample and Hold(S/H) Characteristics, Digital to Analog Converter, Analog to Digital Converter	**8**

Text/References

1. R. Jacob Baker, H. W. Li, and D.E. Boyce, “CMOS Circuit Design ,Layout and Simulation”, PHI,1998
2. Md. Ismail and Terri Faiz, “Analog VLSI Signal and Information Processing”, McGraw-Hill, 1994
3. Paul R. Gray and R. G. Meyer, “Analysis and design of Analog Integrated circuits”, John Wiley and sons,USA, 3rd Edition, 1993
4. B. Razavi, “RF Microelectronics”, Prentice-Hall PTR,1998
5. David A. Johns and Ken Martin, “Analog Integrated circuit Design, John Wiley & Sons.

Course Outcomes:

CO101.1 Recall the basic basics of MOSFET device physics and its operation

CO101.2 Understanding the operations of current mirror and differential amplifier using CMOS

CO101.3 Design the circuit of operational amplifier, Two stage operational amplifier and Operational Transconductance Amplifier using CMOS

CO101.4 Design the principles of comparators

CO101.5 Understand concept of Switched capacitor technique and data converter in CMOS technologies

MAMC 102	VLSI CIRCUIT DESIGN	L: 4	T: 0	P: 0	Credits : 4

Course Objective: Students undergoing this course are expected to:

1. To understand the various principles and techniques of designing combinational logic gates in CMOS technology.
2. To teach various principles and techniques of designing combinational logic gates in CMOS technology.
3. To study design and optimize sequential logic circuits.
4. To study digital circuits using various logic methods and their limitations.
5. To highlight the circuit design issues in the context of VLSI technology.

Syllabus:

Unit	Topics	Lectures
I	The CMOS Inverter: Introduction, The Static CMOS Inverter An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter: The Static Behavior, Switching Threshold, Noise Margins, Robustness Revisited, Performance of CMOS Inverter: The Dynamic Behavior, Computing the Capacitances, Propagation Delay: First Order Analysis, Propagation Delay from a Design Perspective, Power, Energy, and Energy Delay, Dynamic Power Consumption, Static Consumption, Perspective: Technology Scaling and its Impact on the Inverter Metrics	10
II	Designing Combinational Logic Gates in CMOS: Introduction, Static CMOS Design, Complementary CMOS, Ratioed Logic, Pass Transisto r Logic, Dynamic CMOS Design, Dynamic Logic: Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates, Perspectives, How to Choose a Logic Style, Designing Logic for Reduced Supply Voltages	12
III	Introduction, Timing Metrics for Sequential Circuits, Classification of Memory Elements, Static Latches and Registers, The Bistability Principle, Multiplexer Based Latches Master Slave Edge Triggered Register, Low Voltage Static Latches, Static SR Flip Flops Writing Data by Pure Force.	7
IV	Dynamic Latches and Registers, Dynamic Transmission Gate Edge triggered Registers C2MOS A Clock Skew Insensitive Approach, True Single Phase Clocked Register (TSPCR), Pipelining: An approach to optimize sequential circuits, Latch vs. Register Based Pipelines, NORA CMOS A Logic Style for Pipelined Structures, Non Bistable Sequential Circuits, The Schmitt Trigger, Monostable Sequential Circuits, Astable Circuits,Perspec tive: Choosing a Clocking Strategy	7
V	CMOS Integrated Circuit Layout: Design Rules, Parasitics.Building blocks:	6

	ALU's, FIFO's, counters. Basic Introduction of Physical VLSI system design: data and control path design, floor planning, Physical design methodology	

Reference Books:

1. S. M. Kang & Y. Leblebici, "CMOS Digital Integrated Circuits", McGraw Hill Publication.
2. Jackson & Hodges, "Analysis and Design of Digital Integrated circuits",. TMH Publication.
3. Ken Martin, "Digital Integrated Circuit Design", Oxford Publications.
4. Sedra and Smith, "Microelectronic Circuits" Oxford Publications.

Course Outcomes:

CO102.1	Recall the basic fundamental principles of CMOS inverter circuit with its design techniques to optimize their operation.
CO102.2	Understand the various principles and techniques of designing combinational logic gates in CMOS technology.
CO102.3	Design and optimize sequential logic circuits.
CO102.4	Understand digital circuits using various logic methods and their limitations.
CO102.5	Understand the design model, method, criterion and steps of physical design methodology.

MAMC-151	ANALOG CMOS CIRCUIT DESIGN LAB	L: 0	T: 0	P: 3	Credits :2

Course Objective: student will be able to:

1. Acquire comprehensive knowledge about the functionality and components of the Analog System Lab Kit PRO, enabling effective utilization of the kit for practical experiments and projects.
2. Develop a strong understanding of operational amplifiers (op-amps) and their fundamental concepts, allowing for their application in various analog signal processing tasks.
3. Analyze the principles and working of multivibrator circuits using operational amplifiers, gaining insights into their behavior and applications in signal generation and timing circuits.
4. Apply theoretical concepts to analyze the stability and response time of Automatic Gain Controlled circuits under varying input conditions, enabling the optimization and performance evaluation of these circuits.
5. Gain proficiency in designing op-amp based circuits to meet specific application requirements, considering factors such as gain, bandwidth, stability, and power consumption, ensuring the desired functionality and performance of the circuits.

List of Experiments

1. Study of MOS Characteristic and Characterization
2. Design and Simulation of Single Stage Amplifiers (Common Source, Source Follower, Common Gate Amplifier)
3. Design and Simulation of Single Stage Amplifiers (Cascode Amplifier, Folded Cascode Amplifier)
4. Design and Simulation of a Differential Amplifier (with Resistive Load, Current Source Biasing)
5. Design and Simulation of Basic Current Mirror, Cascode Current Mirror
6. Analysis of Frequency response of various amplifiers (Common Source, Source Follower, Cascode, Differential Amplifier
7. Design/Simulation/Layout of Telescopic Operational Amplifier/ Folded Cascode Operational Amplifier

Session-II: Analog CMOS Circuit Design Laboratory Based

Modeling and Functional Simulation of the following digital circuits (with Xilinx/ ModelSim tools) using VHDL/Verilog Hardware Description Languages

1. Part – III Memories and State Machines:
   a. Read Only Memory (ROM), Random Access Memory (RAM),
   b. Mealy State Machine, Moore State Machine,
   c. Arithmetic Multipliers using FSMs
2. Part-IV: FPGA System Design:
   a. Demonstration of FPGA and CPLD Boards,
   b. Demonstration of Digital design using FPGAs
   c. CPLDs. Implementation of UART/Mini Processors on FPGA/CPLD etc

Course Outcomes:

CO151.1	Attain knowledge about the functionality and components of the Analog System Lab Kit PRO.
CO151.2	Discover the fundamental concepts of operational amplifiers (op-amps) and their applications in analog signal processing.
CO151.3	Analyze the principles and working of multivibrator circuits using operational amplifiers.
CO151.4	Apply theoretical concepts to analyze the stability and response time of Automatic Gain Controlled circuits under varying input conditions.
CO151.5	Gain the knowledge of op-amp based circuits to meet specific application requirements.

MAMC-152	**VLSI CIRCUIT DESIGN LAB**	**L: 0**	**T: 0**	**P: 3**	**Credits : 2**

Course Objective: Students undergoing this course are expected to:

1. Familiar with Xilinx to perform the circuit analysis.
2. To perform the analysis and layout designing of the circuit.
3. Calculate all the performance parameters of the implemented circuits.
4. Perform programming on Sparton kit.

Experiments shall be carried out using Tanner/Mentor Graphics/Cadence/Xilinx Tools

Session – I: Digital IC Design Laboratory

1. Introduction to SPICE (Operating Point Analysis, DC Sweep, Transient Analysis, AC Sweep, Parametric Sweep, Transfer Function Analysis)
2. Modeling of Diodes, MOS transistors, Bipolar Transistors etc using SPICE.
3. An Overview of Tanner EDA Tool/MicroWind/Electric/ Magic/LTSpice
4. I-V Curves of NMOS and PMOS Transistors
5. DC Characteristics of CMOS Inverters (VTC, Noise Margin)
6. Dynamic Characteristics of CMOS Inverters (Propagation Delay, Power Dissipation)
7. Schematic Entry/Simulation/ Layout of CMOS Combinational Circuits
8. Schematic Entry/Simulation/ Layout of CMOS Sequential Circuits
9. High Speed and Low Power Design of CMOS Circuits

Session-II: Analog IC Design Laboratory Based

Modeling and Functional Simulation of the following digital circuits (with Xilinx/ Model Sim tools) using VHDL/Verilog Hardware Description Languages

1. Part – I Combinational Logic: Basic Gates,
    a. Multiplexer,
    b. Comparator,
    c. Adder/ Substractor,
    d. Multipliers,
    e. Decoders,
    f. Address Decoders,
    g. Parity generator,
    h. ALU

2. Part – II Sequential Logic:

    a. D-Latch, D-Flip Flop, JK-Flip Flop,
    b. Ripple Counters, Synchronous Counters,
    c. Shift Registers (serial-to-parallel, parallel-to-serial),
    d. Cyclic Encoder / Decoder.

Course Outcomes:

CO152.1	Familiar with HDLs to perform the circuit simulation.
CO152.2	To perform the analysis and layout designing of the circuit.
CO152.3	Calculate all the performance parameters of the implemented circuits.
CO152.4	Obtain results from Sparton Kit.

MAMC 201	VLSI TESTING AND VERIFICATION	L: 4	T: 0	P: 0	Credits : 4

Course Objective: Students undergoing this course are expected to:

1. Analyze the use of procedural statements and routines in testbench design with system verilog.
2. Apply fault modeling concepts in designing testbench.
3. IDDQ fault modeling and testing application specific memory testing
4. To learn RAM fault modeling and testing for memory
5. Understand use of functional and formal verification in test design.

SYLLABUS:

Unit	Topics	Lectures
I	**Introduction to Testing:** Testing Philosophy, Role of Testing, Digital and Analog VLSI Testing, VLSI Technology Trends Affecting Testing.VLSI Testing Process and Test Equipment: How to Test Chips? Automatic Test Equipment, Electrical Parametric Testing. Faults in Digital Circuits: Failures and Faults, Modeling of Faults, Temporary Faults.	10
II	**Test Generation for Combinational Logic Circuits:** Fault Diagnosis of Digital Circuits, Test Generation Techniques for Combinational Circuits, Detection of Multiple Faults in Combinational Logic Circuits. Testable Combinational Logic Circuit Design: The Reed-Mullar Expansion Technique, Three-Level OR-AND-OR Design, Automatic Synthesis of Testing Logic, Testable Design of Multilevel Combinational Circuits, Synthesis of Random Pattern Testable Combinational Circuits, Path Delay Fault Testable Combinational Logic Design, Testable PLA Design.	12
III	**Test Generation for Sequential Circuits:** Testing of Sequential Circuits as Iterative Combinational Circuits, State Table Verification, Test Generation Based on Circuit Structure, Functional Fault Models, Test Generation Based on Functional Fault Models.	7
IV	**Design of Testable Sequential Circuits:** Controllability and Observability, Ad Hoc Design Rules for Improving Testability, Design of Diagnosable Sequential Circuits, The Scan-Path Technique for Testable Sequential Circuit Design, Level-Sensitive Scan Design, Random Access Scan Technique, Partial Scan, Testable Sequential Circuit Design Using Nonscan Techniques, Cross Check, Boundary Scan	7
V	**Built-In Self-Test:** Test Pattern Generation for BIST, Output Response Analysis, Circular BIST, BIST Architectures. **Testable Memory Design:** RAM Fault Models, Test Algorithms for RAMs, Detection of Pattern Sensitive Faults, BIST Techniques for Ram Chips, Test	6

	Generation and BIST for Embedded RAMs.Design verification techniques based on simulation, analytical and formal approaches. Functional verification. Timing verification. Formal verification. Basics of equivalence checking and model checking. Hardware emulation.	

Text Books:

1. P. K. Lala, "Digital Circuit Testing and Testability", Academic Press.
2. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwar Academic Publishers.
3. M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico Publishing
   House
   T.Kropf, "Introduction to Formal Hardware Verification", Springer Verlag, 2000.
1. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers, 2001.

Course Outcomes:

CO201.1 apply the concepts in testing which can help them design a better yield in IC design.

CO201.2 tackle the problems associated with testing of semiconductor circuits at earlier design
levels so as to significantly reduce the testing costs.

CO201.3 analyse the various test generation methods for static & dynamic CMOS circuits.

CO201.4 identify the design for testability methods for combinational & sequential CMOS circuits.

CO201.5 recognize the BIST techniques for improving testability.

MAMC 202	DESIGNING WITH ASICS	L:4	T: 0	P: 0	CREDITS : 4

Course Objective: Students undergoing this course are expected to:

1. Demonstrate in-depth knowledge in ASIC Design flow, ASICs Design styles and issues.
2. ASICs Design Techniques. ASIC construction.
3. Analyze the characteristics and performance of ASICs and judge independently the best suited device for conducting research in ASIC design.
4. Solve problems of Design issues, simulation and Testing of ASICs.
5. Apply appropriate techniques, resources and tools to engineering activities for appropriate solution to develop ASICs

Syllabus:

Unit	Topics	Lectures
I	Types of ASICs -Standard Cell-Gate Arrays, PLD's, Structured Gate Array .ASIC Design Flow , CMOS modeled as Transistor and , Capacitor ,CMOS Design rules – Lamda Based Design Rule, Mead Conway ,Design of Combinational Logic Cell, ,Data Path cell Library architecture.	8
II	ASIC Library Design- Transistors as Resistors, Logical Effort , Transistor Parasitic Capacitance, Drive Strength calculation ,Logical effort - Library cell design programmable ASIC design software: Design system – logic synthesis – half gate ASIC.	8
III	Low level design entry: Schematic entry – low level design languages – PLA tools – EDIF .Problems with Boolean function implementation based on ACTEL & Xilinx FPGA in detail with an example	8
IV	An overview of VHDL and verilog. Logic synthesis in verilog and & VHDL simulation. Implementation of combinational and sequential circuits	8
V	ASIC Construction–.Constructive Partitioning - Iterative Partitioning; K-L Algorithm; Ratio-Cut; Look-ahead algorithm Placement: Floor planning- Delay Measurement – Channel and I/O power planning - Placement- Min-Cut algorithms in detail ,Physical Design Flow. Routing: Global Routing , Interconnection Mechanism – routing inside flexible bolcks ,Detailed Routing- Left Edge algorithm; Area routing with an example, Special Routing. Clock Routing; Power routing. Circuit ,Extraction & DRC for ASIC design - Design checks	8

Text / References:

1. J.S. Smith, "Application specific Integrated Circuits", Pearson Education, 2008
2. Wayne Wolf, "FPGA-Based System Design", Prentice Hall PTR, 2009.
3. Farzad Nekoogar and Faranak Nekoogar, "From ASICs to SOCs: A Practical Approach", Prentice Hall PTR, 2003.

Course Outcomes:

CO202.1 Demonstrate VLSI tool-flow and appreciate FPGA architecture.

CO202.2 Understand the issues involved in ASIC design, including technology choice, design management, tool-flow, verification, debug and test, as well as the impact of technology scaling on ASIC design.

CO202.3 understand the algorithms used for ASIC construction

CO202.4 Understand the basics of System on Chip, On chip communication architectures like AMBA, AXI and utilizing Platform based design.

CO202.5 Demonstrate and appreciate high performance algorithms available for ASICs

MAMC-011	PHYSICAL ELECTRONICS	L: 4	T: 0	P: 0	Credits : 4

Course Objective: After completion of this course student will be able to:

1. Understand the semiconductor physics and quantum mechanics
2. Knowledge about Energy band diagram and current in semiconductor material
3. Knowledge about the different types of diode and their characteristics
4. Understand the working of MOS capacitor, MOSFET, BJT and their characteristics

Syllabus:

Unit	Topics	Lectures
I	Introduction to Semiconductor Physics- Review of quantum mechanics, Electrons in periodic lattices, E-k diagrams, Quasiparticles in semiconductors, electrons, holes and phonons	**8**
II	Boltzmann transport equation and solution- Mobility and diffusivity, Carrier statistics, Continuity equation, Poisson's equation and their solution, High field effects: velocity saturation, hot carriers and avalanche breakdown	**8**
III	Semiconductor junctions- Schottky, homo- and hetero-junction band diagrams and I-V characteristics, and small signal switching models; Two terminal and surface states devices based on semiconductor junctions	**8**
IV	MOS structures- Semiconductor surfaces; The ideal and non-ideal MOS capacitor band diagrams and CVs; Effects of oxide charges, defects and interface states; Characterization of MOS capacitors: HF and LF CVs, avalanche injection; High field effects and breakdown	**8**
V	Characterization of Semiconductors- Four probe and Hall measurement; CVs for dopant profile characterization; Capacitance transients and DLTS	**8**

Texts/References

1. J. P. Mc Kelvey, introduction to Solid State and Semiconductor Physics, Harper and Row and John Weathe Hill, 1966.
2. E. H. Nicollian and J. R. Brews, “MOS Physics and Technology,” John Wiley, 1982.
3. K. K. Ng, “Complete Guide to Semiconductor Devices,” McGraw Hill, 1995.
4. D.K. Schroder, “Semiconductor Material and Device Characterization, “John Wiley, 1990.
5. S. M. Sze, “Physics of Semiconductor Devices, “2nd edition John Wiley, 1981.

Course Outcomes:

CO011.1	To develop the understanding of intrinsic and extrinsic semiconductor material and crystal lattice structure
CO011.2	Understanding of energy band diagram at 0K and 300K of semiconductor material and current phenomenon in semiconductor material
CO011.3	Understanding of depletion layer of P-N junction diode and I-V characteristics
CO011.4	To develop the understanding of energy band diagram of different types of diode
CO011.5	To develop the understanding of accumulation depletion and inversion mode in MOS capacitor, I-V characteristics of MOSFET

MAMC-012	Digital Techniques for High Speed Design	L: 4	T: 0	P: 0	Credits : 4

Course Objective: Students undergoing this course are expected to:

1. To enhance the knowledge about the real challenges faced by the designers while preparing high speed designs.
2. To meet thesignaling technologies of high speed devices as well as circuits.
3. To provide some idea of good design principles, and to simplify the process for simulation, verification and layout of high speed designs.
4. To understand the in-depth knowledge of effects of various parameter's variations on the designed circuit.
5· To utilize the knowledge to design high speed designs as per the given specifications.

Syllabus:

Unit	Topics	Lectures
I	Trends in High-Speed Design, backplane configurations, SerDes technology, Signal integrity, signaling technologies and devices, Gunning transceiver Logic, Low voltage differential signaling (LVDS), Bus LVDS, LVDS multipoint	8
II	High-speed transceiver logic and Stub-series terminated logic, ECL, Current-mode logic, FPGAs - 3.125 Gbps rocket IOs and Hard copy devices, Fiber optic components, High speed interconnects and cabling.	8
III	Memory device overview, memory signaling technologies, double data rate SDRAM (DDR, DDR2), GDDR3, ZBT, CRAM, Sigma RAM, RLDRAM, DDR SRAM, Flash, FeRAM, and MRAM, Quad data rate SRAM, Direct Rambus DRAM(DRDRAM),Xtreme data rate DRAM, Flex Phase and ODR.	8
IV	Differential and mixed-mode S parameters, Time domain reflectometry (TDR),Time domain transmission (TDT) and VNAs, Modeling with IBIS, Overview of EDA Tools for high-speed design, simulation, verification and layout.	8
V	Advances in design, Modeling, Simulation and measurement validation of high-performance Board-to-Board 5-to-10 Gbps Interconnects, High-Speed Fiber-Optic transceivers, SerDes transceivers, serializers and deserializers, WarpLinkSerDes system, Emerging protocols and technologies, Electrical Optical Circuit Board, Rapid IO, PCI Express and express card.	8

Text Books

1. Tom Granberg, "Handbook of Digital Techniques for High-Speed Design", 1st Edition, Prentice hall, 2012
2. Stephen H. Hall and Howard L. Heck, " Advance Signal Integrity for High speed Digital Designs", Willy, IEEE Press, 2009.

Reference Books

1. Howard Johnson and Martin Graham, "High Speed Digital Design: A Handbook of Black Magic", 2nd Edition, Prentice Hall, 2000
2. Stephen H. Hall, Garrett W. Hall, & James A. McCall, "High speed Digital system Design", WILLY -IEEE Press, 2000.

Course Outcomes: After successful completion of the course student will be able to

CO012.1 Understand the knowledge of different trends in high speed design.
CO012.2 Understand the memory signalling technologies.
CO012.3 Analyse all the differential and mixed mode S parameters needed to be considered in time domain.
CO012.4 Understand the Advances in design, Modeling, Simulation and measurement validation of high performance interconnects.

MAMC-013	VLSI ALGORITHMS FOR VLSI DESIGN AUTOMATION	L: 4	T: 0	P: 0	Credits : 4

Course Objectives: Students undergoing this course are expected to:

1. Understand the VLSI design cycle and the new trends in VLSI design, including physical design automation and fabrication processes.
2. Study the algorithms and techniques for VLSI design automation, including partitioning, floor planning, pin assignment, placement, global routing, detailed routing, over the cell routing, via minimization, and compaction.
3. Explore the problem formulations and classifications of algorithms for each stage of the physical design cycle, including partitioning, floor planning, pin assignment, placement, routing, and compaction.
4. Learn about the different algorithmic approaches used in VLSI design automation, such as group migration, simulated annealing, constraint-based algorithms, simulation-based algorithms, Steiner tree-based algorithms, and hierarchical compaction.
5. Gain practical knowledge of VLSI design automation tools and understand their application in the physical design cycle.

Syllabus:

Unit	Topics	Lectures
I	**VLSI physical design automation and Fabrication** VLSI Design cycle, New trends in VLSI design, Physical design cycle, Design style, Introduction to fabrication process, design rules, layout of basic devices	8
II	**VLSI automation Algorithms Partitioning:** Problem formulation, classification ofpartitioning algorithms, Group migration algorithms, simulated annealing.	8
III	**Floor planning & pin assignment:** Problem formulation, classification of floorplanning algorithms, constraint based floor planning, floor planning algorithms for mixedblock& cell design, chip planning, pin assignment, problem formulation, classificationof pin assignment algorithms, General & channel pin assignment Placement Problemformulation, classification of placement algorithms, simulation base placementalgorithms, recent trends in placement	8
IV	**Global Routing and Detailed routing:** Problem formulation, classification of global routingalgorithms, Maze routing algorithm, line probe algorithm, Steiner Tree based algorithms,performance driven routing Detailed routing problem formulation, classification ofrouting algorithms, introduction to single layer routing algorithms, two layer channelrouting algorithms, greedy channel routing, switchbox routing	8

	algorithms.	
V	**Over the cell routing & via minimization:** Two layers over the cell routers,constrained & unconstrained via minimization **Compaction:** Problem formulation, classification of compaction algorithms, one dimensional compaction, two dimension based compaction, hierarchical compaction	**8**

Reference Books :

1. NaveedShervani, "Algorithms for VLSI physical design Automation", KluwerAcademic Publisher, Second edition.
2. ChristophnMeinel& Thorsten Theobold, "Algorithm and Data Structures for VLSIDesign", Kluwer Academic Publisher.
3. R. Drechsler, "Evolutionary Algorithm for VLSI CAD", Kluwer Academic Publication.

Course Outcomes:

CO013.1 Upon completion of the course, students will be able to explain the VLSI design cycle and the current trends in VLSI design, including physical design automation and fabrication processes.

CO013.2 Students will be able to analyze and apply partitioning algorithms for efficient VLSI design, considering problem formulations and classifications.

CO013.3 Upon completion of the course, students will be able to design floor plans and assign pins using constraint-based algorithms and analyze the algorithms used for mixed block and cell design.

CO013.4 Students will be able to implement placement algorithms for effective VLSI design, considering problem formulations and classifications, and understand the recent trends in placement techniques.

CO013.5 Upon completion of the course, students will be able to design global and detailed routing solutions, implement over the cell routing techniques, minimize vias, and perform compaction using appropriate algorithms.

MAMC-014	Nano-Electronics Devices and Materials	L: 4	T: 0	P: 0	Credits : 4

Course Objectives: Students undergoing this course are expected to:

1. Understand the fundamental concepts of nano-scale systems, including length, energy, and time scales.
2. Explore different lithography techniques for nano-scale fabrication, such as optical, deep ultraviolet, X-ray, electron beam, and ion beam lithography.
3. Study the behavior of single electron transistors and the coulomb blockade effects in ultra-small metallic tunnel junctions.
4. Gain knowledge of quantum mechanics in the context of nanostructures, including quantum confinement in semiconductor nanostructures, band gap engineering, and the Landauer-Büttiker formalism.
5. Learn about molecular techniques in nano-scale systems, including molecular electronics, chemical self-assembly, carbon nanotubes, self-assembled monolayers, and electromechanical techniques.

Syllabus:

Unit	Topic	Lectures
I	**Introduction** to nano scale systems, Length energy and time scales, Top down approach to Nano lithography, Spatial resolution of optical, deep ultraviolet, X-ray, electron beam and ion beam lithography, Single electron transistors, coulomb blockade effects in ultra small metallic tunnel junctions.	8
II	**Quantum Mechanics** Quantum confinement of electrons in semiconductor nano structures, Two dimensional confinement (Quantum wells), Band gap engineering, Epitaxy, Landaeur – Buttiker formalism for conduction in confined geometries,	8
III	**One Dimensional Confinement**, Quantum point contacts, quantum dots and Bottom up approach, Introduction to quantum methods for information processing.	8
IV	**Molecular Techniques** Molecular Electronics, Chemical self assembly, carbon nano tubes, Self assembled mono layers, Electromechanical techniques,	8
V	**Applications** in biological and chemical detection, Atomic scale characterization techniques, scanning tunnelling microscopy, atomic force microscopy	8

TEXT BOOKS:

1. Beenaker and Van Houten "Quantum Transport in Semiconductor Nanostructures in Solid state Physics" Ehernreich and Turnbell, Academic press, 1991.

REFERENCE BOOKS:

1. David Ferry "Transport in Nano structures" Cambridge University press 2000.
2. Y. Imry "Introduction to Mesoscopic Physics, Oxford University press 1997.
3. S. Dutta "Electron Transport in Mesoscopic systems" Cambridge University press 1995.
4. H Grabert and M Devoret "Single charge Tunneling" Plenum press 1992.

Course Outcomes:

CO014.1	Upon completion of the course, students will be able to explain the principles and significance of nano-scale systems and their length, energy, and time scales.
CO014.2	Students will be able to compare and analyze different lithography techniques for nano-scale fabrication, considering their spatial resolution and limitations.
CO014.3	Students will be able to analyze and understand the behavior of single electron transistors and the coulomb blockade effects in ultra-small metallic tunnel junctions.
CO014.4	Upon completion of the course, students will be able to apply quantum mechanics concepts to explain quantum confinement in semiconductor nanostructures, band gap engineering, and the Landauer-Büttiker formalism for conduction in confined geometries.
CO014.5	Students will be able to describe and evaluate molecular techniques in nano-scale systems, including molecular electronics, chemical self-assembly, carbon nanotubes, self-assembled monolayers, and electromechanical technique

MTMC-021	ADVANCED EMBEDDED SYSTEM DESIGN	L: 4	T: 0	P: 0	Credits : 4

Course Objectives: Students undergoing this course are expected to:

1. Understand the components and architecture of typical embedded systems, including the core, memory, sensors and actuators, communication interface, embedded firmware, and other system components.
2. Explore the characteristics and quality attributes of embedded systems, including hardware-software co-design, program modeling, and the use of Unified Modeling Language (UML) in embedded design.
3. Gain knowledge of embedded hardware design and development, including the use of Electronic Design Automation (EDA) tools for schematic design, PCB layout design, and netlist creation.
4. Study the architecture and programming features of the ARM Cortex M3 32-bit microcontroller family, including the use of general-purpose registers, interrupt controllers, and memory protection.
5. Learn about embedded firmware design approaches, development languages, and the role of real-time operating systems (RTOS) in embedded system design, including task scheduling, communication, synchronization, and device drivers.

Syllabus:

Unit	Topics	Lectures
I	**Typical Embedded System:** Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware,Other System Components. **Characteristics and Quality Attributes of Embedded Systems:** Hardware Software Co-Design and Program Modeling: Fundamental Issues inHardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language, Hardware SoftwareTrade-offs.	8
II	**Embedded Hardware Design and Development** :EDA Tools, How to Use EDA Tool, Schematic Design – Place wire, Bus , port, junction,creating part numbers, Design Rules check, Bill of materials, Netlist creation , PCB Layout Design – Building blocks, Component placement,PCB track routing.	8

III	**ARM -32 bit Microcontroller family.** Architecture of ARM Cortex M3 –General Purpose Registers, Stack Pointer, Link Register, ProgramCounter, Special Register,.Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming. AdvancedProgramming Features.Memory Protection. Debug Architecture.	**8**
IV	**Embedded Firmware Design and Development:** Embedded Firmware Design Approaches, Embedded Firmware Development Languages **Real-Time Operating System (RTOS) based Embedded System Design**: Operating System Basics, Types of OS, Tasks, Process and Threads,Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Putting them altogether, Task Communication, TaskSynchronization, Device Drivers, How to Choose an RTOS.	**8**
V	**The Embedded System Development Environment**: The Integrated Development Environment (IDE), Types of Files Generated on Crosscompilation, Disassembler/ELDompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan.	**8**

Text Books:

1. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Ltd
2. Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", Newnes, (Elsevier). James K Peckol, "Embedded Systems – A contemporary Design Tool", John Weily & Sons.

Course Outcomes:

CO021.1 Upon completion of the course, students will be able to identify and describe the core components and architecture of typical embedded systems.

CO021.2 Students will be able to analyze the characteristics and quality attributes of embedded systems and understand the importance of hardware-software co-design and program modeling.

CO021.3 Students will be able to use EDA tools for schematic design and PCB layout design, and generate netlists and bill of materials for embedded hardware development.

CO021.4 Upon completion of the course, students will be able to explain the architecture and programming features of the ARM Cortex M3 microcontroller family, including interrupt handling and memory protection.

CO021.5 Students will be able to design and develop embedded firmware using appropriate approaches and development languages, and understand the role of an RTOS in task scheduling, communication, synchronization, and device driver implementation.

MAMC-022	RF INTEGRATED CIRCUITS	L: 4	T: 0	P: 0	Credits : 4

Course Objectives: Students undergoing this course are expected to:

1. Gain a foundational understanding of RF design principles and complexities, as well as the impact of nonlinear behavior and noise in RF circuits.
2. Develop proficiency in analog and digital modulation techniques, while also comprehending the advantages and trade-offs associated with different modulation methods.
3. Acquire skills in RF testing methodologies for different receiver architectures, and grasp the essentials of receiver design.
4. Understand the behavior of BJT and MOSFET devices in RF contexts, while also learning about modeling, noise performance, and integrated parasitic effects.
5. Develop advanced skills in RF circuit design, encompassing filters, active components, oscillators, mixers, and synthesizers, while considering noise, phase noise, and power efficiency.

Syllabus:

Unit	Topic	Lectures
I	Introduction to RF design and Wireless Technology: Design and Applications, Complexity and Choice of Technology. Basic concepts in RF design: Nonlinearly and Time Variance, Inter-symbol interference, random processes and noise. Sensitivity and dynamic range, conversion of gains and distortion.	**8**
II	RF Modulation: Analog and digital modulation of RF circuits, Comparison of various techniques for power efficiency, Coherent and non-coherent detection, Mobile RF communication and basics of Multiple Access techniques. Receiver and Transmitter architectures. Direct conversion and two-step transmitters.	**8**
III	RF Testing: RF testing for heterodyne, Homodyne, Image reject, Direct IF and sub sampled receivers.	**8**
IV	BJT and MOSFET Behavior at RF Frequencies: BJT and MOSFET behavior at RF frequencies, Modeling of the transistors and SPICE model, Noise performance and limitations of devices, integrated parasitic elements at high frequencies and their monolithic implementation	**8**
V	RF Circuits Design: Overview of RF Filter design, Active RF components & modeling, Matching and Biasing Networks. Basic blocks in RF systems and their VLSI implementation, Low noise Amplifier design in various technologies, Design of Mixers at GHz frequency range, Various mixers- working and implementation. Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Resonator VCO designs, Quadrature and single sideband generators. Radio frequency Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers, Power	**8**

	Amplifier design, Liberalization techniques, Design issues in integrated RF filters.	

TEXT BOOKS:

1. Ludwig R, Bretchko P, "RF Circuits Design", Pearson 2000 Ed
2. Thomas H. Lee "Design of CMOS RF Integrated Circuits" Cambridge University press 1998.

REFERENCE BOOKS:

1. B Razavi "RF Microelectronics" PHI 1998
2. R Jacob Baker, H W Li, D E Boyce " CMOS Circuit Design, layout and Simulation" PHI 1998
3. Y P Tsividis "Mixed Analog and Digital Devices and Technology" TMH 1996

Course Outcomes:

CO022.1 Demonstrate knowledge of the significance of RF design, analyze technology choices, and identify key challenges in RF circuits due to nonlinear behavior and noise.

CO022.2 Apply various modulation techniques in RF circuit design and evaluate their benefits and drawbacks in terms of power efficiency and signal integrity.

CO022.3 Successfully perform RF testing for different receiver architectures, demonstrating the ability to assess receiver performance and understand receiver design principles.

CO022.4 Analyze BJT and MOSFET behavior in RF environments, model transistors using SPICE, evaluate noise performance, and address device limitations and parasitic effects.

CO022.5 Design and implement sophisticated RF circuits including filters, active components, oscillators, mixers, and synthesizers, while optimizing for noise, phase noise, and power efficiency.

MAMC-023	VLSI Technology	L: 4	T: 0	P: 0	Credits : 4

Course Objective: Students undergoing this course are expected to:

1. To understand the concepts of MOS transistors operations and their wafer cleaning process
2. To know the fabrication process of CMOS technology and its various kinetics of Silicon dioxide growth design rules.
3. To know the concepts of Failure mechanisms in metal interconnects
4. To learn about the VLSI Plasma and Rapid Thermal Processing
5. To study the concepts of process integration for NMOS, CMOS and Bipolar circuits.

Syllabus:

Unit	Topics	Lectures
I	**Environment for VLSI Technology:** Clean room and safety requirements. Wafer cleaning processes and wet chemical etching techniques. Impurity incorporation: Solid State diffusion modeling and technology; Ion Implantation modeling, technology and damage annealing; characterization of Impurity profiles.	8
II	**Oxidation:** Kinetics of Silicon dioxide growth both for thick, thin and ultra thin films. Oxidation technologies in VLSI and ULSI; Characterisation of oxide films; High k and low k dielectrics for ULSI, Oxidation Techniques. **Epitaxy:** Epitaxy Growth Methods, Diffusion, Fick's 1-Dimensional Diffusion Equation, Fick's second Law, Ion Implantation, Range Theory	12
III	**Lithography:** Photolithography, E-beam lithography and newer lithography techniques for VLSI/ULSI; Mask generation. Chemical Vapour Deposition techniques: CVD techniques for deposition of poly silicon, silicon dioxide, silicon nitride and metal films; Epitaxial growth of silicon; modeling and technology. **Metal film deposition:** Evaporation and sputtering techniques. Failure mechanisms in metal interconnects; Multi-level metallization schemes.	8
IV	**Plasma and Rapid Thermal Processing:** PECVD, Plasma etching and RIE techniques; RTP techniques for annealing, growth and deposition of various films for use in ULSI.	6
V	Process integration for NMOS, CMOS and Bipolar circuits; Advanced MOS technologies.	6

Texts/References

1. C.Y. Chang and S.M.Sze (Ed), “ULSI Technology,” McGraw Hill Companies Inc, 1996.
2. S.K. Ghandhi, “VLSI Fabrication Principles,” John Wiley Inc., New York, 1983.
3. S.M. Sze (Ed), “VLSI Technology, “2nd Edition, McGraw Hill, 1988.

Course Outcomes:

CO023.1	Recall the basic basics of MOSFET device physics and its wafer operation
CO023.2	Understand the various operations of fabrication process of CMOS technology
CO023.3	Understand the concept of Evaporation and sputtering techniques.
CO023.4	Design the principles of PECVD, Plasma etching and RIE techniques
CO023.5	Understand the concept of advanced MOS technologies

MAMC-024	DEVICE MODELING & CIRCUIT SIMULATION	L: 4	T: 0	P: 0	Credits : 4

Course Objective: Students undergoing this course are expected to:

1. To explain the fundamental knowledge of semiconductor devices.
2. To provide an introduction to the basic semiconductor physics/solid-state physics needed to understand device modelling of electronic devices.
3. To understand the operation of several basic semiconductor devices: p-n junctions, metal-semiconductor junctions, Diodes, metal oxide semiconductor field effect transistors (MOSFETs), Complementary MOSFETs (CMOS).
4. To provide fundamental understanding of device modeling and numerical simulation techniques.

Syllabus:

Unit	Topics	Lectures
I	Introduction to SPICE modelling, Growth of fables design industry, SPICE modelling of resistor, Capacitor, Inductor, Semiconductor devices such as Diode, BJT, FET, MOSFET.MOSFET model parameters, Introduction to MOSFET SPICE Level 1, Level 2 and Level 3 models. CAD tools, Introduction to Device simulators, Tools for simulating device performance, Introduction to Circuit simulators	**8**
II	Circuit simulation techniques, DC analysis, AC analysis, Transient analysis, Modelling of Process Variation, Process corners, Monte Carlo simulation, and Sensitivity/worst case analysis, Simulation of digital and analog circuits, Transfer function, Frequency response, Noise analysis, Distortion and Spectral analysis.	**8**
III	MOSFET DC model, Static model and dynamic model, MOSFET Models for Digital Design, performance considering short channel and narrow width effects, Mechanicastress etc	**6**
IV	MOSFET Models for Analog Design, Long Channel MOS model, Short Channel MOS model. Large signal and Small signal model. Analog Circuit Performance Parameters: Impact of parasitic effects, Process /temperature variation, Device reliability effects. Effect of temperature on model parameters.	**8**
V	Data Acquisition and model parameter measurements, MOSFET models for mixed Analog-Digital circuit design, MOSFET models for	**8**

	Radio frequency circuit design, Deep submicron MOSFET models, Power MOSFET Simulation Models, Advanced MOSFET Models for Circuit Simulators, Brief overview of BSIM and EKV model.	

Text Books

1 Tor A. Fjeldly, Trond Ytterdal, Michael S. Shur, “Introduction to Device Modeling and Circuit Simulation” Wiley, Latest Edition.
2 Paul W. Tuinenga, “SPICE: A Guide to Circuit Simulation and Analysis Using PSpice”, 3rd Edition, Pearson, 2006.
3 Paolo Antognetti and Giuseppe Massobrio, “Semiconductor Device Modeling with SPICE”, 2nd Edition, McGraw-Hill, 2010.

Reference Books

1 Y. Tsividis, “Operation and Modeling of MOS transistors”, 3rd Edition, Oxford University Press, 2010.
2 Jacob Millman, “Millman's Electronic Devices and Circuits”, 4th Edition, McGraw Hill, 2015.
3 Muhammad H. Rashid, “Introduction to PSpice Using OrCAD for Circuits and Electronics”, Pearson, 2015.

Course Outcome: After successful completion of the course student will be able to

CO024.1 Understand concepts of MOSFET modelling.
CO024.2 Implement the device models on software.
CO024.3 Design and implement the codes for device modelling.
CO024.4 Implement the analog and digital circuit simulation.

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MAMC-031	ADVANCED MICROCONTROLLERS AND SYSTEMS	L: 4	T: 0	P: 0	Credits : 4

Course Objective: After completion of this course student will be able to:

1. Understand the importance of low power embedded systems, low power RF capabilities and applications of microcontroller
2. Knowledge about types of low power microcontrollers, architectures and usage
3. Knowledge about the MSP430 microcontroller and its working
4. Understand the working ARM Cortex-M3 microcontroller and its architecture

Syllabus:

Unit	Topics	Lectures
I	**Motivation for advanced microcontrollers** – Low Power embedded systems, On-chip peripherals, low-power RF capabilities. Applications of Microcontrollers.	8
II	**MSP430 – 16-bit Microcontroller family**. CPU architecture, Instruction set, Interrupt mechanism, Clock system, Memory subsystem, bus – architecture. The assembly language and „C programming for MSP-430 microcontrollers	8
III	**MSP430 – 16-bit Microcontroller Peripherals-** On -chip peripherals. WDT, Comparator, Op-Amp, Timer, Basic Timer, Real Time Clock (RTC), ADC, DAC, Digital I/O. Using the low-power features of MSP430. Clock system, low-power modes, Clock request feature, Low-power programming and interrupts.	8
IV	**ARM -32 bit Microcontroller family.** Architecture of ARM Cortex M3 – General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Register,. Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming.Advanced Programming Features.Memory Protection. Debug Architecture.	8
V	**Applications** – Wireless Sensor Networking with MSP430 and Low-Power RF circuits; Pulse Width Modulation(PWM) in Power Supplies.	8

Reference Books:

1. Joseph Yiu, “ The Definitive Guide to the ARM Cortex-M3, , Newnes, (Elsevier).
2. John Davies, “ MSP430Microcontorller Basics”,Newnes (Elsevier Science).
3. MSP430 Teaching CD-ROM, Texas Instruments.

Course Outcomes:

CO031.1	To develop the understanding of the importance of low power embedded systems, low power RF capabilities and applications of microcontroller
CO031.2	Understanding and applying of MSP430 microcontroller architecture, memory, Real Time Clock, ADC, DAC and low power features
CO031.3	Understanding and applying of ARM Cortex-M3 microcontroller architecture, memory, Interrupt behaviour, exceptions programming
CO031.4	To understand the uses of microcontroller in Wireless sensor Networking with MSP430, Low power RF circuits, Pulse width modulation in power supplies

MAMC-032	ANALOG SIGNAL PROCESSING	L: 4	T: 0	P: 0	Credits : 4

Course Objectives: After completion of this course student will be able to:

1. Understand the principles of translinear circuits and their applications, including squarer, divider, square rooting, vector magnitude circuits, and multipliers.
2. Study MOS analog integrated circuits and their basic building blocks, such as the differential amplifier pair, current mirrors, active loads, level shifters, and differential to single-ended converters.
3. Explore low voltage signal processing and the design considerations for CMOS op-amps, including input stages, output stages, frequency response, and slew rate.
4. Learn about current-mode signal processing and its advantages over voltage-mode signal processing, including continuous-time signal processing, current conveyors, current feedback, and their applications.
5. Study selected recent topics in the field, such as the realization of MOS resistors in MOS technology, N-MOS OTA, CMOS OTA, MOSFET-C circuits, and CMOS transconductor circuits.

Syllabus:

Unit	Topics	Lectures
I	Translinear Bipolar and MOS Circuits: General Translinear principles , various translinear circuits: squarer, divider, square rooting, vector magnitude circuit, multipliers, translinear multiplier etc.	8
II	MOS Analog Integrated Circuits: Basic building blocks, differential amplifier pair, various current mirrors, active loads, level shifter, differential to single ended converter, complete N-MOS Op-amp.	8
II	Low Voltage Signal Processing: Need of low voltage signal processing, C-MOS Op-amp design: input stages, output stages, frequency response, slew rate etc., BI-CMOS op-amp design, input stages, out put stages, introduction to low voltage filter filters.	8
IV	Current-Mode Signal Processing: Current-mode compared to voltage mode, continuous time signal processing, current conveyors and their applications, current feedback and its applications.The General Impedance Convertor (GIC), optimal design of the GIC, realization of simple ladders, Gorski-Popiel's Embedding Technique, Bruton's FDNR technique, Creating negative components.	8
V	Selected Recent Topics: Realization of MOS resistors in MOS technology, N-MOS OTA, C-MOS OTA, MOSFET-C and other related circuits, C-MOS transconductor circuits, Ideal low-pass filter,	8

	Buttreworth and Chebyshev magnitude response, pole locations, low-pass filter specifications, comparison of Maximally flat and Equal ripple responses.	

Text/References

1. R. Schaumann and M.E. Valkenberg, Design of Analog Filters, Oxford University Press, 2001.
2. C.Toumazou, F.J. Lidgey and D.G.Haigh, 'Analog IC design: The current-mode approach', Exeter, England: Peter Peregrinus, 1990.
3. M. Ismail and T. Fiez, 'Analog VLSI: Signal and Information Processing', Mc Graw Hill, 1994.
4. B. Razavi, 'Design of Analog CMOS Integrated Circuits', Mc Graw Hill, 2000.
5. A.B.Grebene, ' Bipolar and MOS Analog Integrated Circuit Design', Wiley, 1984.
6. A.S.Sedra and K.C.Smith, ' Microelectronic circuits', Oxford University Press.

Course Outcomes:

CO032.1 Upon completion of the course, students will be able to analyze and design various translinear circuits, including squarers, dividers, square rooters, vector magnitude circuits, and multipliers.

CO032.2 Students will be able to analyze and design MOS analog integrated circuits, including differential amplifier pairs, current mirrors, active loads, level shifters, and differential to single-ended converters.

CO032.3 Upon completion of the course, students will be able to design low voltage signal processing circuits, including CMOS op-amps with considerations for input stages, output stages, frequency response, and slew rate.

CO032.4 Students will be able to compare and evaluate current-mode signal processing techniques and their advantages over voltage-mode signal processing, and apply current conveyors and current feedback in relevant applications.

CO032.5 Students will be able to analyze and design circuits based on selected recent topics, such as MOS resistors, OTA circuits, MOSFET-C circuits, and CMOS transconductor circuits.

MAMC-033	CMOS MIXED-SIGNALS VLSI DESIGN	L: 4	T: 0	P: 0	Credits : 4

Course Objective: After completion of this course student will be able to:

1. To understand the basic theory of analog circuits, design principles and techniques for analog ICs blocks implemented in CMOS technology.
2. To explain the theory and design skills of CMOS op-amps, voltage reference circuits, switched capacitor circuits, sample-and- hold circuits, and A/D & D/A converters used in modern communication systems and consumer electronic products.
3. To understand the design of core mixed-signal IC blocks: comparators and data converters and system level design flow: top-down and bottom-up design methodologies

Syllabus:

Unit	Topics	Lectures
I	Building blocks for CMOS amplifiers: design of current mirrors, differential amplifiers, CMOS operational transconductance amplifiers: design of single ended telescopic cascode, folded cascode and two-stage amplifiers.	8
II	Frequency compensation schemes: Miller compensation, Ahuja compensation and Nested-Miller compensation	8
II	Design of fully differential amplifiers, discussion of common mode feedback circuits. Switched capacitor circuits, design of switched capacitor amplifiers and integrators, effect of opamp finite gain, bandwidth and offset, circuit techniques for reducing effects of opamp imperfections, switches and charge injection and clock feed-through effects.	8
IV	Design of sample and hold and comparators. Fundamentals of data converters; Nyquist rate A/D converters (Flash, interpolating, folding flash, SAR and pipelined architectures); Nyquist rate D/A converters - voltage, current and charge mode converters, hybrid and segmented converters); Oversampled A/D and D/A converters.	8
V	Design of PLL's and DLL's and frequency synthesizers.	8

Course Outcomes:

CO033.1	Understand analog and discrete-time signal processing
CO033.2	Undersatnd the basics of Analog to digital converters (ADC) and Digital to analog converters (DAC).
CO033.3	Analyse High-speed ADCs (e.g. flash ADC, pipeline ADC and related architectures) and successive approximation ADCs.

CO033.4 Understand the Phase locked loops.

CO033.5 Demonstrate the ability to design practical circuits that perform the desired operations.

MAMC 034	MEMS & MICRO SENSOR DESIGN	L: 4	T: 0	P: 0	Credits : 4

Course Objectives: After completion of this course student will be able to:

1. Understand the fundamentals of MEMS (Microelectromechanical Systems) and their applications in various fields.
2. Study the fabrication technologies and processes used in MEMS, including micromachining techniques and materials selection.
3. Explore the mechanics of beam and diaphragm structures, including stress, strain, Hooke's Law, bending moment, and displacement.
4. Learn about air damping and its effects on micro-dynamics, including drag effects, squeeze-film air damping, and slide-film air damping.
5. Study the principles of electrostatic actuation, including electrostatic forces, fringe effects, and driving mechanisms for mechanical actuators.

Syllabus:

Unit	Topics	Lectures
I	Introduction to MEMS, MEMS Fabrication Technologies, Materials and Substrates for MEMS, Processes forMicromachining, Characteristics, Sensors/Transducers, Piezoresistance Effect,Piezoelectricity, Piezoresistive Sensor.	**8**
II	**Mechanics of Beam and Diaphragm Structures**,Stress and Strain, Hooke's Law. Stress and Strain of Beam Structures: Stress, Strain in aBent Beam, Bending Moment and the Moment of Inertia, Displacement of BeamStructures Under Weight, Bending of Cantilever Beam Under Weight.	**8**
III	**Air Damping**,Drag Effect of a Fluid: Viscosity of a Fluid, Viscous Flow of a Fluid, Drag ForceDamping, The Effects of Air Damping on Micro-Dynamics. Squeeze-film Air Damping:Reynolds' Equations for Squeeze-film Air Damping, Damping of Perforated ThickPlates. Slide-film Air Damping: Basic Equations for Slide-film Air Damping,Couette-flow Model, Stokes-flow Model.	**8**
IV	**Electrostatic Actuation** Electrostatic Forces, Normal Force, Tangential Force, Fringe Effects, ElectrostaticDriving of Mechanical Actuators: Parallel -plate Actuator, Capacitive sensors. Step and Alternative Voltage Driving: Step Voltage Driving, Negative SpringEffect and Vibration Frequency.	**8**

V	**Thermal Effects**, Temperature coefficient of resistance, Thermo-electricity, Thermocouples, Thermal andtemperature sensors. **Applications of MEMS in RF**,MEMS Resonator Design Considerations, One-Port Micromechanical ResonatorModeling Vertical Displacement Two-Port Microresonator Modeling,Micromechanical Resonator Limitations.	**8**

Reference Books:

1. S.M. Sze, "Semiconductor Sensors", John Wiley & Sons Inc., Wiley Interscience Pub.
2. M.J. Usher, "Sensors and Transducers", McMillian Hampshire.
3. RS Muller, Howe, Senturia and Smith, "Micro sensors", IEEE Press.

Course Outcomes:

CO034.1 Upon completion of the course, students will be able to explain the concepts and applications of MEMS in various fields, such as sensors, transducers, and RF devices.

CO034.2 Students will be able to analyze and apply different fabrication technologies and processes used in MEMS, considering materials selection and micromachining techniques.

CO034.3 Upon completion of the course, students will be able to calculate stress, strain, bending moment, and displacement in beam and diaphragm structures.

CO034.4 Students will be able to analyze the effects of air damping on micro-dynamics, including drag effects and various models of squeeze-film and slide-film air damping.

CO034.5 Upon completion of the course, students will be able to analyze electrostatic actuation principles, calculate electrostatic forces, and understand the driving mechanisms for mechanical actuators.

MAMC 041	ADVANCED COMPUTER ARCHITECTURE	LTP 4 0 0	Credits:4

Course Objectives: After completion of this course student will be able to:

1. Understand the concepts, challenges, and history of the Internet, including high-speed networks like ATM.
2. Study TCP/IP congestion and flow control mechanisms in the Internet, analyzing throughput, fairness, and performance for high-bandwidth delay networks.
3. Explore real-time communications over the Internet, adaptive applications, latency and throughput issues, and the integrated services model (intServ) for resource reservation.
4. Learn about traffic characterization using linearly bounded arrival processes (LBAP), (o, p) regulators, leaky bucket algorithm, and packet scheduling algorithms for guaranteed service connections.
5. Study IP address lookup challenges, packet classification algorithms, flow identification methods, admission control in the Internet, differentiated services (DiffServ) architecture, and IP switching with MPLS.

Syllabus:

Unit	Topics	Lectures
I	Overview of Internet-Concepts, challenges and history. Overview of high speed networks-ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP. Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP.	**8**
II	Characterization of Traffic by Linearly Bounded arrival Processes (LBAP). Concept of (o,, p) regulator. Leaky bucket algorithm and its properties. Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic.	**8**
III	Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management. IP address lookup-challenges. Packet classification algorithms and Flow Identification- Grid of Tries, Cross producting and controlled prefix expansion algorithms.	**8**
IV	Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (DiffServ). DiffServ architecture and framework.	**8**

V	IP switching and MPLS-Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS. [P control of Optical Routers. Lamda Switching, DWDM Networks	**8**

Text/References:

1. Jean Wairand and Pravin Varaiya, High Perforamnce Communications Networks, Second Edition, 2000.
2. Jean Le Boudec and Patrick Thiran, Network Calculus A Theory of Deterministic Queueing Systems for the Internet, Springer Veriag, 2001.
3. Zhang Wang, Internet Qo,5, Morgan Kaufman 2001.

Course Outcomes:

CO041.1 Upon completion of the course, students will be able to explain the concepts, challenges, and historical development of the Internet, including high-speed networks like ATM.

CO041.2 Students will be able to analyze TCP/IP congestion and flow control mechanisms, evaluate throughput, fairness, and performance for high-bandwidth delay networks.

CO041.3 Upon completion of the course, students will be able to design and analyze real-time communications applications, considering latency, throughput, and resource reservation using the integrated services model.

CO041.4 Students will be able to characterize traffic using linearly bounded arrival processes, apply (o, p) regulators and the leaky bucket algorithm, and implement packet scheduling algorithms for guaranteed service connections.

CO041.5 Upon completion of the course, students will be able to evaluate IP address lookup methods, implement packet classification algorithms, understand admission control mechanisms, analyze differentiated services architecture, and comprehend IP switching with MPLS.

MAMC 042	MICROWAVE INTEGRATED CIRCUIT	LTP 4 0 0	Credits:4

Course Objectives: After completion of this course student will be able to:

1. Develop a foundational understanding of Monolithic Microwave Integrated Circuits (MMICs) and their benefits over discrete circuits.
2. Gain proficiency in the fabrication techniques of MMICs, including MOSFET fabrication and thin film formation processes.
3. Acquire knowledge of planar transmission lines for Microwave Integrated Circuits (MICs), focusing on microstrip analysis using conformal transformation.
4. Explore the analysis of slot lines in comparison with microstrip lines, and understand the use of lumped elements in MICs.
5. Study microwave semiconductor devices and passive components, including tunnel diodes, varactor diodes, PIN diodes, and Gunn diodes.

Syllabus:

Unit	Topics	Lectures
I	Introduction to Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, materials, MMIC fabrication techniques, MOSFET fabrication. Thin film formation.	8
II	Planar transmission lines for MICs. Method of conformal transformation for microstrip analysis, concept of effective dielectric constant, Effective dielectric constant for microstrip, Losses in Microstrip.	8
III	Slot Line Approximate analysis and field distribution, Transverse resonance method and evaluation of slot line impedance, comparison with micro strip line.	8
IV	Lumped Elements for MICs: Use of Lumped Elements, Capacitive elements, Inductive elements and Resistive elements.	8
V	Microwave semiconductor Devices & Microwave passive components Parametric amplifires, tunnel diode, varactor diode, PIN diode, Gunn diode, their principle of operation, performance characterstics & applications, scattering parameter calculations of E plane-Tee, Magic Tee, Directional Coupler.	8

Text Book:

1. Microwave Integrated circuits, K.C. Gupta.
2. Micro strip lines and Slot lines, K.C. Gupta, R. Garg. , I. Bahl, P. Bhartia

References:
1. Microwave Devices & Circuits 3/e, Samuel Y. Liao.
2. Stripline-like Transmission lines for Microwave Integrated circuits, B. Bhat, S. K. Koul, Wiley Eastern Ltd., New Delhi.
3. Microwave Integrated circuits, By Ivan Kneppo, J Fabian, P. Bezousek
4. RF MEMS and their Application Vijay K. Vardan, K. J. Vinoy, K. A. Jose

Course Outcomes:

CO042.1	Understand what MMICs are and why they're cool in modern tech.
CO042.2	Learn how chips like MOSFETs are made for MMICs.
CO042.3	Understand how signals behave in these lines and how to make them work better.
CO042.4	Analyze slot line structures, their field distribution, and compare them with microstrip lines. Understand the applications and design principles of capacitive, inductive, and resistive lumped elements.
CO042.5	Apply: Use these special parts to create devices that do specific things in our gadgets..

MAMC 043	EMBEDDED SYSTEM FOR WIRELESS & MOBILE COMMUNICATION	LTP 4 0 0	Credits:4

Course Objective: After completion of this course student will be able to:

1. Understand the importance of embedded systems, it components, peripherals and requirements.
2. Knowledge about hardware and software co-design used in microcontrollers and their issues and trade-offs.
3. Knowledge about the Wireless technologies.
4. Knowledge about the Bluetooth protocols and communication using Bluetooth.
5. Knowledge about the Bluetooth networking, connection establishment procedure, Bluetooth security architecture and its levels.
6. Knowledge about the java programming J2ME architecture and packages.
7. Understand the working Bluetooth client and server application, JINI, IrDA, Wireless LAN.

Syllabus:

Unit	Topics	Lectures
I	Typical Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Components.	8
II	Characteristics and Quality Attributes of Embedded Systems: Hardware Software Co-Design and Program Modeling: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language, Hardware Software Trade-offs.Introduction to wireless technologies: WAP services, Serial and Parallel Communication, Asynchronous and synchronous Communication, FDM,TDM, TFM, Spread spectrum technology	8
III	Introduction to Bluetooth: Specification, Core protocols, Cable replacement protocol Bluetooth Radio: Type of Antenna, Antenna Parameters, Frequency hoping Bluetooth Networking: Wireless networking, wireless network types, devices roles and states, adhoc network, scatter net Connection establishment procedure, notable aspects of connection establishment, Mode of connection, Bluetooth security, Security architecture, Security level of services, Profile and usage model: Generic access profile (GAP), SDA, Serial port profile,	8
IV	Secondary Bluetooth profile Hardware: Bluetooth Implementation, Baseband overview, packet format, Transmission buffers, Protocol Implementation: Link Manager Protocol, Logical Link Control Adaptation Protocol, Host control Interface, Protocol Interaction with layers	8

V	Programming with Java: Java Programming, J2ME architecture, Javax. Bluetooth package Interface, classes, exceptions, Javax. obex Package: interfaces, classes Bluetooth services registration and search application, Bluetooth client and server application. Overview of IrDA, Home RF, Wireless LANs, JINI	**8**

Reference Books:

1. Hibu K V, "Introduction to Embedded Systems", THM Publication
2. C.S.R. Prabhu and A.P. Reddi," Bluetooth Technology", PHI Publication.
3. U. Dalal& M. Shukla, "Wireless & Mobile Communication", Oxford University Press.
4. C. Y. William, Lee, "Mobile communication engineering theory and applications", TMH, Publication.
5. S .Haykins, "Communication Systems", John Wiley and Sons.

Course Outcomes:

CO043.1	To develop the understanding of the importance of embedded systems, its components, peripherals and requirements.
CO043.2	Understanding of about hardware and software co-design used in microcontrollers and their issues and trade-offs
CO043.3	Understanding about the Wireless technologies, types of digital communications that can be used in microcontroller.
CO043.4	To understand the Bluetooth protocols and communication using Bluetooth Radio antenna and its types
CO043.5	To understand about the Bluetooth networking, connection establishment procedure, Bluetooth security architecture and its levels
CO043.6	To understand the Secondary Bluetooth profile, packet format, protocol implementation: L2CAP, host control, link control
CO043.7	To understand about the java programming J2ME architecture and packages
CO043.8	To understand the Bluetooth client and server application, JINI, IrDA, Wireless LAN

MAMC 044	SEMICONDUCTOR MEMORY DESIGN	LTP 4 0 0	Credits:4

Course Objective: After completion of this course student will be able to:
1 To acquire knowledge about different types of semiconductor memories.
2 To study about architecture and operations of different semiconductor memories.
3 To comprehend the low power design techniques and methodologies.
4 To verify the theoretical concepts through laboratory and simulation experiments.

Syllabus:

Unit	Topics	Lectures
I	MOS RAM technologies, SRAMs, architecture, SRAM cell and peripheral, Circuit operation, SRAM Technologies, SOI Technology, advanced SRAM architectures and technologies, DRAM technology development, CMOS SRAMs cell, Theory and advanced cell structures.	8
II	Nonvolatile memories, MOS ROMs, PROMs, EPROMs, One-Time Programmable EPROMS, Electrically erasable PROMs, EEPROM technology and architecture,	8
III	Nonvolatile SRAM-Flash Memories, advanced Flash Memory architecture. Memory failure modes, Reliability modelling, Prediction design for reliability, Reliability test Structure, Reliability screening and qualification	8
IV	Radiation effects, Radiation hardening, Process and techniques, Radiation hardened memory characteristics, Soft errors. Ferroelectric random access memories (FRAMs), Gallium arsenide FRAMs, Analog memories, resistive RAMs	8
V	Experimental memory devices, Memory hybrids and MCMs (2D), Memory stacks and MCMs (3D), Memory cards, High density memory packaging.	8

Text Books

1. Ashok K. Sharma, “Advanced Semiconductor Memories: Architectures, Designs, and Applications”, 2nd Edition, John Wiley, 2009.
2. A.K Sharma, “Semiconductor Memories Technology, Testing and Reliability”, 1st Edition IEEE Press, 2003.
3. Santosh K. Kurinec and KrzysztolIniewski, “Nanoscale semiconductor Memories”, CRC Press, 2017.

Reference Books

1. Luecke Mire Care, “Semiconductor Memory Design and Application”, 1st Edition, Mc-Graw Hill, 1999.
2. Belty Prince, “Semiconductor Memory Design Handbook”, 1st Edition, IEEE Computer Society, 2001.
3. William D. Brown, and Joe E.Brewer, “Nonvolatile Semiconductor Memory Technology”, IEEE Press, 2018.

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

CO044.1 Analyze different types of RAM, ROM designs.

CO044.2 Analyze different RAM and ROM architecture and interconnects.
CO044.3 Analyze the design and characterization technique.
CO044.4 Understand different memory testing and design for testability.
CO044.5 Identify new developments in semiconductor memory design.