SCHEME OF TEACHING M.TECH.(MICRO-ELECTRONICS)
FOR THE EXAM. 2011-12

FIRST SEMESTER (Any Five of the following)

MIC 6101 Semiconductor Device physics.
MIC 6102 Integrated Circuit Technology.
MIC 6103 MOS Integrated Circuit Modeling.
MIC 6104 Computer Aided Design Methodologies and Tools.
MIC 6105 Hardware Description Languages and VLSI Design.
MIC 6106 Material Science & Engineering.
MIC 6107 Embedded System Design.

SECOND SEMESTER (Any Five of the following)

MIC 6202 Measurement and Characterization Techniques.
MIC 6203 Architecture of VLSI System.
MIC 6204 Analog and Mixed Signal Device Design.
MIC 6205 Advanced Memory Technology and Design.
MIC 6206 MEMS and Microsystems.
MIC 6207 RF and High Speed Digital Design.

THIRD SEMESTER (Any Two of the Following and Major Project)

MIC 7101 Low Power Digital CMOS Design
MIC 7102 Microelectronic Packaging and Testing
MIC 7103 Nano Scale Devices and Systems
MIC 7104 Major Project

FOURTH SEMESTER

MIC 7201 Major Project and Thesis

Student would be required to give seminar on the thesis topic. This would be given before the Departmental Faculty and students of the department. The evaluation will be done by a board consisting of supervisor, Chairman or his nominee and a member of faculty to be nominated by Board of studies out of panel of 3 persons suggested by supervisor.

Thesis work will be based on research work conducted in the department of approved research laboratory on the approved topic under the supervision of a faculty member of the department.

Note:
1) Theory papers will be of three hours duration.
2) Students will be required to attempt five questions out of eight questions for theory paper.
3) Practical Examination will be of three hours duration.
## EXAMINATION SCHEME

### FIRST SEMESTER

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Total Marks: 750  
Total Credits: 20

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Total Marks: 750  
Total Credits: 20

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Total Marks: 400  
Total Credits: 18
## FOURTH SEMESTER

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Total Marks: 100  
Total Credits: 17

**GRAND TOTAL:**  
**MARKS: 2000**  
**CREDITS: 75**
SYLLABUS

COURSE CONTENTS FOR M.TECH (MICRO-ELECTRONICS)

1st SEMESTER

MIC 6101: SEMICONDUCTOR DEVICE PHYSICS

NOTE: There will be eight questions in total and only five questions are to be attempted.

- Review of Physics and properties of semiconductor, Bond and Bands, Electron Mass, Mobility, continuity equation, charge transport
- p-n junction diode, bipolar transistor, Metal Semiconductor contacts, JFETs and MOSFETs, MIS diode and CCD MOSFET and scaling effects.
- Photonic Devices, Hetero junction and Hetero structure devices, Introduction to Quantum Physics.

References:

4. MOS Field Effect Transistor and Integrated Circuits by Paul Richaman, John Wiley and Sons.

MIC 6102: INTEGRATED CIRCUIT TECHNOLOGY

NOTE: There will be eight questions in total and only five questions are to be attempted.

- Crystal growth and wafer preparation, defects, clean room concept, wafer cleaning techniques.
- Oxidation diffusion, Epitaxy, Ion Implantation, Metallization, Lithography, Etching.
- Typical Bipolar and MOS device fabrication techniques.
- Integration of unit processes, process modeling, IC Packaging, Reliability and failure analysis.

References:
5. Silicon VLSI Technology, James D. Plummer and Michael D. Deal Pearson Education. 2001

**Practical:**

1. Introduction to process simulation tools, e.g. SUPREM, MINIMOS, STEPS etc.
2. Simulation of typical MOS processes and MOSFET Characteristics, extraction of parameters for circuit simulation.

**MIC 6103: MOS INTEGRATED CIRCUIT MODELLING**

**NOTE:** There will be eight questions in total and only five questions are to be attempted.

- Characteristics of MOS digital circuits, Inverters, NMOS NOR and NAND gate logic circuits.
- CMOS Logic gates, transmission gates, signal propagation delays, Noise in Digital logic circuits.
- Random Logic vs. standard logic forms, PLA Structured gate layout.
- Clocking systems, clocked CMOS logic, semiconductor memories.
- Microprocessor design, Device modeling, Circuit modeling.

**References:**

2. Introduction to VLSI Systems, Mead and Convey, Addison Wesley. 1982

PRACTICALS

- Simulation using schematic editor
- Schematic page editor. Part editor, programmer’s editor,
- Session Log editing properties- spreadsheet editor property editor.
- Hierarchical design- Hierarchical blocks, ports, pins
- Placing, editing and connecting parts
- Editing and adding graphics
- Configuring a macro
- Creating a netlist
- Exporting and importing schematic data
- Analog stimuli-VSTIM, ISTIM
- Editing and creating models
- Digital simulation-Digital simuli DIGLOCK
- Simulation Parameters
- D.C Sweep Analysis
- Transient Analysis
- AC Sweep Analysis
- Parametric Analysis
- Performance Analysis

MIC 6104: COMPUTER AIDED DESIGN METHODOLOGIES AND TOOLS

NOTE: There will be eight questions in total and only five questions are to be attempted.
• Introduction to VLSI design methodologies and supporting CAD tool environment. Overview of C and Data structures, Graphics and CIF, concepts and structure and algorithms for some of the CAD tools.
• Schematic editors, layout editors, Module generators, silicon compliers, placement and routing tools.
• Behavioral, functional, logic and circuit simulators, Aids for test vector generation and testing.

References:
1. Computer Aids for VLSI by Steven M. Rubin (Addison-Wesley) 1980
3. An introduction to VLSI Physical design, Majid Serafzadeh, McGraw Hill.2002

PRACTICAL

Study of
• schematic,
• layout editors,
• layout of gates, cells,
• layout optimization,
• use of silicon compliers.

MIC 6105: HARDWARE DESCRIPTION LANGUAGES AND VLSI DESIGN

NOTE: There will be eight questions in total and only five questions are to be attempted.
• Design Environment, Design automation, role of EDA tools in design automation, introduction to different EDA tools, simulation and synthesis issues.
• Design entry through schematic, Design simulation with SPICE, Designing with VHDL-features and capabilities of VHDL, levels of abstraction and basic building blocks, modes and language elements, behavior modeling, Data flow and structural modeling.
• VHDL description of combinational circuits, VHDL modeling of finite state machines, PLD based system design- features of different CALD devices, physical downloading of design on CPLD chip, FPGA chip.
References:

1. VHDL by Douglas Perry, Tata Mc Graw Hill 2004
2. VHDL Analysis & Modelling of Digital system by Navabi Z., Mc Graw Hill, 2002

MIC 6106: Material Science & Engineering

NOTE: There will be eight questions in total and only five questions are to be attempted.

- Material Science: Atomic Bonding, Crystal structure and Defects, Diffusion, Mechanical Behaviour, Thermal Behaviour, Failure Analysis & prevention.
- Materials of special applications viz. cryogenic, high temperature, high frequency applications.

References:

MIC 6107: EMBEDDED SYSTEM DESIGN

NOTE: There will be eight questions in total and only five questions are to be attempted.

- **Introduction:** A system, processors and other hardware units for embedded systems, embedded into system, regular processors and microcontrollers for embedded systems.
- **Hardware Aspects:** Brief discussion about processor structure, registers, memories, parallel and serial communication and ports, timers and interrupts.
- **Programming Tools and handheld Devices:** Using embedded C++, use of RTOS µc/os-I, use of RTOS Vx Works, Kernel of an embedded system and device drivers.
- **Using Multiple Processors in Embedded Systems:** Multiple process in parallel, modeling tools for a multiprocessor system, distributed embedded systems, Systems on chip(SOC).
- **Design of an embedded system:** System design, design cycle development phase for an embedded system, users of target systems, emulator and ICE, use of software tools for embedded systems, scopes and analyzers for system hardware tests.

References:

1. Embedded Systems, Raj Kamal, Tata Mcgraw Hill. 2004
MIC 6201: DIGITAL INTEGRATED CIRCUITS & SYSTEMS

NOTE: There will be eight questions in total and only five questions are to be attempted.

- Noise Considerations in logic families.
- Digital system implementation using algorithmic state m/c concepts, Register transfer, bus clocking and control, asynchronous and synchronous systems.
- High speed adders, multipliers, FIFOs, and Barrel shifters, ALU control semiconductors for memories and PLAs, microprogrammed and PLA based control design.
- Data transfer techniques-examples of interface chips. Channel communication- protocols and standard.

References:

MIC 6202: MEASUREMENT AND CHARACTERIZATION TECHNIQUES

NOTE: There will be eight questions in total and only five questions are to be attempted.

- Measurement of Resistively, Film thickness, reflectivity, refractive-index, stress, line width.
- Doping profile, Electron Beam Techniques (STM, AFM, TEM, SEM, electron beam induced current (EBIC) and voltage contrast technique).
- AES, Electron Microphone (EDX), LEED, RHEED), Ion beam Techniques (SIMS, RBS), X-ray techniques (XPS, X-ray Topography).

References:
1. Imperfections and Impurities in Semiconductor Silicon By K.V. Ravi, John Wiley and Sons.
2. Characterization of Semiconductor Materials by Philip F. Kare and Greydon B. Laubee, Mc-Graw Hill.

**MIC 6203: ARCHITECTURE OF VLSI SYSTEMS**

**NOTE:** There will be eight questions in total and only five questions are to be attempted.

- Overview of architectural schemes, organization, representations and systems, single processor design, mechanism for higher performance.
- CISC Vs RISC, memory organization, cache Memory, I/O subsystems and control unit design, Algorithms.
- Specific architecture, upper computer architecture, pipeline and overlap processing, data flow, systolic, distributed and paralleled architectures.

**References:**

3. Computer system organization and Architecture, Carpinellie, Pearson Education. 2001

**MIC 6204: ANALOG AND MIXED SIGNAL DEVICE DESIGN**

**NOTE:** There will be eight questions in total and only five questions are to be attempted.

- Basic concepts, Bi CMOS and technology, current and voltage sources. Differential and operational amplifiers, multiplexing and modulators, phase locked techniques.
- D to A and A to D converters, Microwave circuits, High voltage circuits, Filter design, Current mirror, differential amplifier, theory and design of operational amplifiers, common mode range.
• Design considerations for rail to rail inputs and output. MOS operational amplifier timers, function generators, Multipliers and PLL.

References:
1. Digital Bipolar circuits by Mohammed I. Elmasy, John Wiley & Son

PRACTICAL
• Simulation of analog integrated circuits
• Simulation & characterization of mixed signal devices

MIC 6205: ADVANCED MEMORY TECHNOLOGY AND DESIGN

NOTE: There will be eight questions in total and only five questions are to be attempted.

• Basics of Memory, Advanced Semiconductor Memories, Memory Device and Process Technology, Static Random Access Memory Technology.
• High –performance Dynamic random Access Memory, Non volatile memory, Radiation effects, Ferroelectric memory, Flash Memory, Future trends.
• Basic Memory Architecture and Cell Structure, Application- Specific DRAM Architectures and Design.
• Advanced Nonvolatile Memory Design and Technology, Embedded Memory Design and Applications.

References:

MIC 6206: MEMS AND MICROSYSTEMS

NOTE: There will be eight questions in total and only five questions are to be attempted.

- Overview, Working principle of microsensors & microactuation, Scaling laws in geometry, electrostatic & electromagnetic forces, electricity, fluid mechanics and heat transfer.
- Materials for MEMS, active substrate materials, polymers as MEMS materials. Considerations for microfabrication, bulk micromanufacturing, surface micromachining, LIGA process.
- Microsystem packaging, die-, devices-and system-level packaging, interfaces in microsystem packaging for different applications, signal mapping and transduction.
- Microsystem design considerations, process design, mechanical design, mechanical design using FEM, design considerations for optical, fluidic, RF and Bio-MEMS.
- Overview of CAD tools for MEMS design and simulation.

References:


**MIC 6207: RF and High Speed Digital Design**

**NOTE:** There will be eight questions in total and only five questions are to be attempted.

- High speed Design: ideal transmission line fundamentals, Crosstalk.
- Non Ideal interconnect issues, connectors packages and vias, Non ideal return paths, simultaneous switching noise, and power delivery, buffer modeling, digital timing analysis, timing specific design methodologies, radiated emissions compliance and system noise minimization, high speed measurement techniques.
- RF Design: Introduction to RF Electronics, basic concepts in RF design, MOS Review, Path Loss Small Signal Model, Receiver Design RF Transreceivers, Low Noise RF amplifiers and Mixers, RF Power amplifiers, RF Oscillators.

**References:**

3rd SEMESTER

MIC 7101: LOW POWER DIGITAL CMOS DESIGN

NOTE: There will be eight questions in total and only five questions are to be attempted.

• Hierarchy of limits of power.
• Sources of power consumption, power estimation, Synthesis for low power, Voltage scaling approaches.
• Design and test of low power circuits, Adiabatic switching, Minimizing switched capacitance.
• Low power static RAM architecture, Low energy computing using energy recovery techniques, low power Programmable computation, Software design for low power.

References:

1. Low power CMOS VLSI Circuit Design, Kaushik Roy and Sharat Parsad, John Wiley & Sons. 1998

MIC 7102: Microelectronics Packaging and Testing

NOTE: There will be eight questions in total and only five questions are to be attempted.

• Packaging: Introduction, Packaging Hierarchy, Package parameters, packaging substrates, package types, Hermetic packages, die attachment techniques, package parasitic, package modeling, packaging in wireless application, future trends.
• Testing: Introduction, basic concepts, DFT, importance of test, boundary scan test, boundary scan controller, faults, faults models, physical faults, stuck- at faults, logical
faults, CAD for stuck-at faults and path delays, IDDQ tests, fault collapsing, fault/
Automatic test pattern generation, Basic, ATPG algorithm, PODEM algorithm, Built- in self test, LPSR, MISR.

References:


MIC 7103: NANOSCALE DEVICES AND SYSTEMS

NOTE: There will be eight questions in total and only five questions are to be attempted.

- Introduction, sub micron scaling, ballistic effects in MOS Devices, quantum transport phenomenon, nanoscale modeling.
- Overview of Quantum Dots, Resonant tunneling devices (Diodes and transistors), Single electron effects and Coulomb Blockade, Introduction to Nano electro mechanical systems (NEMS).
- Introduction to Molecular electronic devices, self assembled monolayers (SAM), Diodes, Optoelectronic Devices, Switches, Nanowires, programmable logic arrays, digital gates, flip-flops, shift registers, memories, rectifiers, Overview of nano materials.
- Nano Fabrication Techniques (Lithography, Self- Assemble, contact imprinting and Binding of organics and semiconductors).
References:

2. Nanotechnology: G. Timp, Bell Labs, Murray Hill, NJ (Ed.)

MAJOR PROJECT

Each student will be required to work on the major project approved by department faculty that will span III and IV semesters during which periodic progress reports will be monitored. At the end of III semester, project progress will be evaluated by the departmental faculty.

At the end of IV semester, the student will submit the thesis based on his project work.