ANNAMALAI UNIVERSITY
DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

VISION

To nurture higher echelons of technology through participative education, innovative and collaborative research with a view to bring out employable graduates of International standard.

MISSION

- To establish state of art facilities related to diverse dimension in the field of Instrumentation Engineering, Biomedical Engineering and Microelectronics and MEMS.

- To foster higher quality of education with equivocal focus in theory and practical areas of Electronics, Control and Instrumentation Engineering, Biomedical Engineering and Microelectronics and MEMS.

- To ensure that the dissemination of knowledge reaches the stakeholders and forge the opening of a fresh flair of human resources.

- To create opportunities for advancements in different facets of this discipline and offer avenues to reach the citadels of one’s carrier.

M.E. MICROELECTRONICS AND MEMS

PROGRAMME EDUCATIONAL OBJECTIVES

1. To provide a pool of post graduate engineers who are specialists in the modeling and design of basic and advanced semiconductor devices.

2. To create a knowledge society in the area of design, fabrication and characterization of micro electro mechanical systems such as microsensors and micro actuators by introducing various simulation tools and micro fabrication technologies.

3. To train a group of engineers who would be capable of supporting Indian electronics industry to develop advanced and indigenous microsystems for the modern society.

4. To train engineers who would design and develop nano electronic circuits and nano electro mechanical systems for the future world.

5. To inculcate students a professional approach to problem solving, using analytical, academic, and communication skills effectively, with special emphasis on working in teams.
6. To encourage students to acquire breadth of knowledge, including the multidisciplinary nature of microelectronic engineering as well as the broad social, ethical, safety, and environmental issues within which engineering is practiced.

7. To lay the foundation for a strong desire to achieve leadership positions in industry or academia.

PROGRAMME OUTCOMES

After the successful completion of the M.E. (Microelectronics and MEMS) degree programme, the students will be able to:

**PO1:** Understand the fundamental scientific principles governing semiconductor electronic devices, modelling of such devices and their incorporation into modern integrated circuits.

**PO2:** Provide the knowledge of semiconductor manufacturing process to utilize thin film processing methods to fabricate and packaging electronic components, communication devices and micromechanical devices. Understand the relevance of a process or device, either proposed or existing, to current manufacturing practices.

**PO3:** Develop in-depth knowledge in existing or emerging areas of the field of Nano electronics such as device engineering, circuit design, lithography, materials and processes, yield, and manufacturing.

**PO4:** Understand the basic concepts of MEMS technology, an interdisciplinary field related to technologies, used to fabricate nano to micro scale devices and system-on-a-chip that embed electrical, mechanical, chemical, and hybrid mechanisms to realize devices and systems for a broad array of applications such as physical sensors, biomedical systems, and complex multifunctional nano-micro systems.

**PO5:** Introduce students to the techniques of micro and nano-manufacturing, design and multiphysical simulation tools for the analysis of micro and nano-structures and study of their behaviour and the classification of micro and nano sensors and actuators in integrated technology.

**PO6:** Produce Engineers with the highly specialized knowledge and expertise that they need to design, fabricate, test and package sensors and actuators of micro and nano scale using conventional semiconductor technologies and other emerging technologies.

**PO7:** Develop process engineer to understand electrical engineering design rules, electronic material properties, and the physics using modern VLSI design tools.

**PO8:** Produce post graduates who have strong engineering knowledge and technical competence to use techniques, skills and modern engineering tools that allow them to work effectively on the design of VLSI circuits that process Analog, Digital and mixed signals for Communications, Signal Processing and Control Systems,
**PO9:** Induce an enthusiasm for learning and develop continuous improvement of skills throughout one’s career to adopt and accept changes within the field.

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ANNAMALAI UNIVERSITY
FACULTY OF ENGINEERING AND TECHNOLOGY
M.E. / M. Tech (Two-Year Full Time & Three-year Part Time) DEGREE PROGRAMME
CHOICE BASED CREDIT SYSTEM (CBCS)
REGULATIONS

1. Condition for Admission
Candidates for admission to the first year of the four-semester M.E / M.Tech Degree programme in Engineering shall be required to have passed B.E / B.Tech degree of Annamalai University or any other authority accepted by the syndicate of this University as equivalent thereto. They shall satisfy the condition regarding qualifying marks and physical fitness as may be prescribed by the syndicate of the Annamalai University from time to time. The admission for part time programme is restricted to those working or residing within a radius of 90 km from Annamalainagar. The application should be sent through their employers.

2. Branches of Study in M.E / M.Tech
The Branch and Eligibility criteria of programmes are given in Annexure 1

3. Courses of study
The courses of study and the respective syllabi for each of the M.E / M. Tech programmes offered by the different Departments of study are given separately.

4. Scheme of Examinations
The scheme of Examinations is given separately.

5. Choice Based Credit System (CBCS)
The curriculum includes three components namely Professional Core, Professional Electives and Open Electives in addition to Thesis. Each semester curriculum shall normally have a blend of theory and practical courses.

6. Assignment of Credits for Courses
Each course is normally assigned one credit per hour of lecture / tutorial per week and one credit for two hours or part thereof for laboratory or practical per week. The total credits for the programme will be 65.

7. Duration of the programme
A student of M.E / M.Tech programme is normally expected to complete in four semesters for full-time / six semesters for part-time but in any case not more than four years for full-time / six years for part-time from the date of admission.

8. Registration for courses
A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every other student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head of the Department along with a late fee will be done up to the last working day. Registration for the Thesis Phase - I and II shall be done at the appropriate semesters.

9. Electives
The student has to select two electives in first semester and another two electives in the second semester from the list of Professional Electives. The student has to select two electives in third semester from the list of Open Electives offered by the department/ allied department. A student may be allowed to take up the open elective courses of third semester (Full Time program) in the first and second semester, one course in each of the semesters to
enable them to carry out thesis in an industry during the entire second year of study provided they should register those courses in the first semester itself. Such students should meet the teachers offering those elective courses themselves for clarifications. No specific slots will be allotted in the time table for such courses.

Further, the two open elective courses to be studied in III semester (Full Time programme) may also be credited through the SWAYAM portal of UGC with the approval of Head of the Department concerned. In such a case, the courses must be credited before the end of III Semester.

10. Assessment

The break-up of continuous assessment and examination marks for theory courses is as follows:

- First assessment (Mid-Semester Test-I) : 10 marks
- Second assessment (Mid-Semester Test-II) : 10 marks
- Third Assessment : 5 marks
- End Semester Examination : 75 marks

The break-up of continuous assessment and examination marks for Practical courses is as follows:

- First assessment (Test-I) : 15 marks
- Second assessment (Test-II) : 15 marks
- Maintenance of record book : 10 marks
- End Semester Examination : 60 marks

The thesis Phase I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. The number of reviews must be a minimum of three per semester. 60 marks are allotted for the thesis work and viva voce examination at the end of the third semester. The same procedure will be adopted for thesis Phase II in the fourth semester.

11. Student Counsellors (Mentors)

To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester, monitor their progress in SWAYAM courses / open elective courses and obtain the final approval of the Head of the Department.

12. Class Committee

For each of the semesters of M.E / M.Tech programmes, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from first to fourth semesters for Full time and first to sixth semesters for Part-time will be as follows:

- Teachers of the individual courses.
- A Thesis coordinator (for Thesis Phase I and II) shall be appointed by the Head of the Department from among the Thesis supervisors.
- A thesis review committee chairman shall be appointed by the Head of the Department
- One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.
- The Head of the Department may opt to be a member or the Chairman.
- All counselors of the class and the Head of the Department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees.

The class committee shall meet three times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory / 40 marks for practical and project work will be finalized for every student and tabulated and submitted to the Head of the Department for approval and transmission to the Controller of Examinations.

13. Temporary Break Of Study
A student can take a one-time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the mid-semester test. However, the student must complete the entire programme within the maximum period of four years for Full time / six years for Part time.

14. Substitute Assessments
A student who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the end of semester examination may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.

A student who wishes to have a substitute assessment for a missed assessment must apply to the Head of the Department within a week from the date of the missed assessment.

15. Attendance Requirements
The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.
A student who withdraws from or does not meet the minimum attendance requirement in a semester must re-register and repeat the same semester in the subsequent academic years.

16. Passing and Declaration of Examination Results
All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the controller of examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the grade point average (GPA) and cumulative grade point average (CGPA) and prepare the mark sheets.

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<th>Marks Range</th>
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<tr>
<td>90 to 100</td>
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<td>80 to 89</td>
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<td>70 to 79</td>
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<td>60 to 69</td>
<td>‘C’</td>
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<td>55 to 59</td>
<td>‘D’</td>
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50 to 54 marks  Grade ‘E’
Less than 50 marks  Grade ‘RA’
Withdrawn from the Examination  Grade ‘W’

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course is declared to have successfully completed that course and earned the credits for that course. Such a course cannot be repeated by the student.

A student who obtains letter grade RA / W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

- S - 10;
- A - 9;
- B - 8;
- C - 7;
- D - 6;
- E - 5;
- RA - 0

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-totaling of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department.

After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester.

GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

CGPA is similarly calculated considering all the courses taken from the time of admission.

17. Awarding Degree

After successful completion of the programme, the degree will be awarded with the following classifications based on CGPA.

For First Class with Distinction the student must earn a minimum of 65 credits within four semesters for full-time / six semesters for Part time from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above.

For First Class, the student must earn a minimum of 65 credits within two years and six months for full-time / three years and six months for Part time from the time of admission and obtain a CGPA of 6.75 or above.

For Second class, the student must earn a minimum of 65 credits within four years for full-time / six years for Part time from the time of admission.

18. Ranking Of Candidates

The candidates who are eligible to get the M.E / M.Tech degree in First Class with Distinction will be ranked on the basis of CGPA for all the courses of study from I to IV semester for M.E / M.Tech full-time / I to VI semester for M.E / M.Tech part-time.

The candidates passing with First Class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV semester for full-time / I to VI semester for M.E / M.Tech part-time.
19. Transitory Regulations

If a candidate studying under the old regulations M.E. / M.Tech could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old regulations.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.
<table>
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<tr>
<th>S.No.</th>
<th>Department</th>
<th>Programme (Full Time &amp; Part time)</th>
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<td>ii. Environmental Engineering &amp; Management</td>
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<td>ii. Construction Engg. and Management</td>
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<td>iii. Geotechnical Engineering</td>
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<td>iv. Disaster Management &amp; Engg.</td>
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<td>ii. Welding Engineering</td>
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<td>ii. Smart Energy Systems</td>
<td>B.E. / B.Tech – Electrical and Electronics Engg, Control and Instrumentation Engg, Electronics and communication Engg</td>
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<td>iii. Power System</td>
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<td>Chemical Engineering</td>
<td>i. Chemical Engineering</td>
<td>B.E. / B.Tech – Chemical Engg, Petroleum Engg, Petrochemical Technology</td>
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<td>iii. Industrial Bio Technology</td>
<td>B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Leather Technology</td>
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<td>iv. Industrial Safety Engineering</td>
<td>B.E. / B.Tech – Any Branch of Engineering</td>
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* AMIE in the relevant discipline is considered equivalent to B.E.
# DEPARTMENT OF ELECTRONICS and INSTRUMENTATION ENGINEERING
Curriculum for M.E. (Microelectronics and MEMS) - Full Time

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*Note: * - Four weeks during the summer vacation at the end of II Semester.

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L- Lecture ; P- Practical; T- Thesis; CA- Continuous Assessment; FE- Final Examination
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Note: * - Four weeks during the summer vacation at the end of IVth Semester.

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COURSE OBJECTIVES:

- To equip the students with the Finite Element Analysis fundamentals.
- To model and analyze 1D and 2D finite elements for structural elements like beam, frame and plane elements.
- To introduce basic aspects of finite element technology, including domain discretization, Polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
- To help the students use FEA method and commercial software package to solve problems in heat transfer, mechanics of materials and machine design.
- To familiarize students with professional-level finite element software like ANSYS.

Introduction: Basic Principles of Finite Element Method - Modern Concepts in Simulation and Modelling (Behavioral Modelling, Modelling Levels such as device and system-level) - Some basic but important mathematical and physical concepts in FEA - Concepts such as elements and nodes, Discretization and other Approximations.

1D FEA and 2D FEA: One-Dimensional FEs (e.g., beams, bars, cables and springs). Stiffness and load vector formulations and boundary conditions. Two-Dimensional Finite Elements. Discussion includes plane elements (plane-stress and plane-strain), and plate elements.

Thermal Analysis: Basic Equations. FEs for thermal analysis. Thermal transients. Discussion on Modelling, Numerical Errors and Accuracy. Discussion includes tests for elements, sources and detection of numerical errors, convergence study, and adaptive techniques. Basic Electromagnetics: Basic Electromagnetic Equations, FEs for field equations, transients.

Dynamic Analysis: Free vibration and dynamic problems. Include response spectra analysis.


REFERENCES:
COURSE OUTCOMES:
Upon completing the course, the student should have
1. The ability to identify mathematical model for solution of common engineering problems and formulate finite elements model to obtain the solutions.
2. Familiarity to use professional-level finite element software to solve engineering problems in solid mechanics, fluid mechanics and heat transfer.
3. The capability to derive element matrix equation by different methods based on basic laws in mechanics and integration by parts.
4. Learnt the formulation of one-dimensional, two-dimensional, and three dimensional elements used in MEMS sensors and actuators
5. Exposure to conduct FEA using commercial FEM software

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COURSE OBJECTIVES:
- To introduce the basics of semiconductor materials, their electrical properties and quantitative analysis of such materials based on energy band diagrams
- To acquaint the students with the construction, theory and operation of the P-N junction diode, its characteristics and quantitative analysis of P-N junction diodes
- To teach the concepts of Bipolar Junction Transistors and quantitative analysis to estimate the performance factors
- To make the students understand the effect of junction capacitance, their effect on the performance of diodes and BJTs and Breakdown characteristics of these devices
- To impart knowledge of the operation and characteristics of Photodiodes and phototransistors and qualitative analysis of these devices.

distribution of hole density and electron density – Continuity equation for Semiconductors –
Determination of steady state excess carrier density – Concepts of Quasi Fermi level.

Quantitative analysis of P-N junction Diode: P-N junction under thermal equilibrium – P-N junction under Forward bias – P-N junction under Reverse bias – Behavior under large forward voltage – Temperature dependence of P-N junction characteristics - Break down under reverse bias - Thermal Break down, Zener Break down and Avalanche Break down – Transition capacitance of a P-N junction. Band diagram for a Semiconductor with an applied voltage – P-N junction in thermal equilibrium – Minority carrier densities in a P-N junction under Forward bias – Expression for total current in a P-N junction – Calculation of carrier density and current in a reverse biased junction – P-N junction behavior in terms of minority carrier stored charge – Calculation of electric field and voltage drop in the bulk.


Junction Transition capacitance and junction Break down voltages: Electric field and potential distribution in P-N junction at thermal equilibrium – transition capacitance and Break down voltages in linearly graded junction and an abrupt junction- $C_T$ in PIN Diode – Break down voltage in transistor.

Quantitative analysis of Photo diodes and Photo transistors: Carrier generation by light in a uniform piece of semiconductor – P-N junction photo diode for light detection – Open circuit photo voltages – Short circuit current in photo diode – Photo diode current under combined action of light and reverse bias – Photo diode current under combined action of light and forward bias - Photo transistor – Expression for current in photo transistor – Solar cells using photo diodes.

REFERENCES:

COURSE OUTCOMES:
On successful completion of the course, the students will be able to
1. Describe the equations based on energy band diagrams, acceptable approximations and for intrinsic, p and N type semiconductors
2. Explain the operation of p-n junction diodes quantitatively and qualitatively.
3. Describe the fabrication, device operation of a BJT quantitatively and model its characteristics from basic principles
4. Understand the effects of junction capacitance and break down voltages on the performance of P-N junction diodes and BJTs the Classify and describe the semiconductor devices for special applications
5. to analyze and develop models of optoelectronic devices such as Solar Cells and LEDs.
COURSE OBJECTIVES:

- To introduce the basic concepts of micro systems and advantages of miniaturization.
- To teach the fundamentals of micromachining and micro fabrication techniques.
- To train the students on the design of micro sensors and actuators and fabrication flow process.
- To bring both circuits and system views on design together.
- To understand MOS transistor as a switch and its capacitance.


REFERENCES:

COURSE OUTCOMES:
Upon completing the course, the students will be able to
1. Know the basic concepts of micro systems and advantages of miniaturization.
2. Understand the fundamentals of micromachining and micro fabrication techniques.
3. To be aware about the trends in semiconductor technology, and how it impacts scaling and performance.
4. Expertise the knowledge in design of micro sensors and actuators fabrication.
5. Able to learn Layout, Stick diagrams, Fabrication steps, Static and Switching characteristics of inverters.

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**COURSE OBJECTIVES:**
- To study the various materials used for micromachining techniques.
- To understand the process of Bulk Micro Machining techniques.
- To understand the process of Surface Micromachining techniques.
- To study the process of bonding techniques.
- To provide the significance of sacrificial process.

**Introduction to micro machined devices:** Materials for micromachining-micromachining term-mechanical properties of silicon-native oxides of silicon and other semiconductors-typical silicon wafer types.

**Bulk Micro Machining:** wet etching of silicon-Isotropic etching-anisotropic etching-alkali hydroxide etchants-ammonium hydroxide-tetra methyl ammonium hydroxide (TMAH)-ethylene diamine pyrochatechol (EDP)-ultrasonic agitation in wet etching- stop layers for dopant elective etchants. Porous-silicon formation –anisotrophic wet etching of porous aluminum-anistrophic wet etching - quartz-vapour phase etches. RLE-laser driven bulk processing.


**Bonding Processes:** Anodic Bonding-Anodic bonding using deposited glass-silicon fusion bonding-other bonding and techniques-compound processes using bonding.

**Sacrificial Processes and Other Techniques:** Sticking problem during wet releasing-prevention of sticking-phase change release methods-geometry-examples of sacrificial processes - Sacrificial LIGA
process: -Vapour phase sacrifical layer etch - sealed cavity formation-sharp tip formation-chemical mechanical polishing-electric charge machining (ECM)-photosensitive glass micromachining focused on beam micromachining.

REFERENCES:

COURSE OUTCOMES:
Upon completing the course, the student should have
1. Thorough knowledge of materials used for micromachining techniques.
2. Understood the process of Bulk Micro Machining techniques.
3. Understood the process of Surface Micro Machining techniques.
4. Understood the process of bonding techniques.
5. Understood the sacrificial process and other special techniques.

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LIST OF EXPERIMENTS

1. Discrete energy levels possessed by electrons in an isolated atom.
2. Temperature dependence of intrinsic carrier concentration in semiconductor.
3. Electron and hole concentration in semiconductor doped at different levels.
4. Conductivity and resistivity of semiconductor doped at different levels.
5. Temperature effects on the probability of occupation of energy levels in a semiconductor.
6. Effect of Doping concentration on the contact potential (Vcp) in a P-N junction semiconductor diode.
7. Determination of the forward and reverse characteristics of a P-N junction diode parameter like conductivity of P and N region and their Dimension.
8. Estimation of BJT performance parameters ($\alpha, \beta, \gamma$) for a given device.
9. Analysis of the collector current in P+-N-P and N+-P-N transistors for different device parameters.
10. Simulation studies on diffusion process and estimation of diffusivity at different temperatures.

COURSE OBJECTIVES:

- To introduce the basic concepts of MOS structure under different modes of operation and characteristics
- To educate on solving the problem based on MOS structure
- To teach the fundamentals of MOSFET operation under various SPICE level models
- To impart knowledge about short and long channel effects
- To provide an overview on the design of SOI MOSFETS and High Speed Devices

MOS Structure: Ideal MOS structure and different modes of operation - Ideal MOS structure under thermal equilibrium, accumulation mode, depletion mode and inversion mode-small signal capacitance of MOS structure in depletion-Threshold voltage of ideal MOS structure – C - V characteristics of MOS capacitor - Effects of non-idealities on MOS characteristics-effect of work function, charges on oxide like fixed oxide charge, mobile ionic charge, oxide trapped charge and interface trap density – threshold voltage including non-idealities.

MOSFET Operation: Qualitative operation of square law model and for static characteristics-(SPICE level 1) for MOSFET characteristics –Bulk charge model (SPICE-level 2 model) - SPICE level 3 model-body effect or substrate bias effect – Subthreshold conduction in MOSFET – small signal model for MOSFETS.
**Short Channel Effects:** Short channels effects on threshold voltage-channel length modulation - velocity saturation-breakdown voltage - scaling and types of scaling-short channel devices modeling.

**SOI MOSFETS:** Advantages of SOI MOSFETS – SOI wafer fabrication techniques-partially depleted SOI MOSFET-Threshold voltage of a partially depleted SOI MOSFETS - kink effect – fully depleted SOI MOSFET-threshold voltage of fully depleted SOI MOSFET.

**High Speed Devices:** Metal Semiconductor contacts – metal conducts on N type semiconductor and P type semiconductor-Surface states and their effects – Schottky barrier function. **MESFETs** – Structure of GaAs MESFETS - pinch off voltage and threshold voltage- MESFET modelling.

**REFERENCES:**

**COURSE OUTCOMES:**
At the end of the course the students will be able to
- Know the basic concepts of MOS structure under different modes of operation and characteristics
- Understand the fundamentals on solving the problem based on MOS structure
- Expertise the knowledge in fundamentals of MOSFET Operation under various SPICE level models and problem solving
- Understand the design concepts about short and long channel effects
- Acquire knowledge on the SOI MOSFETS and High Speed Devices

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COURSE OBJECTIVES:

- To impart knowledge on basic mechanics and properties of materials.
- To study the architecture of various MEMS pressure sensors, MEMS accelerometers and Microphones.
- To study the architecture of various MEMS actuators and their industrial applications.
- To introduce the knowledge of Optical MEMS and their allied devices.
- To study the principles of various thermal sensors and actuators.

**Basic Mechanics:** Axial stress and strain – Shear stress and strain – Poisson’s ratio – Commonly used deflection equations for micro structures – static beam equations – static torsion equations – Dynamics.

**Mechanical properties of materials:** Material failure – Mechanical characterization of thin films – Direct measurement of Young’s modulus – Poisson’s ratio and tensile strength.

**MEMS Pressure sensors:** Sensing mechanisms – MEMS Pressure sensors – Types of pressure sensors – Piezo resistive pressure sensors – V-grove etching – Surface micro machined pressure sensors using Poly Silicon Piezo resistors – Overload protection – Capacitive pressure sensors – Resonant pressure sensors.


**REFERENCES:**
COURSE OUTCOMES:
Upon completing the course, the student should have
1. Understood basic mechanics and material properties.
2. The capacity to design the structure of MEMS pressure sensors, MEMS accelerometers and Microphones.
3. Know the structural design of MEMS actuators suitable for specific industrial applications.
4. Understood the principles of Optical MEMS used in various light sensitive devices.
5. Acquired the knowledge of thermalsensors and actuators used in industrial applications.

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MEMC203 NANO MATERIALS AND NANO ELECTRONICS

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COURSE OBJECTIVES:
- To impart knowledge on Nanomaterials, its present applications, Atom, Clusters and its importance.
- To educate on Synthesis / Preparation of nanomaterials.
- To provide an overview on influence of scaling of size on material properties.
- To introduce the concepts of Quantum size effect, quantum wells, quantum wires and quantum dots.
- To give an overview of the future applications of Nanomaterials.

Introduction to nanomaterials and nanotechnology: History of nanomaterials - Influence on properties by nano - structure induced effects - Some present and future applications of Nanomaterials.
Atoms, clusters and nanomaterials: Introduction - importance of clusters.
Future applications including bottom-up nanotechnology and microelectronics: The red brick wall in microelectronics - Future needs of microelectronics industries Review of possible bottom up approaches still in research - Self organization.

REFERENCES:
4. Journals/Magazines/Websites
   http://www.nanotech-now.com/
   http://www.foresight.org/

COURSE OUTCOMES:
Upon completing the course, the student should
1. Understand Nanomaterials, the basic concepts of atoms, clusters and its importance.
2. Acquire the concepts behind preparation and synthesis of Nanomaterials.
3. Understand the influence of scaling of size on different properties of nanomaterials.
4. Understand Quantum size effect, quantum wells, quantum wires and quantum dots.
5. Understand the future applications of Nanomaterials.

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MEMC204 ANALOG INTEGRATED CIRCUIT DESIGN

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COURSE OBJECTIVES:
- To introduce on analog integrated circuit design and various CAD tools.
- To review MOSFET fabrication, models, secondary effects and their influence on analog circuits design.
- To teach the design of MOS based switches, current mirrors and amplifiers.
- To make the students understand various MOS based op-amp configurations and their biasing.
- To educate the concepts of comparators, switched capacitors, analog filters and A/D converters using MOSFETs.

Introduction: Course overview - Analog IC design: CAD tools and methodology - Notations, symbols, and terminology - Example of analog signal processing and analog ICs - Review of IC technology, device modeling and layout: Modeling of BJT and MOS devices - BJT and MOS fabrication technology - Basic IC layout and passive components.
Basic analog sub circuits: MOS switch and resistor - Current sources/sinks and current mirrors - Design of basic amplifiers - Current and voltage references - Noise analysis and modeling: Time and frequency-domain analysis - Noise models for IC devices – Noise analysis examples.

Basic operational amplifier (op amp) design: Non-ideal characteristics of op amp - Design of two-stage op amps - Stability and frequency compensation - Advanced operational amplifiers: Buffered op amps - Folded-cascaded, rail-to-rail input, and class-AB input op amps - Fully-Differential op amps and Common-Mode Feedback Circuits


Introduction to data converters: Characterization and definition of data converters - Nyquist – Rate - Digital - to - Analog Converters - Nyquist-Rate Analog – to - Digital Converters - Oversampled Converters

REFERENCES:

COURSE OUTCOMES:
Upon completing the course, the student should have
1. Understood the concept of MOSFET based analog IC design.
2. Acquired the expertise on the tools and methodologies used in analog IC design.
3. Understood the design of basic differential amplifiers and issues to be addressed in the design of high performance op-amps.
4. The ability to test and analyse the performance characteristics of Analog Integrated Circuit.
5. Acquired the complete knowledge of the design of comparators, switched capacitor based analog circuits and analog to digital converters.

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**LIST OF EXPERIMENTS**

1. Study of IntelliSuite Software for the design and fabrication process of MEMS devices.
2. Deflection Response of SOI (Silicon-On-Insulator) Pressure Sensor.
3. Construction and Simulation of RF Switch.
7. Studies on effect of Air Gap on Pull-in voltage of fixed beam employed in RF Switch.
8. Design and Construction of different types of Accelerometer and determination of its natural frequency
   a) Design and Analysis of Piezoresistive Accelerometer using CoventorWare software.
   b) Design and Analysis of Comb drive type Capacitive Accelerometer using IntelliSuite software.

**COURSE OBJECTIVES**

- To work on a technical topics related to microelectronics and MEMS and acquire the ability of written and oral presentation.
- To acquire the ability of writing technical papers for Conferences and Journals.

The students will work for two periods per week guided by student counsellor. They will be asked to present a seminar of not less than fifteen minutes and not more than thirty minutes on any technical topic of student’s choice related to their specialization in Process Control and Instrumentation Engineering and to engage in discussion with audience. They will defend their presentation. A brief copy of their presentation also should be submitted. Evaluation will be done by the student counselor based on the technical presentation and the report and also on the interaction shown during the seminar.

**COURSE OUTCOMES**

1. The students will be getting the training to face the audience and to interact with the audience with confidence.
2. To tackle any problem during group discussion in the corporate interviews.
MEMT303  
**THESIS PHASE – I**  

**COURSE OBJECTIVES**  
- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.  
- To train the students in preparing project reports and to face reviews and viva voce examination.

**COURSE OUTCOMES**  
Upon completion of this course, the students will be able to:  
1. Take up any challenging practical problems and find solution  
2. Learn to adopt systematic and step-by-step problem solving methodology

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MEMI304  
**INDUSTRIAL TRAINING**  

**COURSE OBJECTIVES**  
- To train the students in the field work related to microelectronics and MEMS and to have a practical knowledge in carrying out microelectronics and MEMS related works.  
- To train and develop skills in solving problems during execution of certain works related to microelectronics and MEMS.

The students individually undergo a training program in reputed concerns in the field of microelectronics and MEMS during the summer vacation (at the end of second semester for full-time / fourth semester for part-time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training they had, within ten days from the commencement of the third semester for Full-time / fifth semester for part-time. The students will be evaluated by a team of staff members nominated by head of the department through a viva-voce examination.

**COURSE OUTCOMES**  
1. The students can face the challenges in the practice with confidence.  
2. The student will be benefited by the training with managing the situation arises during the execution of works related to Process Control and Instrumentation.

MEM401  
**THESIS PHASE – II**  

**COURSE OBJECTIVES**  
- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.  
- To train the students in preparing project reports and to face reviews and viva voce examination.
COURSE OUTCOMES
Upon completion of this course, the students will be able to:
1. Take up any challenging practical problems and find solution.

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COURSE OBJECTIVES:
- To impart knowledge on RF Circuits and associated parameters.
- To educate on RF MEMS Circuit Elements and modelling.
- To provide an overview on reconfigurable circuit and circuit elements.
- To introduce the concepts and working of reconfigurable antennas
- To give an overview of the RF MEMS based phase shifter and oscillator.

Motivation for RF MEMS: Advantages of developing MEMS based RF passive components and RF circuits – Physical aspects of RF design – Skin effect – Transmission lines on thin substrate – self resonance frequency – Quality factor – Packaging – Practical aspects of RF circuit design – DC biasing – Impedance mismatch effects in RF MEMS.


Phase shifter: X band and Kα band millimeter wave micromachined tunable filter – A high 8 MHz MEMS resonator filter. RF MEMS oscillator: 14 MHz MEMS oscillator – Case study and a Kα band micromachined cavity oscillator

REFERENCES:
1. Santos Hector J.D.L, RF MEMS circuit design for wireless communication, Artech house, MEMS series, 2002.
COURSE OUTCOMES:
Upon completing the course, the student should
1. Understand the basic concepts of RF MEMS.
2. Acquire the working concepts of RF MEMS Circuit Elements.
3. Understand the concepts and structure of RF MEMS Circuits, reconfigurable RF MEMS
circuit elements and their modelling.
4. Acquire the working knowledge of RF MEMS based reconfigurable antenna.
5. Understand the concepts and working of RF MEMS based phase shifter and oscillators.

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MEMEX0X SEMICONDUCTOR DEVICES AND MODELLING

COURSE OBJECTIVES:
- To introduce the basics of semiconductor materials, their electrical properties and quantitative
analysis of such materials based on energy band diagrams
- To acquaint the students with the construction, theory and operation of the P-N junction diode, its
characteristics and quantitative analysis of P-N junction diodes
- To teach the concepts of Bipolar Junction Transistors and quantitative analysis to estimate the
performance factors
- To make the students understand the effect of junction capacitance, their effect on the performance
diodes and BJTs and Breakdown characteristics of these devices
- To impart knowledge of the operation and characteristics of Photodiodes and phototransistors and
qualitative analysis of these devices.

Quantitative analysis of Semiconductors: Atomic picture of Silicon and Germanium – Electric current,
free electron density and mobility in Semiconductors - Effect of doping on minority carrier density in
Semiconductors – Energy band picture of P and N type Semiconductors – Temperature dependence of
conductivity – Degeneracy. Calculation of free electron density and hole density in a Semiconductor –
Determination of position of Fermi level for a given Semiconductor – Carrier density expressed in terms of
departure of Fermi level from intrinsic Fermi level – Fermi level in N-type and P-type samples as
measured from intrinsic Fermi level – Very lightly doped samples – representation of energy band diagram
in terms of potential – Equation governing potential distribution in a Semiconductor – Equation governing
distribution of hole density and electron density – Continuity equation for Semiconductors –
Determination of steady state excess carrier density – Concepts of Quasi Fermi level.

Quantitative analysis of P-N junction Diode: P-N junction under thermal equilibrium – P-N junction
under Forward bias – P-N junction under Reverse bias – Behavior under large forward voltage –
Temperature dependence of P-N junction characteristics - Break down under reverse bias - Thermal Break
down, Zener Break down and Avalanche Break down – Transition capacitance of a P-N junction. Band
diagram for a Semiconductor with an applied voltage – P-N junction in thermal equilibrium – Minority
carrier densities in a P-N junction under Forward bias – Expression for total current in a P-N junction – Calculation of carrier density and current in a reverse biased junction – P-N junction behavior in terms of minority carrier stored charge – Calculation of electric field and voltage drop in the bulk.


**Junction Transition capacitance and junction Break down voltages:** Electric field and potential distribution in P-N junction at thermal equilibrium – transition capacitance and Break down voltages in linearly graded junction and an abrupt junction- $C_T$ in PIN Diode – Break down voltage in transistor.

**Quantitative analysis of Photo diodes and Photo transistors:** Carrier generation by light in a uniform piece of semiconductor – P-N junction photo diode for light detection – Open circuit photo voltages – Short circuit current in photo diode – Photo diode current under combined action of light and reverse bias – Photo diode current under combined action of light and forward bias - Photo transistor – Expression for current in photo transistor in transistor – Solar cells using photo diodes.

**REFERENCES:**

**COURSE OUTCOMES:**
On successful completion of the course, the students will be able to
1. Describe the equations based on energy band diagrams, acceptable approximations and for intrinsic, p and N type semiconductors
2. Explain the operation of p-n junction diodes quantitatively and qualitatively.
3. Describe the fabrication, device operation of a BJT quantitatively and model its characteristics from basic principles
4. Understand the effects of junction capacitance and break down voltages on the performance of P-N junction diodes and BJTs the Classify and describe the semiconductor devices for special applications
5. to analyze and develop models of optoelectronic devices such as Solar Cells and LEDs.

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COURSE OBJECTIVES:

- To introduce on polysilicon deposition and various processes.
- To explain electrical properties, Carrier Transport, Effective mobility and different passivation techniques of polysilicon.
- To teach the vital applications of Polysilicon.
- To make the students understand modelling of PSOI MOSFETs and threshold voltage model for various modes of PSOI MOSFETs.
- To educate the concepts of Polysilicon for MEMS applications and motivate the students to design different devices.


**Polysilicon applications**: As resistor – Zero temperature coefficient resistor using polysilicon – High value resistors – Polysilicon links – Polysilicon diodes – Polysilicon solar cells – Self aligned gate technology using polysilicon.

**PSOI MOSFETs**: Comparison of single crystal silicon MOSFETs and polysilicon MOSFETs – Application of polysilicon TFT for AMLCDs and SRAM – Inversion mode PSOI MOSFETs – Modelling of PSOI MOSFETs - Threshold voltage model of inversion mode PSOI MOSFETs – Passivation and its influence on the transistor parameters - Effect of doping on threshold voltage in PSOI MOSFETs - Accumulation mode PSOI MOSFETs – Advantage of accumulation mode PSOI MOSFETs – Threshold voltage model for accumulation mode PSOI MOSFETs.

**Polysilicon for MEMS applications**: – Polysilicon mechanical properties – Polysilicon cantilever structures – MEMS switches using polysilicon – Polysilicon piezo resistor for MEMS pressure sensor application – Floating gate transistor for gas sensing applications – MEMS integration using polysilicon TFTs with polysilicon structures.

REFERENCES:
1. Ted Kamins, Polycrystalline Silicon for IC Applications, Kluwer academic

COURSE OUTCOMES:
Upon completing the course, the student should have
1. Understood the concept of polysilicon deposition and various processes.
2. Acquired the expertise on electrical properties, Carrier Transport, Effective mobility and Different passivation techniques of polysilicon.
3. Understood the vital applications of Polysilicon.
4. Understood the modelling of PSOI MOSFETs and threshold voltage model for various modes of PSOI MOSFETs.
5. Acquired the complete knowledge of the design of Polysilicon for MEMS applications.

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MEMEX0X MICROFLUIDICS AND BIO MEMS

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**COURSE OBJECTIVES:**
- To impart knowledge on microfluidics and fluidic sensors.
- To educate on the design of micropumps.
- To provide an overview on chemical sensors and transducers.
- To introduce the concept of work function based sensors
- To give an overview of the sensors application in the field of biology.

**Fluidics Fundamentals:** Basic fluid properties and equations – Types of flow – Bubbles and particles in microstructures – Capillary forces – Fluidic resistance – Fluidic inductance – Bulk micromachined channels – Surface micromachined channels.


**Micropumps:** Membrane pumps – Diffuser pumps – Rotary pumps – Electro hydro dynamic (EHD) pumps – Injection type and non injection type EHD – Microfluidic system issues – Interconnect packing and system integration – Design for disposable or reuse.

**Passive chemical sensors:** Chemiresistors – Chemicapacitors – Chemomechanical sensors – Calorimetric sensors – Metal-Oxide gas sensors. **Work function based Sensors:** ADFET gas sensors – Platinide based hydrogen sensors – Ion sensitive FETS (ISFETS and CHEMFETS).


**Biosensors:** Resonant biosensors – Optical detection biosensors – Thermal detection biosensors – ISFET biosensors – Other pH based biosensors – Electrochemical detection biosensors – CMOS compatible

REFERENCES:

COURSE OUTCOMES:
Upon completing the course, the student should
1. Understand the basic properties of microfluids.
2. Acquire the working concepts of fluidic sensors.
3. Understand the concepts and structure of micropumps.
4. Acquire the working knowledge of Passive chemical sensors, Work function based Sensors, Electrochemical Transducers.
5. Understand the application of sensors for various biological applications.

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MEMEX0X VLSI DESIGN L T P
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COURSE OBJECTIVES:
- To introduce the basic theories and techniques of digital VLSI design in CMOS technology.
- To describe the general steps required for processing of CMOS integrated circuits.
- To understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry.
- To bring both Circuits and System views on design together.
- To analyze performance issues and the inherent trade-offs involved in system design.

**Introduction to VLSI:** Digital systems and VLSI - Gate Arrays - Standard Cells - Functional Blocks - CMOS Logic. **Programmable ASICs:** The Antifuse - Static RAM - EPROM and EEPROM Technology - Practical Issues Specifications - PREP Benchmarks - FPGA Economics.

**Hardware Description Languages:** VHDL: A Counter - A 4-bit Multiplier - Syntax and Semantics of VHDL - Identifiers and Literals Entities and Architectures - Packages and Libraries - Interface

**Simulation:** Types of Simulation - The Comparator/MUX Example - Logic Systems - How Logic Simulation Works - Cell Models - Delay Models - Static Timing Analysis - Formal Verification - Switch-Level Simulation – Transistor Level Simulation - Summary


**Tests:** Design for Testability - Test Program Development - Prototype Evaluation

**ASIC Construction:** Interconnects and Routing, Floorplanning - Placement - Physical Design Flow - Information Formats.

**REFERENCES:**

**COURSE OUTCOMES:**
Upon completing the course,
1. Student will be able to design digital systems using CMOS circuits.
2. Be able to use mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits.
3. Student will be able to learn Layout, Stick diagrams, Fabrication steps.
4. It offers a profound understanding of the design of complex digital VLSI circuits, computer aided simulation and synthesis tool for hardware design.
5. Student will be able to understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry.

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COURSE OBJECTIVES:

- To introduce the fundamentals of digital integrated circuits and expose them to examples of applications.
- To give the ability to analyze, design, and optimize digital circuits with respect to different quality metrics: cost, speed, power dissipation, and reliability.
- To give the basic background to go through a complete digital design cycle: analysis, design, simulation, layout and verification.
- To analyze and design of static sequential circuits and understand basic clocking issues.
- To know the basics of semiconductor memories.

Introduction: Design of static CMOS, nMOS and BiCMOS inverters. Calculation of noise margins, power dissipation and gate delays.


Design of I/Os and Clock Generation: I/O Structures - PLL, clock generation and clock buffering.

Design of Memory: Memory Core - Memory Peripheral Circuits - Memory Faults and Test Patterns.

Digital System Design using Hardware Description Language: Introduction to HDL, Modeling and Designing with VHDL - VHDL Description of Combinational Networks - VHDL Description of Sequential Networks - VHDL Model for Memories


REFERENCES:

COURSE OUTCOMES:
Upon completing the course, the students will be able to
1. Understand the impact of technology scaling.
2. Understand the basic operation of MOS transistors, current equations, and parasitic and to understand the concepts of propagation delay, power consumption of CMOS ICs.
3. Know how to analyze and design complex logic gates in standard CMOS technology and compute their delay and power consumption.
4. Be able to analyze and design of static sequential circuits and understand basic clocking issues.
5. Know the basics of semiconductor memories.

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MEMEX0X ADVANCED VLSI SYSTEM DESIGN

COURSE OBJECTIVES:
- To introduce the concepts and techniques of modern integrated circuit design and testing (CMOS VLSI).
- To train the students on the design project involved with data path operators, data registers, serial/parallel conversion, clocking/timing details and feedback.
- To complete a significant VLSI design project having a set of objective criteria and design constraints.
- To develop tests, and the use of design for testability techniques during the VLSI system design and implementation process.
- To use automated layout tools to produce geometric descriptions of complex integrated circuit designs with VLSI chip.


REFERENCES:
COURSE OUTCOMES:
Upon completing the course,
1. Student will be able to learn and participate in the process of modern VLSI design and verification.
2. Student will be able to develop an understanding for the advanced design concepts in modern VLSI technologies.
3. Student will be able to design and layout a complex chip containing entities such as a register arrays, shifters, multipliers, an arithmetic logic unit (ALU), and other large scale devices.
4. Student will be able to apply techniques used to test and debug IC designs.
5. Be able to complete a VLSI design project having a set of objective criteria and design constraints.

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COURSE OBJECTIVES:
- To know the importance on Integrated Circuit Packaging.
- To impart the knowledge on various manufacturing process technologies.
- To understand the design considerations on electrical, thermal and mechanical parameters.
- To test and analyse the performance characteristics of Integrated Circuit Packages.
- To study and understand various emerging technologies in the field of Integrated Circuit Packaging.


Emerging Technologies: Ball Grid Array, Chip-scale package (CSP) - Flip Chip, Direct Chip Attach (DCA) and Wafer Scale package (WSP) - 3D Packaging - Known Good Die.
REFERENCES:

COURSE OUTCOMES:
Upon completing the course, the student should have
1. Understood the importance and issues of Integrated Circuit Packaging.
2. Acquired the expertise in the manufacturing of various Integrated Circuit Packages.
3. Understood the design considerations on various physical parameters.
4. The ability to test and analyse the performance characteristics of Integrated Circuit Packages.
5. Acquired the knowledge of various emerging Integrated Circuit Package technologies.

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COURSE OBJECTIVES:
- Exposure to analog and digital circuit design techniques in an integrated context.
- Learn to design mixed-signal building blocks including comparators and data converters.
- To gain experience with system level design flow: bottom-up and top-down design methodologies.
- To gain mixed-signal design experience in Cadence CAD tools, including both custom and automated design:
  - Analog, Digital and Mixed-Mode simulation
  - Digital synthesis and Place & Route
  - Layout, DRC, LVS, Post-layout verifications

Submicron CMOS: Overview and Models - CMOS Process Flow - Capacitors and Resistors - Using a MOSFET as a Capacitor - Using a Native or Natural MOSFET Capacitor - The Floating MOS Capacitor - Metal Capacitors – Resistors - SPICE MOSFET Modeling - Model Selection - Model Parameters.


**Design 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 - Delta-Sigma data converters- Design of PLLs, DLLs and frequency synthesizers

**REFERENCES:***

**COURSE OUTCOMES:**
Upon completing the course, the students will be able to
1. Appreciate capabilities and limitations of advanced microelectronic (or IC) technologies.
2. Understand and use advanced circuit models of IC components
3. Analyse analogue and digital microelectronic circuits
4. Design analogue, digital and mixed microelectronic circuits
5. Critically read and present papers from technical journals, and keep up-to-date with future technological development in the field.

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COURSE OBJECTIVES:

- To impart knowledge on Hardware description language.
- To give an overview of Switch and Gate Level Modeling.
- To educate the importance of the timing and delay in VHDL.
- To create the knowledge in VHDL simulators.
- To impart knowledge on the synthesis using VHDL.


REFERENCES:

COURSE OUTCOMES:
Upon completing the course, the student should
1. Understand the basic operation of Verilog simulators.
2. Acquire knowledge of different modelling methods like Switch, Gate Level and Behavior Modeling
3. Understand the concepts of introducing timing and delay in VHDL programming.
4. Acquire the working knowledge in VHDL simulation.
5. Understand the synthesis process in VHDL.
COURSE OBJECTIVES:

- To impart knowledge on Electronic properties of semiconductor materials for optoelectronic devices.
- To educate on basic structure and realization of Optoelectronic Devices and LEDs.
- To provide an overview on semiconductor LASER diodes and their application in optical fibre communication.
- To introduce the concepts and working of photo detectors and optoelectronic modulators


P-N junction - the basic structure for optoelectronic device realization: Operation of various junctions including Schottky barrier contacts - Heterojunctions and their importance to optoelectronic device fabrication - Solar cells.

Light Emitting Diodes: Operation of LEDs, their structures, and applications - Homojunctions and heterojunctions.

Semiconductor Laser Diodes: Operation of semiconductor laser diodes semiconductor lasers - Types of semiconductor lasers - Multi quantum-well lasers - Beam characteristics and modulation of semiconductor lasers - Role of semiconductor lasers in modern fiber-optic communication systems.

Photodetectors: Operation of different types of photodetectors - Materials for the fabrication of photodetectors and their applications. Optoelectronic Modulators: Electro-Optic effect (linear and quadrature) - Materials that exhibit the E-O effect - Fabrication of optoelectronic modulators (into practical light - intensity and/or phase modulators).

REFERENCES:
COURSE OUTCOMES:
Upon completing the course, the student should
1. Understand the basic concepts of Optoelectronic Materials and Devices.
2. Acquire the knowledge on basic structure and realization of Optoelectronic Devices, LEDs and acquire the working concepts of LEDs.
3. Understand the concepts and structure of semiconductor LASER diodes and their application in optical fibre communication.
4. Acquire the working knowledge of RF MEMS based reconfigurable antenna.
5. Understand the concepts working and application of photo detectors and optoelectronic modulators.

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COURSE OBJECTIVES:

- To introduce the basic concepts of micro systems and advantages of miniaturization
- To teach the fundamentals of micromachining and micro fabrication techniques
- To train the students on the design of micro sensors and actuators and fabrication flow process.
- To impart knowledge on various packaging technologies for MEMS.


**Integration of micro and smart systems:** CMOS First Approach - MEMS First Approach - Other Approaches of integration - Microsystem Packaging: Objectives of Packaging, Special Issues in Microsystem Packaging, types of microsystem packages, Packaging Technologies, Reliability and key Failure Mechanisms – case studies of integrated microsystems: Pressure sensor, Micro machined Accelerometer.

**REFERENCES:**

**COURSE OUTCOMES:**
At the end of the course the students will be able to
1. Know the basic concepts of micro systems and advantages of miniaturization.
2. Understand the fundamentals of micromachining and micro fabrication techniques.
3. Expertise the knowledge in design of micro sensors and actuators fabrication.
4. Develop various packaging techniques in the design of MEMS.