Nano Electronics and MEMS(404191)

Teaching Scheme:
Lectures:3Hrs/ Week

Examination Scheme:
In Semester Assessment:
Phase I : 30
End Semester Examination:
Phase II: 70

Course Objectives:

- To understand the processes in Nano electronic manufacturing.
- To understand the construction, characteristics and operation of Nano electronic devices.
- To get acquaint with MEMS technology.
- To gain the concepts of MEMS sensors and measurement methods.

Course Outcomes:

After successfully completing the course students will,

- Gain knowledge of Nano electronics material, and manufacturing of Nano devices.
- Be introduced to MEMS and its sensors and actuators.
- Understand various measuring methods and tools.

Unit I : Introduction to materials in Nano Electronics 6L

Band structures in Silicon, Historical development and basic concepts of crystal structure, defects, crystal growth and wafer fabrication, crystal planes and orientation. Modern CMOS technology, construction of MOS Field Effect Transistor, Electrical characterization: IV/CV characterization, temperature dependent characterization.

Unit II : Semiconductor Nano Electronic manufacturing 6L

Basic understanding of contaminations, Levels of contaminations, Wafer cleaning methods, Lithography: basic concepts of optics, photoresists, wager exposure systems, methods and equipment. Thermal Oxidation: formations of Si and SiO2 interface, types of thermal oxidations and their comparisons. Dopant Diffusion and Ion implantation fundamentals, Thin film deposition, sputtering methods and types, etching process and types.

Unit III : Nano Electronic Devices 6L

Single Electron devices and Transistors, Quantum particle, Quantum Dot, Logic circuits using quantum dots, nanowires construction and applications, FinFETs, construction of FinFET, properties of FinFETs.

Unit IV : Introduction to MEMS 6L

Intrinsic characteristics of MEMS, miniaturization, Sensors and actuators, sensor noise and design complexity, packaging and integration, stress and strain, intrinsic stress, torsion deflections, types of beams and deflection of beams.

Unit V : MEMS based sensors and actuators 6L

Electrostatic sensors and Actuators, Thermal sensing and actuation, piezoresistive sensing and actuation, Magnetic actuation. Comparison of major sensing and actuation methods. Case studies of selected MEMS: Acceleration sensors, gyros etc.

Unit VI : Measurements methods and tools 6L

Electrical methods: Hot probe method, Sheet resistance, Hall effect measurements. Physical measurements: Fourier Transform Infrared Spectroscopy, Electron microscopy, Atomic Force Microscope, X-Ray photoelectron Spectroscopy, Profilometers, Reflectrometers.

Text Books

1. James D Plummer, Michael d Deal and Peter B Griffin, Silicon VLSI Technology, Fundamentals, Practice and Modeling, Pearson Education.
2. George W Hanson, Fundamentals of Nanoelectronics, Pearson education
3. Chang Liu, Foundations of MEMS, Pearson Education.

Reference Books

1. Minhang Bao, Analysis and Design Principles of MEMS Devices, Elsevier
2. Byung-Gook Park, Sung Woo Hwang, Young June Park, Nanoelectronic Devices, Pan Stanford Publishing Pte. Ltd.
3. Niraj K. Jha Deming Chen , " Nano Circuit Design", Springer.