BE-528: MEMS and Nanotechnology	L	T	P	CH	CR
	3	0	0	3	3

Introduction to MEMS: Micro and Nano-scale size domains; Evolution of MEMS Technology in Early Days, Moore's Law in MEMS, Prospects and Challenges in Commercialization of MEMS Technology Scaling laws in Miniaturization, MEMS materials and Processes; MEMS devices and Applications

Introduction to Submicron Technology: Semiconductor materials; Photolithography; Doping; Thin film growth and Deposition; CVD and Ion Implantation, Metallization; Wet and Dry Etching; Silicon Micromachining; Metal MEMS Processes; Submicron Optical Lithography; Electron Beam Lithography; Soft Lithography and Printing.

Mechanics of beam and diaphragm: Elasticity, Stress-Strain Relation, Bending Moment, Beam Bending Theory, Micro-cantilever Beam, Analysis of Deformation of Membranes.

Sensing and actuation principles: Sensing Principles in MEMS: Piezoresistive, Capacitive, Thermoelectric, Thermoresistive etc. Actuation Principles in MEMS: Electrostatic, Thermal, Piezoelectric etc. Microactuators based on various principles: electrostatic, electromagnetic, piezoelectric, Capacitive and SMA; Pull in Effect, Actuator applications: Inkjet, Electrical and Optical Switching, Micropump.

Case Studies: Physical sensor like pressure, chemical, flow sensor, accelerometer and gyroscope, inkjet nozzle, electrical and optical switching, micropumps etc

BioMEMS: Introduction, Chemical and Biomedical Sensing Mechanisms and Principles, Chem-Lab on a Chip, Chemoresistors, Chemocapacitors, Chemotransistors, DNA sensors.

Microfluidics: transport in micro-channels; microfluidic components (filters, mixers, valves, and pumps)

Nanotechnology: Nanomaterials: Quantum wire, quantum well, quantum dots, fullerenes, graphene, carbon nanotube; Synthesis of Nanomaterials: Physical methods (electrodeposition, sputtering, molecular beam epitaxy, spary pyrolysis), chemical methods (CVD, solvothermal etc)

Top down and bottom up approach for nanofabrication: electron beam lithography, FIB lithography, soft lithography, nanoimprint, nanosphere, Dip-pen nanolithography, self assembly and chemical synthesis.

Characterization Technique: scanning electron microscopy, scanning tunnelling microscopy, X-ray photoelectron spectroscopy, Surface enhanced Raman spectroscopy etc.

Medical Application of Nanotechnology: Nano-biosensor, Nanotechnology in drug delivery

Text/ Reference Books:

1. MEMS, Author: N. P. Mahalik; Publisher: TATA McGraw HILL
2. Modeling MEMS and NEMS; Author: J A Pelesko, David H Bernstein; Publisher: CRC press
3. Microsensors ,MEMS and Smart Devices; Author: J W Gardener, V K Vardhan, O.O. Awadelkarim; Publisher: John Wiley and Sons