

EC441 MICRO ELECTRO MECHANICAL SYSTEMS (Dept. Elective - III)

Course Description & Objectives:

This subject introduces the micro fabrication techniques and applications. It is to the design and manufacturing of MEMS devices or a micro systems. It is to know the major classes, components, and applications of MEMS devices/ systems and to demonstrate an understanding of the fundamental principles behind the operation of these devices/systems.

Course Outcomes:

Upon successful completion of this course, students should be able to:

- a. Students will be able to understand working principles of currently available microsensors, actuators, and motors, valves, pumps, and fluidics used in microsystems.
- b. Students will be able to apply scaling laws that are used extensively in the conceptual design of micro devices and systems.
- c. Students will be able to use materials for common micro components and devices.
- d. Students will be able to choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process.
- e. Students will be able to understand the basic principles and applications of micro-fabrication processes.

UNIT I - Over view of MEMS and Microsystems :

Evolution of micro fabrication, difference between Microsystems and Microelectronics, Multidisciplinary nature of Microsystems design and manufacture. Working principles of Micro sensors-acoustic wave, chemical, pressure and thermal sensors. Working principles of Micro actuators-using thermal, piezoelectric and electrostatic forces.

UNIT II - Review of Mechanical Concepts :

Stress, Strain, static bending of thin plates, Deflection Curves for Canti Levers – Fixed beam. Electrostatic Excitation – Columbic Force between the Fixed and Moving Electrodes. Mechanical vibration –general formulation, resonant vibration and design theory of accelerometers.

Scaling laws in miniaturization: Introduction, scaling in Geometry, Rigid body dynamics, Electrostatic forces, Electromagnetic forces and Electricity.

UNIT III - Materials for MEMS and Microsystems :

Active substrate materials, silicon as a substrate Material, Silicon compounds, Silicon Peizoresistors, Gallium arsenide, Quartz, Polymers, Packaging materials and Piezoelectric crystals.

UNIT IV - Microsystem Fabrication Process :

Introduction, Photolithography, Ion implantation, Diffusion, Oxidation chemical vapour deposition technique, physical vapour deposition technique and etching.

UNIT V - Micromanufacturing :

Introduction, Bulk Micro manufacturing, Surface Micromachining and the LIGA process. Microsystem design: Introduction, design considerations, process design, mechanical design. Case study of MEMS pressure sensor fabrication process.

TEXT BOOK:

1. MEMS & Microsystems Design and Manufacture Tai-RanHsu Tata McGraw-Hill EDITION, 2002.

REFERENCE BOOKS :

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2006.
2. Stephen D.Senturia "Microsystem Design" Springer International edition, 2010.
3. Gabriel.M.Review, R.F. MEMS Theory, Design and Technology, John Wiley & Sons, 2003.
4. Vijay.K.Vardan, K.J.Vinoy, K.A.Bose, "RF MEMS and their applications", John Wiley & Sons, 2003.
5. Thimo Shenko, "Strength of Materials", CBS Publishers & Distributors., 2000.
6. Ristic L. (Ed.), "Sensor Technology and Devices", Artech House, London 1994.
7. Servey E.Lyshevski, "MEMS and NEMS, Systems Devices; and Structures", CRC Press, 2002.