



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part time)

Subject Code: 2971105

SEMESTER: VII

Subject name: Introduction to MEMS

Type of course:

Prerequisite: Knowledge of basic Electronics and Micromechanical structures.

Rationale: Micro-electro-mechanical system designing is one of the emerging fields. This course extends the applicability of different materials, fabrication techniques, and simulation design tools used in microelectronic circuits to develop new types of microengineered electro mechanical systems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
2	0	2	3	70	30	30	20	150

Contents:

Sr. No.	Contents	Hrs.
1	Introduction: MEMS, Transducers, and actuators	2
2	Materials and Fabrication Techniques: Materials, Substrates, Additive Materials, Fabrication Techniques, Deposition, Lithography Etching, Surface Micromachining, Wafer Bonding, Thick-Film Screen Printing,, Electroplating LIGA , Porous Silicon ,Electrochemical Etch Stop ,Focused Ion Beam Etching and Deposition	7
3	MEMS Simulation and Design Tools: Simulation and Design Tools; Behavioral Modeling Simulation Tools; Static Analysis, Linearized Analysis, and Transient Analysis of MEMS devices.	4
4	Mechanical Sensor Packaging: Standard IC Packages, Ceramic Packages, Plastic Packages, Metal Packages, Packaging Processes, Electrical Interconnects, Methods of Die Attachment, Sealing Techniques MEMS Mechanical Sensor Packaging, Protection of the Sensor from Environmental Effects Protecting the Environment from the Sensor, Mechanical Isolation of Sensor Chips	7
5	Mechanical Transduction Techniques: Piezoresistivity , Piezoelectricity , Capacitive Techniques , Optical Techniques , Intensity , Phase Wavelength ,Spatial Position , Frequency , Polarization ,Resonant Techniques , Vibration Excitation and Detection Mechanisms, Resonator Design Characteristics ,Actuation Techniques , Electrostatic Piezoelectric, Thermal , Magnetic ,Smart Sensors	8
6	MEMS applications: MEMS as Secondary Storage in Computer System, Optical Applications, Biomedical Application	2



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Reference Books:

1. MEMS Mechanical Sensors, by Stephen Beeby, Graham Ensell, Michael Kraft Neil White, Publication: Artech House, Inc.,
2. MEMS and MOEMS Technology and Application, by P Rai Choudhury, PHI Publication.
3. Stephen D. Senturia, "Microsystem Design", Kluwer Academic Publishers, 1st Ed., 2001.
4. Marc Madou, "Fundamentals of Microfabrication" , CRC Press, 1st Ed., 1997.
5. Gregory Kovacs, "Micromachined Transducers Sourcebook", WCB McGraw-Hill, Boston, 1 st Ed., 1998.
6. M. H. Bao, "Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes" by Elsevier, New York, 1st Ed., 2000.
7. Julian W. Gardner, "Microsensors — Principles and Applications", John Wiley and Sons, inc., NY, 1st Ed., 1994.
8. Maluf N., "An Introduction to Micro electromechanical Systems Engineering", Norwood, MA: Artech House, 2000.
9. Julian W. Gardner, "Micro sensors - Principles and Applications", John Wiley & Sons, Inc.1997.
10. Current literature from journals and magazines.

Course Outcome:

Course Outcomes: After completion of this course students will be able to...

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the basics of Micro-Electro Mechanical Systems and role of Transducers and Actuators.	
CO-2	Recognize different materials used in fabrication process and understand various fabrication techniques to implement MEMS.	
CO-3	Imitate the behavior of different MEMS using various simulation tools	
CO-4	Understand the techniques and structures that can be used to package micromachined mechanical sensors.	
CO-5	Apply knowledge of MEMS fabrication and process techniques to develop various applications in the field of Biomedical, Optical and Computer storage system	

List of Experiments:

1. Design and simulation of microcantilever beam with different load conditions and finding its mechanical response.
2. Design and simulation of Piezoresistive MEMS devices with square and round diaphragm.
3. Design and simulation of capacitive MEMS devices under acceleration for sensing different signals.
4. Design and simulation of piezoelectric accelerometer under longitudinal load.



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5. Design and simulation of thin film based Piezoelectric.
6. Design and simulation of cantilever based bimetallic thermal actuator.
7. Design and simulation of thermal bimorph actuator.
8. Design and simulation of Electrostatic parallel plate actuator for normal motion.
9. Design and simulation of Torsion bar actuator for torsional motion.
10. Design and simulation of Longitudinal and transverse piezoelectric actuator.
11. Process simulation experimentation of oxidation and diffusion techniques.
12. Process simulation experimentation of mask making and Pattern transferring using Lithography.

Laboratory tool:

- 1 MEMSolver free simulation tool
- 2 SUGAR simulation tool for MEMS devices