MICRO ELECTRO MECHANICAL SYSTEMS

Course Code	20EC6601C	**Year**	III	**Semester**	II
Course Category	HONORS3	**Branch**	ECE	**Course Type**	Theory
Credits	4	**L-T-P**	3-1-0	**Prerequisites**	
Continuous Internal Evaluation:	30	**Semester End Evaluation:**	70	**Total Marks:**	100

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the operation of micro devices, micro systems and their applications (L2)
CO2	Apply scaling laws that are used extensively in the conceptual design of micro devices and systems (L3)
CO3	Choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process (L3)
CO4	Simplify the design of micro devices, micro systems using the MEMS fabrication process (L4)

Mapping of course outcomes with Program outcomes (CO/ PO/PSO Matrix)
Note: 1- Weak correlation 2-Medium correlation 3-Strong correlation
* - Average value indicates course correlation strength with mapped PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2									2			2	
CO2	3									3			3	
CO3	2				2					2			2	
CO4		3			3				3	2			2	
Average* (Rounded to nearest integer)	3	3			3				3	2			2	

Syllabus		
Unit No.	**Contents**	**Mapped CO**
I	**Introduction:** Intrinsic Characteristics of MEMS- Miniaturization, Microelectronics Integration, Mass Fabrication with Precision, Sensors and Actuators- Energy Domains and Transducers, Sensors, Actuators. **Introduction to Micro fabrication:** The Microelectronics Fabrication Process, Silicon based MEMS processes, New Materials and Fabrication Processes, Points of Consideration for Processing. **Review of Essential Electrical and Mechanical Concepts:** Conductivity of Semiconductors,	CO1 , CO2, CO4

	Crystal Planes and Orientation, Stress and Strain, Flexural beam bending analysis under simple loading conditions, Torsional deflections.	
II	**Electrostatic Sensing and Actuation:** Introduction to Electrostatic Sensors and Actuators, Parallel-Plate Capacitors, Applications of Parallel-Plate Capacitors, Interdigitated Finger Capacitors, Applications of Comb-Drive Devices. **Thermal Sensing and Actuation:** Introduction, Sensors and Actuators Based on Thermal Expansion, Thermal Couples, Thermal Resistors, Applications. **Magnetic Actuation:** Essential Concepts and Principles, Fabrication of Micromagnetic Components, Case Studies of MEMS Magnetic Actuators.	CO1 , CO2, CO3
III	**Piezoresistive Sensors:** Piezoresistive Sensor Materials, Stress Analysis of Mechanical Elements, Applications of Piezoresistive Sensors. **Piezoelectric Sensing and Actuation:** Introduction, Properties of Piezoelectric Materials, Applications.	CO1, CO2, CO4
IV	**Bulk Micromachining and Silicon Anisotropic Etching:** Introduction, Anisotropic Wet Etching, Dry Etching of Silicon-Plasma Etching, Deep Reactive Ion Etching (DRIE), Isotropic Wet Etching, Gas-Phase Etchants, Native Oxide, Wafer Bonding, Case Studies. **Surface Micromachining:** Basic Surface Micromachining Processes, Structural and Sacrificial Materials, Acceleration of Sacrificial Etch, Stiction and AntiStiction Methods, Assembly of 3D MEMS, Foundry Process.	CO1, CO3, CO4
V	**Polymer MEMS:** Introduction, Polymers in MEMS-Polyimide, SU-8, Liquid Crystal Polymer (LCP), PDMS, PMMA, Parylene, Fluorocarbo, Representative Applications-Acceleration Sensors, Pressure Sensors, Flow Sensors, Tactile Sensors. **Optical MEMS:** Passive MEMS Optical Components-Lenses, Mirrors, Actuators for Active Optical MEMS-Actuators for Small Out-of-Plane Translation, Actuators for Large In-Plane Translation Motion, Actuators for Out-of-Plane Rotation.	CO1, CO2, CO4

Learning Resources
Text Books
1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012. 2. Stephen D Senturia, Microsystem Design, Springer Publication, 2000.
Reference Books
1. Tai Ran Hsu, MEMS & Micro systems Design and Manufacture, TMH, New Delhi, 2002.
E-Resources
1. https://nptel.ac.in/courses/108106165 2. https://www.me.iitb.ac.in/~gandhi/me645/05L1_coursecontents_mtvn.pdf