

## 17ES012 MICRO ELECTRO MECHANICAL SYSTEM

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P	WA/RA	SSH/HSB	CS	SA	S	BS
45	15	-	15	30	-	5	5	-

### Course Objectives:

This course is an introduction to Micro Electro Mechanical Systems and is intended for Post Graduate students. Silicon-based integrated MEMS promise reliable performance, miniaturization and low-cost production of sensors and actuator systems with broad applications in data storage, biomedical systems, inertial navigation, micromanipulation, optical display and micro fluid jet systems. The course covers such subjects as materials properties, fabrication techniques, Mechanical sensor packaging, mechanical transduction techniques, pressure sensors, Force, torque and internal sensors.

### Course Outcomes:

- Understand the different materials-Substrates used in MEMS manufacture.
- To acquire knowledge on different fabrication techniques.
- To acquire different mechanical transduction techniques.
- Understand the different techniques used in pressure sensors and different types of pressure sensors.
- To understand the functional and usages of various sensors like, electro static thermal, force, torque and inertial sensors.
- To understand the functional and usages of various actuators like, electro static thermal and etc.,.

### SKILLS :

- Understand future applications of MEMS.
- Be able to apply all these skills to the design of a MEMS system.
- The above can be applied to understand the design and fabrication of MEMS.

**ACTIVITIES:**

- Design and Simulation of Inertia Sensors.
- Design and Simulation of Pressure Sensors.
- Design and Simulation of Electrostatic Actuators.
- Design and Simulation of Piezo resistive Actuators.

**UNIT - I**

**INTRODUCTION** : Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators — Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection, Broad response of MEMS to mechanical, thermal and electrical stimuli.

**UNIT - II**

**MICROMACHINING** : Introduction to Micro fabrication –Photo lithography-Deposition techniques-Chemical vapour deposition, physical vapour deposition-Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants –Basic surface micromachining processes – Structural and Sacrificial Materials

**UNIT - III**

**Electrostatic and Thermal Sensors And Actuators** : Electrostatic sensors – Parallel plate capacitors – Applications – Inter digitated Finger capacitor – Comb drive devices – Thermal Sensing and Actuation – Thermal expansion– Thermal couples – Thermal resistors – Applications

**UNIT - IV**

**Piezo-Resistive and Piezo-Electric Sensors And Actuators** : Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia, Tactile and Flow sensors.

**UNIT V**

**POLYMER MEMS** : Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors.

**TEXT BOOKS:**

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2006.
2. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.
3. Stephen D.Senturia "Microsystem Design" Springer International Edition, 2010
4. Julian w. Gardner, Vijay k. varadan, Osama O.Awadelkarim, "Micro Sensors, MEMS and Smart devices", John Wiley & son LTD, 2002
5. Steeve P Beeby, G Ensel, "MEMS Mechanical Sensors" Architect House.
6. Marc J Madou " Fundamentals of Micro Fabrication", CRC Press, 2011

**REFERENCE BOOKS:**

1. Nadim Maluf, "An introduction to Micro electro mechanical system design", Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, "The MEMS Handbook", CRC press Baco Raton, 2000
3. James J.Allen, "Micro Electro Mechanical System Design", CRC Press published in 2005