IV B.Tech – I Semester

(20EC7454) INTRODUCTION TO MEMES
(Open Elective-IV)

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
30	70	100	3	0	0	3

Course Objectives:

- Understand the Basic concept of MEMS
- Understand the Mechanics of Beam and Diaphragm Structures
- Understand the Air Damping and Electrostatic Actuation
- Know the knowledge of Thermal Effects
- Know Applications of MEMS in RF

UNIT–I: Introduction to MEMS

MEMS Fabrication Technologies, Materials and Substrates for MEMS, Processes for Micromachining, Characteristics, Sensors/Transducers, Piezo resistance Effect, Piezo electricity, Piezo resistive Sensor.

UNIT–II: Mechanics of Beam and Diaphragm Structures

Stress and Strain, Hooke's Law. Stress and Strain of Beam Structures: Stress, Strain in a Bent Beam, Bending Moment and the Moment of Inertia, Displacement of Beam Structures Under Weight, Bending of Cantilever Beam Under Weight.

UNIT–III: Air Damping

Drag Effect of a Fluid: Viscosity of a Fluid, Viscous Flow of a Fluid, Drag Force Damping, The Effects of Air Damping on Micro-Dynamics. Squeeze-film Air Damping: Reynolds' Equations for Squeeze-film Air Damping, Damping of Perforated Thick Plates.

Slide-film Air Damping: Basic Equations for Slide-film Air Damping, Couette-flow Model, Stokes-flow Model.

UNIT–IV: Electrostatic Actuation

Electrostatic Forces, Normal Force, Tangential Force, Fringe Effects, Electrostatic Driving of Mechanical Actuators: Parallel-plate Actuator, Capacitive sensors. Step and Alternative Voltage Driving: Step Voltage Driving, Negative Spring Effect and Vibration Frequency.

UNIT–V: Thermal Effects

Temperature coefficient of resistance, Thermo-electricity, Thermocouples, Thermal and temperature sensors.

Applications of MEMS in RF: MEMS Resonator Design Considerations, One-Port Micromechanical Resonator Modeling Vertical Displacement Two-Port Microresonator Modeling, Micromechanical Resonator Limitations.

Course Outcomes:

After successful completion of the course, the students can be able to

S.No	Course Outcome	BTL
1	Understand the Basic concept of MEMS Fabrication Technologies, Piezo resistance Effect, Piezo electricity, Piezo resistive Sensor	L2
2	Explain Mechanics of Beam and Diaphragm Structures	L2
3	Understand the Basic concept of Air Damping and Basic Equations for Slide-film Air Damping, Couette-flow Model, Stokes-flow Model	L2
4	Know the concept of Electrostatic Actuation	L2
5	Understand the applications of MEMS in RF	L2

Correlation of Cos with Pos & PSOs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	2	1	-	-	-	-	-	-	-	-	-	-	2	-
CO 2	2	1	1	-	-	-	-	-	-	-	-	-	2	-
CO 3	2	1	1	-	-	-	-	-	-	-	-	-	2	-
CO 4	2	1	1	-	-	-	-	-	-	-	-	-	2	-
CO 5	2	1	1	-	-	-	-	-	-	-	-	-	2	-

Text Books:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat and V. K. Atre, “Micro and smart systems”, Wiley India, 2010.
2. S.M. Sze, “Semiconductor Sensors”, John Wiley & Sons Inc., Wiley Interscience Pub.

Reference Books:

1. M.J. Usher, “Sensors and Transducers”, McMillian Hampshire.
2. RS Muller, Howe, Senturia and Smith, “Micro sensors”, IEEE Press.