Micro Electro Mechanical Systems

Course code	23ME4601C	**Year**	III	**Semester**	I
Course category	**Professional Elective**	**Branch**	ME	**CourseType**	Theory
Credits	3	**L-T-P**	3-0-0	**Prerequisites**	Material Science and Metallurgy, Manufacturing Processes
Continuous Internal Evaluation:	30	**Semester End Evaluation:**	70	**Total Marks:**	100

CourseOutcomes: At the end of the course students will be able to

CO's	**Statement**	**Skill**	**Blooms Level**	**Units**
CO1	Explain the core concepts of MEMS, including microfabrication techniques, scaling laws, and the integration of mechanical and electrical components at the microscale.	**Understand, Communication**	**L2**	**1,2,3, 4,5**
CO2	To understand basics of Micro Electro Mechanical Systems (MEMS), mechanical sensors and actuators.	**Understand, Communication**	**L3**	**1**
CO3	Illustrate thermal sensors and actuators used in MEMS.	**Apply, Communication**	**L3**	**2**
CO4	To apply the principle and various devices of Micro-Opto-Electro Mechanical Systems (MOEMS), magnetic sensors and actuators.	**Apply, Modern Tool Usage Communication**	**L3**	**3**
CO5	Analyze applications and considerations on micro fluidic systems.	**Apply, Communication**	**L3**	**4**
CO6	Illustrate the principles of chemical and biomedical micro systems.	**Apply, Communication**	**L3**	**5**

Contribution of Course outcomes towards the achievement of program outcomes &Strength of correlations(High :3,Medium:2,Low:1)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	2					2		2	3	2
CO2	3	3	2	2	2				2		2	3	2
CO3	3	3	2	2	2				2		2	3	2
CO4	3	3	2	2	2				2		2	3	2
CO5	3	3	2	2	2				2		2	3	2

Unit	Contents	CO
I	**INTRODUCTION:** Definition of MEMS, MEMS history and development, micromachining, lithography principles &methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micromachining, wafer bonding, LIGA. **MECHANICAL SENSORS AND ACTUATORS:** Principles of sensing and actuation: beam and cantilever, capacitive, piezo-electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inch worm technology.	**CO1 CO2**
II	**THERMAL SENSORS AND ACTUATORS:** Thermal energy basics and heat transfer processes, thermistors, thermodevices, thermocouple, micro machined thermo couple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.	**CO1, CO3**
III	**MICRO-OPTO-ELECTROMECHANICALSYSTEMS:** Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement. **MAGNETIC SENSORS AND ACTUATORS:** Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe-based storage device.	**CO1, CO4**
IV	**MICRO FLUIDIC SYSTEMS:** Applications, considerations on micro scale fluid, fluid actuation methods, dielectrophoretic (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, optoelectro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, micro fluid dispenser, micro needle, molecular gate, micro pumps. RADIOFREQUENCY	**CO1, CO5**

	(RF) MEMS: RF – based communication systems, RF MEMS, MEMS inductors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.	
V	CHEMICAL AND BIOMEDICAL MICRO SYSTEMS: Sensing mechanism &principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemo-resistors, chemo-capacitors, chemo-transistors, electronic nose (E-nose), mass sensitive chemo-sensors, fluorescence detection, calorimetric spectroscopy.	**CO1, CO6**

LearningResource
Textbooks:
TEXT BOOKS: 1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009.
Referencebooks
1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001. 2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001. 3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999. 4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011. 5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

E-Resources&otherdigitalMaterial:
1. Micro Electromechanical Systems | Courserahttps://nptel.ac.in/courses/112/104/112104250/ 2. Design Of Mechatronic Systems - Course