

## Department Elective Course-5 (DEC-5)

### EC413: MEMS and Sensor Design

Details of course:-

Course Title	Course Structure			Pre-Requisite
	L	T	P	
MEMS and Sensor Design	3	1	0	

**Course Objective:** The primary objective of the course is to provide a comprehensive understanding of the concepts, design principles, and manufacturing techniques of Microelectromechanical Systems (MEMS). The course emphasizes the integration of physics, mechanics, and thermofluid engineering to enable students to design and analyze MEMS devices, considering material properties, scaling effects, and micromanufacturing processes.

#### Course Outcomes:

CO1: Describe the fundamental principles, components, and typical applications of MEMS and microsystems.

CO2: Analyze the role of physics, mechanics, and thermo-fluid engineering in the design and operation of MEMS devices and sensors.

CO3: Evaluate the effects of scaling in MEMS and selection of appropriate materials for specific applications, considering their properties and compatibility.

CO4: Describe the key fabrication methods, including photolithography, ion implantation, surface micromachining, and the LIGA process.

CO5: Develop designs for MEMS devices and sensors, including mechanical structures, silicon die layouts, and microfluidic systems, addressing mechanical and process design considerations.

S. No.	Content	Contact Hours
Unit 1	<b>Overview and working principles of MEMS:</b> MEMS and Microsystems, typical MEMS products, applications, Microsensors, Microactuation, MEMS with microactuators, Microaccelerometers, Microfluidics	8
Unit 2	<b>Physics, Mechanics, and Thermo-fluid engineering for MEMS design:</b> <b>Physics:</b> Ionization, doping of semiconductors, diffusion, plasma physics, electrochemistry <b>Mechanics:</b> Static bending of thin plates, mechanical vibration, thermomechanics, fracture mechanics, thin film mechanics, finite element stress analysis <b>Thermofluid engineering:</b> fluid mechanics basics	10
Unit 3	<b>Scaling and Materials for MEMS:</b>	8

	<b>Scaling:</b> scaling in - geometry, rigid body dynamics, electrostatic forces, electromagnetic forces <b>Materials:</b> substrate material, silicon, silicon compounds, gallium arsenide, quartz, piezoelectric crystals, polymers	
Unit 4	<b>Fabrication and Micromanufacturing:</b> Photolithography, Ion implantation, diffusion, oxidation, CVD, epitaxy, Bulk micromanufacturing, surface micromachining, LIGA process	8
Unit 5	<b>Microsystems Design:</b> Design considerations, Process design, Mechanical design, Design of silicon die, design of microfluidic networks systems	8
	Total	42

Books:-

S. No	Name of Books/Authors/Publisher
1	MEMS and Microsystems Design and Manufacturing / Tai-Ran Hsu / Tata McGraw-Hill, edition 1, 2002
2	Foundations of MEMS / Chang Liu / Pearson 2nd edition, 2012
3	Microsystem Design / S. D. Senturia / Kluwer Academic Publishers, 2001