COURSE CONTENT

MEMS: Design and Manufacturing (Professional Elective – IV)								
II Semester: CAD/CAM								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
2424021	**Advanced**	3	0	0	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisites: Electronic Circuits, Basic knowledge in material science								

Course Overview:

The course MEMS: Design and Manufacturing covers fundamentals of micro systems, including sensors, actuators, and fluidics, with applications in industries. It integrates engineering science, mechanics, thermo fluid principles, and finite element analysis for reliable design. Emphasis is placed on materials like silicon, Gas, and polymers, along with fabrication techniques such as photolithography, deposition, etching, and micromachining for developing advanced MEMS devices.

Course Objectives:

1. Basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques.
2. To design, analysis, fabrication and testing the MEMS based components.
3. To find various opportunities in the emerging field of MEMS.

Course Outcomes: After Completion of the Course, Students should be able to

1. Synthesize and characterize nanomaterials for engineering applications.
2. Design and analyze methods and tools for micro and nano manufacturing.
3. Improve the quality of MEMS by analyzing the variables of the underlying micro and nano manufacturing method.
4. Apply the concepts of thermo fluid engineering.
5. Select appropriate industrially-viable process, equipment and tools for a specific product.

UNIT - I:

Overview and working principles of MEMS and Microsystems: MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & miniaturization, Applications of MEMs in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics

UNIT - II:

Engineering Science for Microsystems Design and Fabrication: Atomic structure of Matter, Ions and Ionization, Molecular Theory of Matter and Intermolecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics.

UNIT - III:

Engineering Mechanics for Microsystems Design: Static Bending of Thin plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin- Film Mechanics, Overview of Finite Element Stress Analysis

UNIT - IV:

Thermo Fluid Engineering & Microsystems Design: Overview of Basics of Fluid Mechanics in Macro and Micro scales, Basic equations in Continuum Fluid Dynamics, Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Micro conduits, Fluid flow in Sub micrometer and Nano scale, Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin films and in solids in sub micrometer scale, Design Considerations, Process Design Mechanical Design, Mechanical design using FEM, Design of a Silicon Die for a Micro pressure sensor.

UNIT - V:

Materials for MEMS & Microsystems and their fabrication: Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, Chemical and Physical vapor deposition, etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process.

TEXT BOOKS:

1. Tia-Ran Hsu, MEMS & Microsystems. Design & Manufacturing, TMH 2002
2. Foundation of MEMS/ Chang Liu/Pearson, 2012

REFERENCE BOOKS:

1. An Introduction to Microelectromechanical Systems Engineering by Maluf M., Artech House, Boston 2000.
2. Micro robots and Micromechanical Systems by Trimmer, W.S.N., Sensors & Actuators, Vol 19, 1989.
3. Applied Partial Differential Equations by Trim, D.W., PWS-Kent Publishing, Boston, 1990.

ELECTRONIC RESOURCES:

1. https://nptel.ac.in/courses/117105082
2. https://onlinecourses.nptel.ac.in/noc25_ee144/preview
3. https://onlinecourses.nptel.ac.in/noc25_ee177/preview
4. https://onlinecourses.nptel.ac.in/noc25_ee01/preview
5. https://nptel.ac.in/courses/112104181
6. https://www.nptelprep.in/courses/117105082/videos
7. https://acl.digimat.in/nptel/courses/video/117105082/lec1.html

MATERIALS ONLINE:

1. Course template
2. Tech talk and Concept Video topics
3. Assignments
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. E-Learning Readiness Videos (ELRV)