SEMESTER S8

MEMS AND NANOELECTRONICS

Course Code	PEAET864	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course Objectives:

1. To understand the materials and technology of MEMS
2. To understand the basic principles of nanoelectronics

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - Overview of Nano and Microelectromechanical Systems, Applications of Micro and Nanoelectromechanical systems. MEMS - Definition, devices and structures. Materials for MEMS - Silicon, Silicon compounds – Silicon Nitride, Silicon Dioxide, Poly Silicon, Silicon Piezo resistors. Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films. Stress-strain relationship and mechanical properties of Silicon	8
2	Microsystem fabrication processes - Photolithography, Ion Implantation, Diffusion and Oxidation. Thin film depositions - LPCVD, Sputtering, Evaporation, Electroplating. Etching techniques - Dry and wet etching, electrochemical etching. Micromachining - Bulk Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology	10
3	MEMS Sensors - Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors. Micro Actuator - Design of Actuators, Actuations using thermal forces, shape memory Alloys, piezoelectric crystals, Electrostatic forces (Parallel plate, Comb drive actuators), Micromechanical pumps	9

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4	Nanoelectronics and Quantum Mechanics - Atomic Structures and Quantum Mechanics Basics of Molecular and Nanostructure Dynamics - Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Molecular Wires and Molecular Circuits	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

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End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

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Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles of MEMS and Nano structures	**K2**
CO2	Understand the fabrication technology of MEMS structures	**K2**
CO3	Design MEMS sensors and actuators	**K3**
CO4	Illustrate the technology of nanoelectronics and quantum dynamics.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2								3
CO2	3	3	3	2								3
CO3	3	3	3	2								3
CO4	3	3	3	2								3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

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Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	MEMS and NEMS: Systems, Devices, and Structures	Sergey Edward Lyshevski	CRC Press	1/e, 2002
2	Fundamentals of Micro fabrication	Mark Madou	CRC Press, Newyork	1/e, 1997

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	VLSI Technology	Chang C Y and Sze S. M.	McGraw-Hill, New York	1/e, 2000
2	Microsensors: Principles and Applications	Julian W Gardner	John Wiley and sons	1/e, 1994
3	Microsystem design	Stephen D. Senturia,	Springer(India)	2/e, 2006
4	Foundations of MEMS	Chang Liu	Pearson	2/e, 2012
5	MEMS and Microsystems Design and Manufacture	Tai-Ran Hsu,	TMH	1/e, 2002
6	Principles of Quantum Mechanics	A M Dirac	Oxford University Presss	1/e, 1978

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117105082
2	https://nptel.ac.in/courses/117105082
3	https://nptel.ac.in/courses/117105082
4	https://nptel.ac.in/courses/117105082

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