SEMESTER S7

INTRODUCTION TO MEMS

Course Code	PEEVT742	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)	Nil	Course Type	PE

Course Objectives:

1. Acquire a thorough understanding of MEMS products, micro fabrication evolution, and multidisciplinary applications including micro sensors and actuators.
2. Gain proficiency in MEMS material selection, fabrication techniques, and micro system packaging design considerations**.**

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	MEMS and Microsystems: Typical MEMS and microsystem products – Evolution of Microfabrication - Microsystem and microelectronics - Multidisciplinary nature of MEMS – Applications of Microsystems in Automotive Industry - Principles and examples of Micro sensors and micro actuators – micro accelerometer, Micro grippers, micro motors, micro valves, micro pumps.	**9**
2	Actuation and Sensing techniques: Actuation using Thermal forces, Actuation using Shape Memory Alloys, Actuation using Piezoelectric crystals, actuation using Electrostatic forces; Microsensors - Acoustic wave sensors, Biomedical sensors and biosensors, chemical sensors, pressure sensors, optical sensors - microfluidics.	**9**
3	Engineering science for Microsystem design - Atomic structure of Matter - Ions & ionization - Molecular Theory of matter & Intermolecular forces - Doping of semiconductors - Diffusion process - Electrochemistry - Quantum physics. Materials for MEMS and Microsystems - Substrate and wafer - Silicon as substrate Material - Silicon compounds - Silicon peizoresistors - Gallium Arsenide - Quartz - Peizoelectric crystals - Polymers.	**9**

4	Overview of Microsystem fabrication – Photolithography – Ion implantation-Diffusion – Oxidation – Chemical vapour deposition – Etching. Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining , LIGA process. Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging.	**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**

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

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 concepts of MEMS and microsystem products.	**K2**
CO2	Understand the working principles of micro sensors and actuators.	**K2**
CO3	Identify the typical materials used for fabrication of micro systems.	**K2**
CO4	Illustrate the various methods in microsystem fabrication and micro manufacturing.	**K2**

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

CO-PO Mapping Table:

	PO31	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										3
CO2	3	2										3
CO3	3	2	1									3
CO4	3	2	1									3

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	MEMS and Microsystems Design, Manufacture and Nanoscale Engineering	Tai-Ran Hsu,	Wiley	2nd , 2020
2	Foundations of MEMS	Chang Liu	Pearson	2nd , 2012
3	Microsystem Design	Stephen D Senturia	Springer	3rd, 2013

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Silicon VLSI Technology	James D Plummer	Prentice Hall	4th, 2012
2	MEMS	Nitaigur Premchand Mahalik	Tata Mc Graw Hill	2013
3	Micro and Nano Fabrication: Tools and Processes	Hans H. Gatzen	Springer	2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	NPTEL course : "MEMS & Microsystems" by Prof. Santiram Kal, Video Lecture No: 5, MEMS materials https://archive.nptel.ac.in/courses/117/105/117105082/
2	NPTEL course: "MEMS & Microsystems" by Prof. Santiram Kal, Video Lecture No: 13, Surface & Quartz Micromachining. https://archive.nptel.ac.in/courses/117/105/117105082/

SEMESTER 7

ADAPTIVE SIGNAL PROCESSING

Course Code	**PEEVT 743**	**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)	PBEVT 604	**Course Type**	Theory

Course Objectives:

1. Explain the role and importance of adaptive signal processing in communications signal processing
2. List and apply the various mathematical models to adaptive signal processing

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Adaptive systems: Definitions and characteristics - applications – properties examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum mean square error - introduction to filtering smoothing and prediction - linear optimum filtering-orthogonality - Wiener – Hopf equation-performance surface	**9**
2	Searching performance surface-stability and rate of convergence: Learning curve gradient search - Newton's method - method of steepest descent - comparison - Gradient estimation - performance penalty - variance - excess MSE and time constants – mis-adjustments	**9**
3	LMS/Newton algorithm - properties - sequential regression algorithm - adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals.	**9**
4	Applications-adaptive modelling and system identification: Multipath communication channel, geophysical exploration, FIR digital filter synthesis	**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

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

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	Devise filtering solutions for optimising the cost function indicating error in estimation of parameters and appreciate the need for adaptation in design.	**K1**
CO2	Remember the performance of various methods for designing adaptive filters through estimation of different parameters of stationary random process clearly considering practical application specifications	**K2**
CO3	Understand convergence and stability issues associated with adaptive filter design and come up with optimum solutions for real life applications taking care of requirements in terms of complexity and accuracy	**K1**
CO4	Design and implement filtering solutions for applications such as channel equalisation, interference cancelling and prediction considering present day challenges.	**K2**

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

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

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

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

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Adaptive Signal Processing	Bernard Widrow and Samuel D. Stearns	Person Education	1985

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Adaptive Filter Theory	Simon Haykin	Person Education	2003
2	Theory and Design of Adaptive Filters	John R. Treichler, C. Richard Johnson, Michael G. Larimore	Prentice-Hall of India	2002

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/ya0-S1apej8?si=aaGBqDeR13YEa-67
2	https://youtu.be/xFQsSn0IVUQ?si=hm4Ow6n43XWx0LiR
3	https://youtu.be/AWcl2as6N1E?si=5dQbSh6smFOJrJn7
4	https://youtu.be/8fq02jEq2lY?si=aMPFYAdEH97V24xf