Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – May / June 2026

Date: 25-05-2026 **Time:** 01:00pm – 04:00pm

School: SOCSE and Allied Courses	**Program:** B. Tech	
Course Code: PHY3002	**Course Name:** MICROELECTROMECHANICAL SYSTEMS	
Semester: VI	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	CO1	CO2	CO3	CO4	CO5
Marks	24	14	14	24	24

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2marks. 10Q x 2M=20M

1.	What does MEMS stand for? Give one example of a MEMS device found in a smartphone.	**2 Marks**	**L1**	**CO1**
2.	What is the difference between micro-scale and macro-scale behavior? Give one example.	**2 Marks**	**L2**	**CO1**
3.	What is Young's modulus? How does it relate to the stiffness of a MEMS beam?	**2 Marks**	**L1**	**CO2**
4.	What is a membrane in MEMS? State one application of a MEMS membrane.	**2 Marks**	**L1**	**CO2**
5.	What is anisotropic etching? How is it different from isotropic etching?	**2 Marks**	**L2**	**CO3**
6.	What is the role of a sacrificial layer in surface micromachining?	**2 Marks**	**L2**	**CO3**
7.	What is an accelerometer? How is it different from a gyroscope?	**2 Marks**	**L1**	**CO4**
8.	What is piezoelectricity? Name two materials that show this property.	**2 Marks**	**L1**	**CO4**
9.	What is the pull-in effect in an electrostatic actuator? Why is it important?	**2 Marks**	**L2**	**CO5**

10.	What is a MEMS micro-mirror? Name one application.	**2 Marks**	**L1**	**CO5**

Part B

Answer the Questions. **Total Marks 80M**

11.	**a.**	What are MEMS? Explain how MEMS are fabricated using IC-like batch processing. Describe how miniaturization has enabled the development of small, efficient sensors and actuators.	**10 Marks**	**L3**	**CO1**
	b.	Explain the benefits of scaling in MEMS. How do speed, power consumption, and robustness improve when device dimensions are reduced?	**5 Marks**	**L3**	**CO1**
	c.	How does heat conduction scale in MEMS? What happens to the thermal time constant as device size decreases? Explain with the concept of thermal scaling.	**5 Marks**	**L3**	**CO1**
Or					
12.	**a.**	Explain the structure and characteristics of single crystal silicon. What are Miller indices? Describe the properties of the (100), (110), and (111) crystal planes of silicon.	**10 Marks**	**L3**	**CO1**
	b.	Explain the mechanical behavior of MEMS membranes. How does the stiffness of a membrane depend on its thickness and tension? Describe one sensing application.	**5 Marks**	**L3**	**CO1**
	c.	Explain the guided-guided beam structure in MEMS. How is it different from a cantilever? Where is it used and why?	**5 Marks**	**L3**	**CO1**

13.	**a.**	Explain the working of metal evaporation, metal sputtering, and chemical vapor deposition (CVD) for thin film deposition in MEMS. Include neat diagrams and compare the three processes.	**10 Marks**	**L3**	**CO2**
	b.	Explain bulk micromachining in MEMS. What are the important techniques used? How are membranes, trenches, and moving structures created?	**5 Marks**	**L3**	**CO3**
	c.	List the two types of photoresists used in MEMS fabrication and explain in detail the process of photoresists formation, photoresists development and its removal with proper diagrams.	**5 Marks**	**L3**	**CO3**
Or					
14.	**a.**	Explain the photoresist formation process in MEMS fabrication. Describe spin coating, soft baking, UV exposure, development, and post-baking steps with their purpose.	**10 Marks**	**L3**	**CO2**

	b.	Explain hermetic and non-hermetic packaging in MEMS. What materials are used in each? What types of MEMS devices require hermetic packaging?	**5 Marks**	**L3**	**CO3**
	c.	Explain KOH anisotropic etching of silicon. Why does it etch the (100) plane faster than the (111) plane? What shapes can be created?	**5 Marks**	**L3**	**CO3**

15.	**a.**	Explain the working of a MEMS pressure sensor using piezoresistive sensing. Include the Wheatstone bridge circuit, placement of resistors, and how pressure causes resistance change.	**10 Marks**	**L3**	**CO4**
	b.	Explain capacitive sensing in MEMS. How does the capacitance change when a dielectric material is inserted or removed between the plates? Give the relevant equation.	**5 Marks**	**L3**	**CO4**
	c.	Explain the terms sensitivity, noise, and measurement range for a MEMS sensor. Why is a high signal-to-noise ratio important in sensor design?	**5 Marks**	**L3**	**CO4**
Or					
16.	**a.**	Explain how a MEMS accelerometer works using capacitive sensing. Describe the proof mass, spring suspension, and how acceleration changes the capacitance gap. Include equations.	**10 Marks**	**L3**	**CO4**
	b.	A capacitive MEMS sensor has an initial capacitance of 2 pF with a gap of 5 μm. If the gap reduces to 3 μm due to applied pressure, calculate the new capacitance. (Assume parallel plate model, $C = \varepsilon A/d$)	**5 Marks**	**L3**	**CO4**
	c.	Explain a metal strain gauge. How does it work and how is it used in MEMS pressure sensing?	**5 Marks**	**L3**	**CO4**

17.	**a.**	Explain thermal actuation in MEMS. Describe the working of a U-shaped hot-arm and cold-arm thermal actuator. How does asymmetry in heating cause lateral deflection?	**10 Marks**	**L3**	**CO5**
	b.	Explain the Seebeck effect and how it is used in a MEMS thermocouple. What are the three main effects that influence the Seebeck coefficient in silicon?	**5 Marks**	**L3**	**CO5**
	c.	Describe four main actuation mechanisms in MEMS: electrostatic, thermal, piezoelectric, and magnetic. Compare their power consumption and displacement range in brief.	**5 Marks**	**L3**	**CO5**
Or					

18.	**a.**	Explain the working of a comb-drive electrostatic actuator in MEMS. How are the electrostatic forces generated? Describe the equation for force and how it is used to produce linear motion.	**10 Marks**	**L3**	**CO5**
	b.	What are MEMS micro-switches? How do they work and what types of actuation are used? Give two advantages over conventional mechanical switches.	**5 Marks**	**L3**	**CO5**
	c.	Explain how a piezoelectric actuator generates force and displacement. Compare piezoelectric actuation with thermal actuation in terms of response speed, displacement, and power usage.	**5 Marks**	**L3**	**CO5**