

**MICRO SENSOR SCIENCE AND TECHNOLOGY  
(AEIE 5231)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group - A  
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Metal oxide gas sensors fall in categories of  
(a) Bio-sensors (b) Chemical sensors  
(c) Bio-medical Sensors (d) Optical sensors.
- (ii) The cleanest plane in Silicon crystal is  
(a) (100) (b) (110) (c) (111) (d) (001).
- (iii) The theory of thin films in diaphragm based micro pressure sensors can be used to assess  
(a) the deflection only (b) the stress only  
(c) both deflection and stress (d) the strain only.
- (iv) The wet etching process is  
(a) Isotropic (b) Anisotropic (c) Conformal (d) Planarization.
- (v) The sensors preferably use as “band filters” in mobile telephones and base stations are  
(a) Chemiresistor sensors (b) SAW sensors  
(c) Optical sensors (d) Piezo-resistive sensors.
- (vi) The main advantage of a MEMS piezo-resistive type pressure sensor is  
(a) suitable for high temperature applications  
(b) its simplicity  
(c) its low cost in production  
(d) very strong temperature dependence.
- (vii) The material preferred for optical sensing purpose with high electron mobility is  
(a) SiC (b) SiO<sub>2</sub> (c) Polysilicon (d) GaAs.
- (viii) For higher rate of deposition, the process engineer would choose  
(a) APCVD (b) LPCVD (c) PECVD (d) Diffusion.

- (ix) Implanting foreign substances through ion implantation is done by  
(a) melting (b) insertion by force  
(c) slow diffusion (d) plasma.
- (x) The material that can be used to generate “gates for transistors”, is  
(a) Polysilicon (b) Organic polymer  
(c) Silicon carbide (d) Silicon di-oxide.

### Group - B

2. (a) What are the different types of micro-pressure sensors available in market? [(CO1)(Remember/LOCQ)]  
(b) Among them which two are the most popular and why? [(CO2)(Understand/LOCQ)]  
(c) Explain the pros and cons of these two types of pressure sensors. [(CO1)(Analyze/IOCQ)]  
**3 + (2 + 2) + 5 = 12**
3. (a) Write at least five distinction points between CMOS based microelectronic system from MEMS based microsystem. [(CO2)(Analyze/IOCQ)]  
(b) Explain the working principle of SAW sensors. [(CO1)(Understand/LOCQ)]  
(c) Evaluate the performance of a SAW sensor for identifying antigen from a bio-sample. [(CO2)(Examine/HOCQ)]  
**4 + 4 + 4 = 12**

### Group - C

4. (a) Why does LB films so popular as a candidate material in micro-systems? [(CO4)(Understand/LOCQ)]  
(b) State a few examples of natural and synthesized piezo electric crystals. [(CO2)(Analyze/IOCQ)]  
(c) A MEMS based parallel capacitor is made of two rectangular plates with the dimensions  $L = 100 \mu\text{m}$  and  $W = 50 \mu\text{m}$  as shown in Fig.1. Evaluate the normal electrostatic force if the gap between these two plates is  $d = 4 \mu\text{m}$ . The plates are separated by static air with  $\epsilon_0 = 8.85 \times 10^{-12}$  Farad/m. [(CO1)(Evaluate/HOCQ)]

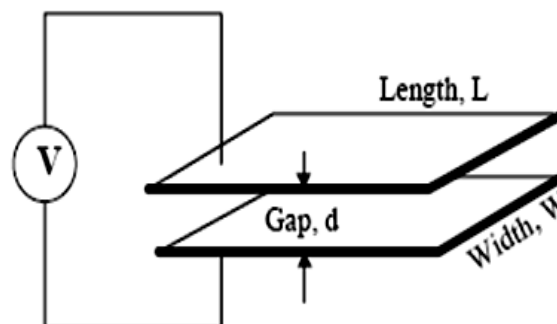


Fig.1

**3 + 4 + 5 = 12**

5. (a) Explain the process flow of MEMS sensor fabrication with suitable block diagram. [(CO4)(Analyze/IOCQ)]  
(b) State a few different deposition techniques used in micro-sensor fabrication process. [(CO2)(Analyze/LOCQ)]  
(c) What are the issues associated with deposition? [(CO3)(Remember/LOCQ)]  
**5 + 3 + 4 = 12**

**Group - D**

6. (a) What are the issues associated with deposition techniques? Explain with suitable diagram. [(CO4)(Remember/LOCQ)]  
(b) What are the uses of mask in photolithography? [(CO2)(Understand/LOCQ)]  
(c) Define the term PLASMA and how do you produce it? [(CO1) (Analyze/IOCQ)]  
**(2 + 3) + 2 + (2 + 3) = 12**
7. (a) Explain the differences between physical vapour deposition and chemical vapour deposition techniques. [(CO3)(Remember/LOCQ)]  
(b) What do you mean by etching? Describe the different techniques of etching. [(CO5)(Understand/LOCQ)]  
(c) For making an interdigitated sensor, which type of etching will you recommend and why? [(CO4)(Evaluate/HOCQ)]  
**4 + (2 + 3) + (1 + 2) = 12**

**Group - E**

8. (a) Explain the working principle of micro valve action technique with a suitable schematic diagram. [(CO2)(Understand/LOCQ)]  
(b) Describe in brief what you understand by micro-sensing element and transduction unit in a biomedical sensor. [(CO1)(Analyze/IOCQ)]  
(c) What are the main disadvantages of wet etching? [(CO6)(Remember/LOCQ)]  
**3 + 5 + 4 = 12**
9. (a) What do you understand by bulk micro-machining? [(CO6)(Remember/LOCQ)]  
(b) List a few points of advantages and disadvantages of bulk micro-machining over surface micro-machining. [(CO6)(Understand/LOCQ)]  
(c) When will you go for LIGA process and why? What are the advantages of LIGA process? [(CO6)(Analyze/IOCQ)]  
**3 + 4 + (3 + 2) = 12**

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	53.12	34.38	12.50

**Course Outcome (CO):**

After the completion of the course students will be able to

1. Gain the concept of transduction principle in micro-sensors.
2. Understand the atomic structure of matter, doping process, ionization process and diffusion in semiconductor.
3. Learn the process microfabrication technology.
4. Identify the pattern generation and transfer process like masking, photolithography, etc.
5. Learn different types of materials used in micro-sensor fabrication.
6. Understand various types of micro-manufacturing techniques and concept of smart sensors.

\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question;  
HOCQ: Higher Order Cognitive Question