

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

**Time Allotted : 2½ hrs**

**Full Marks : 60**

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

*Candidates are required to answer Group A and  
any 4 (four) from Group B to E, taking one from each group.*

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

**Group – A**

1. Answer any twelve:

**12 × 1 = 12**

*Choose the correct alternative for the following*

- (i) In smart phone, the most commonly used touch screen sensor is
  - (a) MEMS gyroscope
  - (b) MEMS accelerometer
  - (c) MEMS capacitive sensor
  - (d) MEMS inductive sensor
- (ii) The silicon crystal consists of
  - (a) 15 atoms
  - (b) 18 atoms
  - (c) 16 atoms
  - (d) 14 atoms
- (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 toughest plane for processing in a single silicon crystal is
  - (a) The (100) plane
  - (b) The (110) plane
  - (c) The (111) plane
  - (d) the (101) plane
- (v) The compound with highest electron mobility is
  - (a) Polysilicon
  - (b) SiC
  - (c) GaAs
  - (d) SiO<sub>2</sub>

- (vi) Van der Waal's force is also referred to as
  - (a) Inter molecular force
  - (b) Nuclear force
  - (c) Intra molecular force
  - (d) Electromagnetic force
- (vii) Quartz crystals is a compound of
  - (a) SiO<sub>2</sub>
  - (b) Polysilicon
  - (c) SiC
  - (d) AgCl
- (viii) The chemical process used for doping Silicon substrate is
  - (a) Diffusion
  - (b) Ion Implantation
  - (c) Sputtering
  - (d) LPCVD
- (ix) The concept used in "air bag" deployment system in automobile is:
  - (a) microgyroscope
  - (b) balanced force micro accelerometer
  - (c) cantilever based micro accelerometer
  - (d) magnetometer
- (x) The dry etching process is
  - (a) Isotropic
  - (b) Anisotropic
  - (c) Conformal
  - (d) Planarization.

*Fill in the blanks with the correct word*

- (xi) The problem of "peel off" is mostly seen in finished micro-structures made by \_\_\_\_\_ micromachining.
- (xii) Small systems tend to move or stop more quickly due to low \_\_\_\_\_.
- (xiii) The most popular chemical vapour deposition technique is \_\_\_\_\_.
- (xiv) The angle between 100 plane and 111 plane of a SCS is \_\_\_\_\_.
- (xv) A series of thermocouples in parallel combination are made of \_\_\_\_\_.

### Group - B

2. (a) Describe the steps involved in microfabrication technique with a suitable block diagram. [[CO1](Apply/IOCQ)]
- (b) Distinguish MEMS fabrication technique from conventional IC fabrication technology. [[CO1](Apply/IOCQ)]
- (c) Why is oxidation being considered as a very important process in both microelectronic and microsystem fabrication? [[CO2](Remember/LOCQ)]

**5 + 5 + 2 = 12**

3. (a) Describe the working principle of a chemical sensor with a suitable diagram. [[CO3](Analyse/HOCQ)]  
 (b) Classify chemical sensors according to their transduction effect. [[CO4](Remember/LOCQ)]  
 (c) Which type of sensor is deployed for LPG sensing? Explain the operation of LPG sensor. [[CO2](Apply/IOCQ)]
- 3 + 4 + (2 + 3) = 12**

### Group - C

4. (a) "Silicon- an ideal substrate material for micro-sensor fabrication" – Justify. [[CO3](Evaluate/HOCQ)]  
 (b) Why are Polymers preferred as industrial material? [[CO4](Remember/LOCQ)]  
 (c) How to prepare SiO<sub>2</sub> in lab? State the key chemical reactions involved in this process. [[CO3](Apply/IOCQ)]
- 5 + 3 + (2 + 2) = 12**
5. (a) Why is "Quartz" the ideal material for micro-sensor? Name two natural and two synthetic piezoelectric crystals. [[CO3](Analyse/IOCQ)]  
 (b) Which material is deposited to the substrate surfaces to produce localized "resistors" and "gates for transistors" during micro fabrication techniques? [[CO3](Remember/LOCQ)]  
 (c) Illustrate the preparation process of the material mentioned in (Q.(b)) from silicon and why is it so popular as piezo resistive material? [[CO2](Apply/IOCQ)]
- (2 + 2 + 2) + 2 + (2 + 2) = 12**

### Group - D

6. (a) State the different types of Chemical vapor deposition techniques in micro-fabrication process. [[CO3](Remember/LOCQ)]  
 (b) Distinguish the advantages of positive photo resist over negative photo resist in photolithography. [[CO4](Apply/IOCQ)]  
 (c) Define the term PLASMA and how do you produce it? [[CO2](Understand/LOCQ)]
- (2 + 3) + 3 + (1 + 3) = 12**
7. (a) Define the causes of using electrostatic forces to run micro motors rather than conventional electromagnetic forces. [[CO3](Analyse/HOCQ)]  
 (b) Why are LB films so popular in micro sensors? [[CO5](Remember/LOCQ)]  
 (c) Briefly describe the use of Polymers as Packaging materials in MEMS. [[CO6](Apply/IOCQ)]
- 4 + 5 + 3 = 12**

### Group - E

8. (a) State the pros and cons of surface micromachining? [[CO4](Remember/LOCQ)]  
 (b) Write the differences between isotropic and anisotropic etching? [[CO6](Analyse/HOCQ)]

- (c) “Electroplating is necessary in LIGA process” – explain. List the principal advantages and disadvantages of LIGA process over other micromachining processes.

[[C05](Apply/IOCQ)]

**4 + 4 + 4 = 12**

9. (a) Compare the surface micromachining with bulk micromachining.

[[C04](Remember/LOCQ)]

- (b) Among them which one is more preferable and why? Define the advantages of LIGA over the conventional micro machining technologies.

[[C06](Create/HOCQ)]

- (c) Explain briefly the LIGA process.

[[C02](Apply/IOCQ)]

**4 + (1 + 1 + 3) + 3 = 12**

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| Cognition Level         | LOCQ | IOCQ | HOCQ |
|-------------------------|------|------|------|
| Percentage distribution | 33   | 46   | 21   |

**Course Outcome (CO):**

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