

**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) In micro gripper arrangement, with the increase in electrode pair, the actuation voltage
  - (a) decreases exponentially
  - (b) increases linearly
  - (c) remains unaltered
  - (d) increases exponentially
- (iii) First surface micromachined accelerometer ADXL50 was developed by
  - (a) Bosch
  - (b) DARPA
  - (c) Analog Devices
  - (d) Omron
- (iv) Van der Waal's force is also referred to as
  - (a) Inter molecular force
  - (b) Nuclear force
  - (c) Intra molecular force
  - (d) Electromagnetic force
- (v) The deposition process for depositing GaAs over GaAs is
  - (a) Epitaxy
  - (b) Sputtering
  - (c) Ion Implantation
  - (d) Diffusion
- (vi) The etching process having highest aspect ratio is
  - (a) Reactive ion etching
  - (b) Deep reactive ion etching
  - (c) Plasma etching
  - (d) Wet etching
- (vii) The silicon crystal consists of
  - (a) 15 atoms
  - (b) 18 atoms
  - (c) 16 atoms
  - (d) 14 atoms
- (viii) The material that can be used to generate "gates for transistors"
  - (a) polysilicon
  - (b) organic polymer
  - (c) Silicon carbide
  - (d) Silicon di-oxide
- (ix) In MEMS and Microsystems, the LB process is used to produce
  - (a) Piezoelectric polymers
  - (b) Piezoresistive polymers
  - (c) Photoresistive material
  - (d) Photosensitive material

- (x) DRIE (deep reactive ion etching) process can produce  
 (a) Deep trenches (b) Slight trenches  
 (c) No trenches (d) Isotropic pattern

*Fill in the blanks with the correct word*

- (xi) Small systems tend to move or stop more quickly due to low \_\_\_\_\_.  
 (xii) In sputtering, the carrier gas for metal vapour is \_\_\_\_\_.  
 (xiii) The angle between 100 plane and 111 plane of a SCS is \_\_\_\_\_.  
 (xiv) SU 8 can be used as a \_\_\_\_\_ material.  
 (xv) Smart sensors are having \_\_\_\_\_ conditioning circuitry inside.

### Group - B

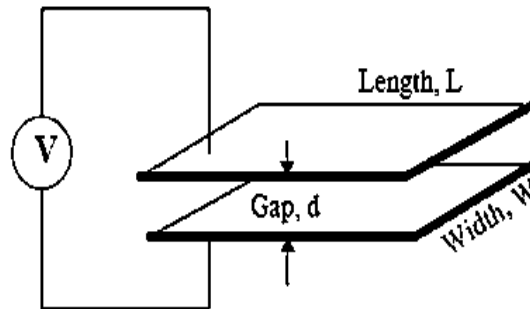
2. (a) “Miniaturization Makes Engineering Sense” – Justify. [[CO1](Analyse/HOCQ)]  
 (b) Describe the working principle of surface acoustic wave (SAW) sensors. [[CO1](Remember/LOCQ)]  
 (c) How do Acoustic Wave sensors work as “Band Pass Filters” in mobile sets? Write down other application areas of Acoustic Wave sensors. [[CO2](Apply/IOCQ)]  
**4 + 4 + (2 + 2) = 12**
3. (a) What do you mean by MOEMS? [[CO3](Remember/LOCQ)]  
 (b) Which type of material is preferred for such type of devices and why? [[CO4](Understand/LOCQ)]  
 (c) Describe briefly any one type of optical sensor. [[CO2](Apply/IOCQ)]  
**3 + 3 + 6 = 12**

### Group - C

4. (a) Illustrate the taxonomy of microfabrication process with a suitable block diagram. [[CO4](Remember/LOCQ)]  
 (b) Distinguish Micro Sensor fabrication techniques from conventional micro electronics (VLSI) technology. [[CO4](Understand/LOCQ)]  
 (c) Explain the requirement of mask used in photolithography of Micro sensor fabrication process. [[CO2](Apply/IOCQ)]  
**5 + 5 + 2 = 12**
5. (a) Classify different types of Physical vapour deposition techniques. [[CO3](Analyse/HOCQ)]  
 (b) How does metal vapour form in sputtering? What is used as carrier gas in sputtering? [[CO4](Remember/LOCQ)]  
 (c) What do you mean by epitaxial growth? State any one type of reactors for epitaxy. [[CO2](Apply/IOCQ)]  
**4 + (2 + 2) + 4 = 12**

## Group - D

6. (a) 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.



- (b) Why are LB films so popular in micro sensors? [[CO3](Evaluate/HOCQ)]  
 (c) Briefly describe the use of Polymers as Packaging materials in MEMS. [[CO4](Remember/LOCQ)]  
[[CO3](Apply/IOCQ)]  
**3 + 5 + 4 = 12**
7. (a) Why is “Quartz” the ideal material for micro-sensor? [[CO3](Analyse/IOCQ)]  
 (b) Name two natural and two synthetic piezoelectric crystals [[CO3](Remember/LOCQ)]  
 (c) Describe briefly the working principle of piezoelectric material. [[CO2](Apply/IOCQ)]  
**4 + 4 + 4 = 12**

## Group - E

8. (a) Define the mechanism of “Bulk micro manufacturing”. [[CO3](Analyse/HOCQ)]  
 (b) What is the primary technique used in this mechanism and how many types of this technique is utilised here? [[CO4](Remember/LOCQ)]  
 (c) State at least three substrate materials employed in this manufacturing technique. [[CO2](Apply/IOCQ)]  
**5 + 4 + 3 = 12**
9. (a) Define “Smart Sensor” in electronic measurement system. [[CO6](Remember/LOCQ)]  
 (b) Why MEMS technology is part and parcel for smart sensors? [[CO6](Analyse/HOCQ)]  
 (c) Describe the working principle of a smart sensor with suitable block diagram. [[CO6](Apply/IOCQ)]  
**4 + 3 + 5 = 12**

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	42.71	37.5	19.79

