

**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. [(C01)(Analyse/HOCQ)]
(b) Describe the working principle of surface acoustic wave (SAW) sensors. [(C01)(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. [(C02)(Apply/IOCQ)]

$$4 + 4 + (2 + 2) = 12$$

3. (a) What do you mean by MOEMS? [(C03)(Remember/LOCQ)]
(b) Which type of material is preferred for such type of devices and why? [(C04)(Understand/LOCQ)]
(c) Describe briefly any one type of optical sensor. [(C02)(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)]

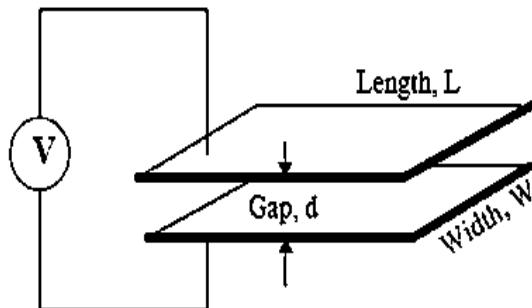
(b) How does metal vapour form in sputtering? What is used as carrier gas in sputtering? [(CO4)(Remember/LOCQ)]

(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 $\epsilon_0 = 8.85 \times 10^{-12} \text{ Farad/m}$.



(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

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	42.71	37.5	19.79

