INTRODUCTION TO MEMS
(AEI3121)

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 concept used in "air bag" deployment system in automobile is
(a) Microgyroscope
(b) Balanced force micro accelerometer
(c) Cantilever based micro accelerometer
(d) Magnetometer

(iii) The deposition process for depositing GaAs over GaAs is
(a) Epitaxy (b) Sputtering
(c) Ion Implantation (d) Diffusion

(iv) The etching process having highest aspect ratio is
(a) Reactive ion etching (b) Deep reactive ion etching
(c) Plasma etching (d) Wet etching

(v) In the packaging of micro sensors and micro-systems, polymers are used for
(a) Masking (b) Grounding (c) Decapsulation (d) Encapsulation

(vi) Silicon is almost an ideal structure material as its Young's modulus is same as
(a) Aluminium (b) Steel (c) Nickel (d) Copper

(vii) Quartz crystals is a compound of
(a) SiO2 (b) Polysilicon (c) SiC (d) AgCl

(viii) The problem of "Stiction" is mostly seen in finished micro-structures made by
(a) bulk micromachining (b) surface micromachining
(c) LIGA (d) LASER microfabrication

(ix) The finite element method (FEM) is a viable analytical tool for micro-structures because of
(a) simple geometry
(b) complex geometry and loading/boundary conditions
(c) complex loading and boundary conditions
(d) simple loading with boundary conditions

(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) In sputtering, the carrier gas for metal vapour is _______________.

(xii) A series of thermocouples in parallel combination are made of _________.

(xiii) The physical process to dope silicon substrate is_______________.

(xiv) SU 8 can be used as a _____________ material.

(xv) Diffusion is a process of __________________.

Group - B

2. (a) Describe the working principle of a Bio -MEMS based sensor. *[(CO3)(Analyse/HOCQ)]*
(b) Classify micro pressure sensors according to their transduction effect. *[(CO2)(Apply/IOCQ)]*
(c) What are the applications of micro-grippers? Explain the operation of micro-motor. *[(CO2)(Understand/LOCQ)]*

3 + 4 + (2 + 3) = 12

3. (a) Write the full form of MOEMS? Which type of material is preferred for such type of devices and why? *[(CO3)(Remember/LOCQ)]*
(b) What is thermopile? Describe the working principle of a micro thermal sensor. *[(CO4)(Understand/LOCQ)]*
(c) Describe briefly the difference between photo conductive sensors from photo resistive ones. *[(CO2)(Apply/IOCQ)]*

(1 + 1 + 1) + (2 + 3) + 4 = 12

Group - C

4. (a) Describe the steps involved in MEMS and microsystem fabrication with a suitable flow chart. *[(CO3)(Analyse/IOCQ)]*
(b) State the importance of lithography technique in MEMS fabrication process. *[(CO4)(Remember/LOCQ)]*
(c) Distinguish the advantages of positive photo resist over negative photo resist in photolithography process. *[(CO2)(Apply/IOCQ)]*

5 + 3 + 4 = 12

5. (a) Classify different types of Physical vapour deposition techniques. *[(CO3)(Analyse/HOCQ)]*
   (b) Compare three types of chemical vapour deposition techniques. *[(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) "Silicon- an ideal substrate material for micro-sensor fabrication" – Justify. *[(CO3)(Evaluate/HOCQ)]*
   (b) Which plane of the Si is the easiest to work with and why? *[(CO4)(Remember/LOCQ)]*
   (c) Identify the Silicone compound used as a *low-cost material for masks* and why? Name the key chemical reactions to produce this compound in Laboratory. *[(CO2)(Apply/IOCQ)]*

5 + (1 + 2) + (1 + 1 + 2) = 12

7. (a) Explain in detail the role of polymers in MEMS and microsystems. *[(CO3)(Analyse/IOCQ)]*
   (b) Describe the methods applied for polymers to make it conductive. *[(CO4)(Remember/LOCQ)]*
   (c) What is the use of SU 8? *[(CO2)(Apply/IOCQ)]*

6 + 5 + 1 = 12

Group - E

8. (a) State the differences between bulk and surface micro machining. *[(CO3)(Apply/IOCQ)]*
   (b) What are the mechanical problems associated with surface micro machining. *[(CO4)(Remember/LOCQ)]*
   (c) When will you prefer LIGA process? Define its advantages over the conventional micro machining technologies. *[(CO2)(Analyse/IOCQ)]*

4 + 3 + (2 + 3) = 12

9. (a) Identify the term selectivity ratio. Which type of selectivity ratio is required for a material used as *mask*? *[(CO3)(Analyse/HOCQ)]*
   (b) What are the pros and cons of anisotropic etching? *[(CO4)(Remember/LOCQ)]*
   (c) Describe the process of plasma etching. *[(CO4)(Apply/IOCQ)]*

(3 + 1) + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.45	46.88	16.67