Group – E

8. (a) Explain the working principle of micro gyroscopic action with a suitable schematic diagram.

   (b) Why are electrostatic forces used to run micro motors rather than conventional electromagnetic forces?

6 + 6 = 12

9. (a) What do you mean by LB films? State the attributes of LB films. Why is Si02 so important in MEMS fabrication technique?

   (b) Write at least two distinction points between dry and wet etching. What is Plasma and how can it be generated?

(4 + 2 + 3) + 3 = 12

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) The (110) plane in Silicon crystal consists of
   (a) 5 atoms (b) 8 atoms
   (c) 6 atoms (d) 7 atoms.

   (ii) Lithography is required in microfabrication because
   (a) to take photograph of micro-device
   (b) to create SEM pictures
   (c) to develop pictures in micro scale
   (d) to create patterns in micro-scale on substrate.

   (iii) Metal oxide gas sensors fall in categories of
   (a) bio-sensors (b) chemical sensors
   (c) bio-medical sensors (d) none of the above.

   (iv) The physical process used for doping Silicon substrate is
   (a) diffusion (b) ion implantation
   (c) sputtering (d) LPCVD.

   (v) The main disadvantage of a MEMS capacitance type pressure sensor is
   (a) suitable for high temperature applications
   (b) its low cost in production
   (c) its non-linear I/O characteristics
   (d) no temperature dependency.

   (vi) 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) all of the above.

(vii) Piezoelectric actuation works on the principle of
- (a) electric heating
- (b) mechanical-electrical conversion
- (c) electrical-mechanical conversion
- (d) both (c) & (b).

(viii) Ion implantation in implanting foreign substances by
- (a) melting
- (b) insertion by force
- (c) slow diffusion
- (d) none of the above.

(ix) The LB process is used to produce
- (a) thin films
- (b) thick films
- (c) piezoelectric polymers in MEMS and microsystems
- (d) all of the above.

(x) Mechanical stiction commonly occurs in
- (a) bulk micromachining
- (b) surface micromachining
- (c) LIGA
- (d) LASER microfabrication.

Group – B

2. (a) Explain the process flow of MEMS sensor fabrication with suitable block diagram. State a few different deposition techniques used in micro-sensor fabrication process. What are the issues associated with deposition?

   (b) What is the importance of "mask" in photolithography? Name at least one material that can be used as positive photo-resist and one material as negative photo-resist.

(2 + 3 + 3) + (2 + 2) = 12

3. (a) How does the physical process of doping in Silicon substrate differ from chemical process? Explain the chemical process of doping with a suitable diagram.

   (b) State the pros and cons of surface micromachining. Write the differences between isotropic and anisotropic etching.

(3 + 3) + (3 + 3) = 12

Group – C

4. (a) Explain the characteristics of single Silicon crystal for best suitable structure material in micro-sensor fabrication. Name any three widely used actuation techniques in micro-devices.

   (b) How do Acoustic Wave sensors work as "Band Pass Filters" in mobile sets? List down other application areas of Acoustic Wave sensors.

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

5. (a) Why is surface micro machining more advantageous over bulk micro machining? State the mechanical problems associated with the fabrication of surface micro machining.

   (b) When will you prefer LIGA process? Define its advantages over the conventional micro machining technologies.

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

Group – D

6. (a) How do you distinguish bio-medical sensors from biosensors? What are the major technical issues associated with Bio-MEMS products?

   (b) Describe the working principle of a chemical sensor with a suitable block diagram. Name the different types of chemical sensors.

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

7. (a) A thin piezoelectric crystal film, PZT is used to transduce the signal in a micro accelerometer involving a cantilever beam made of Silicon. The accelerometer is designed for a maximum acceleration / deceleration of 10 g. The PZT transducer is located at the support of the cantilever beam where the maximum strain exists (near the support) during the beading of the beam as illustrated in Fig.1.

   Determine the electrical voltage output from the PZT film at a maximum acceleration/ deceleration of 10 g. Assume that the Young's modulus of the beam is 1.9×10^{11}.

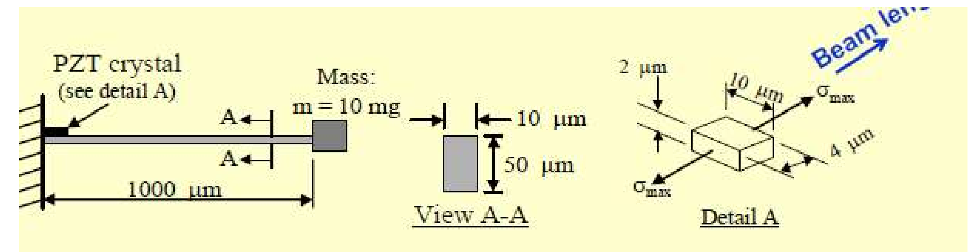

Fig.1.

   (b) Explain with a neat diagram the Czochralski (CZ) method for single crystal silicon formation.

6 + 6 = 12