(b) Why is GaAs treated as an excellent material for photoelectronic applications? What is SU-8 and where it is used in microfabrication process?

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

Group - E

8. (a) Explain the working principle of micro pumping 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) Define "Smart Sensor" in electronic measurement system. How does micro electronics differ from micro-system?

(b) Write short note on any one of the following:
   (i) Ion implantation vs. diffusion
   (ii) Low pressure chemical vapor deposition vs. Oxidation
   (iii) Optical sensor vs. Thermal sensor

(3 + 6) + 3 =12

MICRO SENSOR SCIENCE AND TECHNOLOGY
(AEIE 5202)

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 main working components in Bio-sensors require
   (a) bio-molecules
   (b) electro-chemical compounds
   (c) chemical compounds to work
   (d) all the above.

(ii) The angle between (100) plane and (111) plane in silicon crystal is
   (a) 45.75 degree   (b) 58.89 degree
   (c) 46.54 degree   (d) 54.74 degree.

(iii) Photolithography is used in microfabrication to
   (a) take photograph of micro-device
   (b) create patterns in micro-scale on substrate
   (c) develop pictures on micro scale
   (d) create pictures on micro-device.

(iv) The process of diffusion analysis is based on
   (a) Fourier's Law   (b) Fick's law
   (c) Hooke's Law   (d) oulomb's Law.

(v) The main advantage of a MEMS capacitance type pressure sensor is
   (a) suitable for high temperature applications
   (b) ease of fabrication
   (c) very strong temperature dependence
   (d) its low cost of production.

(vi)   One of the principal advantages of LIGA process is its ability to produce
(a) microstructures with high aspect ratio
(b) microstructures with low cost
(c) microstructures with precise dimension
(d) none of the above.

(vii)   The piezoelectric micro actuators work on the principle of
(a) electric heating
(b) mechanical-electrical conversion
(c) electrical-mechanical conversion
(d) both (a) & (b).

(viii) The LB process is used to produce
(a) thin Films
(b) thick Films
(c) piezoelectric polymers in MEMS and micro-systems
(d) all of the above.

(ix)   The shape of Quartz crystal is
(a) face centred cube   (b) tetrahedron
(c) body centred cube   (d) cylindrical.

(x)   To maintain a plasma, one needs to keep supplying
(a) high temperature   (b) high pressure
(c) high electric field   (d) all of the above.

Group - B

2. (a)   "Silicon- an ideal substrate material for micro-sensor fabrication" – why? Why are Polymers preferred as industrial material?

    (b)   How would you prepare SiO_2 in lab?
          State the key chemical reactions involved in this process.
          (5 + 3) + (2 + 2) = 12

3. (a)   What is the physical process of doping in Silicon substrate?
          Illustrate this process with a suitable block diagram.
          How does it differ from chemical process of doping?

    (b)   What do you mean by epitaxial growth? State any one type of reactors for epitaxy.
          (3 + 2 + 2) + (2 + 3) = 12

Group - C

4. (a)   State the different types of Chemical vapor deposition techniques in micro-fabrication process.

    (b)   What are the advantages of positive photo resist over negative photo resist in photolithography? Which type of light source is used in photolithography? What is PLASMA and how do you produce it?
          5 + (2 + 1 + 4) = 12

5. (a)   What do you mean by LB films and what are its applications? State a few examples of natural and synthesized piezo electric crystals.

    (b)   A MEMS based parallel capacitor is made of two rectangular plates with the dimensions L = 100μm and W = 50μm as shown in Fig.1. Determine the normal electrostatic force if the gap between these two plates is d = 4μm. The plates are separated by static air with $\varepsilon_0 = 8.85 \times 10^{-12}$ Farad/m.
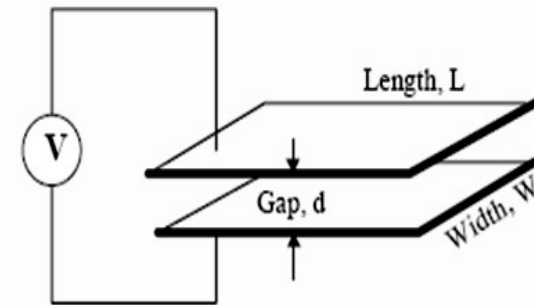

Fig. 1
          (3 + 4) + 5 =12

Group - D

6. (a)   Explain the working principle of chemical sensors with a suitable block diagram. State the different types of chemical sensor.

    (b)   Define the application area of micro sensors in bio-medical field.
          (4 + 4) + 4 = 12

7. (a)   Which mechanical aspects one should consider for designing a diaphragm based micro-pressure sensor? Specify the reasons of selecting LB films as good conducting material.