Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII EXAMINATION – WINTER 2015

Subject Code:182008 **Date: 30/11/2015**

Subject Name: MEMS & NANOTECHNOLOGY

Time: 2:30pm to 5:00pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Differentiate between **07**

(a) Ion Implantation and Diffusion process.

(b) Squeeze film and damping in shear

(b) A silicon substrate is doped with boron ions at 100 KeV. Assume the maximum concentration after the doping is 30 x 10^{18}/cm^3. Find: **07**

(a) the dose, Q,

(b) the dopant concentration at the depth 0.15 μm,

(c) the depth at which the dopant concentration is at 0.1% of the maximum value.

Rp = 307 nm and ΔRp = 69 x10^{-7} cm.

Q.2 **(a)** What are the characteristics required for an Ideal substrate material for MEMS structures? Explain. **07**

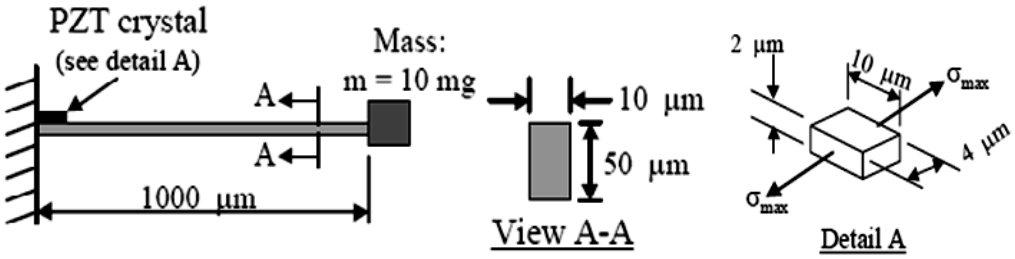
(b) Explain the Czochralski method for producing single-crystal silicon. **07**

OR

(b) List the micro fabrication processes used for MEMS. Explain photolithography and Chemical Vapour Deposition techniques in detail. **07**

Q.3 **(a)** What are BIOMEMS? List the major technical issues to be handled by BIOMEMS products. With an example differentiate Biomedical and Biosensors. **07**

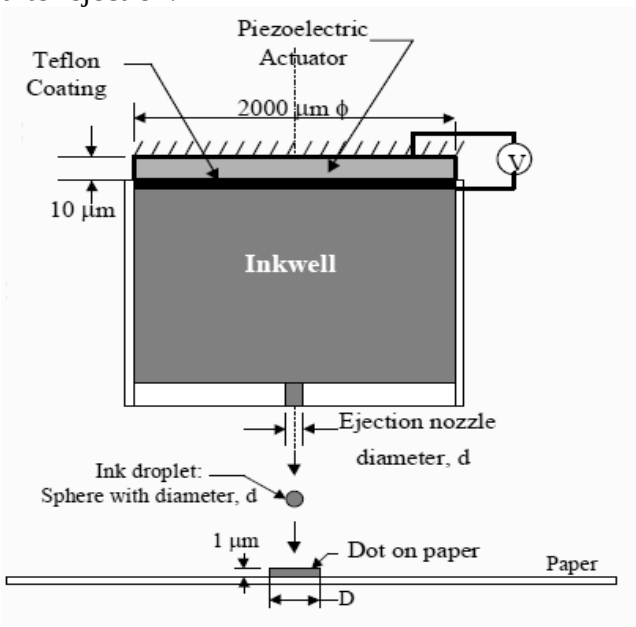
(b) A thin Piezoelectric crystal film of PZT is used to traduce the signal in a micro accelerometer with a cantilever beam made of silicon. The accelerometer is designed for a maximum acceleration and deceleration of 10g. The PZT transducer is located at the support based of the cantilever where the maximum strain exists during bending of the beam. Find the electrical voltage output from the PZT film at the maximum acceleration/deceleration. **07**



OR

Q.3 **(a)** Sketch and explain the Three modes of fracture (in terms of the stress intensity factors) related to the fracture of a solid. With a neat sketch explain the three stages of creep deformation. **07**

(b) Determine the required electric voltage for ejecting a droplet of ink from an inkjet printer head (shown in below figure) using PZT piezoelectric crystal as a pumping mechanism. The ejected ink will have a resolution of 300 dpi (dots per inch). The ink droplet is assumed to produce a dot with a film thickness of 1 μm on the paper. The geometry and dimension of the printer head is illustrated below. Assume that the ink droplet takes a shape of a sphere and the inkwell is always re-filled after ejection. **07**



Q.4 **(a)** "Electromagnetic forces are not commonly used in MEMS and microsystems as preferred actuation force". Evaluate. **07**

(b) Explain the significance of Finite Element Analysis in Designing MEMS structures. **07**

OR

Q.4 **(a)** "When the physical quantity is to be miniaturized, the design engineer must weigh the magnitudes of the possible consequences from the reduction on both the volume and surface of the particular device." Justify. **07**

(b) Explain the working and applications of different types of Micro accelerometers. **07**

Q.5 **(a)** What are the tools available for measuring the nanostructures? Differentiate between Scanning electron microscopy and Scanning probe microscopy. **07**

(b) What are the types and possible applications of carbon nanotubes? Explain the use of carbon nanotubes as nano bio sensors. **07**

OR

Q.5 **(a)** Explain the process of molecular recognition applied to the field of nanotechnology. **07**

(b) What are the tools available to make the nanostructures? Discuss. **07**

****