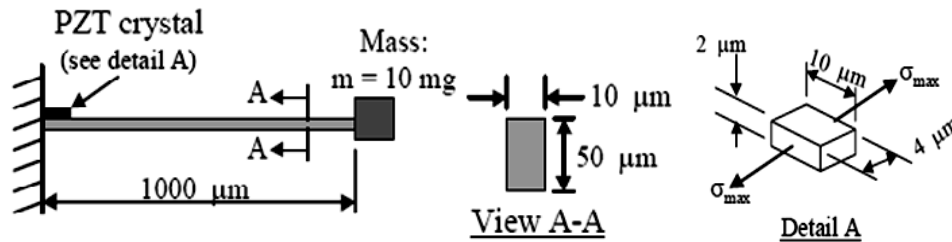


GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VIII • EXAMINATION – SUMMER 2013****Subject Code: 182008****Date: 09-05-2013****Subject Name: MEMS and NANOTECHNOLOGY****Time: 10.30 am - 01.00 pm****Total Marks: 70****Instructions:**

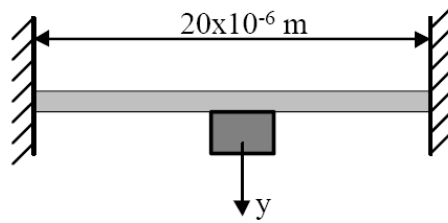
1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1 (a)** List out the most obvious distinctions between Micro systems and Micro Electronics Technologies. **07**
- (b)** Describe the three principal signal transduction methods for micro pressure sensors. What are the advantages and disadvantages of using (1) Piezo resistors and (2) Capacitors as signal transducers? **07**
- Q.2 (a)** A thin Piezoelectric crystal film of PZT is used to transduce 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**



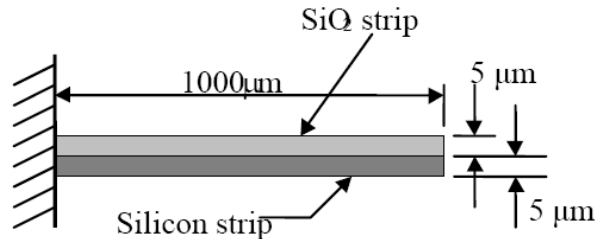
- (b)** (i) Evaluate: “The change in the state of stress in a silicon diaphragm in a micro pressure sensor results in a change of its natural frequency”. **07**
- (ii) Describe the popular micro actuation techniques used in micro devices. **07**
- OR**
- (b)** “Silicon and its compounds are used as Ideal Substrate materials for MEMS” **07**
- Justify. **07**
- Q.3 (a)** Explain the method used for growing silicon crystals. **07**
- (b)** List the micro fabrication processes used for MEMS. Explain photolithography and Chemical Vapour Deposition techniques in detail. **07**
- OR**
- Q.3 (a)** Why do the properties become size dependent at the nanometer scale? Explain. **07**
- (b)** Why [surface area/volume] ratio is very large for nanoparticles compared to bulk materials? Explain with a simple example? Highlight any two problems associated with increase in surface area? **07**
- Q.4 (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 component of a MEMS structure (5gm) is attached to a strip of silicon. The equivalent spring constant is 18,240 N/m. The mass is pulled down by 5E-6 meter initially and is released. Find the natural frequency and maximum amplitude of vibration of the system. Also find the time required to break up the strip if a Force of $F(t) = 5\cos \omega t$ N is applied to the mass at time $t > 0$. Assume that the material of the mass and the strip is silicon and the strip breaks at a

deflection of 1mm. The vibration of the system begins when the system is at rest.



OR

- Q.4 (a)** What are the types and possible applications of carbon nanotubes? Explain the use of carbon nanotubes as nano bio sensors. **07**
- (b)** A micro actuator described below is expected to operate with a temperature rise from 10°C to 50°C . Plot the movements of the free end of the actuator with respect to the range of temperature rise. Use a temperature increment of 10°C . **07**
 $E_{\text{SiO}_2} = 385 \text{ GPa}$, $E_{\text{Si}} = 190 \text{ GPa}$, $\text{CTE}_{\text{SiO}_2} = 5 \times 10^{-7} / ^{\circ}\text{C}$, $\text{CTE}_{\text{Si}} = 2.33 \times 10^{-6} / ^{\circ}\text{C}$.



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