## **GUJARAT TECHNOLOGICAL UNIVERSITY**

**BE - SEMESTER-VIII • EXAMINATION – SUMMER • 2015** 

Subject Code: 182008

Subject Name: MEMS & Nanotechnology

Time:10.30AM-01.00PM

Instructions:

- 1. Attempt all questions.
- 2. Make suitable assumptions wherever necessary.
- 3. Figures to the right indicate full marks.
- Q.1 (a) (i) Evaluate: "The change in the state of stress in a silicon diaphragm in a micro 07 pressure sensor results in a change of its natural frequency".
  (ii) Describe the popular micro actuation techniques used in micro devices

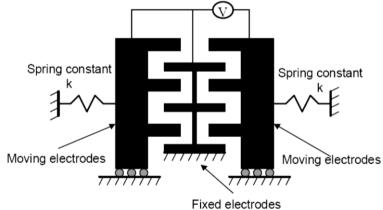
(ii) Describe the popular micro actuation techniques used in micro devices.

- (b) Explain the working and applications of different types of Micro 07 accelerometers. Also discuss the principles of damping used with their applications.
- Q.2 (a) Differentiate Biomedical and Biosensors. List the major technical issues to be 07 handled by BIOMEMS products.
  - (b) Explain the method used for growing silicon crystals.

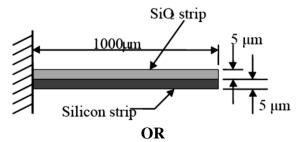
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## OR

(b) Determine the voltage required to pull the moving electrode 10µm from the unstretched position of the spring for the comb driven actuator. The spring constant is 0.05 N/m. The comb drive is operated in air. The gap between the electrodes and the width of the electrodes are 2µm and 5µm respectively.



- Q.3 (a) What are the qualities desired for a substrate to be considered in Micro 07 fabrication? Explain with an example.
  - (b) A micro actuator described below is expected to operate with a temperature rise from  $10^{0}$ C to  $50^{0}$ C. Plot the movements of the free end of the actuator with respect to the range of temperature rise. Use a temperature increment of  $10^{0}$ C.  $E_{siO2} = 385$  GPa,  $E_{si} = 190$ GPa, CTEsio<sub>2</sub> = 5e-7/ $^{0}$ C, CTE<sub>si</sub> = 2.33E-6/ $^{0}$ C.

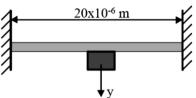


Q.3 (a) "Additive Fabrication processes are best suited for manufacturing at a micro or scale instead of the subtractive machining techniques". Justify. Also explain the

**Total Marks: 70** 

need of a clean room for these techniques.

(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) =  $5\cos \omega nt N$  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.



- Q.4 (a) Explain the diffusion process used for fabricating micro and nanostructures. 07 How is it different from Ion Implantation?
  - (b) "Carbon Nanotubes are the best candidates for sensing atomic scale biological 07 objects". Evaluate.

OR

- **0.4 (a)** Explain the importance of scaling in Nanostructures giving suitable example. 07 Write in brief: 07 **(b)** Chemical Vapour Deposition process • • Ion Implantation process 07 Q.5 **(a)** Explain the techniques used to make nanostructures. "Fracture and Creep in Nanostructures Temperature dependent 07 **(b)** are phenomenon". Evaluate. OR
- Q.5 (a) Differentiate between different types of microscopy techniques with emphasis 07 on characterizing the Nanostructures.
  - (b) What do you understand by 'Molecular Recognition'? Explain in brief in 07 context of Nanotechnology. How it is useful to the society at large?

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