Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2182008 **Date: 04/05/2017**

Subject Name: MEMS and Nanotechnology(Departmental Elective - III)

Time: 10:30 AM to 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)**	Describe the various domain applications of MEMS devices.	**07**
	(b)	Give the comparison between Microelectronics and Microsystem.	**07**
Q.2	**(a)**	Explain scaling in fluid mechanics.	**07**
	(b)	Using a nest sketch explain the construction and working of a MEMS thermal sensor.	**07**
		OR	
	(b)	Explain the merits and demerits of micro actuation techniques used in MEMS devices.	**07**
Q.3	**(a)**	What are the qualities desired for a substrate to be considered in Micro fabrication? Explain with an example.	**07**
	(b)	Determine the equivalent spring constant k and the natural frequency ω_n of a cantilever beam element in micro accelerometer as illustrated in Figure 1. The beam is made of silicon with a Young's modulus 190,000 MPa.	**07**

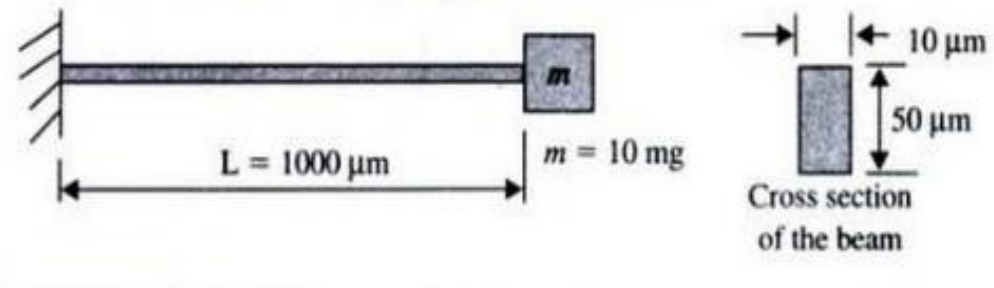

Figure 1.(A beam spring and seismic mass)

OR

Q.3	**(a)**	Explain the method used for growing silicon crystals.	**07**

(b) A microacuator made of a bilayer strip -an oxidized silicon beam- is illustrated in Figure 2. A resistance heating film is deposited on the top of the oxide layer. Estimate the interfacial force between the Si and SiO_2 layers and the movement of the free end of strip with a temperature rise $\Delta T = 10°C$. Use the following material properties: **07**

Young' modulus: $E_{SiO2} = E_1 = 385{,}000 MPa, E_{Si} = E_2 = 190{,}000$ MPa.
CTE: $\alpha_{SiO2} = \alpha_1 = 0.5 \times 10^{-6}$ /°C; $\alpha_{Si} = \alpha_2 = 2.33 \times 10^{-6}$ /°C.

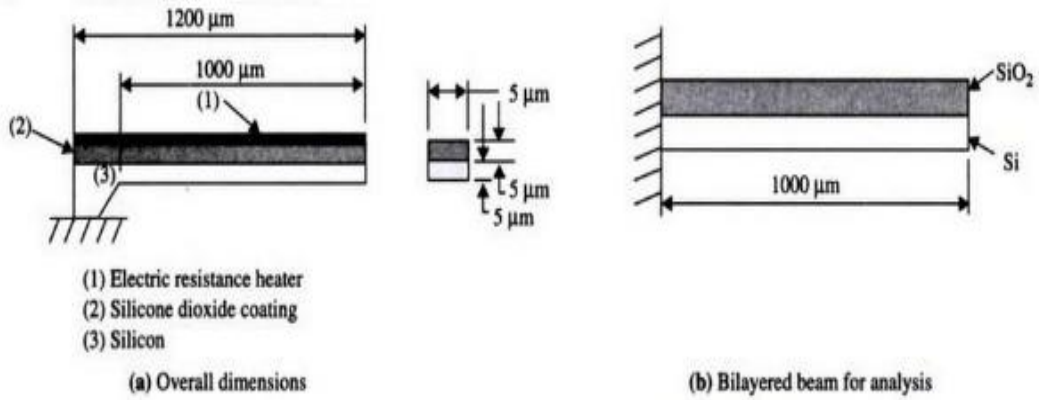

Figure 2(A bilayered strip acuator)

Q.4 **(a)** Explain the Photolithography process in detail with a suitable example. **07**

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

OR

Q.4 **(a)** Differentiate between Ion Implantation and Diffusion process. **07**

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

Q.5 **(a)** What are the types and possible applications of carbon nanotubes? Explain the use of carbon nanotubes as nano bio sensors. **07**

(b) Describe the methods available for making nanostructures. Differentiate between SEM and TEM. **07**

OR

Q.5 **(a)** Explain the tools available to make the nanostructures in detail. **07**

(b) What do you understand by 'Molecular Recognition'? Explain in brief in context of Nanotechnology. How it is useful to the society at large? **07**

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