Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII (NEW) EXAMINATION – WINTER 2018

Subject Code: 2182008 **Date: 15/11/2018**

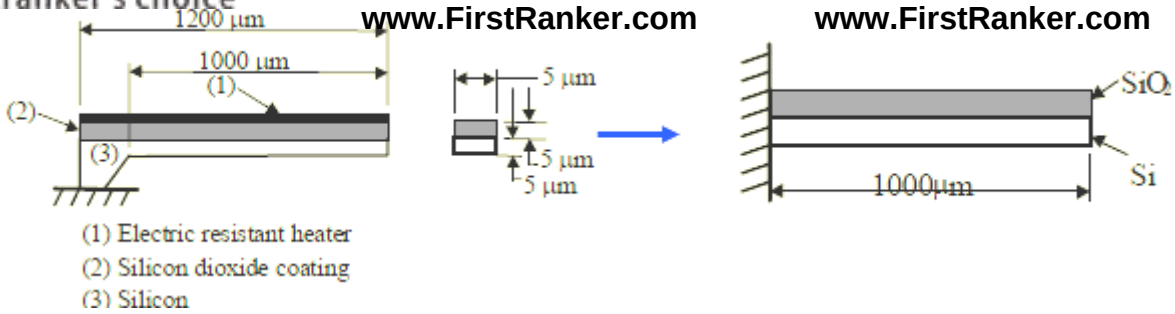
Subject Name: Mems And Nanotechnology

Time: 02:30 PM TO 05:00 PM **Total Marks: 70**

Instructions:

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

			MARKS
Q.1	**(a)**	Give the comparison between Microelectronics and Microsystems.	**03**
	(b)	Discuss the major technical issues to be handled in BIOMEMS products.	**04**
	(c)	Explain the working and applications of different types of Micro accelerometers. Also discuss the principles of damping used with their applications.	**07**
Q.2	**(a)**	In comb drive actuators used in micro grippers, normal plate electrode technique is better suited as compared to sliding plate one". Evaluate.	**03**
	(b)	Explain creep is a temperature independent phenomenon.	**04**
	(c)	A silicon substrate is subjected to diffusion of boron dopant at 1000°C with a dose $10^{11}/cm^2$. Find: (a) the expression for estimating the concentration of the dopant in the depth of the silicon substrate (b) the concentration at 0.1 μm beneath the surface after one hour into the diffusion process. The substrate is initially free of impurity.	**07**
		OR	
	(c)	A CVD process involves a reactant being diluted at 2% in the carrier oxygen gas at 490°C. Find the number of molecules in a cubic meter volume of the carrier gas. Pressure variation in the process is negligible.	**07**
Q.3	**(a)**	Explain Spectroscopy.	**03**
	(b)	Using a neat sketch explain the construction MEMS thermal sensor.	**04**
	(c)	Explain the Czochralski process for producing single crystal silicon.	**07**
		OR	
Q.3	**(a)**	What is Etching explain?	**03**
	(b)	Discuss the significance of scaling laws in Miniaturization with reference to Geometry and Rigid body dynamics.	**04**
	(c)	A microacuator made of a bilayer strip -an oxidized silicon beam- is illustrated in Figure 1. A resistance heating film is deposited on the top of the oxide layer. Estimate the interfacial force between the Si and SiO2 layers and the movement of the free end of strip with a temperature rise $\Delta T = 10°C$. Use the following material properties: Young' modulus: $E_{SiO2} = E_1 = 385000MPa, E_{Si} = E_2 = 190,000$ MPa. CTE: $\alpha_{SiO2} = \alpha_1 = 0.5 \times 10^{-6}$ /°C; $\alpha_{Si} = \alpha_2 = 2.33 \times 10^{-6}$ /°C.	**07**



(1) Electric resistant heater
(2) Silicon dioxide coating
(3) Silicon

Figure 1(A bilayered strip acuator)

Q.4	**(a)**	Why traditional manufacturing techniques cannot be used at micro level?	**03**
	(b)	Differentiate between Ion Implantation and Diffusion process.	**04**
	(c)	Describe the methods available for making nanostructures. Differentiate between SEM and TEM.	**07**

OR

Q.4	**(a)**	Explain working principle of Chemical Vapor Deposition process.	**03**
	(b)	Explain the Photolithography process.	**04**
	(c)	"At the nanoscale, the job of "seeing" is done by molecular recognition." Explain.	**07**
Q.5	**(a)**	What are the types carbon nanotubes?	**03**
	(b)	Explain difference between Squeeze film and damping in shear.	**04**
	(c)	Explain the role of Finite Element Analysis in the Design of MEMS structures.	**07**

OR

Q.5	**(a)**	What are the possible applications of carbon nanotubes.	**03**
	(b)	Explain the use of carbon nanotubes as nano bio sensors.	**04**
	(c)	Explain the tools available to make the nanostructures in detail.	**07**

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