Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII EXAMINATION – SUMMER 2016

Subject Code:182008 **Date:16/05/2016**

Subject Name:MEMS & Nano Technology (Department Elective - II)

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)** With a neat diagram explain the working of an Intelligent Microsystem. **07**

(b) Explain the merits and demerits of micro actuation techniques used in MEMS devices. **07**

Q.2 **(a)** Evaluate the following: **07**

(i) Quantitative assessment of induced stresses in thin films after they are produced on the top of base materials is a very difficult task.

(ii) The effect of creep in MEMS devices diminishes at higher values of temperature.

(b) i. A CVD process involves the reactant being diluted by 2% in carrier oxygen gas at 490^0C. Find the number of molecules in a cubic meter volume of the carrier gas. Pressure does not change throughout the process. **03**

ii. Discuss the major technical issues to be handled in BIOMEMS products. **04**

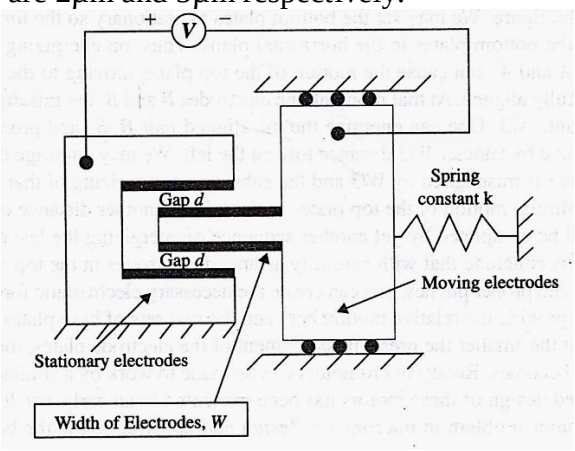
OR

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

Q.3 **(a)** Using a nest sketch explain the construction and working of a MEMS Pressure sensor **07**

(b) i. In comb drive actuators used in micro grippers, normal plate electrode technique is better suited as compared to sliding plate one". Evaluate. **03**

ii. Determine the voltage required (per electrode) 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. **04**



OR

Q.3 **(a)** Explain the working and applications of different types of Micro accelerometers. Also discuss the principles of damping used with their applications. **07**

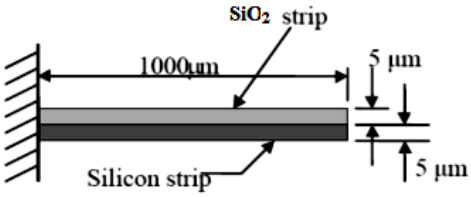
(b) Explain boundary layer and its effect on the deposition during the Chemical Vapour Deposition process. **07**

Q.4 **(a)** Discuss the significance of scaling laws in Miniaturization with reference to Geometry and Rigid body dynamics. Why Electromagnetic force is not used for actuation of MEMS devices? **07**

(b) Discuss the tools available for characterizing nanostructures. Differentiate between Scanning Probe and Scanning Electron Microscopy. **07**

OR

Q.4 **(a)** A micro actuator described below is expected to operate with a temperature rise from 10^0C to 80^0C. Plot the movements of the free end of the actuator with respect to the range of temperature rise. Use a temperature increment of 10^0C. E_{siO2} = 385 GPa, E_{si}= 190GPa, CTE_{sio2} = 5e-7/^{0}C , CTE_{si} = 2.33E-6/^{0}C. **07**



(b) Explain the ion implantation process of micro fabrication in detail. **07**

Q.5 **(a)** "At the nanoscale, the job of "seeing" is done by molecular recognition." Explain. **07**

(b) Discuss various substrate materials and justify the use of silicon as an ideal substrate material. **07**

OR

Q.5 **(a)** Justify : **07**

i. Bulk Gold does not behave as nanogold.

ii. At the nanometer scale, properties become size dependent.

(b) Explain the role of Finite Element Analysis in the Design of MEMS structures. **07**

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