GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER–VIII (NEW) - EXAMINATION – SUMMER 2018

Subject Code: 2182008   **Date: 30/04/2018**
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.
4. Figures to the right indicate full marks.

			MARKS

Q.1 **(a)** Give at least three distinct advantages of miniaturization of machines and device. **03**

(b) Give the comparison between Microelectronics and Microsystems. **04**

(c) Describe the various domain applications of MEMS devices. **07**

Q.2 **(a)** What are the principal application of microsensors, actuators and fluidics? **03**

(b) Evaluate the effect of creep in MEMS devices diminishes at higher values of temperature. **04**

(c) Estimate the damping coefficient in a force balanced micro accelerometer, as illustrated in Fig. 1, for air and for silicone oil as the damping fluid. Assume that the micro accelerometer operates at 20°C. **07**
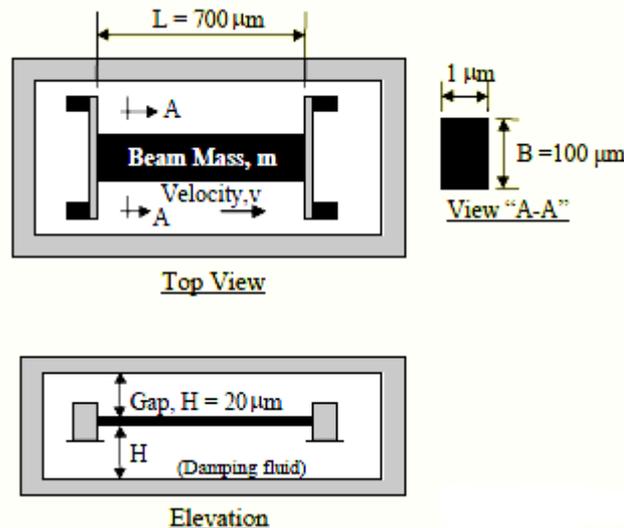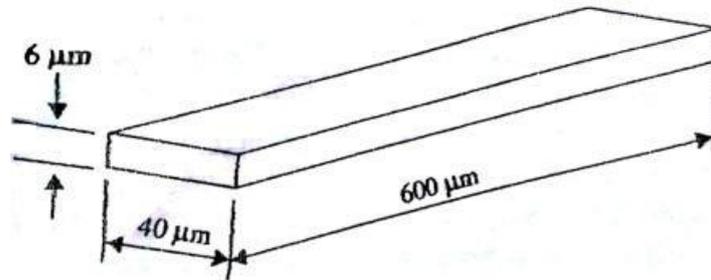

Fig .1

OR

(c) Determine the shift of natural frequency of a fixed-end beam made of silicon, with geometry and dimensions shown below when subjected to a longitudinal stress at 187 MPa. The dimensions of the beam are width $b = 40 \times 10^{-6}$ m, depth (thickness) $h = 6 \times 10^{-6}$ m, length $L = 600 \times 10^{-6}$ m. The following properties are applicable to silicon beam: **07**

Young's modulus E = 190,000 MPa
Mass density ρ = 2300 kg/m^3

Q.3	**(a)**	Differentiate between Ion Implantation and Diffusion process.	**03**
	(b)	Explain the working and applications of different types of Micro accelerometers.	**04**
	(c)	Explain the Czochralski method for producing single-crystal silicon.	**07**

OR

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Q.3	**(a)**	Differentiate between Squeeze film and damping in shear.	**03**
	(b)	Discuss the tools available for characterizing nanostructures.	**04**
	(c)	Explain the Photolithography process in detail with a suitable example.	**07**
Q.4	**(a)**	What is etching? Give the types of it.	**03**
	(b)	Explain Chemical Vapor Deposition process.	**04**
	(c)	Determine the required electric voltage for ejecting a droplet of ink from an inkjet printer head (shown in below figure) using PZT piezoelectric crystal as a pumping mechanism. The ejected ink will have a resolution of 300 dpi (dots per inch). The ink droplet is assumed to produce a dot with a film thickness of 1 μm on the paper. The geometry and dimension of the printer head is illustrated below. Assume that the ink droplet takes a shape of a sphere and the inkwell is always re-filled after ejection.	**07**
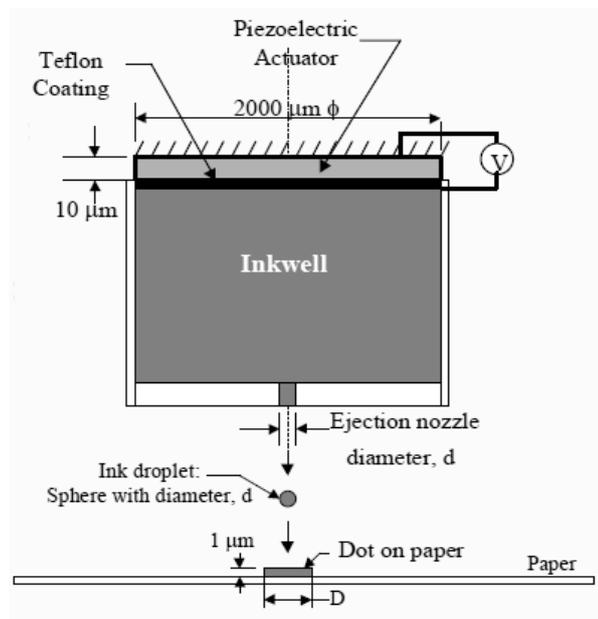
Fig .2

OR

Q.4	**(a)**	Explain working principle of Chemical Vapor Deposition process.	**03**
	(b)	Discuss the major technical issues to be handled in BIOMEMS products.	**04**
	(c)	Explain scaling in fluid mechanics.	**07**
Q.5	**(a)**	Differentiate between SEM and TEM.	**03**
	(b)	What are the types and possible applications of carbon nanotubes?	**04**
	(c)	"At the nanoscale, the job of "seeing" is done by molecular recognition." Explain.	**07**

OR

Q.5	**(a)**	Explain the use of carbon nanotubes as nano bio sensors.	**03**
	(b)	Justify: At the nanometer scale, properties become size dependent.	**04**
	(c)	Explain the role of Finite Element Analysis in the Design of MEMS structures.	**07**

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