Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: MICRO ELECTRO MECHANICAL SYSTEM [MME 423]

REVISED CREDIT SYSTEM
(28/11/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitable assumed.

1A.	Discuss two types of electrostatic MEMS actuator used for microgripping.	**4**
1B.	What are the benefits of miniaturizing gears and turbines.	**2**
1C.	Explain sputtering process used for laying of photoresist on a substrate.	**4**
2A.	Develop a flow chart for an integrated assembly and packaging of micro- pressure sensor.	**3**
2B.	An actuator based on electrostatic force is preferred over the electromagnetic force based type in micro actuation devices. Justify with supporting equations.	**3**
2C.	Discuss the biomedical sensor used for measuring the glucose concentration in the given blood sample.	**4**
3A.	Show the construction and explain the working of a linear stepper motor.	**3**
3B.	A rectangular diaphragm has dimensions a=752μm and b=376 μm . The thickness of the diaphragm h= 13.88 μm. α = 0.0277; β = 0.4974; Applied pressure = 25 MPa; Yield strength of silicon = 7000 MPa; Young's modulus = 190 GPa and Poisson's ratio = 0.25.Determine maximum stress and deflection in the diaphragm.	**2**
3C.	A silicon substrate is subjected to diffusion of boron dopant at 1000^0C with a dose of $10^{11}cm^2$. Find (1) The expression for estimating the concentration of the dopant in the substrate. (2) The concentration at 0.1 μm beneath the surface after 30 min into the diffusion process. The surface is initially free of impurity. (Refer table 3C)	**5**
4A.	Determine the electrical voltage required to eject a droplet of ink from an inkjet printer head with a PZT piezoelectric crystal as pumping mechanism. The ejected ink will have an resolution of 300 dpi . The droplet is assumed to produce a dot film thickness of 1 μm on the paper. The geometry and dimensions of the printer head is shown in fig. 4A Assume that the ink droplet takes the shape of a sphere and the inkwell is always refilled after ejection. (d= $480x10^{-12}$ m/V).	**6**

4B. Explain the plasma enhanced CVD process with diagram **4**

5A. A non compressible fluid is used in a microfluidic system. It flows through a tube with a diameter of 1mm at a rate of 1 μl per min. A reducer is used to connect this tube to the microconduits in the fluidic system. The reducer has an outlet diameter of 20 μm. Determine the velocity of the fluid at the inlet and outlet of the reducer. Refer fig.5A **2**

5B. Derive scaling vectors for acceleration, time, power density based on trimmer force scaling vector. **4**

5C. Explain how single crystal silicon is produced. Discuss the significance of primary and secondary flats. **4**

6A. Discuss micro-assembly workcell with neat diagram **3**

6B. Determine the thickness of the beam spring of a force balanced micro accelerometer as shown in Figure 6B, if the maximum allowable deflection of the beam is 16.875 um. The beam which is at neutral equilibrium position, decelerate from its initial velocity of 50 km/h to a standstill. Young's modulus of beam, E = 190 GPa and density = 2.3 gm/cm^3. **4**

6C. Determine the amplitude and frequency of vibration of a 15mg mass suspended from a spring constant k =6 x 10^{-5} N/m . The vibration of the mass is initiated by a small pull of the mass downward by an amount of δ_{st} = 4 μm. Also determine the natural frequency of the spring mass system. **3**

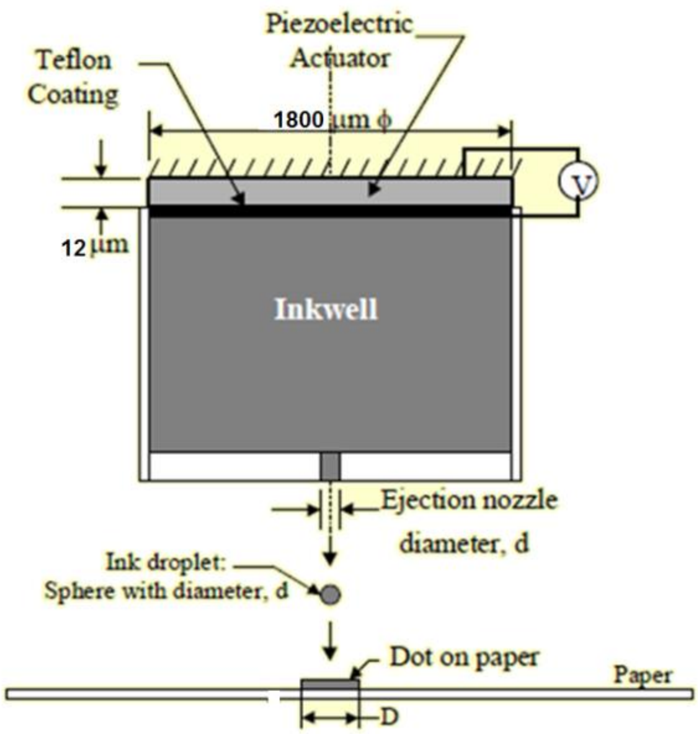

Fig. 4A

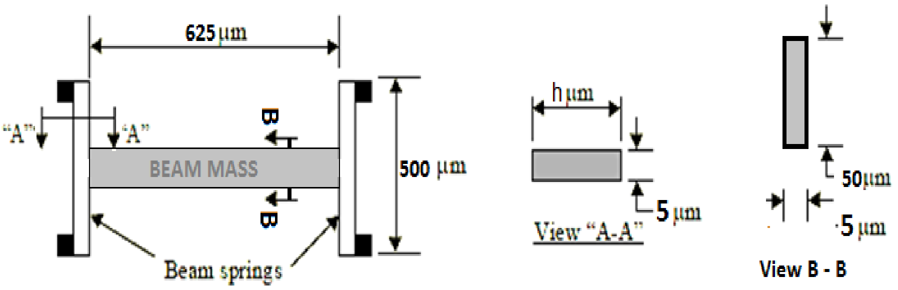

Fig. 6B

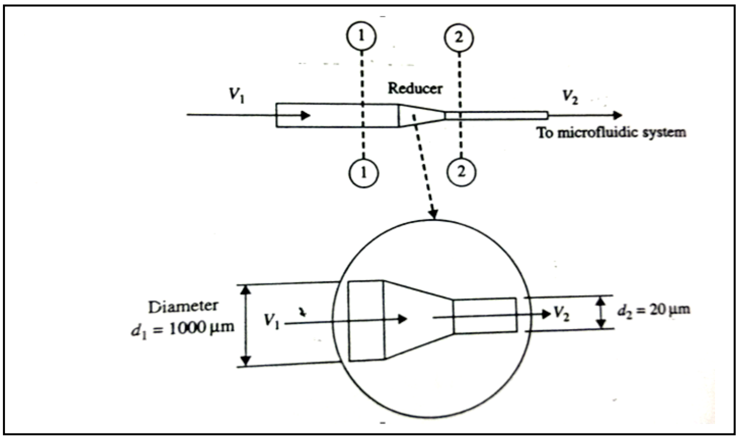

Fig. 5A

X	erf(X)	X	erf(X)	X	erf(X)	X	erf(X)
0.0	0.0						
0.05	0.0564	0.55	0.5633	1.05	0.8624	1.55	0.9716
0.10	0.1125	0.60	0.6039	1.10	0.8802	1.60	0.9763
0.15	0.1680	0.65	0.6420	1.15	0.8961	1.65	0.9804
0.20	0.2227	0.70	0.6778	1.20	0.9103	1.70	0.9838
0.25	0.2763	0.75	0.7112	1.25	0.9229	1.75	0.9867
0.30	0.3286	0.80	0.7421	1.30	0.9340	1.80	0.9891
0.35	0.3794	0.85	0.7707	1.35	0.9438	1.85	0.9911
0.40	0.4284	0.90	0.7969	1.40	0.9523	1.90	0.9923
0.45	0.4755	0.95	0.8209	1.45	0.9597	1.95	0.9942
0.50	0.5205	1.00	0.8427	1.50	0.9661	2.00	0.9953

Table 3c