Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

SIXTH SEMESTER B.TECH. (INSTRUMENTATION & CONTROL ENGG.)

END SEMESTER EXAMINATIONS, JUNE 2017

SUBJECT: MICRO ELECTRO MECHANICAL SYSTEMS [ICE 4010]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. Write a note on the characteristics of MEMS. **4**

1B. Explain why silicon is preferred in micro fabrication and the process of silicon growth from the melt in detail. **6**

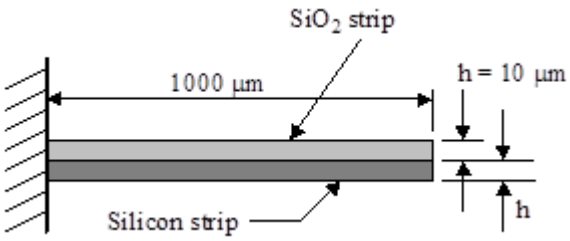
2A. Implement the following logic using CMOS technology. **4**

$Y = \overline{\overline{A.B}\ \overline{C.D}}$

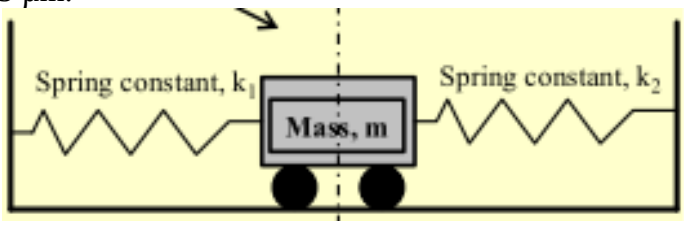
2B. List the steps involved in the fabrication of microelectronic ICs. **2**

2C. Calculate and compare the maximum deflection and stress of a circular and square diaphragm pressure sensor with an area of 196250 μm^2 and thickness of 60 µm for an applied pressure of 50MPa. Young's modulus of silicon is 190 GPa and possion's ratio is 0.27. **4**

3A. A bi-layer strip is subjected to a uniform temperature rise, T as illustrated below. Calculate the radius of curvature and deflection at the free end for a temperature of 70ºC. Consider E_{Sio2} = 385GPa, E_{Si} = 190GPa and $\alpha_{SiO2} = 0.5x10^{-6}$ / ºC, $\alpha_{Si} = 2.33x10^{-6}$ / ºC. **4**

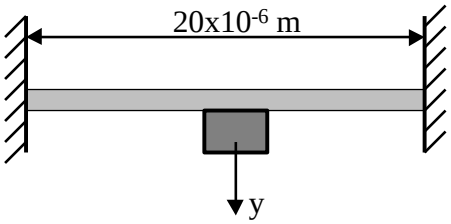


3B. Determine the amplitude and frequency of vibration of a 20-mg mass attached to two springs as shown in the figure. The spring constants are $k_1 = 5 \times 10^{-5}$ N/m and $k_2 = 8 \times 10^{-5}$ N/m. The vibration begins with the mass being pulled to the right with an amount of δ_{st} = 5 µm. **4**

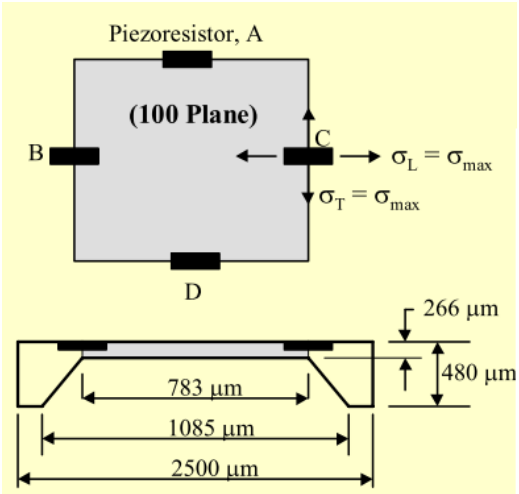


3C. Explain the working of a bio sensor. **2**

4A. A micro device component 5g in mass is attached to a fine strip made of silicon as shown in figure. The equivalent beam spring constant k_{eq} is 18240 N/m. The mass is pulled down by 5 μm initially and is released at rest. Determine (a) the natural frequency of the device and the maximum amplitude of vibration. **3**

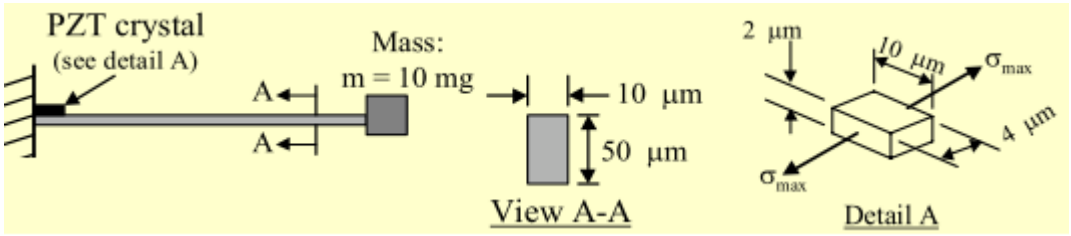


4B. Estimate the change of resistance in silicon piezoresistors attached to the diaphragm of a pressure sensor as shown below for an applied pressure of 50MPa. Consider E as 190GPa and π_{44} = 138.1 x 10^{-11} Pa^{-1}. **4**



4C. Write a note on epitaxial growth. **3**

5A. A thin piezoelectric crystal film, PZT is used to transduce the signal in a micro accelerometer involving a cantilever beam made of silicon. The accelerometer is design for maximum acceleration/deceleration of 10 g. The dimensions are L=800μm, b=50μm and t= 10μm. Calculate the voltage generated by the PZT. The piezoelectric coefficient of the crystal film is 2.3e-12 m/V. **5**



5B. Explain the process of etching and its classification. **3**

5C. Write a short note about lift-off technique. **2**