Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

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

END SEMESTER EXAMINATIONS, APRIL - 2018

SUBJECT: MICRO ELECTRO MECHANICAL SYSTEMS [ICE 4010]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. Draw the cross sectional view of a pMOS and nMOS transistors and explain its working. Also explain the working of a CMOS Inverter. **6**

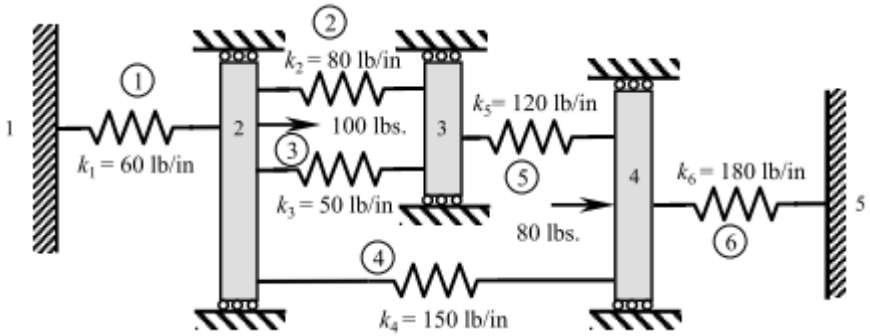
1B. Explain the properties of silicon and the process of silicon growth from the melt. **4**

2A. Write a note on MEMS process flow and explain the steps involved in fabrication of a micro cantilever beam with necessary sketch. **4**

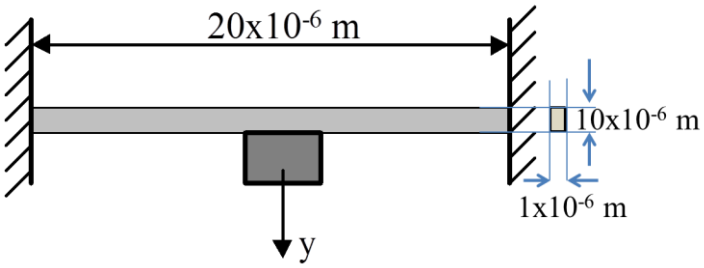
2B. Write a note on scaling effect of the following parameters: **4**
a). Spring Constant b). Stress

2C. A silicon square block of 1mg mass is attached at the free end of a cantilever beam. Calculate its dimensions. Assume required parameters suitably. **2**

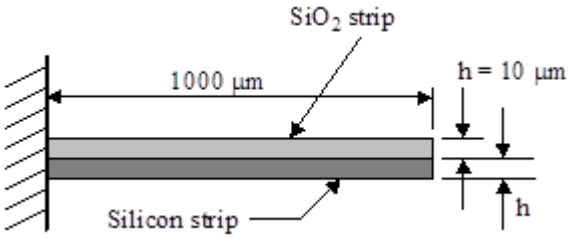
3A. Assemble the element equations to obtain the force-displacement relations for the system shown in figure. Use the boundary conditions and find the unknown displacements. **6**



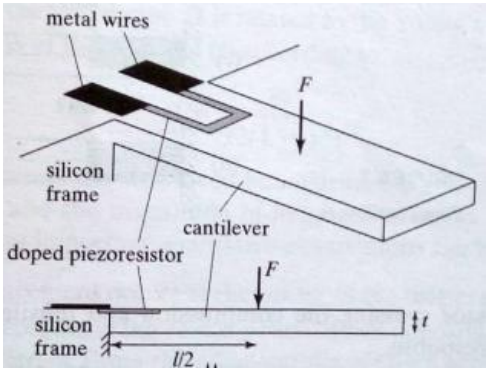
3B. A micro device component 5g in mass is attached to a fine strip made of silicon as shown in figure. The mass is pulled down by 5μm initially and is released at rest. Determine (a) the natural frequency of the device and the amplitude of vibration as a function of time. **4**



4A. A bi-layer strip shown below is subjected to a uniform temperature rise, T. Calculate the radius of curvature and deflection at the free end for a temperature of 60°C. Consider E_{Sio2} = 385GPa, E_{Si} = 190GPa and $\alpha_{SiO2} = 0.5x10^{-6}$ / °C, $\alpha_{Si} = 2.33x10^{-6}$ / °C. **5**



4B. A silicon cantilever beam is diffused with piezo resistive material on the maximum stress region and is connected as one arm of a wheatstone bridge. A force of 100 μN is applied in the middle of the cantilever beam as shown in figure below. Calculate the bridge output. Consider the following dimensional and material parameters: **5**
Cantilever beam: L x W x H: 200μm x 20μm x 5μm.
Young's Modulus & Poisson's Ratio: 131GPa & 0.25.
Longitudinal Gauge Factor: 50.
Resistance value under no strain: 500 Ω.
Bridge supply voltage: 10V.



5A. Explain the process of thermal oxidation with necessary sketch. **4**

5B. Explain the process of pattern transfer and also explain positive and negative resist with diagram. **4**

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

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