Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

SECOND SEMESTER M.Tech. (CS) DEGREE END SEMESTER EXAMINATION
May/June 2016
SUBJECT: MICRO ELECTRO MECHANICAL SYSTEMS (ICE - 576)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A. Write a note on electro chemical sensing of a bio sensor.

1B. Consider the system of linear elastic springs shown in Fig. Q1B. Assemble the element equations to obtain the force-displacement relations for the entire system. Use the boundary conditions and find the unknown displacements.

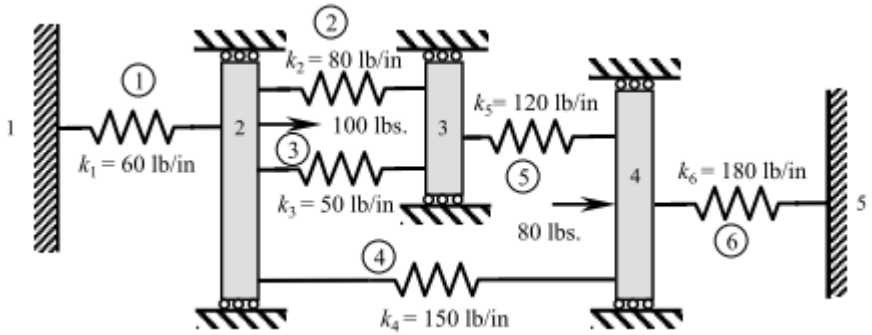

Fig. Q1B

(3+7)

2A. Implement the following logic using CMOS technology.

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

2B. 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.

2C. List the steps involved in the fabrication of microelectronic ICs.

(4+4+2)

3A. Sketch the two common device configuration used in OFETs and explain.

3B. For a circular diaphragm with radius 'a' carries load intensity of 'P' with a shearing force of 'Q', derive an expression for the maximum deflection.

3C. A bi-layer strip is subjected to a uniform temperature rise, T as illustrated in Fig. Q3C. Calculate the radius of curvature and deflection at the free end for a temperature of 50^{o}C. $\alpha_{SiO2} = 0.5x10^{-6}$ / ^{o}C, $\alpha_{Si} = 2.33x10^{-6}$ / ^{o}C.

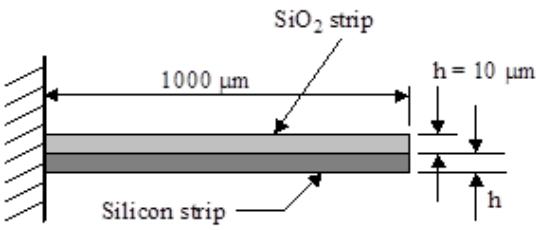

Fig. Q3C

(2+4+4)

4A. A micro device component 5g in mass is attached to a fine strip made of silicon as shown in Fig. Q4A. 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.

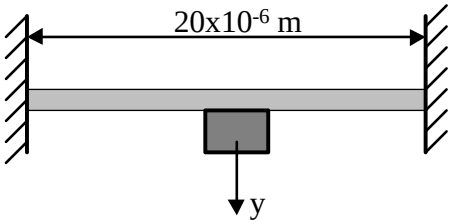

Fig. Q4A

4B. Write a note on acoustic wave sensors.

4C. Explain the working of a micro gyroscope with necessary equations. Also draw the structure of a typical MEMS gyroscope.

(3+3+4)

5A. A cantilever beam shown in Fig. Q5A is used in a micro device. The dimensions are L=1000μm, b=50μm and t= 10μm. A force of 50N is applied at the free end. A p-type piezoresistor with geometry and dimension as shown in figure is placed in the maximum stress region of the cantilever. Assume that the piezoresistor of (100) plane is used and the resistivity of the material is 7.8Ω-cm. Calculate the deflection at the tip and the corresponding change of electric resistance. Assume missing parameters.

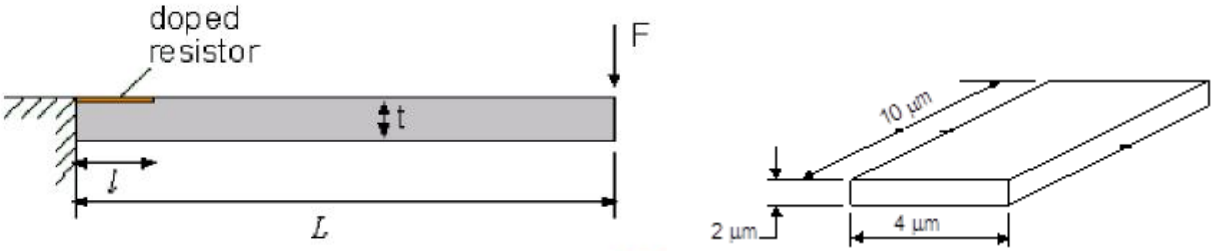

Fig. Q5A

5B. Explain the process of silicon growth from the melt in detail.

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

(5+3+2)

6A. Explain the basics of pattern transfer with necessary sketch and about its performance measurement parameters.

6B. Two vehicles with respective masses, 15000Kg and 12000Kg traveling in opposite directions at velocities 80Km/h and 70Km/h. Estimate the deflection of the proof mass in the sensor in vehicle 1 and also the strain in the two piezoresistors embedded underneath the top and bottom surfaces of the beam near the support after the two vehicles collide. The micro accelerometer dimensions can be used as given in Fig. Q6B. Make necessary assumptions as required.

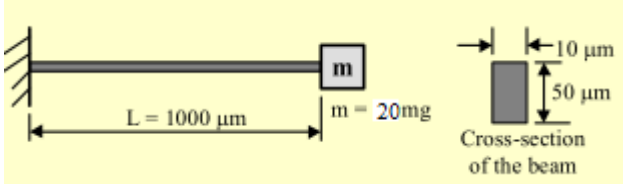

Fig. Q6B

(5+5)