Exam.Code:0976
Sub. Code: 7117

2054
M. Tech. (Microelectronics)
Second Semester
MIC-206: MEMS and Microsystems

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: Attempt <u>five</u> questions in all, including Question No. I which is compulsory and selecting two questions from each Part.

x-x-x

1. a) Define MEMS and Microsystems.
   b) Explain in short the difference between a MEMS thermocouple and thermopile.
   c) Discuss the different applications of LIGA process.
   d) Explain why the packaging of MEMS devices is more complex than microelectronics?
   e) Differentiate between MEMS based microsystems and microelectronics.
   5 x 2 = 10

PART-A

2. a) Estimate the associated changes in the acceleration 'a', time 't' and the power supply to actuate MEMS component if its weight is reduced by a factor of 10. 5
   b) Consider a piezoelectric material 2 μm thick and 200 μm × 200 μm in area. A voltage of 20 V is applied across the film. Calculate the deformation in the direction of the electric field that can be achieved. Also, calculate the value of the maximum force that can be put in a wall preventing the deformation of the material, such as occurs in film embossing. Consider that the film is made of ZnO, $d = 12 \times 10^{-12}\ CN^{-1}$ and $s = 7 \times 10^{-12}$. 5

3. a) Explain with the aid of suitable diagram, the working principle of a MEMS accelerometer. 5
   b) Estimate the number of atoms per cubic centimeter of pure silicon. 5

4. a) In a MEMS RF switch two metal plates $250 \times 250\ \mu m^2$ are driven by a voltage of 9V. Calculate the force required to close the 7 μm gap between them. 5
   b) What are the principal sources of intrinsic stresses induced in microsystems? 5

PART-B

5. a) Estimate the change in resistance in piezoresistors attached to the diaphragm of a pressure sensor when piezoresistive coefficient $\Pi_L = \Pi_T = 0.02\Pi_{44}$ and $\Pi_{44} = 138 \times 10^{-11}\ pa^{-1}$ ($\sigma_L = \sigma_T = \sigma_{Max} = 186.8$ MPa.) 5
   b) Compare the bulk micromachining and surface micromachining. 5

6. A designer has to be deposit a layer of iron in the order of 100 A° for making a MEMS sensor e.g. chemiresistor or any other equivalent sensor. Suggest and explain in detail a microfabrication method/process for this kind of deposition. 10

7. a) A parallel plate capacitor is made of two square plates with the dimensions L=W=1000μm. Determine the normal electrostatic force if the gap between the plates is d=2 μm. The plates are separated by static air. 5
   b) Discuss the process of etching with respect to three principal planes of silicon substrate. 5

x-x-x