Registration No. : | | | | | | | | | | |

Total number of printed pages – 2

B. Tech
PEEI 5405

Eighth Semester Regular Examination – 2015
MICRO-ELECTRO-MECHANICAL SYSTEMS
BRANCH (S) : AEIE, BIOMED, EIE, IEE
QUESTION CODE : J 170

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (a) What are the parameters that significantly influence the rate of Chemical Vapor Deposition (CVD) ?

   (b) List four advantages of polymer over silicon for MEMS device fabrication.

   (c) Name two methods of joining silicon to silicon.

   (d) State Castigliano's first theorem along with its mathematical expression.

   (e) What is Coriolis force ? In which MEMS device is it used ?

   (f) (i) "Gain of a MEMS RF Resonator Oscillator improves if it operates under partial vacuum". Please indicate whether this statement is TRUE or FALSE.

   (ii) Please fill in the blank: Deflection of a loaded MEMS cantilever beam as beam thickness increases.

   (g) What are the relative merits of MEMS varactors over its semiconductor counterpart ?

   (h) Will the gain of a MEMS RF Resonator Oscillator improve if it operates under partial vacuum ? Explain your answer in brief.

   (i) What is a proof mass in the accelerometer ?

   (j) What are the challenges and possible solutions in release etch and dry during processing and packaging of Microsystems ?

2 With the help of suitable diagram, explain the principles of the following fluid flow phenomena : 5 + 5

   (a) Dielectrophoresis (DEP) and

   (b) Electrowetting based fluid flow.

3. (a) Describe the working of a MEMS capacitive accelerometer sensor. 5

   (b) A pressure sensor is to be fabricated on silicon by bulk micro-machining. Explain the process flow (with schematics showing cross-sectional view of the substrate at each stage) 5

4. In this problem you will calculate the deflection of a beam under its own weight. Assume that the beam is a rectangular solid with length 'L', width 'b', and thickness 'a'. Assume that it is made of a uniform isotropic material of density 'ρ', and Young's modulus 'E'.

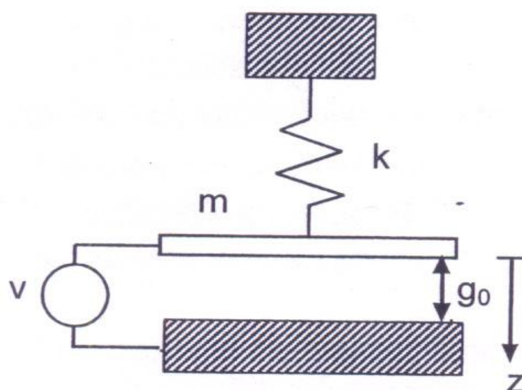
   (a) Calculate M(x), the bending moment as a function of position along the beam. 5

   (b) Calculate y(x), the deflection as a function of position. 5

5. (a) With the help of suitable schematic diagram explain the working principle of an MEMS gyroscope. 5

   (b) What are the purpose of having wafer, structural material and sacrificial material in a typical MEMS fabrication ? 5

6. (a) Show that on application of a voltage the position of the movable plate of a parallel plate capacitor connected with a spring as shown in the Figure below will become unstable when the gap between the movable and fixed plates reduces to two third of the gap at zero applied voltage. 5



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   (b) Describe the two modes of operation of a cantilever sensor. Give one example of application for each mode. 5

7. Discuss the importance of packaging in Microsystems. Compare and contrast with the general requirements for general integrated circuits. 10

8. Write short notes on any **two** of the following : 5×2

   (a) LIGA

   (b) Piezoresistive pressure sensor

   (c) MEMS resonator

   (d) Lab-on-a-chip.