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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50464

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017

Seventh Semester

Electrical and Electronics Engineering

EE 6007 – MICRO ELECTRO MECHANICAL SYSTEMS

(Common to Electronics and Instrumentation Engineering/Instrumentation and Control Engineering/Mechanical Engineering/Mechatronics Engineering/Robotics and Automation Engineering)

(Regulation 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. What is 'drive-in' in the process of doping ?
2. Draw the Young Modulus graph.
3. What are the types of micro actuators ?
4. What is the need of micro grippers ?
5. Define piezoresistive effect.
6. List some industrial applications of Piezoelectric materials.
7. List the advantages of Plasma etching than wet etching.
8. What is LIGA ?
9. List out the polymer MEMS materials.
10. What are the uses of PMMA ?

PART – B **(5×16=80 Marks)**

11. a) i) Explain the Czochralski Growth Process in single-crystal substrates. **(8)**

ii) Derive the torsional moment of inertia of a cylinder. **(8)**

(OR)

b) i) Explain the flexural beam bending. **(8)**

ii) Determine the amplitude and frequency of vibration of a 10-mg mass suspended from a spring with a spring constant $k = 6\times10^{-5}$ N/m. The vibration of the mass is initiated by a small 'pull' of the mass downward by an amount $\delta_t = 5\,\mu m$. **(8)**

12. a) i) A 100-μm long beam is anchored to the substrate at both ends. The temperature of the beam is raised by 300°C. The beam is 2.5 μm thick by 4 μm wide and is made of polysilicon (assume E = 160 GPa and $\alpha_T = 2.5$ microstrain/ °C).

a) Calculate the stress and strain in the beam.

b) Calculate the force and displacement produced in the beam.

c) Is buckling a concern for this beam ? **(8)**

ii) Explain the working of any one thermal actuator with neat diagram. **(8)**

(OR)

b) i) Explain the working of electrostatic rotary micromotors with neat diagram. **(8)**

ii) Explain the working of magnetic actuator with neat diagram. **(8)**

13. a) i) Determine the minimum thickness of the circular diaphragm of a micro pressure sensor made of silicon as illustrated in Figure. The diaphragm has a diameter of 600 μm and its edge is rigidly fixed to the silicon die. The diaphragm is designed to with stand a pressure of 20 MPa without exceeding the plastic yielding strength of 7000 MPa. The silicon diaphragm has a Young's modulus E = 190,000 MPa and a Poisson's ratio v = 0.25.

Figure I A circular diaphragm for a pressure sensor.

(8)

ii) Describe the working principle and circuit diagram of the Tactile Sensor. **(8)**

(OR)

b) i) Discuss on piezoelectric materials. **(8)**

ii) Explain the operation principle of piezoelectric sensor. **(8)**

14. a) i) Illustrate the anisotropic wet etching of cavities in {100}-oriented silicon. **(8)**

ii) Describe the wet etching of crystalline silicon with necessary diagram. **(8)**

(OR)

b) i) Explain the process of deep reaction ion etching (DRIE). **(8)**

ii) Compare the MEMS device capabilities within bulk micromachining, surface micromachining and LIGA fabrication technologies. **(8)**

15. a) Write notes on :

i) Liquid Crystal Polymer (LCP)

ii) PDMS **(16)**

(OR)

b) Discuss about optical lenses and mirrors. **(16)**