Reg. No. : ☐☐☐☐☐☐☐☐☐☐☐☐☐

Question Paper Code : 52937

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Seventh/Eighth Semester

Electrical and Electronics Engineering

EE 6007 — MICRO ELECTRO MECHANICAL SYSTEMS

(Regulation 2013)

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

(Also Common to : PTEE 6007 – Micro Electro Mechanical System for B.E. (Part-
Time) – Sixth Semester – Electrical and Electronics Engineering – Seventh
Semester – Mechanical engineering – Regulation 2014)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the working principle of a piezo resistor to sense the pressure?

2. Which material is the most suitable one for high precision micro fabrication of
    sensors and actuators?

3. A piezoelectric crystal with piezoelectric coefficient 500×10^{-12} m/V undergoes a
    mechanical strain equal to 125×10^{-5} m/m. Calculate the induced voltage per
    meter in the crystal.

4. Why an electrostatic actuator is considered to be superior than an
    electromagnetic actuator?

5. Which MEMS sensor is deployed in the air-bags of car to sense the crash?

6. Write the working principle of a tactile sensor.

7. What type of etching will help to achieve high aspect ratio in MEMS
    fabrication process?

8. Which material is popularly used as the sacrificial layer in surface micro
    machining process?

9.   What are the surface and wetting properties of polymers?

10. Can liquid crystal polymer be used as a substrate? And why?

PART B — (5 × 13 = 65 marks)

11. (a)   Write a detailed technical note on the following :

(i)   Silicon crystal plane and its orientation.

(ii)   Longitudinal strain under pure bending.   (13)

Or

(b)   A polysilicon cuboid with dimensions 2 cm × 2 cm × 3 cm is placed on a surface. A force of 1 mN is applied on the top of surface. Find

(i)   the type of stress and

(ii)   the magnitude of stress induced in the direction of applied force.(13)

12. (a)   Explain in detail the operation of electrostatic micromotor with appropriate sketches.   (13)

Or

(b)   Elaborate on the working principle of an ink jet printer based on electro thermal principle.   (13)

13. (a)   Explain in detail how piezo resistor can be used to measure

(i)   pressure and

(ii)   inertia.   (13)

Or

(b)   Discuss in detail how PZT is used as

(i)   acoustic sensor and

(ii)   ink jet actuator in the printer.   (13)

14. (a)   Write a detailed technical short note on :

(i)   Wet etching and

(ii)   MEMS device fabrication using 3D process.   (6+7)

Or

(b)   (i)   A silicon wafer needs to be etched along < 111 > direction from the surface. Width of the mouth of the slot opening is 30 μm. Depth of the slot is 10 μm, from the mouth's surface.

Compute the width of the inner surface of the slot.   (6)

(ii) Explain the LIGA process and identify anyone device that adopts it.   (7)

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15. (a) Elaborate how parylene is used to build a pressure sensor. (13)

Or

(b) Discuss in detail about any one optical MEMS application. (13)

PART C — (1 × 15 = 15 marks)

16. (a) (i) A thermal bimorph is initially flat where metal 1 is on the top and metal 2 is at the bottom. If its coefficient of thermal expansion (α) is such that $\alpha_1 < \alpha_2$, then in what direction should it bend?

(ii) Barium titanate and Lead zirconate titanate has piezoelectric coefficient as 100 mN and 480 mN respectively. Comment which crystal will produce more mechanical strain due to the electric field. (7+8)

Or

(b) Analyse both the pull-in effect of parallel plate capacitor and the change in the distance between the plates. Hence, prove that the parallel plate capacitor can act as a switch under favourable operating conditions. (15)