QPC: RM17001093 AR - 17 Reg. No. | | | | | | | | | | |

GIET MAIN CAMPUS AUTONOMOUS GUNUPUR – 765022

B. Tech Degree Examinations, May – 2021

(Eighth Semester)

BEIPE 8021 / BPEEC6052 – MICRO ELECTRO MECHANICAL SYSTEMS

(AEI and ECE)

Time: 2 hrs Maximum: 50 Marks

Answer ALL Questions

The figures in the right hand margin indicate marks.

PART – A: (Multiple Choice Questions) (1 x 10 = 10 Marks)

Q.1. Answer ***ALL*** questions

a. Microsystems are basically
   (i) Stationary structures (ii) A pure mechanical system
   (iii) Complex three dimensional (iv) (i) or (ii)

b. Complex patterns with high density of electrical circuitry over substrates are basically
   (i) Microsystems (ii) Microelectronics
   (iii) None of these (iv) All of these

c. A large portion of MEMS applications involves sensors and actuators, collectively known as
   (i) Transducers (ii) Microelectronics Systems
   (iii) Both (a) and (b) (iv) None of these

d. Advanced features for integrated pressure sensors include
   (i) integrated telemetry link (ii) No-loop control
   (iii) Sensitivity to contaminants (iv) None of these

e. micro-opto-electro-mechanical systems and devices (MOEMS), incorporating components such as
   (i) binary optical lens (ii) tuneable filters
   (iii) Both (a) and (b) (iv) None of these

f. Physical sensors are used to measure
   (i) force (ii) concentrations of chemicals
   (iii) protein–protein interactions (iv) All of these

g. Mention the chemical reaction for oxidation process:
   (i) $Si + 2H_2O \rightarrow SiO_2 + 2H_2$ (ii) $Si + O_2 \rightarrow SiO_2$
   (iii) $2Si + 2H_2O \rightarrow 2SiO_2 + 2H_2$ (iv) $2Si + 2H_2O + 2O_2 \rightarrow 2SiO_2 + 2H_2 + O_2$

h. Derive a scaling law for the ratio of surface area and the volume of a cube for MEMS design
   (i) $1/L$ (ii) $A/3L$
   (iii) L^2 (iv) A/L^3

i. Additive MEMS process includes
   (i) Metal evaporation (ii) Reactive ion etching
   (iii) Photolithography (iv) Thermal annealing

j. High-quality silicon-dioxide layer is by reacting silicon wafers with oxygen atoms at high temperatures of
   (i) 375°C and above (ii) 900°C and above
   (iii) 500°C and above (iv) 100°C and above

PART – B: (Short Answer Questions) (2 x 5 = 10 Marks)

Q.2. Answer ***ALL*** questions

a. What is the difference between Micro sensor and Micro actuator?

b. What is Differential capacitance arrangement?

c. A plane intercepts the x-, y-, and z-axes at 2, 3, 4 respectively. Obtain an equation for the plane. Write down the Miller indices for this plane.

d. A longitudinal piezo resistor is embedded on the top surface of a silicon cantilever near the anchored base. The cantilever points in the <110> direction. The piezo resistor is *p*-type doped with resistivity of 7.8 Ω cm. Find the longitudinal gauge factor of the piezo resistor.

e. What is a Face centred Cubic (FCC) structure?

PART – C: (Long Answer Questions) **(6 x 5 = 30 Marks)**

Answer ***ANY FIVE*** questions — Marks

3. With Schematic diagram of a silicon capacitive accelerometer, explain in detail about overview and principle of operation. (6)
4. With Schematic diagram explain about Thermal Oxidation for Silicon Dioxide method in Thin Film Deposition. (6)
5. How Photolithography procedure is carried out in microfabrication? Discuss in detail about Photolithography with suitable diagram. (6)
6. Differentiate between Isotropic Etching and Anisotropic Etching with suitable diagrams. (6)
7. In a cubic crystal like silicon, determine the angle included between (6)

   (i) (100) plane and (111) plane;
   (ii) (100) plane and (101) plane.
8. With appropriate diagram describe about the process of thermal diffusion of Doping. (6)
9. Design a step by step procedure for making a Surface Micro machined Piezo resistive Pressure Sensor. (6)
10. Design a Membrane Parallel-Plate Pressure Sensor with cross sectional diagram representation.

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