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18EC822

Eighth Semester B.E. Degree Examination, July/August 2022

Micro Electro Mechanical Systems

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Explain MEMS as a micro sensor and micro actuator, with neat block diagram. (08 Marks)
- b. Explain with a neat block diagram, the working principle of Intelligent micro system. (06 Marks)
- c. Describe the applications of Microsystems in Aerospace and consumer product industry. (06 Marks)

OR

- 2 a. With a neat figure, explain the role of principal science and Engineering disciplines involved in design and manufacture of a micro system design. (10 Marks)
- b. Explain the difference between MEMS and Micro system. (06 Marks)
- c. Describe the applications of Micro system in Automotive Industry. (04 Marks)

Module-2

- 3 a. Explain the working principles of a common surface Acoustic wave sensor using Piezo electric crystal as transmission medium. (08 Marks)
- b. Explain in detail Pressure Sensors. (08 Marks)
- c. Calculate the capacitance of a parallel plate capacitor. The two plates have identical dimensions of $L = W = 1000\mu\text{m}$ with a gap $d = 2\mu\text{m}$. The air is the dielectric medium. (04 Marks)

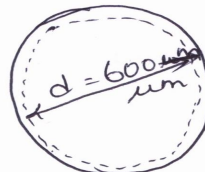
OR

- 4 a. Explain the operating / working principle of : i) Thermocouple ii) Thermopiles. Give relevant Mathematical equations. (08 Marks)
- b. Describe in detail about the Chemical Sensor. (06 Marks)
- c. Explain the working of Microvalves with a neat schematic diagram. (06 Marks)

Module-3

- 5 a. With relevant diagrams, explain the concept of rectangular plate. Write mathematical expressions for bending moment and bending stresses. (08 Marks)
- b. Determine the minimum thickness of the circular diaphragm of a micropressure sensor made of silicon shown in Fig. Q5(b). The diaphragm has a diameter of $600\mu\text{m}$ and its edge is rigidly fixed to the silicon die. The diaphragm is designed to withstand a pressure of 20MPa without exceeding the plastic yielding strength of 7000MPa. Assume Young's modulus. $E = 190.000\text{MPa}$ and Poisson's ratio $\nu = 0.25$. (06 Marks)

Fig. Q5 (b)



- c. Write a short note on Thin – film mechanics. (06 Marks)

OR

- 6 a. Explain the concept of bending of square plates with all edges fixed. Give equation for maximum stress, maximum deflection stress at the centre of the plate and strain at the centre of plate. (06 Marks)
- b. Determine the equivalent spring constant K and the natural frequency W_n of a cantilever beam element in a micro accelerometer shown in Fig. Q6(b). The beam is made of silicon with a Young's modulus of 190.000MPa. (06 Marks)

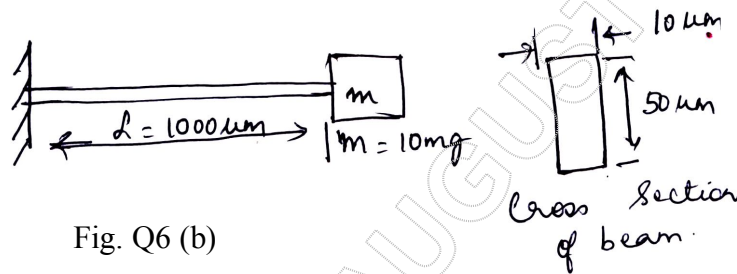


Fig. Q6 (b)

- c. Explain the input information to FEA and output in stress analysis from FEA along with equations. (08 Marks)

Module-4

- 7 a. Derive the expression for scaling Acceleration a , time t and power density P/V , of a system in motion by using Trimmer force scaling vector. (08 Marks)
- b. Explain Scaling in Electrostatic forces with respect to MEMS. (08 Marks)
- c. Derive equations for the effective heat flux, considering gas flow in a micro - channel. (04 Marks)

OR

- 8 a. Derive the expression for scaling of dynamic force. (08 Marks)
- b. Write a short note on :
 i) Scaling of heat flux ii) Scaling in thermal conductivity in sub micro meter regime
 iii) Scaling in effect of heat conduction in solids of MESO and micro – scales.
 Give required equation. (06 Marks)
- c. Derive the expression of scaling in Electricity. (06 Marks)

Module-5

- 9 a. Explain Isotropic and Anisotropic etching process of Bulk Micro manufacturing. (08 Marks)
- b. Give comparison of Wet versus Dry etching process in Bulk Micro manufacturing. (04 Marks)
- c. Demonstrate production of Cantilever beam by Surface Micro Machining Technique. (08 Marks)

OR

- 10 a. Explain the DIRE process and advantages of DIRE process compared with Plasma etching. (10 Marks)
- b. Explain LIGA process used in Micro manufacturing. (10 Marks)

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