Exam Date & Time: 07-Dec-2023 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

VII SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV/DEC 2023

MEMS and Nano Technology [MME 4075]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) Explain components of a microsensor. Discuss any two applications of microsensor used in Automobile. (5)

A)

B) Explain with sketch working of biomedical sensor for measuring glucose concentration. (3)

C) An air-gap capacitor made with two fixed parallel planar plates. At rest (zero bias) the distance between two parallel plates is 100 µm and the areas of the plates are 400 µm x 400 µm. The biasing voltage between these two plates is 5 volts. Calculate the value of capacitance and magnitude of attractive force. What is the capacitance value if half of the area is filled with sea water? (Take relative permittivity of sea water =80). (2)

2) Sketch and explain working of Micropump. (4)

A)

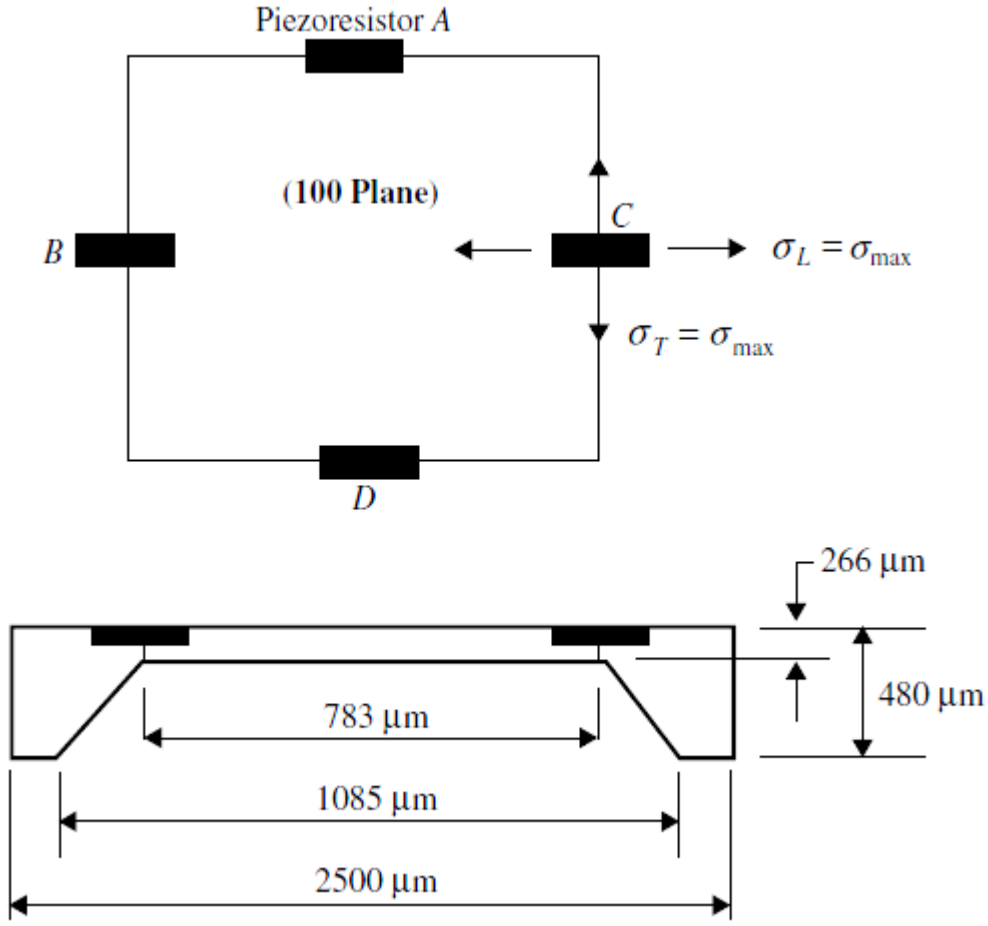
B) Describe the principle of electrostatic actuation and its implementation as comb drive. (3)

C) Determine the amplitude and frequency of vibration of 10 mg mass suspended from a spring with spring constant $6x10^{-5}$ N/m. The vibration of the mass is initiated by a small pull of the mass downward by an amount 5 µm. (3)

3) A square diaphragm used in a micro pressure sensor is as shown in Figure below. The expected maximum applied pressure loading to the micro pressure sensor is 70 MPa. (5)

A) i) Determine the deflection and maximum stress in the diaphragm. (3 marks)
ii) Estimate the change of resistance in piezoresistors attached to the diaphragm of a pressure sensor. (2 marks)
The silicon diaphragm has the following material properties: Young's modulus =190 GPa and Poisson's ratio = 0.25.
The piezoresistive coefficient of silicon at room temperature in < 100> orientation is

$$\pi_{44} = +138.1x10^{-11}\,\text{Pa}^{-1}$$



B) Explain the effect of scaling in electricity. (3)

C) Explain any two mechanical problems associated with bulk micromachining. (2)

4) Sketch and explain the steps involved in LIGA Process involved in making square tube. (5)

A)

B) Describe the role of following materials in MEMS fabrication process. (3)

i) Silicon Carbide

ii) Gallium Arsenide

iii) Quartz

C) Explain the effect of nano-dimensions on Elastic properties of the material. (2)

5) Sketch and explain working principle of Transmission Electron Microscope. (4)

A)

B) Explain with sketch Inert Gas Condensation process of production of metal oxide nano powders. (3)

C) Explain with sketch Arc discharge process of production of carbon nanotubes. (3)

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