MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal)

SIXTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.) END SEMESTER DEGREE EXAMINATION, APRIL/MAY - 2019

SUBJECT: MICRO ELECTRO MECHANICAL SYSTEMS [ICE 4010]

TIME: 3 HOURS

MAX. MARKS: 50

Instructions to candidates : Answer ALL questions and missing data may be suitably assumed.

- 1A Explain the process of silicon growth from melt with necessary sketch.
- 1B Write a note on the types and orientation of silicon wafer.
- 1C Explain about sheet resistance and derive the relation between sheet size and resistance.

(4+3+3)

- 2A Calculate the unknown displacement reactive and element forces for the spring assembly given in Fig.Q2A.
- 2B Write a note on micro chemical sensors.
- 2C A 32 element micro thermopile of Copper/Constantan with a Seebeck coefficient of 38.74 μ V/°C is used to measure 50 °C. Calculate the maximum output.

(5+3+2)

(4+4+2)

- 3A Find the necessary voltage supply for the comb drive structure given in Fig.Q3A to provide a 3 μ m movements at the free end of each of the two arms.
- 3B A bi-layer strip shown in Fig.Q3B is subjected to a uniform temperature rise, T. Calculate the deflection at the free end for a temperature range of $0 40^{\circ}$ C and the maximum deflection. Consider $E_{SiO2} = 385$ GPA, E_{Si}

=190GPA, α_{SiO2} =0.5x10⁻⁶/ °C and α_{Si} =2.33x10⁻⁶/ °C.

3C Write a note on the types of mechanical vibration systems.

4A Calculate and compare the maximum deflection and stress of a circular and square diaphragm pressure sensor with an area of 196250 μ m² and thickness of 60 μ m for an applied pressure of 30MPa. Consider Young's modulus of silicon as 131 GPa and Poison's ratio as 0.27.

- 4B Estimate the change of resistance in silicon piezoresistors attached to the diaphragm of a pressure sensor as given in Fig.Q4B for an applied pressure of 50MPa. Also calculate the output of the Wheatstone bridge with a supply voltage of 10V. Consider E as 190GPa, $\pi_{44} = 138.1 \times 10^{-11} \text{ Pa}^{-1}$, and initial resistance as 2K Ω .
- 5A Discuss the process of photo lithography and its types with necessary figures.
- 5B Explain the process of etching and its classification.
- 5C Write a short note on sputtering.

(5+3+2)

(4+6)







Fig.Q4B

SiO₂ strip h = 10 μm 1000 µm



Fig.Q3B
