

AANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal)

## SIXTH SEMESTER B.TECH. (INSTRUMENTATION & CONTROL ENGG.) END SEMESTER DEGREE EXAMINATIONS, JUNE - 2018

## SUBJECT: MICRO ELECTRO MECHANICAL SYSTEMS [ICE 4010]

Time: 3 Hours

## MAX. MARKS: 50

4

4

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## **Instructions to Candidates:**

- ✤ Answer ALL the questions.
- ✤ Missing data may be suitably assumed.
- 1A. Explain in detail why silicon is preferred in micro fabrication and the process of 6 silicon growth from the melt. Explain in detail.
- 1B. Draw the cross section of a CMOS inverter and explain the working.
- 2A. Implement the following logic using CMOS technology.  $Y = \overline{A.B + C.D}$
- 2B. Calculate and compare the maximum deflection and stress of a circular and square diaphragm pressure sensor with an area of 196250  $\mu$ m<sup>2</sup> and thickness of 60  $\mu$ m for an applied pressure of 50MPa. Young's modulus of silicon is 190 GPa and possion's ratio is 0.27.
- 3A. A bi-layer strip is subjected to a uniform temperature rise, T as illustrated below. 4 Calculate the radius of curvature and deflection at the free end for a temperature of 70°C. Consider  $E_{Sio2} = 385$ GPa,  $E_{Si} = 190$ GPa and  $\alpha_{SiO2} = 0.5 \times 10^{-6}$  / °C,  $\alpha_{Si} = 2.33 \times 10^{-6}$  / °C.



- 3B. Discuss the effect of surface to volume ratio and write a note on scaling effect of 4 Spring Constant.
- 3C. Explain any two working principles of a micro chemical sensor.
- 4A. A micro device component 5g in mass is attached to a fine strip made of silicon as shown in figure. The equivalent beam spring constant  $k_{eq}$  is 18240 N/m. The mass is pulled down by 5 µm initially and is released at rest. Determine (a) the natural frequency of the device and the maximum amplitude of vibration.



4B. Estimate the change of resistance in silicon piezoresistors attached to the diaphragm of a pressure sensor as shown below for an applied pressure of 50MPa. Consider E as 190GPa and  $\pi_{44} = 138.1 \times 10^{-11} \text{ Pa}^{-1}$ .



4C. Write a note on thermal oxidation.

5A.	Explain the basics of pattern transfer with necessary sketch and about its performance	5
	measurement parameters.	
5B.	Explain the process of etching and its classification.	3

5C. Write a short note about lift-off technique.

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