



- **KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Few of the characteristics of generic sensor system are rather very much identical. Justify that these are unique by defining and providing a brief note on each of the following:
 - i) True Value and Measured Value
 - ii) Accuracy and Precision
 - iii) Dead Time and Dead Zone
 - iv) Span and Range
2. An accelerometer, connected to an automobile, is working based on a differential capacitive sensing mechanism where two capacitors are connected in parallel with one common central plate connected to a tether. The length and width of the plates are $10\ \mu\text{m}$ and $5\ \mu\text{m}$. The plates are kept $4\ \mu\text{m}$ apart in each case. The tether moves in such a way that it shifts the central plate by $4\ \mu\text{m}$ for $3\ \text{g}$ acceleration. Calculate the voltage, capacitance and difference in the voltage across the capacitor plates when the vehicle experiences $3\ \text{g}$ acceleration. (Take $\epsilon_0 = 8.85 \times 10^{-12}\ \text{F/m}$; excitation voltage as $2\ \text{V}$).
3. (a) Explain with a neat schematic diagram, how temperature compensation circuits work for a Wheatstone bridge configuration? **[5]**
(b) The impedance of the basic AC bridge as shown in figure 1 below are given **[5]**
 $Z_1 = 210\ \Omega$, $\theta_1 = 70^\circ$; $Z_2 = 400\ \Omega$, $\theta_2 = -60^\circ$, $Z_3 = 300\ \Omega$, $\theta_3 = 0^\circ$ and $Z_4 = 600\ \Omega$, $\theta_4 = 30^\circ$. Determine whether it is possible to balance the bridge under this condition.

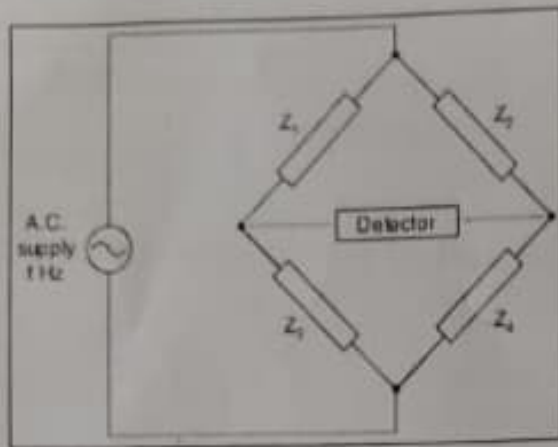


Figure 1

4. Elaborate the technique involved in the fabrication of the nano-structures shown in Figure 2 and explain the steps involved in fabrication of the same.

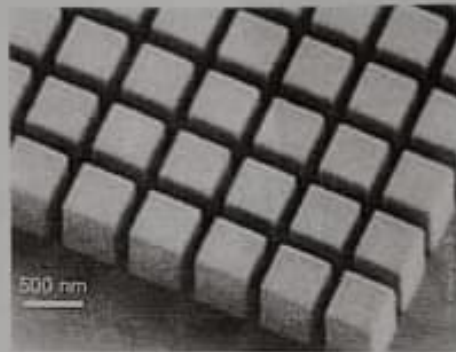


Figure 2

5. Describe in detail the different types of Immobilization techniques adopted for Biosensing applications.
6. Explain the concept of Smart Sensors and elaborate the essential components of the same with a neat diagram.
7. Highlight the essential elements of Smart cities and explain with suitable schematic/block diagrams.
8. (a) A Hall sensor made from n-type silicon has been doped to a level of $9 \times 10^{16} \text{ cm}^{-3}$. If its thickness is $11 \mu\text{m}$, the current is 1.5 mA , and the magnetic field is 0.7 T , find the sensor's output voltage V_H . [5]
- (b) A capacitive sensor with its plate separation of 0.25 mm under static condition has a capacitance of $14 \times 10^{-2} \text{ F}$. Find the displacement which causes a capacitance of 1.75×10^{-2} (Take $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$). [5]

- 9.(a) Highlight briefly the working principle of a Fibre Optic sensor using fibre Bragg Grating (FBG) principle and elaborate its use in distributed pressure measurement for structural monitoring when embedded within a bridge structure.

OR

- 9.(b) A force applied on a cantilever beam of length 11 cm is measured using two strain gages (as shown in figure 3). Strain gauge-1 is mounted on top side of the cantilever with a gage factor of 5 and strain gauge-2 is mounted on bottom side of the cantilever and has a gage factor of 2. Each sensor has an unstrained resistance of $120\ \Omega$. Two strain gages are connected in series across a dc battery of 6 V. If the force applied on the cantilever produces a deformation of $10\ \mu\text{m}$ in the cantilever beam, determine the strain developed in each strain gage, voltage produced across each strain gage also find the percentage change in resistance in each strain gage.

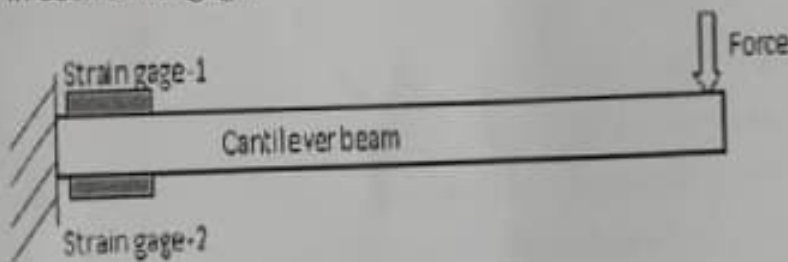


Figure 3

- 10.(a) Explain any four properties of materials at nanoscale. Why are the properties of nano-structured materials different from those of their bulk counterparts?

OR

- 10.(b) i) Identify an advanced sensor which can be used to detect changes in optical intensities and mention the sensing material used in it. Suggest and describe any two applications based on this sensor. [6]
- ii) Highlight the properties of any 4 metals which may be used for the development of sensors. [4]

Y/K/TX