

**SENSORS & TRANSDUCERS**  
**(AEIE 2102)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group – A**  
**(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) In case of a coaxial cylindrical type capacitive level measurement system, with increase in liquid level, capacitance will  
(a) increases (b) decreases linearly  
(c) decreases exponentially (d) remains constant
- (ii) An LVDT has a secondary voltage of 4 V for a displacement of  $\pm 10$  mm. The modulated output voltage for a core displacement of  $-6$  mm from its central position is  
(a)  $-2.4$  V (b)  $2.4$  V  
(c)  $-1.6$  V (d)  $1.6$  V
- (iii) Example of natural piezoelectric crystal material is  
(a) Lithium Sulphate (b) Barium Titanate  
(c) Ammonium di-hydrogen Phosphate (d) Rochelle salt
- (iv) For piezoelectric crystal 'd' coefficient is related to 'g' coefficient by the relationship  
(a)  $d = \frac{\epsilon_0 \epsilon_r}{g}$  (b)  $d = \epsilon_0 \epsilon_r g$   
(c)  $d = \epsilon_0 \epsilon_r + g$  (d)  $d = 2\epsilon_0 \epsilon_r g$
- (v) In a capacitive type differential pressure measurement system, the pressure sensing element is  
(a) bourdon tube (b) bellow  
(c) diaphragm (d) none of these
- (vi) A parallel combination of thermocouples is used for the measurement of  
(a) small temperature differences between two junctions  
(b) large temperature differences between two junctions  
(c) average temperature of a number of points  
(d) all of these

- (vii) Which arrangement has the capability to measure the temperature of a stationary or moving object?  
(a) Thermocouples (b) Thermistors  
(c) Total radiation pyrometer (d) Resistance temperature detector
- (viii) In resistive potentiometer with increase in meter resistance  
(a) linearity and sensitivity both increase  
(b) linearity decreases but sensitivity increase  
(c) linearity increases but sensitivity decrease  
(d) linearity and sensitivity both decrease
- (ix) Which of the following optical transducer is an active transducer?  
(a) photo-emissive cell (b) photo-diode  
(c) photo-transistor (d) photo-voltaic cell
- (x) A 10 cm by 10 cm surface has a coefficient of heat transfer of  $0.4 \text{ W/cm}^2 \text{ } ^\circ\text{C}$ . How much heat is transferred if the temperature difference is  $50 \text{ } ^\circ\text{C}$ ?  
(a) 1000 W (b) 2000 W  
(c) 200W (d) 4000 W

### **Group – B**

2. (a) For the measurement of displacement by resistive potentiometer the output voltage indicated by the voltmeter is less than the true voltage. Give the reason and also justify this statement by showing necessary calculations.
- (b) A strain gauge having nominal resistance 100 ohms and gauge factor 2 is connected to one arm of a Wheatstone bridge. In unstrained condition all the arm resistances are same. The strain gauge is cemented on a beam. As a result of the bending of the beam the strain gauge is strained and the unbalance voltage of the bridge is 2.5 mV. The supply voltage of the bridge is 8 volt. Find the change in resistance of the strain gauge. Also find the strain experienced by it.

$$(2 + 5) + 5 = 12$$

3. (a) How does a capacitive microphone work?
- (b) Draw the phase sensitive demodulator circuit for LVDT to make the core displacement direction sensitive. Hence draw the graph of output voltage against the core displacement for the position of the core above null, below null and at null.

$$6 + (3 + 3) = 12$$

### **Group – C**

4. (a) For piezoelectric force transducer establish the relationship between the output voltage and the crystal voltage sensitivity. Hence show how is crystal charge sensitivity related to crystal voltage sensitivity?

- (b) A Barium titanate piezoelectric pickup has dimension of 6mm x 6mm x 1.5 mm and a voltage sensitivity of 0.012 Vm/N. Relative permittivity of the barium titanate is 1400 and modulus of elasticity of the barium titanate is  $12 \times 10^{10}$  N/m<sup>2</sup>. The force applied to the pickup is 10N. Determine
- (i) the output voltage
  - (ii) charge sensitivity
  - (iii) strain
  - (iv) charge generated and the capacitance of the pickup.

**(3 + 3) + 6 = 12**

5. (a) What is Villari effect? How is torque measured by magnetostrictive transducer?
- (b) What are Hall Effect and Hall field? How displacement is measured by Hall Transducer?

**(2 + 4) + (3 + 3) = 12**

### **Group – D**

6. (a) Draw the schematic diagram for connection of 3-wire RTD. Explain why 3- wire RTD is advantageous over 2-wire RTD with necessary calculation.
- (b) In a two wire RTD installation using Pt<sub>100</sub> RTD, if the lead wire resistance per leg is 5Ω, calculate the measured temperature if actual temperature is 200°C. Assume the temperature coefficient as 0.385Ω/ Ω °C for PT<sub>100</sub> RTD.
- (c) What is thermowell and where is it used?

**(2 + 5) + 2 + 3 = 12**

7. (a) For a certain thermistor,  $\beta=3140$  K and the resistance at 27°C is known to be 1050Ω. The thermistor is used for temperature measurement and the resistance measured is as 2330Ω. Calculate the measured temperature.
- (b) State & explain the different laws associated with the operation of thermocouple.
- (c) Write a short note on Optical Pyrometer.

**4 + 4 + 4 = 12**

### **Group – E**

8. (a) Explain the principle of operation of ultrasonic level detectors and compare the merits and demerits of different mountings of the sensor.
- (b) Explain the principle of operation of photodiode? What are the main features of photodiode?

**(4 + 2) + (3 + 3) = 12**

9. Write short notes of *any two* of the followings:

**2 × 6 = 12**

- i) Scintillation detectors
- ii) Geiger Counters
- iii) Photomultiplier tube.

Department & Section	Submission Link
AEIE	<a href="https://classroom.google.com/c/MTg0NDU2Njg0MDY1/a/MjcwOTk4OTA1MDkw/details">https://classroom.google.com/c/MTg0NDU2Njg0MDY1/a/MjcwOTk4OTA1MDkw/details</a>