

**SENSORS AND TRANSDUCERS**  
**(AEI2104)**

**Time Allotted : 2½ hrs**

**Full Marks : 60**

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

*Candidates are required to answer Group A and  
any 4 (four) from Group B to E, taking one from each group.*

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

**Group – A**

1. Answer any twelve:

**12 × 1 = 12**

*Choose the correct alternative for the following*

- (i) A dummy strain gauge is used to
  - (a) improve the stability of the sensor system
  - (b) increase the sensitivity of measurement
  - (c) compensate ambient temperature variation
  - (d) all of the above.
- (ii) A translational wire wound resistive potentiometer has 125 turns per cm. Its resolution is
  - (a) 0.12 cm
  - (b) 0.008 cm
  - (c) 0.125 cm
  - (d) 0.08 cm
- (iii) Which of the following is the example of active strain gauge?
  - (a) LVDT
  - (b) Thermocouple
  - (c) Resistive potentiometer
  - (d) Strain gauge.
- (iv) The charge amplifier is most appropriate signal conditioning unit for
  - (a) LVDT
  - (b) LDR
  - (c) Piezoelectric transducer
  - (d) Potentiometer
- (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) The RTD, assigned  $PT_{100}$ , refers to
  - (a)  $100\Omega$  at  $100^{\circ}\text{C}$
  - (b)  $100\Omega$  at  $0^{\circ}\text{C}$
  - (c)  $0\Omega$  at  $0^{\circ}\text{C}$
  - (d)  $0\Omega$  at  $100^{\circ}\text{C}$
- (vii) Which of the following devices is used to measure relatively high temperatures, such as encountered in furnaces?
  - (a) Bolometer
  - (b) Pyrometer
  - (c) Ammeter
  - (d) Flux meter.

- (viii) Thermocouple works on  
 (a) Peltier Effect (b) Kelvin Effect  
 (c) Joule's Effect (d) Seebeck Effect.
- (ix) Which of the following is not a type of radiation detectors?  
 (a) Geiger Muller counter (b) Proportional counter  
 (c) Semiconductor detector (d) Flame emission detector.
- (x) Which one of the following materials would be used for making an LDR?  
 (a) Lead Sulphide (b) Pure Aluminium  
 (c) Iron Ore (d) Aluminium Oxide.

*Fill in the blanks with the correct word*

- (xi) A resistive potentiometer having total resistance  $100\Omega$ , total length 100mm, input voltage 5v, gives output voltage 1.75 v for the input displacement \_\_\_\_\_.
- (xii) The expression of gauge factor for a strain gauge is \_\_\_\_\_.
- (xiii) Resistance of the thermistors varies \_\_\_\_\_ with temperature.
- (xiv) The materials with \_\_\_\_\_ lattice structure show piezoelectric effect.
- (xv) Photoconductors are the devices whose \_\_\_\_\_ changes with change in light intensity.

### Group - B

2. (a) Find out the output voltage of the Wheatstone Bridge for an active strain gauge connected to one arm of it. [[C05](Analyse/IOCQ)]
- (b) A strain gauge having nominal resistance  $100\Omega$  and gauge factor 2.2 is cemented on a steel bar having modulus of elasticity  $205 \times 10^6 \text{ KN/m}^2$  and cross sectional area  $6.5 \text{ cm}^2$ . It is connected to one arm of Wheatstone Bridge having supply voltage 8.5 v. Find the applied force for the bridge output 0.65 mv. [[C02](Evaluate/HOCQ)]
- (c) How weight of vehicle is measured by column type load cell? [[C04](Remember/LOCQ)]
- 5 + 4 + 3 = 12**
3. (a) Design the schematic diagram of LVDT. Explain the construction and operation of it for the measurement of linear displacement. Also draw the characteristic curve of it for measuring displacement. [[C01](Understand/LOCQ)]
- (b) An LVDT is used for measuring the deflection of a bellows element. The sensitivity of LVDT set up is 8 v per mm. The bellows element is deflected by 0.15mm by a pressure of  $0.2 \times 10^6 \text{ N/m}^2$ . Determine the sensitivity of the LVDT in V per  $\text{N/m}^2$  and the pressure when the voltage output of LVDT is 2.5v. [[C02](Evaluate/HOCQ)]
- (c) How inductive transducer is used to measure displacement on the basis of variation of permeability of the magnetic circuit? [[C02](Analyze/IOCQ)]
- (1 + 3 + 1) + 4 + 3 = 12**

### Group - C

4. (a) Define piezoelectric effect. State example of one natural crystal and one synthetic crystal that shows piezoelectric effect. [[C01](Remember/LOCQ)]  
(b) Use of charge amplifier makes the measurement independent of transducer and cable capacitance of piezoelectric transducer. Explain it with necessary circuit diagram and find out the expression for output voltage. [[C05](Analyse/IOCQ)]  
(c) Explain operation of piezoelectric microphone with necessary schematic diagram. [[C04](Understand/LOCQ)]  
**(2 + 2) + (2 + 3) + 3 = 12**
5. (a) State the law associated with Hall effect. Hence derive the expression for Hall voltage. [[C02](Understand/LOCQ)]  
(b) Design a scheme to measure rotational speed of a rotating wheel using hall sensor. Hence find the expression for the RPM. [[C02](Analyse/IOCQ)]  
(c) A Hall Effect element used for measuring a magnetic flux density gives an output voltage of 12.5 mV. The element is made up of silicon and is 4.5 mm thick and carries a current of 5 A. The Hall coefficient is  $4.1 \times 10^{-6} \text{ Vm A-Wb/m}^2$ . Find out the magnetic flux density. [[C03](Evaluate/HOCQ)]  
**(1 + 3) + (3 + 2) + 3 = 12**

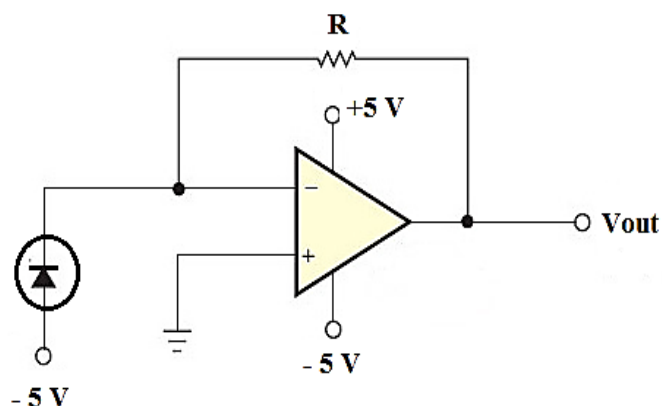
### Group - D

6. (a) An RTD having resistance 100 ohms at 0°C is connected to an arm of a Wheatstone bridge circuit having supply voltage 5 Volt. Each of the other three resistances is 100ohms. The bridge circuit is connected to an amplifier having gain 10. What will be the amplified voltage output for the temperature 120°C? The temperature coefficient of the RTD material is  $0.00385/^{\circ}\text{C}$ . [[C06](Evaluate/HOCQ)]  
(b) Construct a wire wound type RTD. What should be the properties of RTD material? [[C03] (Remember/LOCQ)]  
(c) Mention and explain one application of PTC type thermistor. [[C03] (Apply/IOCQ)]  
**5 + (2 + 2) + 3 = 12**
7. (a) Explain operation of optical pyrometer with suitable schematic diagram. [[C04](Analyse/IOCQ)]  
(b) Propose a hardwire scheme to identify a thermocouple with broken wire. [[C06](Create/HOCQ)]  
(c) For a certain thermistor,  $\beta = 4000 \text{ K}$  and the resistance at 25°C is known to be 10 KΩ. The thermistor is used for temperature measurement and the resistance measured is as 990Ω. Calculate the measured temperature. [[C02](Apply/IOCQ)]  
(d) What do you mean by dissipation constant of RTD as 25-mW/°C? [[C03](Apply/IOCQ)]  
**3 + 3 + 4 + 2 = 12**

### Group - E

8. (a) Explain operation of photodiode using necessary diagram. [[C01](Remember/LOCQ)]

- (b) LDR shows a non-linear response between light intensity and resistance. Show a scheme to make the response fairly linear. [[CO4](Apply/HOCQ)]
- (c) The responsivity of a photo diode shown in the Fig. 1 is 0.9A/W. Evaluate the value of R to obtain output voltage (Vout) of -1V for an incident optical power of 1 mW. [[CO4](Apply/IOCQ)]



**Fig. 1**

$$5 + 2 + 5 = 12$$

9. (a) Describe operation of Geiger-Mueller counters with necessary schematic diagram. [[CO1](Analyse/HOCQ)]
- (b) Draw the driver circuit for LED. Hence find the expression for series resistance in terms of LED specifications. [[CO4](Remember/LOCQ)]
- (c) Explain operation of bi-colour LED. [[CO3](Apply/IOCQ)]

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

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.34	39.58	27.08