# 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) Strain gauge is used to measure
(a) Stress (b) Force
(c) Pressure (d) All of the above

(ii) An LVDT has a secondary voltage of 4 V for a displacement of ±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) An LVDT gives secondary voltage 4.5 V for ±10.5 mm displacement. The demodulated output voltage for -6 mm from the central position is
(a) 2.57 V (b) 3.52 V
(c) 1.25 V (d) -2.57 V

(iv) Hall effect is clearly visible in
(a) Pure conductors (b) Semiconductors
(c) Insulators (d) Ceramic materials

(v) In capacitive type microphone, the capillary tube is used to
(a) Equalize pressure to the diaphragm
(b) Reduce deflection of the diaphragm
(c) Get steady output
(d) Minimize error in measurement

(vi) Which of the following transductions is done by the Hall Effect device as a transducer?
(a) Humidity to resistance (b) Magnetism to voltage
(c) Temperature to voltage (d) Light to resistance

(vii) Piezoelectric transducers are generally used for measuring:
(a) Static pressure
(b) Constant temperature
(c) Dynamic force, pressure, and vibration
(d) Steady-state displacement

(viii) The RTD, assigned $PT_{100}$, refers to
(a) 100Ω at 100°C (b) 100Ω at 0°C
(c) 0Ω at 0°C (d) 0Ω at 100°C

(ix) Thermocouple works on
(a) Peltier Effect (b) Kelvin Effect
(c) Joule's Effect (d) Seebeck Effect

(x) Which of the following is not a part of a smart sensor?
(a) Transducer (b) Network interface
(c) Processor (d) Display

*Fill in the blanks with the correct word*

(xi) The suitable signal conditioning circuit to make LVDT direction sensitive is _____.

(xii) Piezo-resistive effect is prominent in _____ type strain gauge.

(xiii) Working of hall sensors are based on the force on charge carriers arise from _____ force.

(xiv) Name of the temperature measuring instrument that consider energy associated with a particular wavelength in the range of visible light is _____.

(xv) Photo diode operates in _____ condition.

## Group - B

2. (a) With the help of a suitable schematic diagram, explain the working principle of a metal detector that operates on the basis of inductive transduction. *[(CO4)(Apply/IOCQ)]*

(b) Using strain gauges as the sensing elements, design a weighing machine with the required signal conditioning circuit. *[(CO5)(Evaluate/HOCQ)]*

(c) Draw the modulated and demodulated characteristics of LVDT. *[(CO4)(Understand/LOCQ)]*

**4 + 5 + 3 = 12**

3. (a) Define Repeatability and Fidelity. A RTD is used to measure temperature from -10°C to 550°C and corresponding resistance of the RTD 96 Ω and 297 Ω. Find the input and output span of RTD. *[(CO2)(Understand/LOCQ)]*

(b) Explain how LVDT can be used to measure both positive and negative gauge pressure with necessary schematic diagram. *[(CO3)(Apply/IOCQ)]*

(c) Draw the schematic for the flat grid type strain gauge. Name one strain gauge material. *[(CO2)(Remember/LOCQ)]*

**(2 + 2) + 5 + (2 + 1) = 12**

## Group - C

4. (a) With a neat diagram explain the operation of a capacitive type microphone. *[(CO3)(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. *[(CO5)(Analyse/IOCQ)]*

   (c) How differential pressure can be measured using capacitive transducer? *[(CO2)(Understand/LOCQ)]*

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

5. (a) Define charge sensitivity and voltage sensitivity for piezoelectric transducer. Hence find the relation between them. *[(CO2)(Understand/LOCQ)]*

   (b) Draw the schematic of a ultrasonic transducer. State the function of wear plate. *[(CO1)(Understand/LOCQ)]*

   (c) Why do piezoelectric bimorph or multimorph is connected in parallel for sender type transducers? *[(CO3)(Analyse/IOCQ)]*

**(1 + 4) + 4 + 3 = 12**

## Group - D

6. (a) State the law of intermediate metal of thermocouple? *[(CO1)(Remember/LOCQ)]*

   (b) Draw the measuring circuit for the thermocouple. Why do it is necessary for cold junction compensation of thermocouple? *[(CO2)(Analyse/LOCQ)]*

   (c) Discuss various types of thermowell with their relative advantages and disadvantages. *[(CO5)(Analyse/IOCQ)]*

**2 + (2 + 2) + 6 = 12**

7. (a) Explain operation of total radiation pyrometer with suitable schematic diagram. *[(CO4)(Analyse/IOCQ)]*

   (b) Propose a hardwire scheme to identify a thermocouple with broken wire. *[(CO6)(Apply/IOCQ)]*

   (c) For a certain thermistor, $\beta = 4000$ 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. *[(CO2)(Apply/IOCQ)]*

   (d) What do you mean by dissipation constant of RTD as 25-mW/°C. *[(CO3)(Apply/IOCQ)]*

**3 + 3 + 4 + 2 = 12**

## Group - E

8. (a) Design a switching circuit using LDR to switch ON/OFF a light based on ambient light condition. *[(CO6)(Create/HOCQ)]*

   (b) How do ionisation chamber can be used to measure vacuum pressure? State the relation between ionisation current and pressure. *[(CO3)(Analyse/IOCQ)]*

   (c) State the features of a smart sensor. *[(CO2)(Remember/LOCQ)]*

**5 + 5 + 2 = 12**

9. (a) Design a speedometer to measure angular speed of a rotating wheel using optical detector. *[(CO3)(Create/HOCQ)]*

(b) Describe operation of proportional counter with necessary schematic diagram. *[(CO4)(Analyse/IOCQ)]*

(c) State the principle MEMS magnetometer. *[(CO4)(Remember/LOCQ)]*

**5 + 5 + 2 = 12**

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| Cognition Level | LOCQ | IOCQ | HOCQ |
|---|---|---|---|
| Percentage distribution | 37.5 | 46.88 | 15.62 |