FUNDAMENTALS OF SENSORS AND TRANSDUCERS
(AEIE 3221)

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) The sensitivity of a potentiometric transducer is defined as
(a) Output voltage per unit displacement
(b) Input voltage per unit displacement
(c) Output current per unit displacement
(d) None of the above

(ii) The gauge factor in a strain gauge is given by
(a) $(\Delta R/R)/(\Delta L/L)$ (b) $(\Delta L/L)/(\Delta R/R)$
(c) $R \times L$ (d) L/R

(iii) The working principle of an LVDT is based on
(a) Capacitance change (b) Inductance change
(c) Piezoelectric effect (d) Resistance change

(iv) Working of capacitive microphone is based on change in
(a) Distance between plates (b) Dielectric medium
(c) Overlapping area between plates (d) None of these

(v) Ultrasonic transducer uses sound frequency
(a) Below 20 Hz (b) Between 20 Hz to 10 kHz
(c) Between 10 kHz to 20 kHz (d) Above 20 kHz

(vi) Which of the following is synthetic crystal that shows piezoelectric effect?
(a) Quartz (b) Tourmaline
(c) Rochelle Salt (d) Lead Zirconate Titanate

(vii) A PT_{100} RTD has resistance of
(a) 100 Ω at 100°C (b) 100 Ω at 0°C
(c) 0 Ω at 0°C (d) 0 Ω at 100°C

(viii) Working principle of a thermocouple is based on
(a) Seebeck Effect (b) Peltier Effect
(c) Villari Effect (d) Joule's Effect

(ix) Which of the following acts as quenching gas in Geiger Muller counter?
(a) Alcohol (b) Argon gas
(c) Krypton (d) Hydrogen

(x) Operation of photodiode is confined in which quadrant of the diode V-I characteristics?
(a) 1^{st} (b) 2^{nd} (c) 3^{rd} (d) 4^{th}

Fill in the blanks with the correct word

(xi) The strain gauge measures strain by detecting variations in _____.

(xii) Ultrasonic sensors are widely used for measuring _____ in tanks and pipelines.

(xiii) Cold junction compensation in thermocouples helps to correct errors due to _____ variations.

(xiv) Thermistors exhibit a _____ relationship between resistance and temperature.

(xv) Photo diode operates in _____ biased condition.

Group - B

2. (a) Differentiate between a sensor and a transducer. *[(CO1)(Understand/LOCQ)]*
(b) For of a strain gauge, build a relationship of gauge factor with Poisson's ratio and piezoresistive coefficient? *[(CO2)(Analyse/IOCQ)]*
(c) In a full bridge, how many strain gauges are used? Derive the expression of sensitivity of a full bridge configuration employing strain gauge(s). *[(CO2)(Analyse/IOCQ)]*

2 + 4 + (1 + 5) = 12

3. (a) How LVDT can be used to measure both pressure above and below the atmospheric pressure? *[(CO3)(Analyse/IOCQ)]*
(b) What is residual voltage? State the causes of residual voltage appeared in LVDT. *[(CO3)(Analyse/IOCQ)]*
(c) Describe the input-output characteristics of LVDT. *[(CO3)(Understand/LOCQ)]*

4 + (1 + 2) + 5 = 12

Group - C

4. (a) Explain principle of working of a capacitive transducer that can be used to measure displacement by changing position of dielectric. Hence show that change in capacitance is function of displacement of the dielectric. *[(CO2)(Analyse/IOCQ)]*
(b) Draw a circuit that can be used to measure the change in capacitance. *[(CO1)(Analyse/IOCQ)]*

(c) Define piezoelectric effect and state two materials shows the piezoelectric effect. *[(CO1)(Remember/LOCQ)]*

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

5. (a) Draw the equivalent circuit of the piezoelectric transducer. Hence find the transfer function of the transducer. *[(CO3)(Analyse/IOCQ)]*

(b) Explain operation of capacitive microphone with necessary schematic diagram. *[(CO6)(Analyse/IOCQ)]*

(c) What do you mean by magnetostriction? Name an application of it. *[(CO1)(Remember/LOCQ)]*

(2 + 4) + 4 + (1 + 1) = 12

Group - D

6. (a) Which metal is used widely for RTDs? What is the temperature coefficient of RTD? Compare 3-wire and 4-wire RTDs. *[(CO3)(Understand/LOCQ)]*

(b) What is meant by cold junction compensation of thermocouple? Describe one technique for cold junction compensation. *[(CO4)(Analyse/IOCQ)]*

(1 + 2 + 3) + (3 + 3) = 12

7. (a) Which temperature sensor is best for keeping an eye on the motherboard or CPU temperature? State two features of the sensor you mentioned. *[(CO4)(Apply/IOCQ)]*

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

(c) A semiconductor sensor has a sensitivity of $10\ mV/°C$. If the sensor output is $0.75V$, determine the corresponding temperature. *[(CO4)(Apply/IOCQ)]*

(d) State the material composition of any one base metal type and one noble metal type thermocouple. *[(CO2)(Apply/IOCQ)]*

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

Group - E

8. (a) What do you mean by threshold frequency of a photo emissive material? Draw the graph for photo electric current vs. anode potential considering three different incident light intensity and explain the same. *[(CO2)(Analyse/IOCQ)]*

(b) Explain operation of an Ionisation Chamber with necessary schematic diagram. Also find the expression for ionisation current of the device. *[(CO6)(Analyse/IOCQ)]*

(2 + 2 + 2) + (4 + 2) = 12

9. (a) Describe working of a LED with necessary schematic diagram. Hence draw the characteristics of LED. *[(CO2)(Analyse/IOCQ)]*

(b) State the features of smart sensor with necessary explanation. *[(CO5)(Remember/LOCQ)]*

(c) State the working of bi-colour LED. *[(CO2)(Apply/IOCQ)]*

(4 + 2) + 4 + 2 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23.96	76.04	0