

**Group - E**

8. (a) Explain the principle of working of light dependent resistors. Draw its typical spectral response characteristics.
- (b) What do you mean by 'dark resistance' of photo resistor?
- (c) Mention two applications of photo-conductive cells?
- (d) A photovoltaic cell produces a voltage of 0.33 V on open circuit when illuminated by 10 W/m<sup>2</sup> radiant incidence. When a load of 100 Ω is connected to the cell, a current of 2.2 mA is delivered at that intensity. Calculate the internal resistance of the cell.

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

9. (a) What is Geiger counter?
- (b) What are 'Geiger discharge' and 'dead time'?
- (c) What is Doppler effect?
- (d) With a suitable diagram, explain the use of an ultrasonic sensor to measure the velocity of a flowing liquid.

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

**SENSORS AND 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 strain gauge signal conditioning unit, it is necessary to use dummy gauge for temperature compensation in \_\_\_\_\_ configuration.  
 (a) quarter bridge (b) half bridge  
 (c) full bridge (d) quarter, half and full bridge
- (ii) With the increase of load resistance for a potentiometer type transducer  
 (a) linearity increases and sensitivity decreases  
 (b) linearity decreases and sensitivity increases  
 (c) linearity and sensitivity increases  
 (d) linearity and sensitivity decreases.
- (iii) Match the following
- |                        |                         |
|------------------------|-------------------------|
| A. LVDT                | 1. Dielectric           |
| B. Strain Gauge        | 2. Self generating type |
| C. Capacitive          | 3. Inductive            |
| D. Piezo-electric      | 4. Resistive            |
| (a) A-2, B-4, C-3, D-1 | (b) A-3, B-4, C-2, D-1  |
| (c) A-4, B-3, C-2, D-1 | (d) A-3, B-4, C-1, D-2. |
- (iv) The primary winding of the LVDT is excited by a 6.3 V, 2 kHz ac signal. It produces 5.2 V for range of ±0.5 inch of core displacement. When the core is at -0.25 inch from the null position, the modulated output will be  
 (a) 2.08 V (b) -2.08 V (c) 2.6 V (d) -2.6 V.
- (v) A piezoelectric crystal having a thickness of 2 mm and a voltage sensitivity of 0.1 Vm/N. when it is subjected to a pressure of 30 kN/m<sup>2</sup>, the voltage developed in the crystal would be  
 (a) 3 V (b) 6 V (c) 15 V (d) 0.07 V.

- (vi) Thermocouples are  
 (a) active transducers  
 (b) passive transducers  
 (c) both active transducers and passive transducers  
 (d) inverse transducers.
- (vii) Reference junction compensation in thermocouples can be provided through use of  
 (a) hardware only (b) software only  
 (c) both hardware and software (d) none of these.
- (viii) Radiation pyrometers are used in the temperature range of  
 (a) 0°C to 500°C (b) 500°C to 1000°C  
 (c) -250°C to 500°C (d) 1200°C to 2500°C.
- (ix) Which one of the following is an active transducers  
 (a) Strain gauge (b) LVDT  
 (c) Photo-voltaic cell (d) Photo-emissive cell.
- (x) The photo-diode as compared to a photo-transistor has  
 (a) faster switching time  
 (b) lower sensitivity  
 (c) higher size for the same value of output current  
 (d) all the above.

**Group - B**

2. (a) Which types of transducers are the thermocouple and LVDT and why?  
 (b) If the output impedance is high compared to the forward impedance of a transducer system, then is it a constant current source or constant voltage source type transducer? Justify your answer.  
 (c) A resistance potentiometer has a total resistance of 10000 Ω and is rated at 4 Watt. If its displacement measurement range is 0 to 100 mm, then find its sensitivity in V/mm.  
**4 + 3 + 5 = 12**
3. (a) Explain how capacitive transducer can be used to measure angular displacement?  
 (b) Define gauge factor. Find the expression for gauge factor of strain gauge. Which term in the gauge factor expression represents piezo-resistive effect?  
 (c) How RPM can be measured using inductive proximity transducer?  
**3 + (2 + 3 + 1) + 3 = 12**

**Group - C**

4. (a) Define piezoelectric effect. Find the expression for voltage sensitivity of a piezoelectric transducer.  
 (b) Draw the equivalent circuit of the piezoelectric transducer and hence analyse its frequency response.  
 (c) Where to use series combination of piezoelectric transducers?  
**(2 + 3) + (2 + 3) + 2 = 12**
5. (a) Define absolute sensitivity for hall sensor.  
 (b) Consider a Bismuth material based hall transducer of 2.5 mm thickness for measurement of magnetic field of 0.6 WB/m<sup>2</sup>. The current passing through the transducer is 3.5 A and its Hall coefficient is  $-1 \times 10^{-6}$  volt-m/(A-WB/m<sup>2</sup>). Calculate the output voltage from the hall transducer.  
 (c) Explain how hall sensor can be used for measurement of current?  
 (c) Design a signal conditioning circuit for photoelectric RPM meter.  
**2 + 3 + 4 + 3 = 12**

**Group - D**

6. (a) What is Peltier effect?  
 (b) Compare 3-wire and 4-wire RTDs.  
 (c) Describe the self heating error of RTD.  
 (d) Consider a thermocouple made of copper and constantan. Given that thermoelectric e.m.f. of copper and constantan against platinum are 7.4 and -34.4 μV per °C temperature difference. Determine the thermoelectric sensitivity of copper-constantan thermocouple.  
**2 + 4 + 3 + 3 = 12**
7. (a) A thermistor has a resistance of 4000 Ω at 0°C and 800 Ω at 40°C. The resistance temperature relationship is given by the expression  $R_1 = R_0 \alpha e^{\frac{\beta}{T}}$ . Determine the value of α and β.  
 (b) For what application thermistor is preferred as temperature sensor?  
 (c) What do you mean by the K-type thermocouple? What is the measuring range of K-type thermocouple?  
 (d) State the advantage of 'law of intermediate metal'?  
**6 + 2 + 2 + 2 = 12**