FUNDAMENTALS OF SENSORS AND TRANSDUCERS
(AEIE 3221)

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) With the increase in potentiometer resistance
(a) Linearity and Sensitivity both increase
(b) Linearity increases but Sensitivity decreases
(c) Linearity decreases but Sensitivity increases
(d) Linearity and Sensitivity both decreases

(ii) Strain gauge wires should
(a) Be free from hysteresis or creep effect
(b) Be of low temperature coefficient of resistance
(c) Have good frequency response
(d) All of the above

(iii) For linear displacement of the core, the modulated output from LVDT will have frequency equal to
(a) Zero (b) Twice the excitation frequency
(c) Half of the excitation frequency (d) Excitation frequency

(iv) Inductive proximity sensors can be effective only when the objects are of ____ materials.
(a) Ferro magnetic (b) Non magnetic
(c) Semiconductor (d) Insulating

(v) A piezoelectric crystal having a thickness of 2 mm. Its voltage sensitivity is 12×10-3 Vm/N. It is subjected to a pressure of 0.5 MN/m2. The voltage generated is
(a) 6 V (b) 12 V (c) 3 V (d) 5V

(vi) Resistance of metal RTD element changes by virtue of change in
(a) Length of the element
(b) Area of the element
(c) Concentration of the electrons in the conduction band
(d) Mean free path between two consecutive collision of the electrons in the conduction band

(vii) Pt100 refers to RTD element with Platinum material and
(a) 100 Ω resistance at 0 °C (b) 100 Ω resistance at 100 °C
(c) 0 Ω resistance at 100 °C (d) 0 Ω resistance at 0 °C

(viii) Excessive inrush currents in inductive electrical equipment can be supressed by connecting _____ in series with the equipment.
(a) RTD (b) Thermistor
(c) Thermocouple (d) LM35

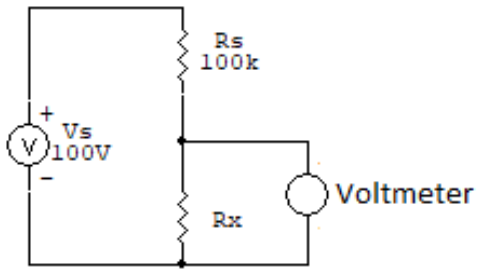
(ix) Consequence of _____ helps to use other temperature sensing element for cold junction compensation of the thermocouple.
(a) Law of homogeneous material (b) Law of intermediate temperature
(c) Law of intermediate material (d) Any of the above.

(x) In black body radiation spectrum, with increase in temperature.
(a) Intensity and wavelength both increases
(b) Intensity and wavelength both decreases
(c) Intensity increases but wavelength decreases
(d) Intensity decreases but wavelength increases

Group – B

2. (a) Define reproducibility and Fidelity.

(b) The voltmeter shown in the figure has a sensitivity of 500 Ω/V and a full scale of 100V. When connected in the circuit as shown, the meter reads 20 V. Find the value of Rx.



(c) Define gauge factor.
A strain gauge has a nominal resistance of 600 Ω and a gauge factor of 2.5. The strain gauge is connected in a d.c. bridge with three other resistances of 600 Ω each. The bridge is excited by a 4 volt battery. If the strain gauge is subjected to a strain of 100 μm/m, find the magnitude of bridge output.

2 + 5 + (2 + 3) = 12

3. (a) Design a system for measuring angular speed of a rotating machine using variable reluctance type inductive transducer. Hence derive the expression for angular speed.

(b) Explain with suitable schematic diagram how information of core movement about the null position of LVDT can be extracted? State reasons behind residual voltage occur in LVDT.

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

Group – C

4. (a) Describe with suitable schematic diagram, how differential pressure can be measured using capacitive transducer?

   (b) A parallel plate capacitor is formed by using two triangular plates having all sides equal to x. The distances between the plates is also x. Derive the expression for capacitance of the capacitor and draw the curve showing variation of capacitance with x.

   (c) What do you mean by Villari effect? Explain one application of this effect with suitable schematic diagram.

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

5. (a) Define charge sensitivity and voltage sensitivity of piezoelectric transducer and find the relation between them.

   (b) Draw the equivalent circuit of piezoelectric transducer and hence find the transfer function of the transducer.

   (c) Describe any one ultrasonic method of liquid flow measurement with necessary diagram.

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

Group – D

6. (a) Explain signal conditioning circuit for 3-wire RTD and find the expression for sensitivity.

   (b) Explain how thermistor can be used as inrush current suppressing element in inductive electrical equipment?

   (c) Draw the signal conditioning circuit for AD590 temperature sensor when applied to measure average temperature. State two features of LM35 temperature sensor.

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

7. (a) State the law of intermediate temperature for thermocouple. Draw the signal conditioning circuit for temperature measuring system that uses thermocouple as the temperature sensor.

   (b) Describe thermocouple burnt out detection circuit.

   (c) With a neat sketch describe operation of the optical pyrometer.

(2 + 3) + 3 + 4 = 12

Group – E

8. (a) Design an automated switching circuit for street light on-off control using LDR.

(b) Explain with necessary schematic diagram how photodiode can be used to measure angular speed of a rotating shaft and hence find the expression for angular speed.

(c) Describe operation of photovoltaic cell.

4 + (3 + 2) + 3 = 12

9. (a) Describe operation of Scintillation detectors with neat sketch.

(b) Draw and describe the smart sensor architecture.

(c) Draw applied voltage vs. plateau height curve to show different regions for gaseous ionisation detectors.

5 + 5 + 2 = 12

Department & Section	Submission Link
CSE	https://classroom.google.com/c/Mjk5MzQwNjg3MDg2/a/MzY0NTM5ODY2NDg2/details
ECE	https://classroom.google.com/c/Mjk5MzQwODE5NTA1/a/MzY0NTM4NTY2MTU4/details