INTRODUCTION TO SMART SENSING TECHNOLOGY FOR AI
(AEI2206)

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) A capacitive humidity sensor works based on change in
(a) Distance between plates (b) Area between plates
(c) Dielectric between plates (d) None of these.

(iii) Which of the following is the example of active transducer?
(a) LVDT (b) Thermocouple
(c) Resistive potentiometer (d) Strain gauge

(iv) LVDT has
(a) Two primary coils connected in phase and a secondary coil
(b) Two primary coils connected in opposition and a secondary coil
(c) One primary coil and two secondary coils connected in phase
(d) One primary coil and two secondary coils connected in phase opposition

(v) Example of natural piezoelectric crystal material is
(a) Lithium Sulphate (b) Barium Titanate
(c) Ammonium di-hydrogen Phosphate (d) Rochelle salt

(vi) For a Hall Effect element having thickness t and current I, the relation between Hall voltage V_H and magnetic flux density B is given by,
(a) $R_H = V_H . t/(I . B)$ (b) $R_H = V_H . t . I . B$
(c) $R_H = V_H . I/(t . B)$ (d) $R_H = V_H . t . I /B$

(vii) Which of the following is not a self-generating type of transducer.
(a) RTD (b) Thermocouple
(c) Piezo-electric crystal (d) Photo-voltaic cell

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

(ix) Process of using strong acid to cut into the unprotected parts of the metal surface to create a design is known as
(a) Patterning (b) Etching
(c) Deposition (d) None of the above

(x) Working of gyroscope is based on
(a) Centrifugal force (b) Centripetal force
(c) Coriolis force (d) Gravitational force

Fill in the blanks with the correct word

(xi) The expression of gauge factor for a strain gauge is _____.

(xii) Ultrasonic transducer can be built with _____ type of transducer

(xiii) Resistance of the thermistors varies _____ with temperature.

(xiv) Operation of photodiode is confined in _____ quadrant of the diode V-I characteristics.

(xv) MEMS take advantage of silicon's mechanical and _____ properties.

Group - B

2. (a) Derive the expression of gauge factor for a resistive strain gauge. State two properties of strain gauge material. *[(CO1)(Analyse/IOCQ)]*
(b) Describe a scheme to measure angular displacement using potentiometer type transducer and hence find the expression for sensitivity. *[(CO1)(Analyse/IOCQ)]*
(c) Define relative error and precision. *[(CO1)(Understand/LOCQ)]*

(4 + 2) + (3 + 1) + 2 = 12

3. (a) Draw the schematic for load cell with necessary signal conditioning circuit. *[(CO1)(Understand/LOCQ)]*
(b) With a neat diagram explain the operation of a capacitive type microphone. *[(CO1)(Evaluate/HOCQ)]*
(c) Define Range, span and threshold. *[(CO2)(Remember/IOCQ)]*

5 + 4 + 3 = 12

Group - C

4. (a) Define piezoelectric effect. State example of one natural crystal and one synthetic crystal that shows piezoelectric effect. *[(CO2)(Analyse/IOCQ)]*
(b) A LVDT is used for measuring the deflection of a bellows element. The sensitivity of LVDT set up is 8 Volt/mm. The bellows element is deflected by 0.15 mm for a pressure of 0.2×10^6 N/m^2. Determine the sensitivity of the LVDT in Volt/N/m^2 and the pressure when the voltage output of LVDT is 2.5 Volt. *[(CO2)(Evaluate/HOCQ)]*

(c) Describe the operation of an inductive transducer used to measure pressure with a schematic diagram. *[(CO2)(Analyze/IOCQ)]*

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

5. (a) What is Hall field? Explain how Hall field is developed in a Hall element. *[(CO3)(Understand/LOCQ)]*

(b) Design a scheme for non-contact type current measurement system using Hall Effect transducer. *[(CO3)(Create/HOCQ)]*

(c) How can ultrasonic transducers be used to measure liquid level in a tank? *[(CO3)(Analyse/IOCQ)]*

(1 + 4) + 4 + 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. What will be the voltage output for the temperature 120°C. The temperature coefficient of the RTD material is 0.00385/°C. *[(CO4) (Evaluate/HOCQ)]*

(b) Show the construct of a wire wound type RTD. Draw the characteristic of Pt_{100} RTD. *[(CO4) (Remember/LOCQ)]*

(c) Mention and explain one application of PTC type thermistor. *[(CO4) (Apply/IOCQ)]*

5 + (2 + 2) + 3 = 12

7. (a) What do you mean by dissipation constant of RTD as 25 mW/°C? *[(CO4)(Analyse/IOCQ)]*

(b) Draw the signal conditioning circuit for 3-wire RTD and hence find the expression for the output voltage. *[(CO4)(Create/HOCQ)]*

(c) For a certain thermistor, β = 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. *[(CO4)(Evaluate/HOCQ)]*

2 + (2 + 3) + 5 = 12

Group - E

8. (a) Explain working of piezoresistive micro-accelerometers with necessary circuit diagram. *[(CO6)(Create/HOCQ)]*

(b) How do smart sensors differs from ordinary sensors? Hence draw the structure of smart sensor. *[(CO6)(Analyse/IOCQ)]*

(c) State the features of a smart transmitter. *[(CO6)(Remember/LOCQ)]*

4 + (2 + 3) + 3 = 12

9. (a) Explain working of MEMS magnetometer with necessary schematic diagram. *[(CO6)(Analyse/HOCQ)]*

(b) What do you mean by sensor network? Draw and describe the block diagram for the same. *[(CO6)(Remember/LOCQ)]*

(c) State one application of MEMS sensor in the medical field. *[(CO6)(Apply/IOCQ)]*

5 + (2 + 4) + 1 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	26.04	36.46	37.50