

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) A dummy strain gauge is used to
 - (a) Improve the stability of the sensor system
 - (b) Increase the sensitivity of measurement
 - (c) Compensate ambient temperature variation
 - (d) All of the above
- (ii) In case of a coaxial cylindrical type capacitive level measurement system, with increase in liquid level, capacitance will
 - (a) Increases
 - (b) Decreases linearly
 - (c) Decreases exponentially
 - (d) Remains constant
- (iii) The charge amplifier is most appropriate signal conditioning unit for
 - (a) LVDT
 - (b) LDR
 - (c) Piezoelectric transducer
 - (d) Potentiometer
- (iv) Which of the following transductions principle is followed in Hall Effect device as a transducer?
 - (a) Humidity to resistance
 - (b) Magnetism to voltage
 - (c) Temperature to voltage
 - (d) Light to resistance
- (v) Thermopiles are generally a collection of
 - (a) RTDs
 - (b) Thermistors
 - (c) Thermocouples
 - (d) All of the above
- (vi) Which one of the following sensors/transducers requires power supply for its operation?
 - (a) Thermocouple
 - (b) Photovoltaic cell
 - (c) Thermistor
 - (d) Piezoelectric
- (vii) Thermocouple works on
 - (a) Peltier Effect
 - (b) Villari Effect
 - (c) Joule's Effect
 - (d) Seebeck Effect

- (viii) Which of the following is common to both transducer and smart sensor?
 (a) Memory (b) Signal conditioning unit
 (c) ADC (d) Digital signal processing
- (ix) MEMS takes advantage of silicon's
 (a) Mechanical properties
 (b) Electrical properties
 (c) Both electrical and mechanical properties
 (d) None of these
- (x) Change in capacitance of the capacitive sensing structure of MEMS device may be by virtue of
 (a) Change in distance between the structural plates
 (b) Change in overlapping area between the structural plates
 (c) Change in dielectric constant between the structural plates
 (d) Either (a) or (b)

Fill in the blanks with the correct word

- (xi) The suitable signal conditioning circuit to make LVDT direction sensitive is ____.
- (xii) Resistance of RTD decreases with _____ of temperature.
- (xiii) Photo diode operates in _____ biased condition.
- (xiv) Example of a LDR material is _____.
- (xv) The combination of electronics & sensors to produce a creative sensor is known as a _____.

Group - B

2. (a) Define active transducer and give an example of it. [[CO2](Analyse/IOCQ)]
 (b) How differential pressure is measured by using capacitive transducer? [[CO1](Analyse/IOCQ)]
 (c) Two identical strain gauges having gauge factor 2.4 and nominal resistance $130\ \Omega$ are cemented on either sides of a beam which is under strain. The strain gauges are connected in two consecutive arms of a Wheatstone bridge having supply voltage 12 Volt. Find out the change in resistance of the strain gauge and the applied strain for which the output of the bridge is 240mV. [[CO1](Evaluate/HOCQ)]
 $(2 + 1) + 4 + 5 = 12$
3. (a) Design and explain a scheme to measure the level of electrically non-conducting liquid in a tank by using capacitive transducer. [[CO1](Analyse/IOCQ)]
 (b) What do you mean by rosette and why it is important? Also draw the various configuration commonly used. [[CO1](Understand/LOCQ)]
 (c) Define Resolution and sensitivity. [[CO2](Remember/LOCQ)]
 $4 + (1 + 2 + 3) + 2 = 12$

Group - C

4. (a) Draw the schematic diagram of LVDT. Explain its operation for measuring linear displacement along with the calibration curve of it. [[CO2](Analyse/IOCQ)]
(b) Design a scheme using LVDT for measuring unknown pressure. [[CO2](Understand/LOCQ)]
(c) State the reason behind the residual voltage of LVDT. [[CO2](Understand/LOCQ)]
(2 + 4) + 4 + 2 = 12
5. (a) What is Hall effect transducer? Derive the expression of Hall voltage for Hall effect transducer. [[CO3](Understand/LOCQ)]
(b) Design a scheme to measure displacement by Hall effect transducer. [[CO3](Analyse/IOCQ)]
(c) A Hall Effect element used for measuring a magnetic flux density gives an output voltage of 12.5 mV. The element is made up of silicon and is 4.5 mm thick and carries a current of 5 A. The Hall coefficient is $4.1 \times 10^{-6} \text{Vm A-Wb/m}^2$. Find out the magnetic flux density. [[CO3] (Evaluate/HOCQ)]
(1 + 4) + 4 + 3 = 12

Group - D

6. (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) What do you mean by NTC thermistor? Draw the characteristics of it and state any one application of it. [[CO4](Analyse/IOCQ)]
(c) A RTD element is used to measure the temperature of a flame. The element shows resistance of 100Ω at 0°C . When the RTD is put in the flame, the resistance of the element is changed by 179.4Ω . Find the flame temperature? Given that temperature coefficient of resistance of RTD is $0.0039 \Omega/\Omega/^\circ\text{C}$. [[CO4](Evaluate/HOCQ)]
(1 + 2) + (2 + 2 + 1) + 4 = 12
7. (a) What is cold junction compensation of thermocouple? [[CO4] (Remember/LOCQ)]
(b) Design and explain a cold junction compensation scheme for continuous temperature measurement. [[CO4] (Analyse/IOCQ)]
(c) What is self heating problem of RTD? How it can be minimized? [[CO4] (Remember/LOCQ)]
2 + (2 + 5) + (2 + 1) = 12

Group - E

8. (a) Draw and describe the schematic illustration of MEMS components. [[CO6](Analyse/IOCQ)]
(b) Describe the operation of Capacitive sensing structure with a schematic diagram. [[CO6] (Analyse/IOCQ)]
(c) Draw the architecture of a smart sensor. [[CO6] (Analyse/IOCQ)]
4 + 4 + 4 = 12

9. (a) Explain working of capacitive micro-accelerometers with necessary circuit diagram. *[(C06)(Analyse/IOCQ)]*
- (b) What do you mean by MEMS? State the advantages of MEMS. *[(C06) (Apply/HOCQ)]*
- (c) Describe the operation of piezoresistive sensing structure with a schematic diagram. *[(C06)(Apply/IOCQ)]*
- 4 + (2 + 2) + 4 = 12**
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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	58.33	16.67