

**INTRODUCTION TO SMART SENSING TECHNOLOGY FOR AI
(AEIE 2206)**

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) To make LVDT direction sensitive the suitable signal conditioning circuit is
(a) analog to digital converter (b) instrumentation amplifier
(c) phase demodulator circuit (d) wheatstone bridge.
- (ii) For rotational wire wound resistive potentiometer having 100 turns per cm and diameter D of the circular construction, angular resolution is
(a) $2/D$ degree (b) $1.146/D$ degree
(c) $0.326/D$ degree (d) $0.764/D$ degree.
- (iii) For semiconductor strain gauge of n type, with compressive stress resistance of the strain gauge
(a) does not get affected (b) decreases
(c) remains constant (d) increases.
- (iv) Which of the following is an active transducer?
(a) LVDT (b) Resistive potentiometer
(c) Photovoltaic cell (d) Capacitive microphone.
- (v) The expression of gauge factor of strain gauge is given by
(a) $G = \Delta R.R/\epsilon$ (b) $G = \Delta R/(R.\epsilon)$
(c) $G = R/(\Delta R.\epsilon)$ (d) $G = \Delta R.R.\epsilon$
- (vi) Which of the following temperature sensors has the best linear characteristics?
(a) Thermocouple (b) RTD
(c) LM35 (d) Thermistor.
- (vii) LM35 is a
(a) Pressure sensor (b) Humidity sensor
(c) Temperature sensor (d) Touch sensor.
- (viii) For a smart sensor, signal conditioning is carried out in _____.
(a) transducer housing (b) processor
(c) network interface (d) none of the mentioned

- (ix) Resistance of LDR
 (a) Increases with the increase in intensity of illumination
 (b) Decreases with the increase in intensity of illumination
 (c) Remain same with the increase in intensity of illumination
 (d) Become zero when illuminated
- (x) A seismic accelerometer has
 (a) hard spring and small proof mass (b) soft spring and large proof mass
 (c) soft spring and small proof mass (d) hard spring and large proof mass.

Fill in the blanks with the correct word

- (xi) A/D conversion is not needed in the smart sensor. True/False. _____
- (xii) Direct conversion of temperature differences to electric voltage and vice versa is called as _____.
- (xiii) The process of removing bulk of the substrate in MEMS fabrication is known as _____.
- (xiv) An LVDT has sensitivity 1.5V/mm. The displacement of the core for the output voltage 8V is _____.
- (xv) The relation between voltage sensitivity and charge sensitivity of a piezoelectric transducer is _____.

Group - B

2. (a) For the measurement of linear displacement using the resistive potentiometer, compare the true output voltage with the measured output voltage when voltmeter is connected to the output terminals. [[CO1](Analyse/IOCQ)]
- (b) A resistive potentiometer having total resistance 24Kohms, length 120 mm is used for the measurement of displacement 40 mm. If a voltmeter having internal resistance 15 Ohms is used to measure the output voltage, then find the percentage error in the measurement of output voltage. [[CO3](Evaluate/HOCQ)]
- (c) How proving ring type load cell is used to measure weight? [[CO6](Apply/IOCQ)]
6 + 3 + 3 = 12
3. (a) How weight of vehicle can be measured by using column type load cell? [[CO3](Analyse/IOCQ)]
- (b) Design a scheme to measure large displacement by using capacitive transducer. [[CO1](Create/HOCQ)]
- (c) How capacitive transducer can be used for liquid level measurement in cylindrical tank? [[CO3](Apply/IOCQ)]
4 + 4 + 4 = 12

Group - C

4. (a) Showing the schematic diagram explain the construction of LVDT and describe the method to measure unknown displacement. What will be the nature of output voltage of LVDT against time for displacement measurement? [[CO3](Understand/LOCQ)]

- (b) An LVDT is used for measuring an unknown force. The sensitivity of LVDT set up is 5 V per mm. The displacement of the core of LVDT is 0.12 mm by the force of 0.6×10^6 N. Determine the sensitivity of the LVDT in V/N and the force when the voltage output of LVDT is 3.5 V. [[CO4](Evaluate/HOCQ)]
- (c) Design and explain a scheme to measure fluid flow rate in a pipe line by transit-time type ultrasonic flowmeter. [[CO6](Apply/IOCQ)]
5 + 3 + 4 = 12
5. (a) What is Hall field? How Hall effect transducer can be used for the measurement of displacement? [[CO3](Analyse/IOCQ)]
- (b) A Piezoelectric crystal has a thickness of 3.5 mm and a voltage sensitivity of 0.07 Vm/N. Determine the output voltage when it is subjected to a pressure of 3.6×10^6 N/m². [[CO5](Evaluate/HOCQ)]
- (c) Showing the necessary circuit diagram find out the transfer function of a piezoelectric transducer. [[CO2](Evaluate/HOCQ)]
4 + 3 + 5 = 12

Group - D

6. (a) State the law associated with the working of thermocouple. Give example of any type of thermocouple with its material and temperature range. [[CO1](Remember/LOCQ)]
- (b) Draw the signal conditioning circuit for 3-wire RTD and hence find the expression for the output voltage. [[CO6](Apply/IOCQ)]
- (c) How thermistor can be used as the in rush current limiter for inductive load? [[CO3](Apply/IOCQ)]
(2 + 2) + (2 + 3) + 3 = 12
7. (a) A platinum RTD PT₁₀₀ measures 100 Ω at 0 °C and 139.1 Ω at 100 °C. Calculate the resistance of the RTD at 50 °C. Calculate the temperature when the resistance is 110 Ω. [[CO4](Analyse/IOCQ)]
- (b) Design a light on-off switching system which can be used to on/off a street light based on ambient light intensity. [[CO6](Create/HOCQ)]
- (c) Explain working of photo voltaic cell with necessary schematic diagram. [[CO4](Understand/LOCQ)]
5 + 4 + 3 = 12

Group - E

8. (a) How do intelligent sensors differs from smart sensors? Hence draw the structure of intelligent sensor. [[CO4](Analyse/IOCQ)]
- (b) Draw and describe the functional blocks of the smart transmitter. [[CO6](Understand/LOCQ)]
(3 + 4) + 5 = 12
9. (a) Describe the operation of piezoelectric type MEMS accelerometer with a schematic diagram. [[CO2](Understand/LOCQ)]

(b) State the use of gyroscope. Explain working of MEMS gyroscope with necessary schematic diagram.

[[CO3)(Analyse/IOCQ)]

5 + (2 + 5) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	22.92	39.58	37.50

Course Outcome (CO):

After the completion of the course students will be able to

1. Identify the sensors for measurement of various physical parameters like displacement, pressure, force, temperature etc.
2. Interpret the operation of various sensors/transducers used for measurement of physical parameters.
3. Apply their knowledge to select right kind of sensors/transducer for application in hand.
4. Analyze the response of the sensors/transducers for fruitful information.
5. Judge the performance of the sensors.
6. Design signal conditioning unit for the sensors.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*