TRANSDUCERS & SENSORS
(ELEC 4111)

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) The smallest change which a sensor can detect is
(a) Resolution (b) Accuracy (c) Precision (d) Scale.

(ii) In a temperature sensing element
(a) low value of α is required (b) infinite value of α is required
(c) α must be zero (d) high value of α is required.

(iii) The _____ of a strain gauge varies with applied strain.
(a) resistance (b) inductance (c) capacitance (d) flux

(iv) Working of Linear Variable Differential Transducer (LVDT) is based on the principle of variation of
(a) Resistance (b) Capacitance (c) Mutual Inductance (d) None of these.

(v) For measuring electric radiation which type of thermal sensor is used?
(a) Thermocouple (b) RTD (c) Thermistors (d) Pyrometers.

(vi) Which of the following is an example of piezoelectric material?
(a) Glass (b) Quartz (c) Corundum (d) Neoprene.

(vii) Which one of the following is not an application of the Hall Effect sensor?
(a) Magnetic switch for electric transducer (b) Measurement of current
(c) Measurement of acceleration (d) Measurement of power

(viii) Orifice meter is used to measure
(a) pressure (b) velocity (c) volume (d) volume rate of flow.

(ix) Optical fibres are used in
(a) CAT scans (b) X-ray photos (c) Ultrasound scan (d) Endoscopy.

(x) Proximity type sensor is a _____ type of sensor.
(a) contact type (b) non-contact type
(c) both (a) and (b) (d) partially contact type

Group – B

2. (a) What is the disadvantage if a solid dielectric medium is used in a variable distance capacitive sensor? [(CO3)(Analyze/IOCQ)]
   (b) How is LVDT's operation dependent on the position of the core? [(CO2)(Understand/LOCQ)]
   (c) How can liquid level change be sensed by a capacitive sensor? Derive the expression of sensitivity. [(CO1)(Analyze/IOCQ)]

3 + 4 + 5 = 12

3. (a) Distinguish between primary and secondary sensors. [(CO1)(Remember/LOCQ)]
   (b) Why semiconductor strain gauges have higher sensitivity than metal strain gauges? [(CO3)(Analyze/IOCQ)]
   (c) Define longitudinal contraction, lateral contraction, Poisson's ratio and gauge factor. [(CO2)(Remember/LOCQ)]

3 + 4 + 5 = 12

Group - C

4. (a) Show how piezoelectric transducers can be used to measure torque. [(CO1)(Remember/LOCQ)]
   (b) Draw and explain the buffer amplifier circuit used for piezoelectric transducers. [(CO2)(Analyze/IOCQ)]
   (c) Mention suitable applications of Hall transducers. [(CO3)(Analyze/IOCQ)]

4 + 5 + 3 = 12

5. (a) Explain briefly the operating principle of a seismic accelerometer. [(CO2)(Remember/LOCQ)]
   (b) List the advantages and disadvantages of Hotwire anemometer. [(CO3)(Evaluate/HOCQ)]
   (c) Compare between a constant area variable pressure drop flow meter and a constant pressure drop variable area flow meter with example. [(CO4)(Analyze/IOCQ)]

6 + 3 + 3 = 12

Group - D

6. (a) Explain with a diagram the working of a 3-wire RTD. [CO2)(Remember/LOCQ)]
   (b) Why platinum is preferred over other materials for making resistance thermometers? [(CO4)(Evaluate/HOCQ)]
   (c) A platinum RTD PT100 measures 100 Ω at 0 °C and 139.1 Ω at 100 °C.
      i) Calculate the Temperature Coefficient of Resistance for platinum.
      ii) Calculate the resistance of the RTD at 50 °C.
      iii) Calculate the temperature when the resistance is 110 Ω. [(CO2)(Evaluate/HOCQ)]

6 + 2 + 4 = 12

7. (a) Compare the functions of grounded and ungrounded thermocouples.
[(CO2)(Analyze/IOCQ)]

(b) Name and explain the function of a sensor which measures thermal radiation
[(CO2)(Understand/LOCQ)]

(c) What is meant by cold junction compensation and how is it implemented in industrial environments? [(CO3)(Analyze/IOCQ)]

4 + 4 + 4 = 12

Group - E

8. (a) Explain how a fibre optic sensor may be used to measure humidity.
[(CO4)(Evaluate/HOCQ)]

(b) Explain the working of a photomultiplier tube. Mention its applications and limitations. [(CO2)(Understand/LOCQ)]

6 + 6 = 12

9. (a) Explain why fibre optic tomography is preferred for medical diagnostics.
[(CO4)(Evaluate/HOCQ)]

(b) Write short notes on any one of the following:
i. photodiodes
ii. smart sensors. [(CO4)(Understand/LOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	45.83	32.29	21.88

Course Outcome (CO):

After the completion of the course students will be able to

1. Relate the concepts for converting a physical parameter into an electrical quantity
2. Explain the working principles, characteristics of sensors and transducers used for measuring physical quantities
3. Understand the operational conditions, range and limitations of sensors and transducers
4. Select the best fit sensors and their use in medical and other applications

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