Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.Tech (EE-CI)/SEM-1/CIM-102/2012-13

2012
ELECTRICAL SENSORS AND TRANSDUCERS

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Answer Question No. 1 of **Group A** and any *two* each from **Group B** and **Group C**.

GROUP – A

1. Justify correctness of the statements with reasons : $7 \times 2 = 14$

   a) Former of an LVDT is made of a non-magnetic material.

   b) The strain gauge output is quadrupled if four strain gauges are used in parallel.

   c) Resolution of a 41/2 digit voltmeter is more than that of a 4 digit voltmeter.

   d) Linearity is more important than sensitivity of the instrument.

   e) A capacitive transducer can be designed more accurately than in inductive transducer.

   f) An indicating instrument is usually critically damped.

   g) Accuracy of instruments when expressed in sigma limits indicates that randomness in measurement has been taken into account.

GROUP – B

2. a) Compare a thermistor with an RTD in respect of construction and performance. 4

   b) Discuss the following related to a resistive potentiometer :

   (i) Overloading, (ii) Resolution and (iii) Applications. 4

   c) A strain gauge of gauge factor 4 and a nominal value of 120 ohms is attached to a rectangular shaped test piece 250 cm long. The bar undergoes a temperature change of 25°C and the strain gauge is observed to have a resistance change of 0·96 ohm. Calculate the coefficient of thermal expansion of the test piece material. How would you compensate for temperature effect on the strain gauge ? Calculate also the output voltage if the Wheatstone bridge supply is 6 V. Deduce the formulae used. 6

3. a) Obtain the sensitivity ($\delta L/\delta g$) of an inductive transducer with ferromagnetic core and small variable air gap (g). Show how this transducer can be used to measure small displacements, and its linearity and sensitivity can be improved. 5

   b) Describe with a neat sketch the constructional features of an LVDT along with the materials used for its parts and explain the principle of operation of an LVDT. How do you make the LVDT direction sensitive ? 4

   c) Show with schematic diagrams how power and energy can be measured for a high voltage, high current circuit using analogue and digital instruments. 5

4. a) Obtain the sensitivity ($\delta C/\delta g$) of a capacitance transducer with solid dielectric and variable air gap (g) between parallel plates. What are its applications and limitations ? 5

   b) What is a hot wire anemometer ? Describe its constructional features and the output circuitry. What are different types of hot wire anemometers ? Compare their features. 3

   c) Define the following performance characteristics of a digital instrument :

      i) Sesolution

      ii) Sensitivity

      iii) Over-ranging

      iv) Accuracy.

      Computer the above parameters for a 31/2 digit voltmeter reading 0–10 V and 0–1 V with an accuracy specification of ± 0·5 % of reading ± 2 digits. 6

5. Attempt any *four* from the following : $4 \times 3\frac{1}{2}$

   a) Shaft encoder

   b) Limits of error

   c) Types of instrument non-linearity and linearization

   d) An inductance coil wound on a magnetic bar placed near a toothed wheel attached to a rotating shaft. Output of the coil is recorded as volts. Show the nature of the output. How can it be used as a non-contact tachometer ?

   e) Output circuits of inductive and capacitive transducers

   f) Active and Passive transducers, and invasive and non-invasive types of measurement.

GROUP – C

6. a) Explain the advantages of digital recording system over their analog counterparts.
   b) Explain the functioning of a basic type of strip chart recorder. Explain the different types of marking mechanism used in it.
   c) Explain the working of an ultraviolet recorder.

   3 + 3 + 4 + 4

7. a) What are the different types of telemetering system ? Explain the land-line telemetering system and describe its advantages.
   b) Explain the land-line telemetering system using a synchro transmitter-receiver pair used in torque transmission mode.
   c) Explain voltage to frequency converter with a neat sketch. 2 + 3 + 4 + 5

8. a) Describe the following amplifiers and state their applications :
      i) Charge amplifier
      ii) Instrumentation amplifier
      iii) Bridge amplifier
   b) Explain working principle with neat sketch of an impedance converter and its applications.

   $3\frac{1}{2} + 3\frac{1}{2} + 3 + 4$

9. Attempt any *four* short notes from the following : $4 \times 3\frac{1}{2}$
   a) Magnetic tape recorder
   b) 5 × 7 LED matric display
   c) Voltage to current converter
   d) Differential amplifier
   e) Multiplexing and De-multiplexing
   f) Digital interfacing techniques.