53 (IE 502) TREN

2013

(December)

TRANSDUCER ENGINEERING

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

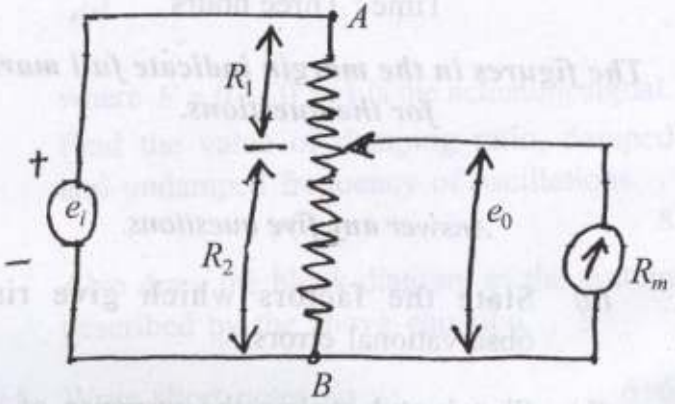
*Answer **any five** questions.*

1. *(a)* State the factors which give rise to observational errors. 4

   (b) Sketch and explain the response of a first order system when subjected to a step-input signal. 6

   (c) Enumerate the main static characteristics of measuring instruments. 5

(d) A resistive displacement transducer with a shaft stroke of 25*mm* is applied to the circuit shown below. The applied voltage is 10*V*. What is the displacement indicated for each of the voltage reading 3*V*, 5*V* and 8*V*? Assume that the resistance of output device R_m is infinite. 5



2. (a) What are thermistors ? Explain their different forms of construction. Draw their resistivity *vs* temperature characteristics and show that they have a very high value of sensitivity as compared with that of RTD. 10

Also describe their applications.

(b) Give an overview of smart sensors explaining their principle of operation. 5

(c) For a transducer describe the following :

(i) transfer function

(ii) hysteresis error. 5

3. (a) Explain with diagrams the bonded and unbonded types of strain gauges. For bonded strain gauges, describe the materials used for base and adhesive materials and also the materials used for leads. 8

(b) Explain the term 'Drift' with suitable examples. 6

(c) Differentiate between the terms 'Accuracy' and 'Precision' with suitable examples. 6

4. (a) What is a piezoelectric transducer ? List the advantages and disadvantages of piezoelectric transducer. 5

(b) A parallel plate capacitor transducer uses plates of area $250mm^2$ which are separated by a distance of $0.2mm$. 5

Calculate the value of capacitance when the dielectric is air having a permittivity of $8.85\times10^{-12}\ F/m$.

(c) Describe briefly the following sensors :

(I) Humidity Sensor

(II) Hot wire anemometer. 10

5. (a) A linear resistance potentiometer is $50mm$ long and is uniformly wound with wire having a resistance of $10k\Omega$. Under normal conditions the slider is at the centre of the potentiometer. Find the linear displacement when the resistance of the potentiometer as measured by Wheastone Bridge for two cases is (i) 3850Ω and (ii) 7560Ω. 6

Are the two displacements in the same direction ?

(b) A strain gauge is bonded to a beam of $12cm$ long and has a cross-sectional area of

$3.8cm^2$. The unstrained resistance and gauge factor of the strain gauge are 220Ω and 2.2 respectively. On the application of load the resistance of gauge changes by 0.015Ω. 8

If the modulous of elasticity for steel is $207GN/m^2$, calculate —

(i) the change in length of steel beam

(ii) the amount of force applied to the beam.

(c) Explain briefly the working of LVDT. 6

6. *(a)* A thermistor has a resistance of 3980Ω at ice point ($0°C$) and 794Ω at $50°C$. The resistance temperature relation is given by — 6

$$R_T = a\,R_0\,exp\left(\frac{b}{T}\right)$$

Calculate the constants 'a' and 'b'.

(b) Compare the properties of the following temperature transducers —

Thermocouple, RTD, Thermistor and IC-sensor. 8

(c) Explain clearly the difference between primary and secondary transducers with suitable examples. 6

7. (a) A servo mechanism is represented by the equations —

$$\frac{d^2y}{dt^2} + 4.8\frac{dy}{dt} = 144E$$

where $E = (C - 0.5y)$ is the actuating signal. Find the value of damping ratio, damped and undamped frequency of oscillations. 8

Also draw the block diagram of the system described by the above equation.

(b) Write short notes on : 6+6

(i) fiber optic transducer

(ii) capacitor microphone.