53 (IE 502) TREN

2014

TRANSDUCER ENGINEERING

Paper : IE 502

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* Prove that when a shunt connected instrument is connected to a circuit the voltage measured is given by — 8

$$E_L = \frac{E_0}{1+(Z_0/Z_L)}$$

where, E_0 = Voltage at no load.

Z_0 = Output impedance of the circuit

Z_L = input impedance of the voltage measuring device.

Also discuss the methods of reducing the loading error in this case.

Contd.

(b) How the standards of measurements are classified ? 3

(c) Define the following terms giving suitable example of each :

Transducer, output transducer 4

(d) An analog indicating instrument with a scale range of 0-10V shows a voltage of 5·30V. The true value of the voltage is 5·40V. 5

Now,

(i) What are the values of absolute error and correction ?

(ii) Express the error as a function of the True value and *fsd*.

2. (a) During a test, measurement of temperature were made 100-times with variation in apparatus and procedure. After applying corrections for known systematic errors the following data were obtained : 8

Temp $(°C)$	397	398	399	400	401	402	403	404	405
Frequency of occurrence	1	3	12	23	37	16	4	2	2

Now calculate —

(i) AM

(ii) Mean deviation

(iii) Standard deviation

(iv) Probable error of mean

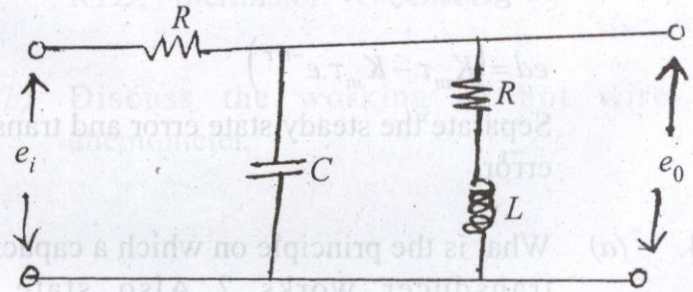
(v) Standard deviation of S.D.

(b) Differentiate between the terms —

(i) repetibility and reproducibility

(ii) threshold and resolution. 6

(c) Derive the transfer function of the following network — 6



3. *(a)* A servo mechanism is represented by the equation $\frac{d^2\theta}{dt^2}+10\frac{d\theta}{dt}=150E$; 6

where $E=(r-\theta)$ is the actuating signal. Calculate the value of damping ratio, undamped and damped frequency of oscillations.

(b) What are 'Gross errors' ? How these can be reduced ? 4

(c) Derive the equations for time response of a first order system when subjected to unit step input. 7

(c) The dynamic error of a first order system in given by —

$$ed=\left(K_m\tau-K_m\tau.e^{-t/\tau}\right)$$ 3

Separate the steady state error and transient error.

4. *(a)* What is the principle on which a capacitive transducer works ? Also state the advantages and disadvantages of capacitive transducer. 6

(b) The final result of a measurement depends on two measurements in series, each having values of 25 and 50 units with errors of $\pm 2\%$ and $\pm 1\%$, such that the result is sum of both. Determine the error of the final result. 5

(c) What is an LVDT ? Explain its principle of working and constructional details. 6

(d) What do you understand by the term "measurement' ? 3

5. (a) Compare the characteristic of the following temperature transducers— 6

RTD, thermistor, IC-sensor.

(b) Discuss the working of hot wire-anemometer. 5

(c) A voltmeter with internal resistance of $200K\Omega$ is connected across an unknown resistance. It reads $250V$ and the milliammeter connected in series with the same resistance reads $10mA$.

Now calculate ———

(i) the apparent resistance

(ii) the actual resistance &

(iii) the loading error due to loading effect of the voltmeter. 9

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

(b) Explain and sketch the types of test signals used for determination of dynamic characteristics. 4

(c) Explain the principle of working and construction of an electric resistance thermometer. In what temperature range it is used ? 7

(d) What do you understand by the term "Smart Sensor" ? Give some examples. 4

7. Write short notes on — ***(any four)*** 20

(i) Fiber optic transducer

(ii) Strain gauge

(iii) Humidity sensor

(iv) Piezoelectric transducer

(v) Capacitor microphone.
