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)* Define the term 'instrumentation'. 2

(b) Explain the difference between the following : 2+2=4

(i) Measurand and measurement

(ii) Measurement and instrument.

(c) Discuss the factors relating to selection of instruments. 4

(d) Describe briefly the main functions of the instruments with examples. 6

(e) Define the following terms as applied to the measuring instrument : 4

(i) True value

(ii) Dead zone

(iii) Sensitivity

(iv) Correction

2. (a) What are static characteristics ? How do they differ from dynamic characteristics ? 2+2=4

(b) What is "noise"? What is signal to noise ratio ? Explain briefly different types of noise. 1+2+3=6

(c) A pressure indicator showed reading as 89 *bar* on a scale range of 0-100 *bar*, but the true value was 88·5 *bar*. 5

Determine :

(i) Static error,

(ii) Static correction and

(iii) Relative static error.

(d) A pressure measuring system consists of a piezoelectric transducer, a charge amplifier and an ultra violet charge recorder, their sensitivities are 8·5 *pC/bar*, 0·004 *V/pC* and 20 *mm/V* respectively. Determine the deflection on the chart for a pressure change of 25 *bar*. 5

3. (a) Describe the dynamics for sinusoidal input to a first-order system.

During a particular process, the air temperature cycle at the rate of 1 *cycle* every 4 *minutes*. The time constant of the temperature measuring device is 20 *seconds*. 4+6=10

Determine

(i) The variation in the indicated temperature if input temperature has a sinusoidal variation of ± 25°*C*.

(ii) The time by which the maximum reading of the thermometer lags the true maximum value.

(b) Define the following terms : 4

(i) Fidelity

(ii) Overshoot

(iii) Dynamic error

(iv) Speed of response

(c) When a step-input was given to a second-order system, the measurements revealed that the system had an overshoot of 12% in a rise time of 0·22 *second*. 6

Determine :

(i) Effective damping ratio

(ii) Undamped natural frequency of the system.

4. (a) What are 'systematic errors' ? Explain briefly the different types of systematic errors with example. 2+4=6

(b) The three resistors R_1, R_2 and R_3 have the following ratings : $R_1 = 25\,\Omega \pm 4\%$, $R_2 = 65\Omega \pm 4\%$, $R_3 = 45\Omega \pm 4\%$. 4

Determine :

(i) Limiting value of the resultant resistance.

(ii) Percent limiting error of series combination of resistance.

(c) While measuring a temperature the following ten readings were recorded :

39·6, 39·9, 39·7, 40·0, 39·8, 39·9, 39·9, 39·8, 40·4 and 39·7°C. *10*

Calculate the following :

(i) The mean

(ii) The standard deviation

(iii) The probable error of one reading

(iv) The probable error of mean, and

(v) The range.

5. (a) Explain resistance potentiometer. A linear resistance potentiometer is 50*mm* long and is uniformly wound with wire having a resistance of 10000 Ω. 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 a Wheatstone bridge for two cases is (i) 3850 Ω (ii) 7560 Ω.

Are the two displacements in the same direction ? If it is possible to measure a minimum value of 10 Ω resistance with the above arrangements, find the resolution of the potentiometer in *mm*. 4+6=10

(b) What is the principle on which a capacitive transducer works ? What are the advantages and disadvantages of capacitive transducers ? 5+5=10

6. (a) Explain linear-variable-differential transformer (LVDT) and its working. The output of a LVDT is connected to a $4V$ voltmeter through an amplifier whose amplification factor is 500. An output of $1 \cdot 8 mV$ appears across the terminals of LVDT when the core moves through a distance of $0 \cdot 6 mm$. If the millivoltmeter scale has 100 divisions and the scale can be read to $\frac{1}{4}$ of a division, 2+4+6=12

Calculate :

(i) The sensitivity of LVDT

(ii) The resolution of the instrument in mm.

(b) What is a piezoelectric transducer ? A piezoelectric crystal measuring $6mm \times 6mm \times 1 \cdot 8mm$ is used to measure a force. Its voltage sensitivity is $0 \cdot 055 Vm/N$. Calculate the force if voltage developed is $120V$. 3+5=8

7. Write short notes on : ***(any four)*** 4×5=20

(a) Strain Gauge

(b) Pneumatic Sensors

(c) Loading effect of measuring instruments

(d) Repeatability and Reproducibility

(e) Variable Inductance Transducers

(f) Thermistors.

———