53 (IE 302) FNIN

2014

FUNDAMENTALS OF INSTRUMENTATION

Paper : IE 302

Full Marks : 100

Pass Marks : 30

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* What are the different types of instruments on the basis of their functions ? – briefly explain.

   Discuss the dumb and intelligent types of instruments with examples.

   Describe the different functional elements of a generalized measurement system.

   3+3+6=12

(b) Determine the average deviation, standard deviation, probable error of mean, standard deviation of mean and standard deviation from the following data 8

Measured Potential	10·2	10·3	10·4	10·6	10·7
Frequency of operation	4	7	9	3	2

2. (a) Using least square method, derive the standard deviation of σ_{a_0} for an approximated straight line $7 = a_1 x + a_0$. 6

(b) Test whether the following set of data follows the normal distribution curve by using Chi-square test. 14

Coefficient of friction	0·40-0·42	0·42-0·44	0·44-0·46	0·48-0·50
Frequency	2	7	13	8

3. (a) Describe the instrumental error. How the instrumental error can be minimized ? 3+1=4

(b) Describe the working & primary standard with examples. 6

(c) What do you mean by signal conditioning ? Discuss the different signal conditioning elements with examples. Briefly explain the working of an electronic voltage standard. 1+5+4=10

4. (a) Differentiate range and span with examples. Explain the linearity and static sensitivity with diagrams. 2+4=6

(b) The voltage across a resistor is actually $20V$, but the measuring instrument shows $19{\cdot}2V$ in a meter of full scale range 0 -$100V$; find the absolute error, static correction and error as a fraction of full scale deflection. 4

(c) Describe the following characteristics and mention whether they are desirable or undesirable 4

(i) non linearity

(ii) resolution

(iii) precision

(iv) sensitivity

(d) What is the effect of input impedance in a measuring instrument ? — explain. 6

5. (a) What are the *two* conditions for the linearity of a system ? Obtain the expression of output of a first order system when a unit step. 1+6=7

(b) A d Arsonval galvanometer is a second order instrument. In the design of a d Arsonval galvanometer, the damping ratio = 0·65 and the natural frequency of undamped oscillation is $4Hz$. 5

(i) If the sensitivity of the movement is doubled by using springs of smaller stiffness, calculate the new damping ratio & new natural frequency.

(c) What do you mean by resonant frequency ? A torque sensing transducer is connected to the shaft of an electric motor which drives a load that has a moment of inertia of $200\times10^{-3}\,kgm^2$. What should be the damping ratio of the system when a sinusoidal torque varying at a frequency of $2\,rad/sec$ is to be reproduced with a maximum error of +10%. The torsional constant is $1{\cdot}5\,N{\cdot}m/rad$. 1+7=8

6. *(a)* Obtain the expression of magnitude ratio and phase angle from the frequency response of a second order system. 7

(b) What is a dead time element ? What will be the output of a dead time element if a sinusoidal signal is applied to it ? 1+2=3

(c) Describe the different calibration techniques employed in measurement system. 10

7. Write short notes on ***any four*** of the following : 4×5=20

(i) Gross error

(ii) Automatic instruments

(iii) Weston cell

(iv) Routine calibration method

(v) Primary and secondary standard.
