53 (IE 302) FNIN

2017

FUNDAMENTALS OF INSTRUMENTATION

Paper : IE 302

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* The following values were obtained from the measurements of the value of a resistor : 131·3Ω, 132·1Ω, 131·6Ω, 131·7Ω, 131·8Ω, 131·8Ω, 132Ω,, 132·3Ω, 131·8Ω and 131·5Ω.

   Determine the *(i)* arithmetic mean, *(ii)* average deviation, *(iii)* standard deviation, *(iv)* variance, *(v)* probable error of one reading, *(vi)* probable error of the mean. 8

(b) Derive the expression for time response of a first order system when subjected to a unit step input. 6

(c) Explain the functional elements of an instrumentation system using a suitable diagram. 6

2. (a) Five automobile tyres, each of two different brands, were tested for wear (in grams) after driving for 2000*km* under the same condition. The data obtained is as follows : 7

Brand A	13·5	13·1	12·4	12·6	13·9
Brand B	12·5	12·7	12·0	13·7	12·6

Can we conclude that brand *A* is significantly superior to brand *B* ?

(b) Describe the standard input signals with relevant mathematical expressions and signal diagrams. 8

(c) Write some of the applications of instrumentation systems. 5

3. *(a)* A study has indicated that the life of TV picture tubes manufactured by a certain firm is normally distributed with a mean life of 6 years and a standard deviation of 400 days. The manufacturer gives a guarantee of 2 years. Determine :

(i) What percentage of picture tubes the manufacturer has to replace in 2 years ?

(ii) If the manufactuter wishes to replace the same amount of picture tubes with 3 years guarantee, what has to be done ?

6

(b) Define the following : 14

(i) Sensitivity, *(ii)* Precision, *(iii)* Dead Time, *(iv)* Threshold, *(v)* Measuring Lag, *(vi)* Fidelity, *(vii)* Loading effects, *(viii)* Hysteresis, *(ix)* Range and Span.

4. *(a)* An experiment has been carried out to investigate the temperature dependence of the resistance of a copper wire. The following observations of R and T were obtained.

Temperature T (°C)	Resistance (Ω)
10	12·4
20	13·0
30	13·7
40	13·9
50	14·6
60	15·2
70	15·3
80	16·0

Using the method of least squares, determine the value for the slope and intercept for the best fitting straight line assuming temperature values to be accurate. 8

(b) Show that $\omega^2 LC$ is non-dimensional, ω being the angular frequency of the applied voltage. 4

(c) Discuss the classification of transducers with suitable examples. 8

5. (a) The power factor of a circuit is determined by : $\cos\phi = \frac{P}{VI}$

where P is the power in watt, V the voltage in volt and I is the current in ampere. The relative errors in power, current and voltage are respectively $\pm 0{\cdot}5\%$, $\pm 1\%$ and $\pm 1\%$. Calculate the relative error in power factor. 4

(b) Describe the mathematical modelling of following system with suitable expressions : 10

(i) Electrical system

(ii) Mechanical system.

(c) Write a short note on classification of instrument with suitable examples. 6

6. (a) A $0-300V$ voltmeter has an error of $\pm 2\%$ of full scale deflection. What would be the range of readings if true voltage is $30V$? 4

(b) What is calibration ? Explain the calibration procedures.

Describe a method for calibration of ammeter. 8

(c) Derive the dimensions of the following quantities in *L,M,T,I* system :

(i) Inductance, *(ii)* Resistance, *(iii)* Capacitance, *(iv)* EMF, *(v)* Work done, *(vi)* Power. 8

7. (a) Describe the primary standard and secondary standard of EMF measurement. 8

(b) Write short notes on : ***(any two)*** 6×2=12

(i) Absolute measurement of current

(ii) Types of errors in measurement system

(iii) Resistance standards.