**53 (IE 302) FNIN**

**2014**

# 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)* Explain how the temperature measurement using RTD can be automatized. 6

   *(b)* Enumerate the types of instruments based on the requirement of power supply. Briefly explain about them. 4

(c) What are the different types of errors ? Describe them and their preventive measures. 10

2. (a) Describe the expression of '$a$' and '$b$' for a straight line $(y = ax + b)$ approximated by the method of least square. 6

(b) What is precision index ? Explain how it is related to the scatteredness of readings. 1+1=2

(c) Using the Chi-square method, test whether the following set of readings follow the gaussian distribution curve or not 12

| Kinetic Viscosity $(\nu)$ | Observed frequency $(f)$ |
|---|---|
| $0 \cdot 60 - 0 \cdot 62$ | 2 |
| $0 \cdot 62 - 0 \cdot 64$ | 9 |
| $0 \cdot 64 - 0 \cdot 66$ | 12 |
| $0 \cdot 66 - 0 \cdot 68$ | 7 |
| $0 \cdot 68 - 0 \cdot 70$ | 5 |

3. (a) Describe about the working and secondary standards. 4

(b) Explain how absolute value of current is determined by using Rayleigh's current balance. Describe the precautions taken to minimize the errors. 8

(c) How will you differentiate calibration and standard ? What are the different kinds of calibration methods employed in measurement ? 1+7=8

4. (a) How the loading effects due to voltameter can be reduced — explain with the help of circuit diagram. 5

(b) Define the following terms : 6

(i) precision

(ii) reproducibility

(iii) linearity

(iv) static sensitivity

(v) threshold and

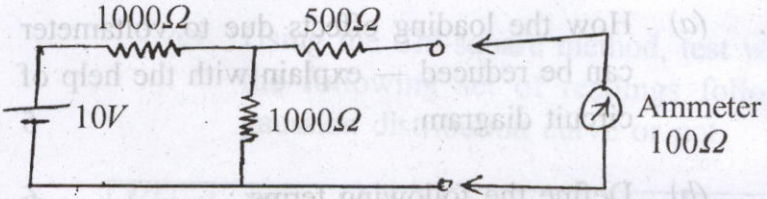
(vi) resolution.

(c) An ammeter is used to measure the value of current in $500\Omega$ resistor by connecting a $100\Omega$ ammeter which is shown in the following diagram. Determine the

(i) actual value of current

(ii) measured value of current and

(iii) percentage error in measurement. 5




(d) What are the different signal conditioning operations required in an electronic measurement system ? 4

5. (a) What are the *two* components of the dynamic response of a system ? Define *any two* desirable dynamic characteristics of a measurement system. 2+2=4

(b) Derive the transfer function of a thermal system when the heat input rate is suddenly increased from its steady condition. Discuss the assumptions made. 8

(c) Obtain the impulse response of a first order system. Also find out the dynamic error and steady state error. 3+1=4

(d) A d' Arsonval galvanometer (second order instrument) is having damping ratio of 0·65 and the natural oscillations is 4*Hz*. Calculate the new damping ratio and new natural frequency, if the sensitivity of the movement is doubled by using springs of smaller stiffness. 4

6. (a) Derive the magnetic ratio, phase angle and resonant frequency from the frequency response of a first order system. 8

(b) In a pressure measuring transducer consisting of a number of strain gauzes bonded to a diaphragm, the undamped natural frequency of the system is found to be 60*Hz*, the damping ratio 0·6. Calculate the amplitude of the output signal in terms of pressure, if the input pressure to the transducer is fluctuating sinusoidally with an amplitude of $800kN/m^2$ at a frequency of 30*kHz*. 7

(c) What is traceability ? Explain the calibration process of voltmeter. 1+4=5

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

(i) Applications of measurement system

(ii) Deflection type instruments

(iii) Voltage standard

(iv) Routine calibration

(v) Functional elements of a measurement system.