53 (IE 302) FNIN

2013

(December)

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)* Elaborate some of the applications of a measurement system. 8

(b) With the help of examples define the following types of instruments — 6

(i) Active instrument *(ii)* Passive instrument *(iv)* Contacting type of instrument and *(v)* Intelligent instrument.

(c) Design and explain a system for the automatic measurement of temperature. 6

2. (a) What do you mean by calibration and standard. Explain about resistance and mass standard. 2+3=5

(b) Explain the construction and working of Weston cell as the voltage standard. What are the demerits of Weston cell ? 7+1=8

(c) What is limiting error ? Describe the random and gross error. 1+6=7

3. (a) If the following data obeys the linear equation $(y = mx + c)$, obtain σ_m using the least square method. 8

y	8.5	9.6	10.9	14.2
x	2.0	2.6	3.2	3.8

(b) The coefficient of viscosity between glass tube and viscous fluid in the laboratory by a technique that is free from systematic error. The data obtained are as follows.

Coefficient of friction	0.44-0.46	0.46-0.48	0.48-0.5	0.5-0.52
Observed frequency	3	7	13	10

Determine if the values of coefficient of viscosity follow the Gaussian distribution or not. 12

4. *(a)* Discuss the hysteresis effect with examples. What is sensitivity drift. 3+2=5

(b) Discuss the loading effect due to input impedance and output impedance of an instrument. 8

(c) What do you mean static characteristic ? Define *any two* desirable and *two* undesirable static characteristics with diagrams if necessary. 1+6=7

5. *(a)* Define fidelity and speed of response. Give an example of linear time invariant system — justify you example with differential equation. 2+4=6

(b) Obtain the unit ramp response of a first order system and give the expression of dynamic error. 5+1=6

(c) A liquid thermometer has its glass bulb protected by a well. The system can be represented by a double capacity system with time constants of 40 sec for the well and 20 sec for the bulb. The thermometer is subjected to a cyclic change of $\pm 10°C$ which occurs every 120 sec. Find the maximum value of the indicated temperature and the delay time. 8

6. (a) A diaphragm pressure transducer behaves as a second order system. The static displacement of the diaphragm is proportional to the applied force. If the natural frequency is $1000Hz$ and the damping ratio is 0.6, determine the frequency range over which the magnitude ratio corresponding to a sinusoidal input deviates by a maximum amount of 10%. 8

(b) Write the procedure employed in the routine calibration of an equipment. 4

(c) Explain how ammeter and voltmeter is calibrated. 8

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

(i) Cumulative error

(ii) Signal conditioning element

(iii) direct and indirect calibration

(iv) time delay element

(v) an application of sensors in recent technology.