Total No. of printed pages = 9

END SEMESTER EXAMINATION, NOVEMBER 2018

Semester – 5th

Subject Code : CAI-503

PRINCIPLES OF INSTRUMENTATION

Full Marks – 70

Time – Three hours

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

Instructions :

1. *All* questions of PART – A are compulsory.
2. Answer any *five* questions from PART – B.

PART – A
Marks – 25

1. Match the following : 1×10=10

(i) Relative limiting error	1.	A device whose output is an enlarged reproduction of the essential features of the input wave and which draws power from a source other than the input signal.

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(ii) Amplifier	2. The act or process of making adjustments or markings on the scale so that the instrument readings conform to an accepted standard.
(iii) Drift	3. An action used to convey information.
(iv) Attenuator	4. An element which converts one form of energy to another.
(v) Signal	5. Unwanted signal that affects the measurement process.
(vi) Transducer	6. Gradual departure of the instrument output from the actual value.
(vii) Precision	7. A device which causes decrease in amplitude of the signal without causing appreciable distortions in it.
(viii) Calibration	8. Smallest increment in measurand that can be detected with certainty by the instrument.
(ix) Resolution	9. The ability of the device to give identical output when repeat measurements are made with the same input signal.
(x) Noise	10. The ratio of the difference between actual value and nominal value to the nominal value of the measurand.

2. Write true or false : 1×5=5

(a) It is not possible to have precise measurements which are not accurate.

(b) An instrument with 1% accuracy is considered better than another with 5% accuracy.

(c) To prevent loading of the circuit under test, the input impedance of the voltmeter must be very low.

(d) The concept of time constant is associated with a first order system subjected to a step input.

(e) Response of a second order system is non-oscillatory when damping ratio is less than unity.

3. Choose the correct answer : 1×10=10

(a) An AC millivoltmeter has range of 0-1000 mV and its accuracy is ± 0.5% of fsd (full scale deflection). If the input voltage of the instrument is 400 mV, the output of the instrument would be

(i) 402 mV

(ii) 398 mV

(iii) between 398 and 402 mV

(iv) between 395 and 405 mV

(b) The error which is repetitive in nature is

(i) observational error

(ii) environmental error

(iii) random error

(iv) systematic error

(c) Threshold of the instrument is defined as the

(i) ratio of output of the instrument to the corresponding input signal

(ii) drift of the output of the instrument due to ageing of components

(iii) smallest input measurable change (non - zero value)

(iv) smallest measurable input signal which can be detected by the instrument

(d) Maximum power is transmitted by an electrical transducer if the impedance of the external load

(i) is very low

(ii) is very high

(iii) matches with the internal impedance of the transducer

(iv) increases from very low values to very high values

(e) LEDs emit light

(i) only in red colour

(ii) only in yellow colour

(iii) only in green colour

(iv) in red, green yellow and amber colour

(f) An LCD requires power of

(i) 20 W (ii) 20 mW

(iii) 20μW (iv) 20 nW

(g) X-Y recorders

(i) record one quantity with respect to another quantity

(ii) record one quantity on X axis with respect to time on Y axis

(iii) record one quantity on Y axis with respect to time on X axis

(iv) Any one of the above.

(h) For a second order system, the settling time for ± 2% band is

(i) $\frac{3}{\varepsilon\omega_n}$ (ii) $\frac{5}{\varepsilon\omega_n}$

(iii) $\frac{7}{\varepsilon\omega_n}$ (iv) $\frac{4}{\varepsilon\omega_n}$

(i) Power in a DC circuit is measured by measuring the voltage across and current through the circuit. The voltage and current measurements are made to an accuracy of ±2% and ±3% respectively. The errors are limiting errors. The error in measurement of power is

(i) ± 2% (ii) ± 3%

(iii) ± 6% (iv) ± 5%

(j) The switching time of LEDs are approximately of

(i) 1s (ii) 1ms

(iii) 1μs (iv) 1ns

PART – B

Marks – 45

4. (a) Define the following terms : 1×6=6

(i) Threshold

(ii) Precision

(iii) Linearity

(iv) Dead Time

(v) Dead Zone

(vi) Resolution

(b) Determine the limiting errors in percentage if three resistances with the following ratings are connected in series and in parallel. 1×3=3

R1= 250Ω ± 3%

R2= 320Ω ± 2%

R3=500Ω ± 3%

5. (a) Describe the functions of the following elements in a measurement system : 2×3=6

(i) Primary sensing element

(ii) Variable conversion element

(iii) Data transmission element

(b) The resistance of a circuit is found by measuring current flowing and the power fed into the circuit. Find the limiting error in the measurement of resistance when the limiting errors in the measurement of power and current are respectively ± 2 % and ± 3%. 3

6. (a) Derive the limiting error in X when 2×3=6

(i) $X = x_1 + x_2$

(ii) $X = x_1 x_2$

(iii) $X = \frac{x_1}{x_2}$

(b) What are the differences between analog and digital type instruments ? 3

7. (a) What are the interferences that affect the measurement system ? Explain in brief. 5

(b) Describe the basic principles of working of an LCD display. 4

8. (a) Explain briefly the single point inductors with diagrams. 5

(b) Explain the working of a scanner. 4

9. (a) Explain the functioning of a basic type of strip chart recorder. 5

(b) Give an example of zero order system and derive the transfer function. 4

10. Derive the transfer functions of the following : 4½×2=9

(i) Thermal system

(ii) Pneumatic system

11. Define the following terms and find expressions for them : 2¼×4=9

(i) Rise time

(ii) Peak time

(iii) Settling time

(iv) Peak overshoot

12. (a) Describe the mathematical models of series and parallel RLC circuits with suitable expressions. 5

(b) Derive the expressions for the transfer function of second order systems. 4