D/3/DIE303
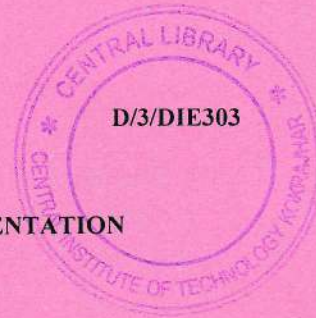
2021

FUNDAMENTALS OF INSTRUMENTATION

Full Marks: 100

Time: Three hours

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

*Answer **any five** questions.*

1. a) Define the terms: Measurand and Instrument of the measurement system.   2

   b) Explain primary and secondary standards of measurement.   4

   c) Explain any three classification of instrument.   6

   d) Explain the elements of a measurement system with the help of an example.   8

2. a) Define the terms: Linearity and Dead Zone of an instrument.   4

   b) A force transducer measures a range of 0- 400N with a resolution of 0.25 percent of full scale. What is the smallest change which can be measured by this transducer? Determine span of the transducer.   4

   c) Define the terms: Sensitivity, Range, Threshold and Resolution of an instrument.   6

   d) A pressure transducer is calibrated at a temperature of 30°C and has the Pressure -Voltage characteristic as shown in Table1.   6
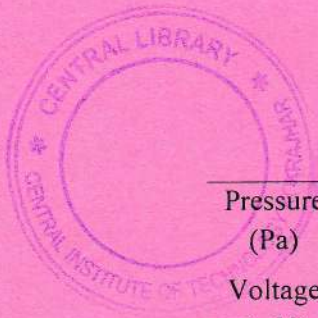
Table1

Pressure (Pa)	0	1	2	3
Voltage (mV)	0	200	400	600

The same transducer is used at a temperature of 40°C and obtained the Pressure – Voltage characteristic of it as shown in Table2.

Table2

Pressure (Pa)	0	1	2	3
Voltage (mV)	0	200	400	600

Determine the following of the transducer (i) Sensitivity at 30°C (ii) Sensitivity at 40°C (iii) Sensitivity drift (iv) Zero drift (v) Zero drift and Sensitivity drift per °C change in ambient temperature.

3. a) The calibration range of a load cell is 40N to 90N. If the dead zone of it is 0.11 percent of span, determine span and dead zone of the load cell. 5

   b) Specify the differences of static and dynamic characteristic of an instrument. Draw an input used for finding the dynamic characteristic of an instrument. 5

   c) Derive the input-output relation for a first order instrument. Draw its dynamic response. 10

4. a) With a neat diagram, explain X-Y recorder. 8

   b) Derive the input-output relation for a second order 12

2

instrument. Draw its dynamic response.

5. a) Three resistors have the following ratings: $R_1 = 37\ \Omega \pm$ 5
5%, $R_2 = 75\ \Omega \pm 5\%$ and $R_3 = 50\ \Omega \pm 5\%$. Determine the magnitude and limiting error in ohm and in percent of the resistance connected in series

   b) The unknown resistance of a wheat-stone bridge is   5
given as $R_X = \dfrac{(R_2 R_3)}{R_1}$; where $R_1 = 100 \pm 0.5\%\ \Omega$, $R_2 = 1000 \pm 0.5\%\ \Omega$, $R_3 = 842 \pm 0.5\%\ \Omega$. Determine the magnitude of the unknown resistance and the limiting error in percent and in ohm for the unknown resistance; Rx.

   c) Define error. Explain types of error.   10

6. a) With a neat diagram, explain strip chart recorder.   6

   b) Define the terms: Drift, Zero drift and Sensitivity drift   6
of an instrument. Specify the factors that contribute towards the drift in the instruments.

   c) Ten students tuned the circuit for resonance and the values of resonant frequency in KHz were recorded as: 8
412, 428, 423, 415, 426, 411, 423, 416, 417and 420. Calculate arithmetic mean and standard deviation of the recorded resonant frequency.

7. a) With the help of diagrams, explain any three methods   10
for measuring displacement.

   b) With the help of diagrams, explain any three methods   10
for measuring temperature.