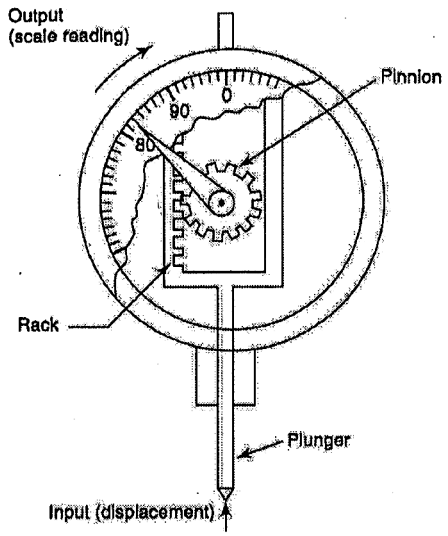
Ex/IEE/PC/B/T/213/2023 (S)

B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING SECOND YEAR FIRST SEMESTERSUPPLEMENTARY EXAMINATION – 2023

FUNDAMENTALS OF INSTRUMENTATION Subject code : IEE/PC/B/T/213 Time 3 hr full marks 100

CO1
ANY TWO (15x2=30)

1	a) Define *Percent Accuracy*. Differentiate the terms '*Repeatability*' and '*Reproducibility*'. b) What are the desirable characteristics of a transducer element?Write in details c) In details, explain functional element of a measurement system.	4+4+7
2	a) What are the advantage of a computer based Instrumentation System? b) What are the types of errors associated with a measurement process? Explain types of Gross Error in details c) How can internal estimate of uncertainty be performed? Indicate the basic and auxiliary functional element of the figure shown here. Justify your answer. 	4+4+7
3	a) Define: limiting Error,Noise factor and Noise figure b) Explain the detail's consideration for selection of any suitable instrumentation basis on performance characteristics c) The length of line is measured with a 150m metallic tape and found to be 935.12 m at 45^{0}C : the tape was standardised at 20 ^{0}C and co efficient of thermal expansion is 0.000 0050 per ^{0}C. what is the correct length of the line to the nearest hundred of a metre ?	4+4+7

CO2
ANY TWO (15x2=30)

4	a) Derive the expression for magnitude and phase of a first order system when subjected to UNIT STEP input signal. b) How could damping in a second order system affect the output response considerably? c) .. *A first-order instrument is to measure signals with frequency content up to 100 Hz with an amplitude inaccuracy of 5%. What is the maximum allowable time constant? What will be the phase shift at 50 Hz?*	4+4+7
5	a) What are the different standard inputs for studying the dynamic response of a system? b) Define and sketch i. Stetting time ii. Retardation time c) Derive the expression for time response of a 2nd order system when subjected to a unit step input signal. Sketch the response.	4+4+7
6	a) Describe in detail the different types of dynamic errors in a measurement system. b) Discuss the necessity to carry out frequency response of a measurement system? What are the plots obtained when the frequency response of a system carried out? c) The moving system of an instrument has a mass of 50gm and a spring stiffness of 4x10^3	4+5+6

[Turn over

	N/rad. Calculate i) natural frequency and ii) the damping constant necessary to prevent oscillations. Suppose if the damping ration is reduced to 60% of its value as in part (ii) what is the frequency of damped oscillation?	
	CO3 (10X1=10) **ANY ONE**	
7	a. Define limiting errors. Derive the expression for relative limiting errors. b. **Means and standard deviations of two sample sizes n_1 and n_2 are a_1, s_1 and a_2, s_2, respectively. The two samples are combined to form a single composite sample of size N ($= n_1 + n_2$) and standard deviation S. Show that:** $$S^2 = \frac{n_1 s_1^2 + n_2 s_2^2}{N} + \frac{n_1 n_2 (a_1 - a_2)^2}{N^2}$$	4+6
8	a) Write the properties of Gaussian Distribution? b) Ten samples of a steel wire tested on a universal testing machine. The breaking strengths in tonnes (t) of the samples were 5.3 | 5.5 | 5.7 | 5.2 | 5.5 | 5.6 | 5.4 | 5.6 | 5.9 | 5.5 Compute the following – i. The mean value of the breaking strength ii. Mean deviation of the data iii. Standard deviation iv. Best estimate of the precision of the apparatus v. The best estimate of the uncertainty of the data	4+6
	CO 4	
	ANY TWO (15X2=30)	
9	a) Explain the working principle, construction and characteristics of *Linear Variable Differential Transformer* (LVDT). b) Give the principle of capacitive transducers. c) A thermistor has a resistance of 10kohm at 25o C and resistance temperature coefficient of -0.05/oc. A Wien Bridge Oscillator uses two such identical thermistors to measure frequency determining part of the bridge. The value of capacitance is used in bridge is 500pF, calculate the value of frequency at 200c. Hint: frequency of oscillation of Wien bridge oscillator f = 1/(2πRC)	15
10	a) Derive the expression of Gage factor of Strain Gauge transducer. Discuss briefly on the various bonded strain gauges b) Define shunt calibration of a strain gauge transducer. c) A capacitance transducer circuit used for measurement of linear displacement. The transducer is a parallel plate air capacitor, wherein the capacitance can be changed by changing the distance between the plates. The transducer is used for dynamic measurement. Suppose the flat frequency response with an amplitude ratio within 5 % is required down t a frequency range of 20hz, what is the minimum allowable value of the time constant? If The area of the plates is 300nm2 and the distance between plates is 0.125 mm, calculate the value of the series resistance R.	15
11	a) Explain photoelectric effect. Describe voltage current characteristic of photo diode at different wavelengths. b) State Piezoelectric effect. Derive the expression of the *Voltage Sensitivity Coefficient*of the piezoelectric transducer c) A Hall effect instrument is installed to measure of a magnetic field of 0.5Wh/m2. The 2 mm thick slab is made of Bismuth for which the Hall Coefficient is (-1x10-6 Vm(A-Wbm-2) and the current is 3 A. Calculate the Hall Voltage.	15