REF:...Ex/IEE/PC/B/T/213/2025

B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING SECOND YEAR FIRST SEMESTER EXAMINATION – 2024

Subject : Fundamentals of Instrumentation Subject code : IEE/PC/B/T/213 Time 3 hr full marks 100

	CO1 (Knowledge based) **Any five**	
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 detail, explain the functional element of a measurement system. d) Classify the transducers according to their characteristics and application. e) Describe the linearity of a transducer and its significance in sensor performance. How can nonlinearity in the static characteristics of a transducer affect the quality of the measurement, and what compensation methods can be used? f) Define: limiting Error, Noise factor and Noise figure . g) Derive the expression for magnitude and phase of a first order system when subjected to UNIT STEP input signal. h) Explain the working principle, construction and characteristics of Linear Variable Differential Transformer (LVDT). i) Write the properties of Gaussian Distribution? j) Explain photoelectric effect. Describe voltage current characteristic of photo diode at different wavelengths	5x5= 25
	CO2 (Understanding based) **Any five**	
2	i. How can internal estimates of uncertainty be performed? ii. Discuss the necessity to carry out frequency response of a measurement system? What are the plots obtained when the frequency response of a system is carried out? iii. How could damping in a second order system affect the output response considerably? iv. What are the different standard inputs for studying the dynamic response of a system? Define and sketch a. Setting time b. Retardation time v. Derive the expression of Gage factor of Strain Gauge transducer. Discuss briefly on the various bonded strain gauges vi. Explain Villary effect with diagrams,how can dynamic force be measured by a piezoelectric pressure transducer. explain with figure/ vii. For semiconductor strain gauges, describe the materials used for base, and adhesive materials and also the materials used for leads. Why is platinum chosen for RTD over Copper or Nickel ? viii. Determine sensitivity of an inductive transducer due to change of air gap distance. Explain fringe effect for capacitance with diagram/.	5x5= 25
	CO3 (Application based) **Any five**	
3	a) The moving system of an instrument has a mass of 50 gm and a spring stiffness of $4x10^3$ N/rad. Calculate i) natural frequency and ii) the damping constant necessary to prevent oscillations. Suppose if the damping ratio is reduced to 60% of its value as in part (ii) what is the frequency of damped oscillation? b) The length of the line is measured with a 150m metallic tape and found to be 935.12 m at 45^0C . The tape was standardized at 20 ^{0}C and the coefficient 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 ? c) Calculate the value of force, charge, and voltage if the quartz crystal is subjected to a strain of 10×10−6 m/m. the other details of the crystal are given below	5x6= 30

	Dimensions of crystal: $2\,\text{mm} \times 2\,\text{mm} \times 1\,\text{mm}$. Charge sensitivity ($d$): $21\,\text{pC/N} - 21 \times 10^{-12}\,\text{C/N}$. Young's modulus ($E$): $8.6 \times 10^{10}\,\text{N/m}^2$. Permittivity ($\varepsilon$): $40.6 \times 10^{-12}\,\text{F/m}$. Strain ($\epsilon$): $10 \times 10^{-6}\,\text{m/m}$. d) A Hall effect instrument is installed to measure 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. e) 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: $$S^2 = \frac{n_1 s_1^2 + n_2 s_2^2}{N} + \frac{n_1 n_2 (a_1 - a_2)^2}{N^2}$$ f) A thermistor has a resistance of 10 kohm 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 used in the bridge is 500pF, calculate the value of frequency at 200c. Hint: frequency of oscillation of Wien bridge oscillator f = 1/(2πRC) g) During a test, current was measured as 20 A. It flows in a resistor of value 0.2 0. The ammeter reads 1.5% low while the resistance reading was high by 0.5%. Find the true power and express it as the percentage of power that was originally calculated h) A second-order transducer with damping ratio ζ=0.7 has a settling time of 2 seconds for a step input. If the damping ratio is increased to 0.9, how will the settling time change? Justify your answer.	
	CO4(Analysis & Creation) **Any four**	
4	a) Draw the diagram for shunt calibration of a strain gauge transducer and explain b) A transducer has a bandwidth of 100 Hz. If it is used to measure a signal of frequency 150 Hz, analyze the effect on the measurement? c) Explain how using a differential arrangement in a capacitive transducer can make the response linear when capacitance varies with displacement. d) How is a differential output taken from an inductive transducer? Explain the advantages of using inductive transducers in push-pull configurations. e) Distinguish between systematic and random errors in a measurement and discuss how they are minimized. To what extent is the experimenter responsible for errors, and how can they be reduced? f) Design an optical transducer to measure the proximity of objects? How does an optical pyrometer work ? g) Can you explain your understanding of the Hall effect? How can current be measured using Hall transducers ?	4x5= 20