

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

Subject : Fundamentals of Instrumentation Subject code : IEE/PC/B/T/213

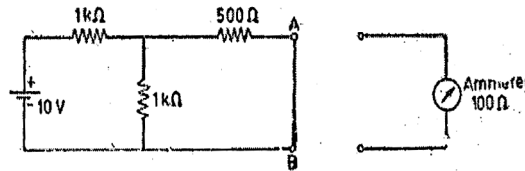
Time 3 hr

full marks 100

CO1**ANY TWO (15x2=30)**

- 1 a) Define percent linearity. Differentiate the terms 'accuracy' and 'precision' 4+5+6
 b) What are the desirable characteristics of a transducer element? Write in details
 c) In details, explain the signal conditioning operation that are carried out in the transduced information.
- 2 a) What are the usual steps taken care for routine calibration? 4+4+(2+
 b) What re the types of errors associated with a measurement process? Explain types of Gross Error in 5)
 details
 c) How can internal estimate of uncertainty be performed?

It is desired to measure the value of current in the 500-ohm resistor as shown in the following figure by connecting a 100-ohm ammeter. Find actual value of current, measured value of current, the percentage of error and accuracy in measurement



- 3 Define: Signal to Noise Ration and Instrument Efficiency. Differentiate between Johnson noise and shot noise? 4+5+6

An amplifier whose bandwidth is 100khz has a noise power spectrum density input of 7×10^{-21} J. If the input resistance is 50 k-Ohm and the amplifier gain 100, what is the noise output voltage?

Explain the detail's consideration for selection of any suitable instrumentation 'basis on performance characteristics

CO2**ANY TWO (15x2=30)**

- 4 What are the various Dynamic characteristics? 2+6+7

Derive the expression for magnitude and phase of a first order system when subjected to a sinusoidal input signal. Draw the magnitude and phase versus frequency plots.

A thermometer with time constant of 60 sec is used for measuring temperature cycling with 600sec time period. Find the time lag and ratio of output to input. If the same instrument is used for measurement of an input with a time period of 120 sec, calculate the measuring lag and the ratio of output to input.

- 5 What are the different standard inputs for studying the dynamic response of a system? Define and sketch 4+(6+2+
 Derive the expression for time response of a 2nd order system when subjected to a unit step input signal. 3)
 Sketch the response. Define the following term and find expression for them

- i) Rise time
 ii) Peak Overshoot

- 6 Define linear time invariant system and linear time variant system 4+5+6
 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?

The moving system of an instrument has a mass of 5gm and a spring stiffness of 2×10^3 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?

[Turn over

CO3 (10X1=10)

ANY ONE

- 7 Define limiting errors. Derive the expression for relative limiting errors. 4+6
 A study has indicated that the life of TV picture tubes manufactured by a certain firm is normally distributed with a mean life of 5 years (1 year=365 days) and a standard deviation of 500 days. The manufacturer gives a guarantee of 1 year. Determine a) what percentage of picture tube will he have to replace in 1 year? b) if the manufacturer wishes to replace the same amount of the picture tubes with 2 years guarantee, what should he do?
- 8 Write the properties of Gaussian Distribution? 4+6

Ten samples of a steel wire tested on a universal testing machine. The breaking strengths in tonnes (t) of the samples were

4.3	4.5	4.7	4.2	4.5	4.6	4.4	4.6	4.9	4.5
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Compute the following –

- The mean value of the breaking strength
- Mean deviation of the data
- Standard deviation
- Best estimate of the precision of the apparatus
- The best estimate of the uncertainty of the data

CO 4

Any one from questions 9 & Any five from question 10 (5+25=30)

- 9 Attempt any one 5x1=5
 A) A Hall effect instrument is installed to measure of a magnetic field of 0.5Wb/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.
 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 $f = 1/(2\pi RC)$
- B) 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.
- 10 Attempt Any five 5x5=25
 A). What are the advantages and disadvantages of RTD? On what basic principle does RTD work? Explain with diagram one of the RTDs.
 B) What is Magnetostrictive phenomena? which material show Magnetostrictive phenomena. Explain construction and working principle of Magnetostrictive Force measurement transducer.
 C) Explain the working principle, construction and characteristics of *Linear Variable Differential Transformer* (LVDT).
 D) Show how a capacitive transducer can be used to monitor the thickness of an insulating sheet in motion, without making physical contact; comment on the linearity and sensitivity of the system.
 E) Derive the expression of Gage factor of Strain Gauge transducer. Discuss briefly on the various bonded strain gauges.
 F) State Piezoelectric effect. Derive the expression of the *Voltage Sensitivity Coefficient* of the piezoelectric transducer
 G) Explain the principle of working of the optical pyrometer and its advantages
 H) Derive the expression of Hall coefficient. Describe the construction and working principle of close loop Hall current sensor.
 I) Explain photoelectric effect. Describe voltage current characteristic of photo diode at different wavelengths.