Ref. No. : Ex/FET/OE/IEE/T/208/2023

Name of the Examinations: THIRD/FOURTH YEAR SECOND SEMESTER - 2023

Subject: BASIC MEASUREMENTS AND INSTRUMENTATION

Time: 3 Hrs.   **Full Marks: 100**

Attempt *question 1* and *any six* from remaining.

Group-A

1. Multiple choice questions.   1 × 10 = 10

   i) .... are integrating instruments?
     a) Ammeters
     b) Voltmeters
     c) Wattmeters
     d) Frequency meters

   ii) A .... torque prevents the oscillation of the moving system and enables the latter to reach its final position quickly.
     a) deflecting
     b) controlling
     c) damping
     d) all of the above

   iii) LVDT which is an instrument for the measurement of displacement, works on the principal of ....
     a) Linear inductance
     b) Non – linear inductance
     c) Mutual inductance
     d) Linear capacitance

   iv) The AC Bridge which is used for the measurement of frequency is ....
     a) Schering bridge
     b) Wien bridge
     c) Hay's bridge
     d) Anderson bridge

   v) A Lissajous pattern is used to measure
     a) Voltage
     b) Frequency
     c) Frequency and phage shift
     d) Power

   vi) Which of the following pair represents active transducers
     a) Solar cell and strain gauge
     b) Thermocouple and solar cell

   c) Thermistor and piezoelectric material
   d) RTD and LVDT

vii) A thermistor transducer is designed with _____ substance?
   a) Semiconductor
   b) Insulator
   c) Conductor
   d) All the above

viii) _____ measures velocity at a point of fluid in a stream.
   a) Venturi meter
   b) pH meter
   c) Pitot-Static tubes
   d) Orifice meter

ix) The data acquisition system implies input data collection in _____
   a) Mixed signal form
   b) Analog form
   c) Digital form
   d) The form of binary codes

x) Absorption spectroscopy work on the basis of
   a) Max-Well Boltzman's equation
   b) Bragg's equation
   c) Noise-whitney equation
   d) Beer's law

2. a) Draw and describe the functional block diagram of a speed measurement system.

                                                                    [CO3, K2, A1, S3]

   b) Define Relative error, resolution, and dynamic error.

                                                                    [CO1, K1, A1, S1]

   c) Find the resolution of an eight-bit A/D converter connected to a reference voltage +5V.

                                                                    [CO1, K1, A1, S2]

   d) Assume a mercury thermometer follow the 1st order system response. It is suddenly put into a bath of boiling water from room temperature of 25°C. If time constant of the thermometer is 2 seconds, find the thermometer reading after 6 seconds.

                                                                    [CO3, K3, A3, S3]

                                                                    5+6+2+2=15

3. a) A set of independent length measurements of a pencil was taken by 10 students and recorded as 16.2 cm, 16.1 cm, 16.3 cm, 16.3 cm, 16.1 cm, 16.2 cm, 16.2 cm, 16.3 cm, 16.1 cm, and 16.2 cm. Calculate average length and the standard deviations.

                                                                    [CO1, K4, A3, S2]

   b) Using a suitable schematic design, describe the operation of a PMMC type ammeter and hence find the expression for the angular deflection.

                                                                    [CO3, K2, A2, S1]

   c) Explain with necessary circuit diagram, how an unknown resistance can be measured using potentiometer?

                                                                    [CO3, K2, A2, S2]

                                                                    (2+3)+5+5=15

4. a) Using necessary schematic diagram, describe the operation of a direct thermal printer.

[CO3, K2, A2, S1]

b) Draw the block diagram of CRO and describe working of electron gun.

[CO3, K4, A3, S4]

c) Consider the Lissajous pattern as shown in *Fig. 1* below. Now calculate the ratio of the frequency of the signal applied to the vertical and horizontal deflection plates.
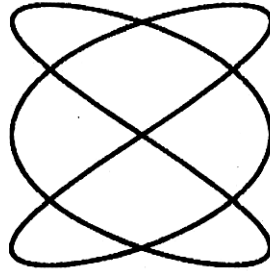

Fig. 1: Lissajous Pattern

[CO4, K6, A5, S5]

5+(4+2)+4=15

5. a) Using a schematic diagram, explain how potentiometer can be used to measure angular displacement.

[CO4, K3, A3, S5]

b) Four strain gauge elements are bonded on either side of a cantilever beam such that two are in compressive mode and other two are in tensile mode. How these elements can be connected into a full bridge configuration and find the sensitivity of this circuit.

[CO4, K6, A4, S5]

c) Explain the working of a capacitive microphone with a neat sketch.

[CO4, K6, A4, S5]

4+(2+4)+5=15

6. a) Using suitable schematic design, describe operation of LVDT? State the cause of residual voltage in LVDT.

[CO4, K2, A1, S3]

b) Draw and describe the block diagram of the smart sensor.

[CO4, K3, A4, S5]

c) Describe operation of seismic accelerometer with a schematic diagram and hence find the transfer function of the same.

[CO4, K3, A4, S5]

5+4+(3+3)=15

7. a) Draw a neat labelled diagram of bourdon tube.

[CO4, K3, A3, S4]

b) Write the expression for Bernoulli's equation. Hence find the volume flow rate for Venturi Meter.

[CO4, K1, A2, S1]

c) Draw the signal conditioning circuit for 2-wire RTD and find out the expression of output voltage.

[CO4, K3, A3, S4]

5+6+4=15

8. a) A thermistor showing resistances 12 KΩ at 25°C. Its characteristic constant is 4000°K. At what temperature the thermistor will show a resistance of 3.5 KΩ?

[CO4, K1, A2, S1]

b) State the law of intermediate temperature for thermocouple.

[CO4, K1, A2, S1]

c) Describe generalised block diagram of a process control loop.

[CO4, K2, A1, S3]

d) Draw and describe the block diagram for a multi-channel data acquisition system?

[CO4, K4, A5, S4]

4+2+4+5=15

9. Write short notes on *any three*.   **3 × 5 = 15**

a) Capacitive moisture transducer.

[CO3, K2, A1, S3]

b) Thermo well.

[CO3, K2, A1, S3]

c) Selective Radiation Pyrometer.

[CO3, K2, A1, S3]

d) Sophisticated Analytical Instrument Facilities.

[CO3, K2, A1, S3]

e) Single beam absorption spectrometer.

[CO3, K2, A1, S3]