Ref. No. EX/PE/PE/H/T/414C/2025

B.E. Power Engineering, Fourth year 1st Semester Examination, 2024-25

SUBJECT: Experimental Techniques and Measurements (HONS.)

Time: Three hours | Full Marks: 100

Instructions: Answer any one Question from Module-I, any two Questions from Module- II and any two questions from Module-III. Figure in the margin indicate marks for each Question. [Total three pages]

Module I

1 Define the term 'Measurements' of Physical/Electrical Quantities. What are the different types of Standards of Measurements and Purposes? Define the term 'Calibrations'. What are the different types of Calibration Techniques? (2+6+3+9)

2 In an experiment, measuring area of 100 sq.cm. with a planimeter the following reading were recorded (20)

Sl. no.	Area (sq. cm.)	Sl. no.	Area (sq. cm.)
1	100.3	7	101.1
2	101.7	8	98.5
3	101.3	9	99.6
4	101.9	10	106.9
5	102.4	11	101.5
6	104.5	12	99.4

Estimate the mean value, mean deviation, standard deviation, Bessel's correction factor, adjusted standard deviation, internal estimation of error, external estimation of error.

Module 2

3 a) Derive the Expression of Amplitude Ratio (z_0/x_0) of Seismic Devices(Spring mass type).
b) In a Seismic Instrument, mass, m =100 grams, Spring stiffness, K = 1 Newton/mm, damping ratio =0.4.
i. Find the Amplitude of Recorded motion, if the motion to be measured is 3sin200t (mm).
ii. Find the maximum frequency for which Instrument can be used as Accelerometer if error is not to exceed 10%. (12+4+4)

4 a) Derive the Expression of Amplitude Ratio (e_{0m}/x_m) of Piezo Electric Transducer.
b) A Piezo-electric Transducer has the following Characteristics: $C_{crystal} = 10^{-9}$ Farad, Capacitance of connecting Cable=$C_{cable} = 3x10^{-10}$ Farad, Charge Constant of Crystal= $4x10^{-6}$ Coulomb/cm. The oscilloscope used for readout has a Resistance of 1.0 Mega ohm in parallel with a capacitance of 10^{-10} Farad.
Find the Amplitude of the Output voltage as displayed on oscilloscope, if the Crystal is subjected to Harmonic deformation of Amplitude 10^{-3} mm and frequency 200 Hz. (12+8)

5	a) Derive expression of Detector output voltage of Full Bridge Strain Gauge arrangement. b) A Rectangular Rosette is mounted on a Steel Plate having Young's Modulus, E = 2.0×10^{11} Newton/m^2,and μ =0.3. Three Strains are measured as **ε_1=+500 µm/m, ε_2=+400 µm/m and ε_3= - 100 µm/m.** i. Calculate the Principal Strains and Stresses and maximum Shear Stress. ii. Locate the axis of the Principal Stress.	(6+10+4)
6	a) Consider the arrangement in which four active strain gauges are used, with R_2 and R_4 are arranged at right angles to R_1 and R_3. It would also be compensated for temperature variations. Calculate current through detector of this bridge arrangement. Indicate the signal enhancement factor. b) A load Cell is formed of a hollow steel cylinder loaded axially. The four strain gauges are so as to enhance the signal and compensate for temperature variation. The cross sectional area of load c ell is 2 cm^2. The Young's modulus of steel is 2.07×10^{11} Newton /m^2 and μ =0.3. Strain Gauge Resistance = 100 ohms, Gauge Factor =2.1. The current in each gauge is limited to 20 mA. Please note gauges R_1 and R_3 measure axial strains while gauges R_2 and R_4 measure circumferential strains which are opposite to nature to the axial ones. Calculate : i. Bridge supply voltage. ii. Current in Galvanometer arm if this consists of 500 ohms Resistance, when the Load cell is subjected to a Force of 10^5 Newton.	(10+2+8)

	Module -3	
7	A variable capacitance pressure gauge has the following specifications: Diameter of clamped Diaphragm = 20 mm, diameter of the fixed electrode =15mm, thickness of diaphragm =1.0 mm, initial air gap 1.0 mm , young's modulus of diaphragm material =2.07×10^{11} Newton/m^2 , Poisson's ratio = μ =0.3 . The variable Capacitance, C due to change of Air gap form the part of the circuit. Find the sensitivity (V/Pa) of this instrumentation arrangement; given V=12 V and R =10^5 ohms.	(20)
8	a) Discuss with neat diagram the principle of operation of Selective Pyrometer for measuring high temperature. b) The Power radiated from hot piece of metal was measured by radiation pyrometer and the temperature was determined as 820 degree C, assuming a surface emissivity of 0.75, later it was found that the accurate value of emissivity was 0.69. Find the error in temperature determination. c) Discuss briefly Temperature measurement in high speed fluid flow system with neat diagram showing Temperature Probe.	(10+3+7)

9	a) Derive Expression of Fluid Flow in Variable Head Meters with schematic diagram. b) A Venturimeter is fitted in a horizontal pipe of diameter 15cm, carrying gas density 1.15Kg/m^3, for the purpose of flow measurement. The differential pressure head indicated by U- tube manometer containing oil of specific gravity 0.8 is 10 cm. If co-efficient of discharge and diameter of nozzle are 0.8 and 5cm respectively, determine the flow of gas through the pipe line. c) Derive the Discharge Equation of Triangular (V-notch) Weir.	(10+3+7)
10	a) Discuss with neat sketch the operating Principle of LASER Doppler Anemometer (LDA) with derivation of Relationship of Doppler shift frequency with wave length and velocity. b) What are the main advantages of LDA. c) Discuss briefly the principle of operation of Particle image velocimetry (PIV)	(10+3+7)