Ex/PE/PC/B/T/321/2025

B.E. POWER ENGINEERING THIRD YEAR SECOND SEMESTER - 2025

Measurement and Transducers **Time 3 Hr.** **Full Marks: 100**

1. Answer any three questions **(CO1)** 3×5
   (a) Derive the expression of the deflection in an electrodynamometer type instrument for AC application.
   (b) What is creeping? How can it be prevented in a single phase induction type energy meter?
   (c) Show that the total number of revolution in a single phase energy meter is proportion to the energy.
   (d) Derive the general expression of deflection for a spring controlled repulsion type MI instruments. Comment on the shape of scale of MI instruments.
   (e) Derive the expression for the steady state deflection of PMMC instrument. How is the error due to the temperature change reduced in voltmeter?

2. Answer any two questions **(CO2)** 2×8
   (a) Compute the sensitivity of Wheatstone bridge circuit for small unbalance and derive the condition for maximum sensitivity. Also find the expression for current through the galvanometer.
   (b) How does Owen's bridge work? Explain with the circuit diagram. Derive the expression for the unknown inductance and the resistance. Draw the phasor diagram of the bridge under balanced operating condition.
   (c) Draw the equivalent circuit and phasor diagram of a current transformer. Derive the expression for ratio error.
   (d) How unknown capacitance can be measured using De Sauty's bridge. What are the limitations of this bridge and how are these limitations overcome using modified De Sauty's bridge? Explain with the phasor diagram.

3. Answer any five questions **(CO3)** 5×8
   (a) A PMMC instrument has a coil of dimension 20mm×16mm. The flux density is 1×10^{-3}Wb/m^2 in the air gap and the spring constant is 0.2×10^{-6} Nm/rad. Determine the number of turns required to produce an angular deflection of 120 degrees when a current of 7.5mA is flowing through the coil.
   (b) The inductance of a MI ammeter is $7+3\theta-\frac{1}{2}\theta^2$ μH, where θ is the deflection in radian from zero position. The control spring torque is 12×10^{-6} Nm/rad. Calculate the deflection for a current of 1, 3 and 5A and discuss the scale shape.
   (c) An Anderson Bridge has the unknown impedance with inductance L and R in arm 'ab', a known variable resistance in arm 'bc', fixed resistance of 450Ω each in arms 'cd' and 'da' and a condenser with fixed capacitance of 1μF in arm 'ce', a known variable resistance in arm 'de'. The ac supply of 50 Hz is connected across 'a' and 'c', the galvanometer is connected between 'b' and 'e'. If the balance is obtained with a resistance of 250 Ω in the arm 'de' and a resistance of 500Ω in the arm 'bc', calculate the value of unknown R and L.
   (d) A single phase potential transformer has a turns-ratio of 1000/100. Primary winding resistance= 100Ω, primary winding reactance = 75Ω, Secondary winding resistance =1.0Ω, Total equivalent reactance = 120Ω, Magnetizing current = 0.05A pf at 0.5 pf. Calculate the phase angle error at no load. Also calculate the load in VA at unity pf at which the phase angle will be zero. State the assumptions made.
   (e) A Wheatstone bridge has the following data: P=100Ω, Q=1000Ω, S=750Ω. A 1.6 V battery with negligible internal resistance is supplying the bridge. The galvanometer resistance is 500Ω. Calculate the value of R. If R is increased by 2Ω what will be the current through the galvanometer. Also determine the sensitivity of the bridge for the unbalance condition if the current sensitivity of the galvanometer is 100 mm/μA.

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(f) A strain gauge has the gauge factor of 4. If the strain gauge is attached to a metal bar that stretches from 0.25 m to 0.255 m when strained, what is the percentage change in the resistance? If the unstrained value of the gauge is 120 Ω, what is the resistance value of the gauge after the application of force?

(g) A Schering bridge is used for measuring power loss in dielectrics. The specimens are in the form of 0.4 cm thick and have a dielectric constant of 2. The area of each electrode is 200 cm^2 and the loss angle is known to be 10 for a frequency of 50 Hz. The fixed resistor is of 1000 Ω and the fixed capacitor is 47 pF. Determine the value of variable capacitor and resistor. Derive the formula used.

4. Answer any three questions **(CO4)** 3×8

(a) Describe the working and the construction of resistance thermometers. Why is platinum preferred as the most suitable for RTD?

(b) Define the following transducer characteristics: Calibration, Reproducibility, Sensitivity and Resolution.

(c) Describe the methods measurement of pressure using different capacitive, piezoelectric transducers.

(d) Write the expression of the relation between the resistance and the temperature of a thermistor. Draw the resistance-temperature characteristics of NTC and PTC thermistors. Discuss the uses of each type of thermistors. Name one thyristor IC used for the measurement of temperature and explain the scheme.

(e) Explain the operation of a capacitive type humidity sensor with suitable diagram. Name one humidity sensor IC.

5. Answer any one: **(CO5)** 1×5

(a) How the Hall-effect transducers can be used to measure magnetic field? Develop a scheme.

(b) Discuss with a neat diagram the working of a pH meter