B.E. POWER ENGINEERING THIRD YEAR SECOND SEMESTER - 2024

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

1. Answer any three questions **(CO1)** 3×5
   (a) Classify Moving Iron instruments. Explain how the deflecting torque is produced in any one of the MI instruments. Also mention the role of control torque and the damping torque in it. Comment on the shape of the scale of MI instrument. 1+2+1+1
   (b) How is the error due to temperature changes reduced in a PMMC instrument? Explain with suitable circuit diagram. Which material is suited best for a swamping resistance to support the same? 3+1+1
   (c) How is the Lag adjustment achieved in a single phase energy meter? Explain with diagram. 3+2
   (d) Derive the expression for the deflection generated in an electrostatic instrument.
   (e) Describe the constructional details of electrodynamometer type instruments using suitable diagram. 4+1

2. Answer any two questions **(CO2)** 2×8
   (a) Draw the circuit diagram of the Hay's bridge. Derive the expressions of the unknown inductance and resistance of this bridge and draw the corresponding phasor diagram. Why is this bridge suitable for measurement of inductance of high Q coils?
   (b) Draw the equivalent circuit and phasor diagram of a potential transformer. Derive the expression for ratio and phase angle error.
   (c) Draw the circuit diagram of a Schering bridge. Derive the expression for the unknown capacitance and the dissipation factor. How this bridge is modified for the high voltage capacitance measurement.
   (d) What is Megger? Draw its circuit diagram and explain its operation.

3. Answer any five questions (CO3) 5×8
   (a) A moving coil instrument whose resistance is 25 ohm gives a full scale deflection with a current of 1mA. This instrument is to be used with a manganin shunt to extend its range to 1A. Calculate the error caused by 10°C rise in temperature when;
      (i) Copper moving coil is connected directly across the manganin shunt
      (ii) A 75 ohm manganin resistance is used in series with the instrument moving coil
   The temperature co-efficient of copper is 0.004/°C and that of the manganin 0.00015/°C.
   (b) For a moving coil voltmeter having the following data calculate the deflection produced by 200V. Dimension: 30mm×30mm; Resistance: 12000Ω; Flux density: 0.1wb/m^2; Spring Constant: 3×10^{-6}Nm/deg
   (c) A current transformer with a bar primary has 500 turns in the secondary wingding. It is operating with the secondary impedance of $(1.5+j1)\ \Omega$. The core-magnetizing and core-loss mmfs are 100A and 40A respectively when the current flowing in the secondary winding is 5A. Calculate the ratio error and the phase angle error.
   (d) The inductance of a moving iron ammeter is given by: $L = (0.004 + C\theta)^2$ where θ is the deflection from zero position in degrees. The angular deflections of the instrument corresponding to 2 A and 4 A are respectively 80° and 120° respectively. Calculate the value of C.
   (e) The ratio arms of a Kelvin double bridge are 1000Ω each. The galvanometer has an internal resistance of 500Ω. The battery is of 100V with 5Ω internal resistance. The bridge is balanced when the standard resistance is $S = 0.001\Omega$. Calculate the value of the unknown resistance. What will be the deflection when the unknown resistance is changed by 0.1% from its value at the balance? The galvanometer sensitivity is 200mm/μA. Neglect the resistance of the link
   (f) Four arms of a Maxwell's capacitance bridge at balance are: arm AB, an unknown induction L_1, having an inherent resistance R_1; arm BC, a non-inductive resistance of 100Ω; arm CD, a capacitor of 0.1 μF in parallel with a resistance of 100Ω; arm DA, a resistance of 100Ω. Derive the expression for the unknown inductance and the resistance and determine their values. Also draw the phasor diagram of the bridge under balanced condition.

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(g) A strain gauge has a resistance of 100Ω unstrained and the gauge factor is (-12). What is the resistance value if the strain is 1%?

(h) The temperature resistance characteristics of a thermistor is given by $R_{T_2} = R_{T_1}(e^{\beta(\frac{1}{T_2}-\frac{1}{T_1})}$. The value of β=*4000K*. The resistance of the thermistor is *200kΩ* at -100°C. Find the value of the resistance at 300K. Find the ratio of the two resistances for Platinum over the same temperature range. The platinum has a resistance temperature coefficient of 0.0039/°C

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

(a) Describe the methods of pressure measurement using embedded and unbounded strain gage pressure transducer.

(b) What are the functions of a signal conditioning system? Draw the block diagram of an A.C. signal conditioning system. Explain the role of Zener diode and Optoisolator in signal conditioning system using proper circuit diagram.

(c) What are the two types of thermistors? Write the expression of the relation between the resistance and the temperature of a thermistor. Also draw the resistance-temperature characteristics of each type of the thermistors. Name one thyristor IC used for the measurement of temperature and explain the scheme.

(d) Define the following transducer characteristics: Resolution, Repeatability, Reproducibility and Error due to Noise

(e) i. Explain the operation of a capacitive type humidity sensor with suitable diagram. Name one humidity sensor IC.
ii. What is Pt100?

5. Answer any one: **(CO5)** 1×5

(a) Discuss a scheme for the measurement of magnetic field using Hall Effect.

(b) Propose a method for measurement of flame temperature using thermocouple. Draw the corresponding diagram. Which type of thermocouple can be used for flame temperature measurement?