Electrical Measurement-I (EE -302)

Time: 3 hrs   **Full Marks: 70**

Use separate answer script for each half
Answer *SIX* questions, taking *THREE* from each half
Two marks reserved for neatness in each half

FIRST HALF

1. (a) What do you mean by measurement? State the importance of measurement in engineering.

   (b) What is the difference between accuracy and precision? State and define the three general classes of error?

   (c) State the number of significant figures in each of the following :
        i) 543   ii) 0.65   iii) 30×10^6 [3 + 5 + 3]

2. (a) Briefly explain the working principle of a single phase dynamometer type wattmeter. Mention two common errors caused in such instruments.

   (b) Find the reading of the wattmeter when the network shown in Fig. 1 is connected to a symmetrical 440V 3ph supply. Phase sequence is RYB. Neglect instrument losses.
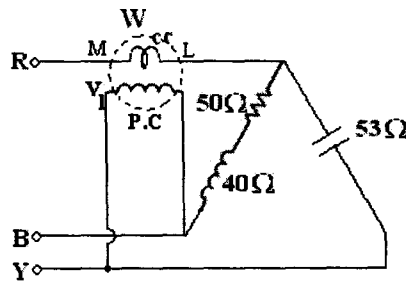

                                                 [6 + 5]

Fig. 1

3. (a) Prove that the power in a 3-phase circuit can be obtained from the readings of the two wattmeters. Draw the circuit and phasor diagrams.

   (b) Two wattmeters connected to measure the power in a 400V, 3-phase balanced delta-connected load. The readings of the meters are 4.5KW and 1KW respectively, while the reading of the second meter was observed after reversing the current coil connections. Compute the active power, reactive power and the power factor of the system.

                                                 [6 +5]

4. (a) Briefly explain how the limitations of Wheatstone bridge in measurement of low resistances are eliminated by using Kelvin double bridge.

   (b) A Wheatstone bridge used to measure the resistance of **X** is balanced with the values as shown in Fig. 2. Due to the presence of chemical impurities in the elements, **emfs** of $X_1 = 12mV$ and $X_2 = 22mV$ are produced in two arms with the polarities as shown. Calculate: i) the apparent value of **X**, (ii) the true value of **X** and (iii) the %error in the apparent value of **X**.
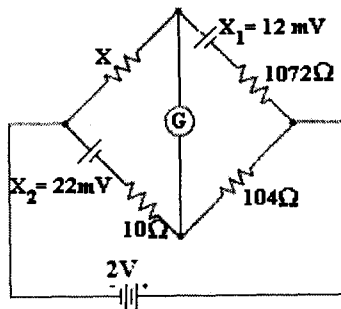

                                                   [5 + 6]

Fig. 2

5. Write short notes on **any two** of the followings :   [5½ × 2]
    a) LPF wattmeter
    b) Localisation of cable faults
    c) 3- phase reactive power measurement
    d) Megger

SECOND HALF

6. a) Draw the neat diagram, label and describe the constructional details of a permanent magnet moving coil type instruments. Derive the equation for deflection if spring control is used. Comment on the shape of scale.

    b) The inductance of a moving iron instrument is given by $L = (0.01 + K_1\theta)^2 \,\mu H$, where θ is the angular deflection in radian from zero position. The instrument angular deflections corresponding to currents of 2A and 5A are 45^0 and 90^0 respectively. Find the value of K_1.
                                                                                [6 + 5]

7. a) Prove that in a rectifier type of voltmeter, the ac sensitivity is 0.45 times the dc sensitivity if a half wave rectifier is used while it is 0.9 times the dc sensitivity if a full wave rectifier is used.

    b) An electrostatic voltmeter reading up to 2500V is controlled by a spring having torsion constant of 0.8×10^{-7} Nm/degree and has a full-scale deflection of 90°. The capacitance at zero voltage is 12pF. Determine the capacitance when the pointer indicates 2500V.
                                                                                [6 + 5]

8. a) Show that for ac operation, the time constants of the shunt and the ammeter must be equal for an accurate reading at all frequencies.

    b) What do you understand by the term "burden" of an instrument transformer?

    c) Calculate the phase angle error in a Biffi's test with the following data: Frequency $=50Hz$; capacitance $=0.5\mu F$; shunt resistance across capacitor $= 105\Omega$.
                                                                                [5 + 3 + 3]

9. a) Describe the method of testing potentiometer transformer using resistive potential divider. Make necessary derivations for ratio and phase angle errors.

    b) Why does the rotating disc of an induction type energy meter carry a small hole?

    c) A 230V, 50Hz single-phase energy meter has a constant of 200 revolutions per kWh. While supplying a non-inductive load of 4.4 A at normal voltage, the meter takes 3 minutes for 10 revolutions. Calculate the percentage error of the instrument.
                                                                                [5 + 3 + 3]

10. Write short notes (**any two**) of the following: [5½ × 2]
    a) Eddy current damping torque with a metal disc
    b) Shunts and multipliers
    c) Quadrant type voltmeter with heterostatic connection