BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING)
2ND YR 1ST SEMESTER EXAMINATION, 2019 (OLD)

SUBJECT: - ELECTRICAL MEASUREMENT AND MEASURING INSTRUMENTS

Full Marks 100

Time: Three hours

Answer any Five Questions. 20X5

1. a) Show that electromagnetic damping for an indicating instrument is inversely proportional to coil circuit resistance. Hence define critical damping external resistance. **10+6+4**

   b) A PMMC instrument has the coil resistance of 50 ohm and gives full scale deflection, when carrying current of 50 mA. Show how it can be adopted to measure i) Voltage upto 600 V and ii) Current upto 20 A.

   c) What is meant by logarithmic decrement parameter of a galvanometer?

2. a) Referring to construction of moving iron type instrument, explain how instrument can measure DC and AC voltage/current. **6+6+8**

   b) Explain why the L/R ratio of the shunt and the fixed coil of moving iron type ammeter must be same?

   c) Distinguish between the working principles of attraction and repulsion type moving iron instruments with the help of diagrams.

3. a) Explain why the scale of dynamometer type wattmeter is uniform but is non uniform for ammeter and voltmeter? **8+6+6**

   b) Prove that the true power in dynamometer type wattmeter is given by:
   $$W \times \left(\frac{Cos(\phi)}{Cos(\beta)Cos(\phi \pm \beta)} \right),$$ where W is the observed reading, $Cos(\phi)$ is the power factor and β is the power factor angle of pressure coil.

   c) A wattmeter with resistance of the pressure coil and current coil are 1000 ohm and 0.01 ohm respectively is used to measure the power supplied to a resistive load. The load current and load voltage are 20 A and 30 V respectively. Calculate the % error in the readings for two different connections between voltage and current coils of wattmeter.

4. a) Draw the equivalent circuit of a C.T. and hence derive the expression of ratio and phase angle error of C.T. **10+5+5**

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b) Explain how braking torque is produced in induction disc type energy meter?

c) Why Lag adjustment is required for induction type energy meter?

10+10

5. a) Describe the ammeter-voltmeter method of measurement of resistances. There are two ways in which the circuit of ammeter voltmeter method can be used (i) ammeter connected to the side of unknown resistance and (ii) voltmeter connected to the side of unknown resistance. Derive the condition which decides which circuit is to be used for a particular set of ammeter, voltmeter and unknown resistance. Assume equal relative error in the both cases.

b) In a Kelvin double bridge each of the ratio arms $P = Q = p = q = 1000\Omega$. The emf of the battery is 100V and a resistance of 5Ω is included in the battery circuit. The galvanometer has a resistance of 500Ω and the resistance of the link connecting the unknown resistance to the standard resistance may be neglected. The bridge is balanced when the standard resistance $S = 0.001\Omega$. Determine (a) the value of unknown resistance, (b) the current through the unknown resistance R at balance, (c) the deflection of the galvanometer when the unknown resistance R is changed by 0.1% from its value at balance. The galvanometer has a sensitivity of 200 mm/μA.

6. a) Define gauge factor and Poisson's ratio and establish a relation between them.   8+12

b) A series type ohmmeter has a movement of 60Ω internal resistance. If full scale deflection current is 1.2 mA, internal battery voltage is 3 volt, and the desired scale marking for half scale deflection is 1500Ω, determine (i) R_{se} and R_{sh} (ii) maximum value of R_{sh} to compensate for a 10% drop in battery voltage (iii) scale error at the half scale mark when R_{sh} is not set as in (ii).

7. a) Explain the advantage of using 'phantom load' in calibration of wattmeter. Draw the connection diagram of calibrating a wattmeter with the help of d.c. potentiometer.   12+8

b) A basic slide wire potentiometer has a working battery voltage of 5 V with negligible internal resistance. The resistance of slide wire is 500Ω and its length is 200cm. A 200 cm scale is placed along the slide wire. The slide wire has 1 mm

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scale divisions and it is possible to read up to 1/5 of a division. The instrument is standardized with 1.0186 V standard cell with sliding contact at the 101.86 cm mark on scale. Calculate (i) working current, (ii) the resistance of series rheostat, (iii) the measurement range and (iv) the resolution of the instrument.

8. a) Derive the general equations for balance of an AC bridge. Prove that two conditions i.e. for magnitude and phase have to be satisfied if an AC bridge is to be balanced unlike a DC bridge wherein only the magnitude condition is to be satisfied. What is the importance of inter bridge transformer in AC bridge?   8+12

   b) An ac bridge is connected as follows: Branch AB is an inductive resistor, branches BC and ED are variable resistors, branches CD and DA are non-reactive resistors of 400Ω each and branch CE is a condenser of 2μF capacitance. The supply is connected to A and C and the detector to B and E. Balance is obtained when the resistance of BC is 400Ω and that of ED is 500Ω. Determine the resistance and inductance of AB. Identify the bridge and deduce the equation at balance condition which is used for solving the above problem.