53 (IE 402) EMIN

2019

ELECTRICAL MEASUREMENTS AND INSTRUMENTS

Paper : IE 402

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* Derive the equation for the deflection of a galvanometer under dynamic conditions. Also, discuss the different conditions for damping. 8

   (b) A moving coil galvanometer has 400 turns and is suspended in a uniform magnetic field of 0·2 Wb/m^2. The control constant is $0{\cdot}3\times10^{-6}$ *N-m/rad*. The coil is 20 *mm* wide and 30 *mm* high, with a moment of inertia of $0{\cdot}2\times10^{-6}$ $kg\text{-}m^2$.

Contd.

If the galvanometer resistance is 400Ω, calculate the value of the resistance which, when connected in the galvanometer terminals, will give critical damping. Assume the damping to be entirely electromagnetic. 5

(c) Describe the construction and working of ballistic galvanometer. 7

2. (a) Explain the construction and working of attraction type and repulsion type moving iron instruments with suitable diagrams. 10

(b) The inductance of moving iron ammeter is given by the following expression :

$$L = \left(10 + 5\theta - 2\theta^2\right)\mu H$$

where θ is the angular deflection in radian from zero position. Determine the angular deflection in radians for a current of $5A$, if the deflection for a current of $10A$ is 60°. 4

(c) A moving coil meter has a resistance of 15Ω and gives full scale deflection for a current of $30mA$. How can it be used to measure a voltage of $500V$ and a current of $100A$? 6

3. (a) Show that in an electrostatic voltmeter, the force between plates is given by

$$F = \frac{1}{2}V^2\frac{dC}{dx}$$ 5

(b) Explain the construction and basic principle of operation of a single phase induction type energymeter with relevant mathematical expressions and diagrams. 10

(c) Describe the working of thermocouple type instrument with a suitable diagram. 5

4. (a) Describe the construction of laboratory type potentiometer. Write the procedure for standardisation of the potentiometer. 7

(b) How can a d.c. potentiometer be used to calibrate a Voltmeter and an Ammeter? Explain. 6

(c) Derive the equation for bridge sensitivity and current sensitivity of a Wheatstone bridge. 7

5. (a) Draw the diagram of Drysdale (Polar type) a.c. potentiometer. Write the procedure for standardisation and working of the potentiometer. 7

(b) Describe a suitable method for the measurement of unknown capacitance. Also, write relevant expressions. 7

(c) The four arms of a bridge are :
arm *ab*, a pure resistance;
arm *bc*, a resistance of 500Ω in parallel with a capacitor of 0·3 μF;
arm *cd*, a resistance of 1000Ω in series with a capacitor of 0·3 μF;
and arm *da*, a resistance of 300Ω.

Determine the frequency at which the bridge can be balanced. Also, calculate the value of resistance in arm *ab* to produce balance. 6

6. (a) Sketch the diagram of Megger and describe how it can be used for the measurement of insulation resistance. 7

(b) A Maxwell inductance capacitance bridge has an unknown inductance with series with an unknown resistance in arm *ab*, a resistance of 470Ω in arm *bc*, a capacitor of 0.1 μF in parallel with a resistance of 500Ω in arm *cd* and a resistance of 2$k\Omega$ in arm *da*.

Calculate the inductance and resistance in arm *ab* under balanced conditions. Also determine the *Q*-factor of the coil. 6

(c) Describe how high currents and voltages are measured by current and voltage transformers. Draw the equivalent circuit and phasor diagram of current transformer. 7

7. (a) Write short notes on the following : 7×2=14

(i) Electrodynamometer type instruments

(ii) Methods used for measurement of low resistance

(b) Describe a suitable method for testing of energymeter. 6