GOVERNMENT POLYTECHNIC COLLEGE, BHILWARA

MODEL TEST PAPER - 2017-18

ELECTRICAL II YEAR

BASIC ELECTRICAL ENGINEERING - EE 203

Max. Marks-15

Time -1 Hour.

NOTE - (i) Answer all questions.
(ii) Marks carried by a question is indicated against it.

Q-1. Define Resistivity and derive its practical units. [2 Marks]

Ans. Resistivity / specific Resistance - For a conductor wire of length l and cross sectional area A. we can write -

$$R \propto \frac{l}{A}$$

or $$\boxed{R = \rho \frac{l}{A}} \quad \text{---(i)}$$

Here ρ is a constant. It's value depends upon the material of the wire. It is called resistivity or specific resistance.

In eqn (i) if $l = 1$ meter and $A = 1$ meter^2 then -

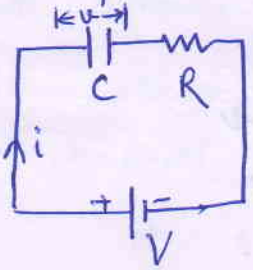
$$\boxed{\rho = R}$$

specific resistance is the resistance of a 1 meter long and 1 meter^2 cross sectional area wire.

unit - $\frac{\text{ओम } (\Omega) \times m^2}{m} = \Omega - m$

Q.2. What do you mean by charging of a capacitor? Derive the expression for v and i of a capacitor during charging. [1+3=4 Marks]

Ans. For charging a capacitor one resistance is connected in series with the capacitor and DC supply. Charging of a capacitor means provide charge to the capacitor with the help of some external power supply.



For the above fig. -

$$V = iR + v$$

$$V = iR + \frac{q}{C} \qquad [\text{for capacitor } q = CV]$$

We know - $q = \int i \cdot dt$

$$V = iR + \frac{1}{C}\int i \cdot dt.$$

by differentiation wrt t.

$$0 = R\frac{di}{dt} + \frac{i}{C}$$

$$\frac{di}{i} = -\frac{dt}{CR}$$

by integration - wrt t

$$\log_e i = -\frac{t}{CR} + A \qquad [A = \text{Constant}]$$

at $t = 0$, $v = 0$, $q = 0$ $\therefore$ $A = \log_e \frac{V}{R}$

$$\log_e i = -\frac{t}{RC} + \log_e \frac{V}{R}$$

$$\boxed{i = \frac{V}{R} e^{-t/RC}}$$

$RC = \tau$ = Time constant

$$\boxed{i = \frac{V}{R} e^{-t/\tau}}$$

- This is the instantaneous value of current during capacitor charging.

Q-3. Find the expression for energy stored in a capacitor. [4 Marks]

Ans. We know that capacitance of a capacitor is given by the following expression -

$$C = \frac{q}{V}$$

or $q = CV$

If dq charge is transfered to the capacitor then work done is -

$$dW = V\,dq.$$

but $q = CV$

$$dq = Cdv$$

$$dW = CV\,dV$$

Integrate this for complete work -

$$W = \int_0^V CV.dV$$

$$W = C\int_0^V V.dV$$

$$W = C\left[\frac{V^2}{2}\right]_0^V$$

$$\boxed{W = \frac{1}{2}CV^2} \text{ Joules}$$

$$q = CV$$

$$\boxed{W = \frac{1}{2}qV} \text{ Joules}$$

$$\boxed{W = \frac{q^2}{2C}} \text{ Joules.}$$

Q.4. Explain charging of a Lead - Acid battery. [3 Marks]

Ans. For charging a lead - acid battery, it is connected with a DC supply which has voltage rating greater than the battery voltage. Positive terminal of the battery is connected with positive terminal of the supply and negative terminal of the battery is connected with negative terminal of the supply. Current flows in the circuit from positive terminal to negative terminal. This causes ionization of the sulphuric acid (H_2SO_4) into $2H^+$ (Hydrogen ion) and SO_4^{2-} (sulphate ion). SO_4^{-2} move towards Anode and Hydrogen ions move towards the cathode. SO_4^{-2} (sulphate ions) react with the $PbSO_4$ at the anode and generate lead peroxide (PbO_2) and Hydrogen ions react with $PbSO_4$ and form pure Lead (Pb) and Sulphuric acid. Chemical reactions are given by -

At cathode -

$$PbSO_4 + 2H^+ \longrightarrow Pb + H_2SO_4$$

At Anode -

$$PbSO_4 + SO_4^{-2} + 2H_2O \longrightarrow PbO_2 + 2H_2SO_4$$

During charging -

(i) Positive plate converted into dark brown lead peroxide (PbO_2)

(ii) Battery voltage increases to 1.8 to 2.2 Volts.

(iii) specific gravity of the electrolyte solution increases.

(iv) Electrical energy is converted into chemical energy.

Q.5. Give expression for Ampere-hour and watt-hour efficiency of a battery ? [2 Marks]

Ans. Ampere-Hour efficiency - In this value of current is measured in Amperes and total time of current flow is taken in hours. It is the ratio of ampere-Hours during discharge to the ampere-Hours during charge

$$\% \eta_{AH} = \frac{\text{Ampere-Hour Discharge}}{\text{Ampere-Hour charge.}} \times 100$$

Watt-Hour efficiency - In this efficiency expression, voltage of the battery is also taken in the consideration. Because this battery voltage changes from 1.8 to 2.2 V during charging. It is the ratio of watt-hour during discharge to watt-hour during charge.

$$\% \eta_{WH} = \frac{\text{watt-Hour discharge}}{\text{watt-Hour charge}} \times 100$$

$$\eta_{WH} = \eta_{AH} \times \frac{\text{Discharge voltage}}{\text{charge voltage.}}$$

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