UNIT IV TIME VARYING ELECTRIC AND MAGNETIC FIELDS

Displacement Current Density and Displacement Current

1. Given the conduction current density in a lossy dielectric as $J_C = (0.02\sin 10^9 t)A/m^2$. Find the displacement current density if $\sigma = 10^3$ mho/m and $\varepsilon_r = 6.5$.

2. Show that the ratio of the amplitudes of the conduction current density and displacement current density is $\sigma/\omega\varepsilon$, for the applied field. $E = Em\ \cos wt$. Assume $\mu = \mu_o$. What is the amplitude ratio, if the applied field is $E = E_m e^{-t/\tau}$, where τ is real?

3. The conduction current flowing through a wire with conductivity $\sigma = 3X10^7$ s/m and relative permeability $\varepsilon_r = 1$ is given by $Ic = 3\sin \omega t(mA)$. If $\omega = 10^8$ rad/sec, find the displacement current.

Induced Voltage and Induced EMF

4. A conducting cylinder of radius 5cms, height 20 cm, rotates at 600 rps in a radial field B=0.5 Tesla. The sliding contacts at the top and bottom are connected to a voltmeter. What is the reading of voltmeter?

5. A circular loop of 'N' turns of conducting wire lies in the x-y plane with its center at the origin of a magnetic field specified by $B = a_z B_o \cos\left(\frac{\pi r}{2b}\right)\sin \omega t$, where 'b' is the radius of the loop and 'ω' is the angular frequency. Find the emf induced in the loop.

6. A conductor 1 cm in length is parallel to – z axis and rotates at radius of 25cm at 1200 rpm. Find induced voltage, if the radial field is given by $\bar{B} = 0.5\bar{a}_r T$.

7. Calculate the maximum EMF induced in a coil of 4000 turns of radius of 12cm rotating at 30 rps in a magnetic field 500 Gauss.

Current Density 'J'

8. If the magnetic field $\overline{H} = (3x\cos\beta + 6y\sin\alpha)\overline{a_z}$, find current density $\overline{J}$ if fields are invariant with time.

Surge Impedance

9. A overhead transmission line has a capacitance of 7.5 nF/km and inductance of 0.9 mH/km. Determine the surge impedance.

Verification of Maxwell's curl Equations, Ampere's Circuital law, Faraday's Law

10. Given $E = E_o Z^2 e^{-t} a_x$ in free space. Verify whether, there is a magnetic field so that both Faraday's Law and Ampere's Law satisfied simultaneously.

11. Do the fields $\overline{E} = E_m \sin x \sin t \quad \overline{a_y}$ and $\overline{H} = \frac{E_m}{\mu_0}\cos x \cos t \quad \overline{a_z}$ satisfy Maxwell's equations?

Divergence of 'D'

12. If $\overline{D} = (20x)\overline{a_x} - (15y)\overline{a_y} + (kz)\overline{a_z} \quad \mu C/m^2$, find the value of 'k' to satisfy the Maxwell's equations for region $\sigma = 0$ and $\rho_v = 0$.

Poynting Theorem Proof

13. Show that Energy produced per unit volume per second is equal to sum of energy stored per unit volume per sec and the energy crossed per unit volume per second.