# EE 340 Electromagnetic Theory
Assignment #02

Q.1 A long cylindrical conductor whose axis is coincident with the z-axis has a radius a and carries a current characterized by a current density $J = J_0 \, e^{-r} \, \hat{\mathbf{z}}$, where J_0 is a constant and r is the radial distance from the cylinder's axis. Obtain an expression for the magnetic field H for (a) $0 \leq r \leq a$ and (b) $r > a$.

Q.2 The square loop shown in Figure is coplanar with a long, straight wire carrying a current $I(t) = 5 \cos(2\pi \times 10^4 t) \, A$,
(a) Determine the emf induced in the loop.
(b) Determine the direction and magnitude of the current that would flow through the loop, if the loop has an internal resistance of 1 Ω.
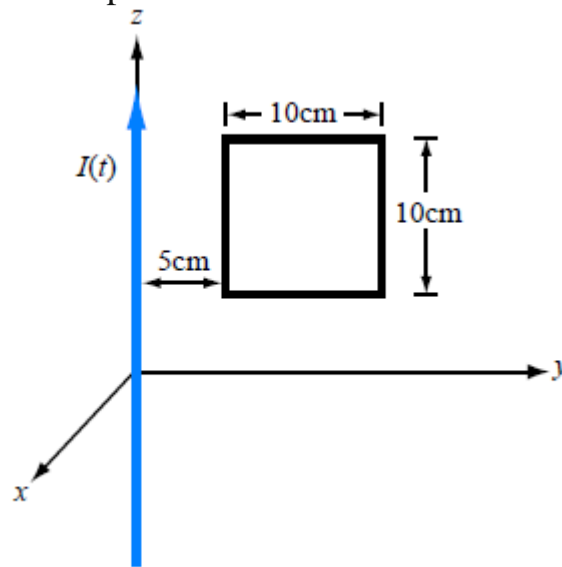
Q.3 A coaxial capacitor of length $l = 6 \, cm$ uses an insulating dielectric material with $\epsilon_r = 9$. The radii of the cylindrical conductors are $a = 0.5 \, cm$ and $b = 1 \, cm$. If the voltage applied across the capacitor is $V(t) = 50 \sin(120\pi t)$, then what is the displacement current?
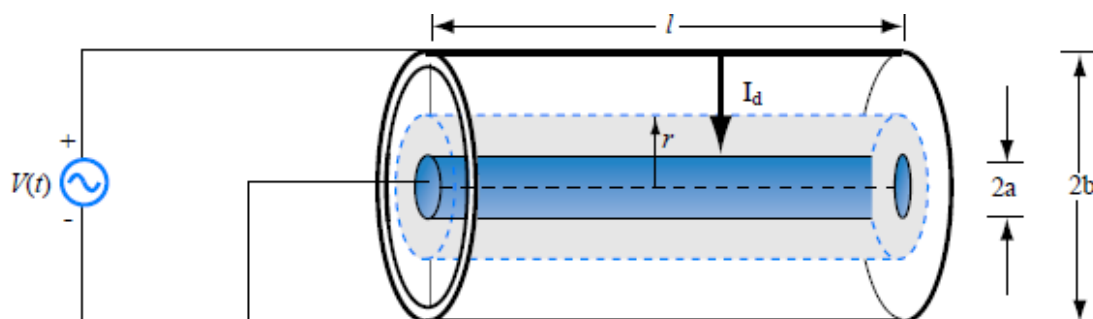
Q.4 If the current density in a conducting medium is given by:
$$J(x, y, z, t) = (z^2\,\hat{x} - 4y^2\,\hat{y} + 2x\,\hat{z})\,\cos(\omega t)$$
Determine the corresponding charge distribution ρ_v .

Q.5 Find out the generalized expression of frequency at which the conduction current density will be equal in magnitude to the displacement current density in a lossy dielectric medium?

Q.6 Which of the following two materials is the better insulator?
    Dry Soil: $\epsilon_r = 2.5,\ \ \sigma = 10^{-4}\ S/m$
    Fresh Water: $\epsilon_r = 80,\ \ \sigma = 10^{-3}\ S/m$

Q.7 The electric field of a plane wave propagating in a **nonmagnetic** material is given by:
$$E = 3\sin(\pi \times 10^7 t - 0.2\pi x)\,\hat{y} + 4\cos(\pi \times 10^7 t - 0.2\pi x)\,\hat{z}\ V/m$$
Determine (a) the wavelength, (b) dielectric constant of the medium, (c) intrinsic impedance of the medium, and (d) the magnetic field H.
Also plot the 3 dimensional E field in matlab and create an animation of the E-field propagation.

Q.8 The magnetic field in a given dielectric medium ($\mu_r = 1$) is given by:
$$H = 6\cos(2z)\sin(2 \times 10^7 t - 0.1x)\,\hat{y}\ \ A/m$$
where x and z are in meters. Determine: (a) the electric field E, (b) the displacement current density, and (c) the charge density.
Also plot the 3 dimensional H field in matlab and create an animation of the H-field propagation.