# EE301 - Tutorial 4

1. Find the Poynting vector on the surface of a long straight conducting wire (of radius 'a' and conductivity σ) that carries a direct current I. Assume current flow in positive z direction.
2. A metallic conductor has a circular cross section of radius 1 cm and $\sigma = 2 \times 10^7$ S/m. The conductor carries uniformly distributed current of 100 Amp d.c. in the $\overline{a_z}$ direction. Calculate:
   i. Resistance R of one meter length and use $I^2R$ to find dc power loss in that length.
   ii. Calculate $\bar{J}$, $\bar{E}$, $\bar{H}$ and Poynting vector within the conductor.
   iii. Integrate $\bar{P}$ over the cylindrical surface enclosing one meter length of conductor and show that the answer is same as in part (i).
3. In free space $\bar{H} = 0.2\cos(\omega t - \beta x)\overline{a_z}$ (A/m). Find the total average power passing through
   i. A square plate of side 10 cm on plane $x + z = 1$ and
   ii. A circular disc of radius 5 cm on plane $x = 1$.
4. Electric field of an electromagnetic wave propagating in a medium in $+\overline{a_z}$ direction is given by
   $$\overline{E_s} = E_0\left(\overline{a_y} - j\overline{a_z}\right)e^{-j\beta x}$$
   Determine the polarization of the wave.
5. An electromagnetic wave has the electric field intensity in the phasor form given by
   $$\overline{E_s} = 4(\overline{a_z} - j\overline{a_x})e^{-j\beta y}$$
   The EM wave is incident on a perfect conductor located at $y = 0$. What will be the polarization of the reflected wave?
6. The electric field of an electromagnetic wave propagation in the positive direction is given by $\bar{E} = \overline{a_x}sin(\omega t - \beta z) + \overline{a_y}sin(\omega t - \beta z + \pi/2)$. Determine the polarization of the wave.
7. Two plane waves propagate in positive z direction. Both waves are at the same frequency and have equal amplitudes. Wave A is polarized linearly in the x direction, and wave B is polarized in the direction $\overline{a_x} + \overline{a_y}$. In addition, wave B lags behind wave A by a small angle θ. What is the polarization of the sum of the two waves?

**Review Questions**

1. Does the Poynting theorem apply to static fields? Explain
2. Define complex permittivity. Is this quantity only a convenient notation or is it a physically measurable quantity? If so, what are the meanings of its real and imaginary parts?
3. Comment on how the dispersion will change with frequency in a lossy dielectric material.