

**Subject: Electromagnetics**

**Assignment-4 [UNIFORM PLANE WAVE]**

**NOTE: Bold letter indicates the vector quantity**

1. What are uniform plane waves? List out all its salient features.
2. Derive the Helmholtz's Plane wave equation for homogeneous unbounded medium.
3. Discuss the solution of Uniform plane wave equation in terms of E field, H field and direction of propagation. Draw a schematic representation of Uniform plane wave.
4. Define the followings with respect to uniform plane wave:  
(i) Intrinsic impedance  $\eta$  (ii) propagation constant  $\mathbf{Y}$  (iii) phase constant  $\beta$  (iv) phase velocity  $\mathbf{v}_p$
5. Develop the concept of complex permittivity and determination of a conductive or dielectric medium based on it.
6. Discuss the uniform plane wave propagation in low loss dielectric. Define the loss tangent and its significance.
7. Discuss the uniform plane wave propagation in good conductor. Also describe the phenomena of Skin effect.
8. Define the Poynting vector and derive the average power density of the uniform plane wave.
9. An E field in free space is given as  $\mathbf{E} = 800 \cos(10^8 t - \beta y) \mathbf{a}_z$  V/m. Find out (i) phase constant (ii) phase velocity (iii) wavelength (iv) intrinsic impedance (v) magnetic field intensity (vi) E at P(0.1,1.5,0.4) at t=8 ns.
10. Compute the skin depth of aluminum, copper and silver at frequency of 10 GHz. The conductivities of these materials are  $28.16 \times 10^6$ ,  $58.13 \times 10^6$ , and  $61.73 \times 10^6$  Si/m respectively.