UNIT-2 : Electromagnetic Field Theory

|| Short Answer Type Questions ||

1. State Stoke's theorem and its physical interpretation.
2. What do you mean by Gauss- divergence theorem? Give its physical meaning.
3. What is Gauss's law in electrostatics? Deduce Coulomb's law from it.
4. What is Ampere's circuital for magnetic field?
5. What is displacement current?
6. Write Maxwell's equations in differential form.
7. Define Poynting vector.
8. Define skin depth of conductor in electromagnetism.

|| Long Answer Type Questions ||

1. Show that Coulomb's law can be deduced from Gauss's law.
2. Derive an expression for equation of continuity by law of conservation of electrical charge in electromagnetism?
3. What is displacement current? How it led to the modification of the Ampere's circuital law.
4. What are Maxwell's equations? Write their integral and differential forms giving their physical meanings.
5. Derive the wave equations of electric and magnetic field for free space and hence show that the velocity of a plane electromagnetic wave in the free space is given by

$$C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}},$$

where symbols have their usual meanings.
6. Prove that and electromagnetic wave is transverse in nature showing electric and magnetic field perpendicular to the direction of propagation vector in free space.

OR

Show that $\vec{E}$, $\vec{H}$ and $\vec{k}$ are mutually perpendicular in propagation electromagnetic field.

7. Prove that for an electromagnetic wave $\dfrac{\vec{E}}{\vec{B}} = \dfrac{E_0}{B_0} = c$, hence show that $Z = \dfrac{E}{H} = 376.6\Omega$ where c is the speed of light.

8. Explain the propagation of a plane electromagnetic wave in conducting media and hence obtain an expression for skin depth in a conductor.

9. What is Poynting vector? Deduce Poynting theorem for the flow of energy in electromagnetic field and explain its physical significance.

|| Numerical Problems ||

1. If a plane electromagnetic wave in free space has magnitude of intensity of magnetic field 1 A/m. What are the amplitudes or peak values or maximum values of electric and magnetic fields.

2. A 500 watt lamp radiates power uniformly in all directions. Calculate the electric and magnetic field intensities at 1 m distance from the lamp.

3. A 100 watt sodium lamp is radiating its power uniformly. Calculate the electric field and magnetic field strength at a distance of 5 m from sodium lamp.

4. Energy from a 1000 Watt lamp is radiated uniformly. Calculate the average values of the intensities of electric and magnetic field of radiation at a distance of 2.0 m from the lamp.

5. Calculate the magnitude of Poynting vector at the surface of the sun. Given that the power radiated by the sun is 3.8 x 10^{26} W and the radius of sun is 6.95 x 10^8 m.

6. If the earth receives 2 cal $min^{-1}cm^{-2}$ solar energy. Calculate amplitudes of electric and magnetic field of radiation?

7. The depth of penetration of a conducting media is 0.1m. The frequency of the electromagnetic wave is 1Hz. Find the conductivity of the media.

8. Calculate the skin depth at frequency 1MHz for copper having electrical resistivity 1.72×10^{-8} Ω-m and relative magnetic permeability unity.

9. If the relative permittivity of distilled water is 81. Calculate refractive index and velocity of light in it.