Assignment – Basics of EM Waves

1. Find the constants a, b and c so that the vector
   $\vec{A} = (x + 2y + az)\,\hat{i} + (bx - 3y - z)\,\hat{j} + (4x + cy + 2z)\,\hat{k}$ is irrotational.

2. The relative permittivity of distilled water is 81. Calculate refractive index of distilled water and velocity of light in it.

3. The magnitude of electric field in free space is 377 V/m. Find the magnitude of magnetic field in free space.

4. A region is specified by the potential function given by
   $V = 5x^2 + 3y^2 - 9z^2$. Find the electric field strength at point (3, 4, 5) in this region.

5. If $\vec{A}$ and $\vec{B}$ are irrotational, prove that $\vec{A} \times \vec{B}$ is solenoidal.

6. Show that gravitational force field vector is irrotational in nature.

7. The average distance between sun and earth is 1.5×10^{11}m. The power radiated by sun is 3.8×10^{26}W. Find the average solar energy per unit area per second incident on earth (i.e. find solar constant).

8. Prove that conduction current in wires and displacement current in capacitor are same when an A.C. voltage source is connected across the plates of a capacitor.

9. A plane electromagnetic wave is given as: $\vec{E} = \vec{E_0}\sin(\omega t - kx)$, find the energy flowing through area elements

   i. $\vec{ds} = A\,dx\,dy\,\hat{k}$.

   ii. $\vec{ds} = A\,dy\,dz\,\hat{i}$

10. Show that the curl of the velocity of any particle of a rigid body is twice the angular velocity of the body.

11. Find the gradient of a scalar field $V = 3x^2y - y^2z^2$ at point (1,-2,-1). Check whether the vector field thus obtained is uniform or not?