Subject: Electromagnetics

Assignment-3 [Steady magnetic field & Time-varying fields & Maxwell's equations]

NOTE: Bold letter indicates the vector quantity

1. State Biot Savart's law and write its mathematical expression.
2. State the Ampere's circuital law and derive its point form.
3. Define the curl operation and give its significance. Write the mathematical expression of curl of any vector for Cartesian, cylindrical and Spherical co-ordinate system.
4. Define magnetic flux density, surface current density, displacement current density and write their mathematical formulation.
5. Explain why magnetic monopole cannot exist. State the Gauss law for magnetism.
6. Explain scalar and vector magnetic potential.
7. State Stoke's theorm for magnetic field and prove it.
8. Write point and integral form of all four Maxwell's equation for static field.
9. State and Explain Faraday's law. Derive its point and integral form.
10. Write point and integral form of all four Maxwell's equation for time varying field.
11. Write the set of Maxwell's Equations for time varying fields in case of Free Space.

NUMERICAL:

1. Find **H** in Cartesian components at P (2, 3, 4) if there is a current filament on the z axis carrying 8 mA in the $\mathbf{a}_x$ direction.

2. Evaluate the close line about a square path of side d=5m with its center on the z-axis at M (0, 0, 4), If $\boldsymbol{H} = 0.2z^2\boldsymbol{a_x}$ for z> 0. Determine the $(\nabla \times H)_y$ at point M using the definition of Curl.

3. In cylindrical co-ordionate system, a magnetic field is given as $\boldsymbol{H} = (2\rho - \rho^2)\boldsymbol{a}_\Phi\ A/m$, $0 \leq \rho \leq 5$. (a) Determine the current density as a function of ρ within this cylinder (b) What total current passes through a surface z=0, $0 \leq \rho \leq 5$ in $\boldsymbol{a_z}$ direction?

4. A certain material has σ=0 and $\mu_R = 1$. If $\boldsymbol{E} = 800\ \sin(10^6 t - 0.01z)\ \boldsymbol{a_y}$ V/m, using Maxwell's equations find out the value of ϵ_R and find **H** (z,t).

5. Derive equation of magnetic field intensity for infinitely long straight filament carrying a direct current I in Z axis from $-\infty \leq z \leq \infty$

6. Consider a filamentary conductor forms a loop contacting two plates of capacitor as shown in figure. A time varying magnetic field inside the closed path produces an emf of $V_0 \cos \omega t$ around the closed path. Prove that the conduction current I is exactly equal to the displacement current between the capacitor plates using Mathematical analysis.