Answer Any FIVE questions. Assume missing data, if any.

1. (a) Show that curl of E is zero.

    (b) Using multipole expansion find the expression for the potential of an arbitrary localized charge distribution.

    (c) Derive Gauss's law in presence of dielectric.   [3+5+2]

2. (a) Using Biot-Savart law derive the expression for divergence and curl of B.

    (b) Quantitatively describe the effect of magnetic field on atomic orbits.   [5+5]

3. (a) Consider a piece of magnetized material and the magnetic dipole moment per unit volume is given. Derive the expression for vector potential.

    (b) Derive the expression for energy in magnetic fields.

    (c) State and prove Poynting's theorem.   [3+3+4]

4. (a) Consider a plane wave of frequency ω, traveling in the x-direction and polarized in y-direction and is approaching the interface from the left. Derive the expressions for reflected and transmitted waves. Also derive expressions for the reflection and transmission coefficients.

    (b) What are wave guides? Discuss quantitatively the *TE* and *TEM* waves.   [6+4]

5. (a) What are retarded potentials and why are they called so?

   (b) Consider a loop of radius a. around which we drive a sinusoidally varying current, at frequency ω. Derive the expressions for electric and magnetic fields. Also find the expression for energy flux for magnetic dipole radiation. [6+4]

6. (a) Find the magnetic field a distance z above a long straight wire carrying a steady current I.

   (b) Derive Neumann formula.

   (c) Write down Maxwell's equations in free space. [4+4+2]