Q.1 (a) Explain divergence, gradient & curl with the help of mathematical expressions.  
(b) With the help of necessary formulas, explain conversion among various co-ordinate systems.

Q.2 (a) Derive the expression for the electric field $E$ due to infinitely long line charge distribution.  
(b) State Gauss’s law. Also derive mathematical formulation for the same.  
OR  
(b) State & derive mathematical formulas for the following: 
(1) Maxwell’s first equation for electrostatics (2) Divergence theorem.

Q.3 (a) Define potential. Write a detailed note on potential gradient.  
(b) What is an electric dipole? Derive the expression for the potential and electric field intensity due to a dipole at distances very large from the origin compared to the spacing between the charges of the dipole.  

Q.3 (a) Derive the boundary conditions at the interface between two dielectric materials with permittivities $\varepsilon_1$ and $\varepsilon_2$.  
(b) Derive the relationship between $\mathbf{J}$ & $\mathbf{E}$ for a metallic conductor.

Q.4 (a) Write down & discuss point and integral forms of Maxwell’s equations for steady electric and magnetic fields.  
(b) Using necessary diagrams, discuss magnetic boundary conditions.  
OR  
Q.4 (a) State & discuss Biot-Savart law & Ampere’s circuital law using necessary diagrams.  
(b) Derive the expression of capacitance for following capacitors: (a) Parallel plate capacitor, (b) Coaxial capacitor, (c) Spherical capacitor.

Q.5 (a) Write a short note on skin effect & skin depth.  
(b) Using faraday’s law, derive first Maxwell’s equation for time-varying fields.  
OR  
Q.5 (a) With the help of necessary expressions, explain uniform plane wave propagation/motion in free space.  
(b) Derive and explain the Poisson’s and Laplace Equations.