1. Given an electric field $\mathbf{E} = \mathbf{a}_x(y - c_1 z) + \mathbf{a}_y(c_2 x - 4z) - \mathbf{a}_z(2c_3 y + z)$

    (a) Determine the coefficients c_1, c_2, and c_3 if $\mathbf{E}$ is irrotational. (8%)
    (b) Determine the electric potential V. (7%)

2. Please derive the boundary conditions for the electrostatic field at an interface between two media. (15%)

3. A point charge q is located at a distance D from the center of a grounded conducting sphere of radius r ($r < D$). Determine
    (a) the charge distribution induced on the surface of the sphere. (10%)
    (b) the total charge induced on the sphere. (10%)

4. Lightning strikes a lossy dielectric sphere which has $\varepsilon = 1.1\varepsilon_0$, $\sigma = 10$ S/m, radius = 0.1 m at time $t = 0$, depositing uniformly in the sphere with a total charge 1 mC.
    (a) Determine the electric field intensity both inside and outside of the sphere. (10%)
    (b) Calculate the time it takes for the charge density in the sphere to diminish to 1% of its initial value. (10%)

5. A current I flows in the inner conductor of an infinitely long coaxial line and returns via the outer conductor. The radius of the inner conductor is a, and the inner and outer radii of the outer conductor are b and c, respectively. Find the magnetic flux density $\mathbf{B}$ for all regions and plot $|\mathbf{B}|$ versus r. (15%)

6. A circular loop of N turns of conducting wire lies in the xy-plane with its center at the origin of a magnetic field specified by $B = a_z B_0 \sin(5\pi r^2 / 3b) \cos wt$, where b is the radius of the loop and ω is the angular frequency.
    (a) Find the emf induced in the loop. (10%)
    (b) What is the phase relationship between the induced emf and the magnetic field? (5%)