1. Given a potential function $V = (cos\frac{1}{2} x)(sin\frac{1}{3} y)e^{-2z}$ determine

   (a) the electric field at the point **P(1,1,2)**. (8%)

   (b) the rate of increase of **V** at **P** in the direction of the origin. (7%)

2. Please derive the electric potential caused by the polarization vector. (15%)

3. A point charge Q is located inside and at distance d from the center of a grounded spherical conducting shell of radius a ($a>d$). Use the method of images to determine

   (a) the potential distribution inside the shell, (8%)

   (b) the charge density induced on the inner surface of the shell. (7%)

4. Derive the boundary conditions for current density at the interface between two conduction media (15%)

5. Determine the mutual inductance between a very long, straight wire and a conducting circular loop with a radius of a. The distance between the wire and the center of the circular loop is d. (15%)

6. Drive the phase form for $V(R,t) = \frac{1}{4\pi\varepsilon}\int_{V'}\frac{\rho_v(t-R/u_P)}{R}dv' \quad (v)$ (10%)

7. A uniform plane wave propagates in the +z-(downward) direction into the ocean ($\varepsilon_r = 84$, $\mu_r = 1$, $\sigma = 7S/m$) The magnetic field at the ocean surface(z=0) is $H(0,t) = a_y 0.6cos10^7 t \quad (A/m)$

   (a) Determine the skin depth and the intrinsic impedance of the ocean water. (5%)

   (b) Find the expressions of E(z,t) and H(z,t) in the ocean. (5%)

   (c) Find the average power loss per unit area in the ocean as a function of z . (5%)