1. Determine the E field (radius R) inside a spherical cloud of electrons (radius b) with a uniform volume charge density $\rho = -\rho_0$ (where $\rho_0$ is a positive quantity) for $0 \leq R \leq b$ and $\rho = 0$ for $R > b$ by solving Poisson's equation for $V$. (10%)

2. (a) An electric dipole consisting of equal and opposite point charges $+q$ and $-q$ separated by a small distance $d$ is shown in Fig. 1. The distances from the charges to a field point P are designed $R_+$ and $R_-$. The distance from the dipole center to a field point P is assumed as R. $\theta$ denotes the angle between the z axis and R. Determine the potential $V$ in terms of $q$, $d$, $\theta$, $R$, and $\varepsilon_0$, permittivity of free space, at an arbitrary point P at a distance $R >> d$ from the dipole? (10%)
   (b) Derive the equation to represent the equipotential lines for an electric dipole? (5%)
   (c) Derive the equation to represent the electric field lines for an electric dipole? (5%)

![Fig. 1 An electrical dipole](image)

3. (a) A direct current $I$ flows in a straight wire of length $2L$ on the z axis, as shown in Fig. 2. Find the magnetic flux density $B$ at a point located at a distance $r$, designed $(r,0,0)$ in cylindrical coordinates, from the wire in the bisecting plane. (10%)
   (b) Find the magnetic flux density at the center of a square loop, $O$, on the z axis and with side $w$ carrying a direct current $I$, as shown in Fig. 3. (10%)

![Fig. 2 A current-carrying straight wire.](image)

![Fig. 3 A square loop carrying current I](image)
4. (a) Please write down the four Maxwell equations in phasor form. (10%) 
(b) Under what criterion will the four Maxwell equations be simplified to the electrostatic and magnetostatic fields? (5%) 
(c) Please write down the equations for the electrostatic and magnetostatic fields. (5%) 

5. Consider the transmission line circuit shown below. (a) What should the per-unit length parameters of the transmission line satisfy that will make the transmission line distortionless? (5%) 
(b) Please write down the attenuation and propagation constants in terms the per-unit-length parameters of the transmission line when the transmission line is distortionless. (5%) 

6. Consider a line current $I \cos(\omega t)$ shown below. The line current is of one quarter of a circle and falls on the $xy$-plane ($z=0$ plane). Besides, the line current is placed between two infinitely conducting wall, extending in the $\pm x$-axis. Please calculate the far-fields at point $P$, which is placed at a distance $R$ from the origin $O$ and falls on the $xy$-plane. (20%) Hint: the potential vector $A$ of a current loop $I$ is $A = \frac{\mu_0 I h^2}{4R^2} \cdot (1 + j \beta R) e^{-j\beta R} \sin \theta$ where $\theta$ is the angle from the $z$-axis.