1. A circular disk of radius b and thickness t carries a current in a circular direction about the center. A cylindrical coordinate system has the origin at the center of the disk and has the z axis coinciding with the axis of symmetry of the disk. The current density in the disk is $\vec{J} = kr\vec{a}_\phi \ A/m^2$, where k is a real constant greater than zero. Derive a formula for the magnetic intensity $\vec{H}$ at the center of the disk, assuming that the thinckness t is very small compared with b. (25%).

2. Briefly answer the following questions: (25%)

   a. The divergence of a vector field $\vec{F}$ is defined as $\nabla \cdot \vec{F} = \lim\limits_{\Delta v \to 0} \dfrac{\oint_s \vec{F} \cdot d\vec{s}}{\Delta v}$, explain it.

   b. What is the difference between *convection current* and *conduction current*?

   c. Explain the *Gaussian Surface* in electrostatics.

   d. Why must the electric field lines point directly away from or toward the conductor surface?

   e. Make comments on the term $\partial \vec{D} / \partial t$ in Ampère law of Maxwell's equations, where $\vec{D}$ is the electric flux density vector.

3. A uniform sinusoidal plane wave in air with the following phasor expression for electric intensity

$$\vec{E}_i(x, z) = \vec{a}_y \, 10 \, e^{-j(6x+8z)} \qquad \text{(V/m)}$$

   is incident on a perfectly conducting plane at z = 0.
   a) Find the frequency and wavelength of the wave.
   b) Write the instantaneous expressions for $\vec{E}_i(x, z; t)$ and $\vec{H}_i(x, z; t)$, using a cosine reference.
   c) Determine the angle of incidence
   d) Find $\vec{E}_r(x, z)$ and $\vec{H}_r(x, z)$ of the reflected wave
   e) Find $\vec{E}_1(x, z)$ and $\vec{H}_1(x, z)$ of the total field

4. An antenna is fed by a $70\,\Omega$ lossless line with a quarter-wave length. With what input impedance must this antenna be designed to yield a $50\,\Omega$ input impedance of this feeding line? (25%)