1. A metal disk of radius $a$ spins with angular velocity $\Omega$ in a magnetic field as shown.

What is the magnitude and direction of the electric field in the disc, what is $\nabla \times \mathbf{E}$, sketch the field lines outside the metal disc.

2. Consider the transmission line shown below. The frequency is $2 \times 10^8$ Hz, and the wavelength is 1m.

$$Z_0 = 100 \ \Omega$$

$$Z_L = 300(1+j) \ \Omega$$

a. What is the reflection coefficient and standing wave ratio?

b. If $L = .15$ m. what is $Z_{\text{in}}$ (the input impedance at the terminals on the left)?
c. Find a length $L$ such that the real part of $Z_{in}$ is 50 $\Omega$, what is the imaginary part of $Z_{in}$?

d. If the transmission line is a coaxial line and the material between the conductors has $\mu = \mu_0$, what is the dielectric constant?

3. A TM$_{21}$ mode propagates down a rectangular wave guide with dimensions $a = .04$ m. and $b = .03$ m., and $\mu = \mu_0$. For $z<0$ the wave guide is filled with vacuum, and for $z>0$ the waveguide is filled with dielectric with $\varepsilon = 2\varepsilon_0$.

a. In what frequency range will the mode propagate in each section of the wave guide?

b. Calculate the frequency for which a wave incident from $z=-\infty$ will be totally transmitted to $z=\infty$.

c. Suppose, for the above waveguide, the dielectric material has a thickness $L$ in the $z$ direction, and the wave frequency is twice the cut off frequency in the vacuum portion of the wave guide. Find $L$ such that the dielectric is a half wavelength window.

4. Two identical dipole antennas of length 5 meters are placed 10 km apart. The first antenna is driven by a 10 A (peak) current at 5 MHz.. The current is approximately constant along the length of the dipole.

a. What is the total power radiated by the driven antenna?

b. How should the two antennas be oriented to maximize the signal received by the second antenna?

c. How much power is received by the second antenna?
5. A cavity is excited by a variable frequency source. The energy density in the cavity as a function of frequency is plotted below. What are the resonant frequency of the cavity and the Q value?