Problem 1: *(20 Points)*

(a) Write down the complete Maxwell's equations in differential form.

(b) Write down the boundary conditions for electric flux density, electric field intensity, magnetic flux density and magnetic field intensity.

Problem 2: *(20 Points)*

The electric field intensity of a plane wave in the air is given by

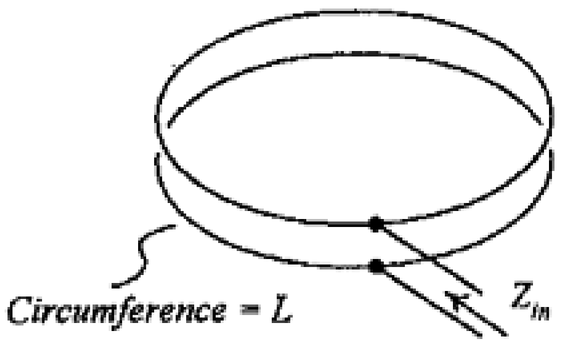
$\vec{E} = \left[\vec{a}_x + E_y\vec{a}_y + (2+j5)\vec{a}_z\right]e^{-j2.3(-0.6x+0.8y)+j\omega t}$ *V/m*. Please find E_y, the wave propagation direction, wavelength, polarization, and the magnetic field of the wave?

Problem 3: *(15 Points)*

Two infinitely long transmission lines are connected together. One's characteristic impedance is 200 Ω and the other's is 50 Ω. If a wave at the 200 Ω line is propagating toward the junction, what are the reflection and the transmission coefficients? Design a transmission-line transformer to reduce the reflection to zero. What is the VSWR at this matching transmission line section?

Problem 4: *(10 Points)*

A length L of two-wire transmission line (of characteristic impedance Z_o and wave number β) is bent into a loop by connecting its ends together as shown below. Find an expression for the input impedance Z_{in} seen looking into the connection terminals.



Problem 5: *(15 Points)*

A rectangular waveguide has width a (in x direction), height b (in y direction), and is infinite long (in z direction). Write down the E_z component for TM_{mn} mode in z direction and H_z component for TE_{mn} modes in z direction. Explain your answers. Are there any limitations on the values for the indices m and n?

Problem 6: *(20 Points)*

A hand-held radar "gun" used for traffic control is operated as CW FM Doppler radar at 10 GHz. It has a conical horn antenna 20 cm in diameter for circular polarization. The antenna aperture efficiency is 0.6. Find the antenna gain in dB. If we want to measure the speed of an automobile (3 m^2 physical cross-section) at a distance of 1 km, find the minimum transmitting power required. For the radar to work properly, the received signal should be no less than -120 dBm. Take radar cross section equal to half the physical cross section. The angle between the directions of the automobile and the radar beam is 60°. If the received signal has a Doppler shift of 1 kHz, what is the speed of this automobile? (Hints: log π = 0.497, log 2 = 0.301, log 3 = 0.477)