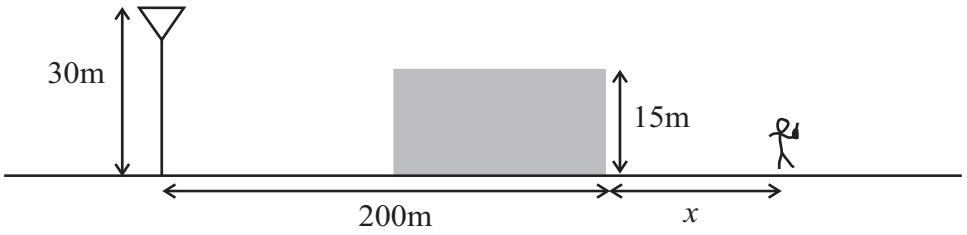
ECE 3065 Homework 6: Diffraction and Waveguides

Due Date: 12 March 2009 (Thursday)

1. A 860 MHz, 10 dBW-EIRP, vertically polarized cell tower is transmitting to a 1.5m-tall user that is shadowed by a building with the following geometry:



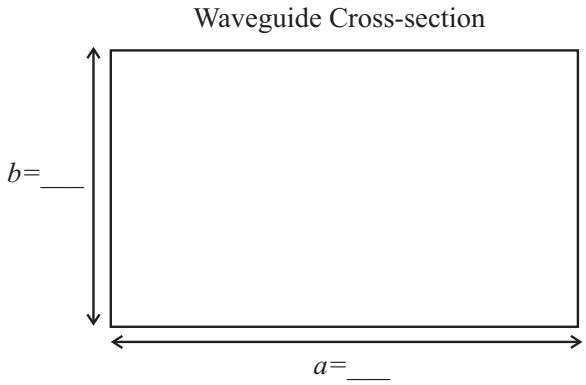
   Discounting the effect of ground reflections, estimate and graph the received power into the 0 dBi-gain handset antenna over the interval 5m $\leq x \leq$ 50m. Approximate the right edge of the building as a vertical PEC screen.

2. Cheng, Problem 10-4: Obtain the expressions for the surface charge density and the surface current density for TM_n modes on the conducting plates of a parallel-plate waveguide. Do the currents on the two plates flow in the same direction or in opposite directions?

3. Cheng, Problem 10-5: Obtain the expressions for the surface current density for TE_n modes on the conducting plates of a parallel-plate waveguide. Do the currents on the two plates flow in the same direction or in opposite directions?

4. Calculate the Poynting vector for the TM_1 mode of a parallel plate, air-filled waveguide of width b. Sketch the magnitude of power flux as a function of y (the vertical dimension).

5. **Mystery Waveguide:** You are told that a rectangular, metallic, air-filled waveguide has cut-off frequencies of 3 GHz, 6 GHz, and 7.5 GHz for its first three modes. Answer the following questions based on this scenario. Calculate the dimensions of this waveguide. Label the dimensions in meters below. In your diagram sketch the E-field distribution for this dominant mode.



6. **Circular vs. Rectangular Waveguide:** You have been hired by small engineering company that specializes in making super-cheap microwave components. The first product that you are asked to design is a new ultra-cheap, air-filled metallic waveguide. Sections of this waveguide are manufactured by taking long rectangular sheets of tin and bending them around a cross-section of your choosing. You must decide between a square cross section or a circular cross section to produce a waveguide with a given low-frequency cut-off.

   (a) Manufacturing cost of the waveguide is proportional to the perimeter of the cross-section. Calculate which cross section is cheaper to build.

   (b) Calculate which of these cross sections has more single-mode bandwidth (bandwidth between dominant and second-highest mode).