Physics 323, Spring Quarter 2015
Electrodynamics: Homework Assignment 1

Turn in all problems and clearly note all constants and assumptions you use. (1-point penalty each otherwise)

Due 9:00 am Thursday April 9

1. In class we found the "waveguide equation" $\frac{1}{\lambda_g^2}+\frac{1}{\lambda_c^2}=\frac{1}{\lambda_0^2}$,

where λ_g is the guided wavelength, λ_c is the cutoff wavelength, and λ_0 is the free-space wavelength for the simple waveguide consisting of two parallel mirrors.

a. Show that this relation also holds for the example of the rectangular waveguide.

b. And thereby show that the group velocity for the rectangular waveguide is always less than or equal to the speed of light. Hint: recall the definition of the group velocity 9.150. Hint: The discussion of problem 9.30 is wrong; the energy-flow velocity is not the group velocity in general.

2. In free space, find the ratio of magnitude of the transverse components of **E** and **H**; that is, find E_{0t}/H_{0t}. What's its numerical value?

3. Consider TE waves in the rectangular waveguide in the TE_{01} mode.

a. What are all the components of the **E** and **B** fields? Hint: you already have 9.186 B_z, so you can then use 9.180

b. Show that the energy transmitted is along the axis of the waveguide. Hint: You can use an average Poynting flux.

4. WR284 waveguide can be purchased. It's rectangular waveguide with inner dimensions 34.04 mm by 72.14 mm.

a. What's the cutoff frequency of the lowest mode?

b. What's the cutoff frequency of the next-lowest mode?

b. Suppose the waveguide is used a λ_0= 100 mm. What's the guided-wave velocity (phase velocity)? What's the group velocity (signal velocity)?