Electrodynamics, spring 2003

Exercise 10 (Thu 10.4., Fri 11.4.)

1. A linearly polarised electromagnetic wave propagates in vacuum into the z-direction and arrives perpendicularly at a perfectly conducting wall whose boundary is the plane $z = 0$.
   a) Determine the average energy flux in vacuum. The amplitude of the electric field of the incident wave is assumed to be known.
   b) Calculate the charge and current densities at the surface of the conductor. Remember that there are no fields inside a perfect conductor.
2. a) Show for the s- and p-polarisation that the reflection and transmission coefficients satisfy $R_s + T_s = 1$ ja $R_p + T_p = 1$.
   b) Using Snell's law, eliminate the reflection coefficient in Fresnel's coefficients.
3. Baywatch man Kari Kukko observes a swimmer to get a dangerous cramp. The baywatcher is at distance d_1 from the shore and the swimmer at distance d_2 (the shoreline is straight). The baywatcher runs at speed c/n_1 and swims at speed c/n_2.
   a) What is the optimal point for Kari Kukko to jump into the water?
   b) What has this problem to do with electrodynamics?
4. Consider a waveguide with an arbitary cross-section and perfectly conducting walls. Show that the surface current associated with the TM mode is always longitudinal. (If the waveguide is into the z-direction then $B_z = 0$ in the TM mode.)
5. A waveguide has a rectangular cross-section, whose sides have lengths a and b into the x- and y-directions ($a > b$), and whose walls are perfectly conducting. Calculate the cut-off frequency the lowest TM mode.

Return answers until Tuesday 8.4. at 14 o'clock