ECE 414 – Spring 2016
Homework #5

Out: 02.03 Due: 02.11

1. Modal Dispersion. Light of wavelength λ_0 = 1.55 μm is transmitted through a mirror waveguide, with the reflecting surfaces separated by a distance $d = 10$ μm, with vacuum in between (i.e., refractive index $n = 1$). Determine the number of TE and TM modes. Determine the group velocities of the fastest and slowest mode. If a narrow pulse of light is carried by all modes a length $l = 2$ m down the waveguide, how much does the pulse spread as a result of the differences in the group velocities?

2. Parameters of a Dielectric Waveguide. Red light with free-space wavelength λ_0 = 0.7 μm is guided by a thin planar film of depth $d = 3$ μm and refractive index $n_1 = 1.55$, surrounded by a medium of refractive index $n_2 = 1.5$.

a. Determine the critical angle θ_c and its complement $\bar{\theta}_c$, the numerical aperture NA, and the maximum acceptance angle for light originating in air ($n = 1$).
b. Determine the number of allowed TE modes.
c. Determine the bounce angle θ and group velocity v_g of the TE mode, where $k_y = 0$ (i.e., m = 0).
d. Now consider the number of allowed TE modes if the cladding $n_2 = 1$. What might be the advantage of using a higher refractive index cladding?