

**ECEn 462 (Block 1)**  
**Electromagnetic Radiation and Propagation**  
Homework #2

1. Book problem 3.5.1
2. A parallel plate waveguide is used to guide an EM pulse. In which of the following cases will a pulse travel the fastest. Be sure to explain your reasoning.
  - a. The operating frequency is much larger than the cutoff frequency
  - b. The operating frequency is slightly larger than the cutoff frequency
3. How long does it take a pulse to travel a distance of 1km if the waveguide mode has a phase velocity of  $v_p=3.5E8$  m/s and a group velocity of  $v_g=2.6E8$  m/s?
4. A waveguide consists of a perfect conductor on both sides of a plastic slab ( $\epsilon_r=2$ ). The thickness of the plastic slab is  $d=25\text{mm}$  ( $\sim 1$  inch). The waveguide is used to guide a signal with a carrier frequency of  $f=20\text{GHz}$ .
  - a. What are the first 4 TE mode cutoff frequencies?
  - b. What is the frequency range for single TE mode operation?
  - c. What are the effective propagation angles for the various modes at the operating frequency ( $f=20\text{GHz}$ )?  $\Theta=\sin^{-1}(k_z/k_o)$
  - d. What is the group velocity of the supported modes?
  - e. A 10ns pulse is transmitted down the waveguide. How far can the pulse travel before it becomes twice as large (20ns)? (Assume equal spread of power between the supported modes.)