

THE UNIVERSITY OF BRITISH COLUMBIA  
Department of Electrical and Computer Engineering

ELEC 311 – Electromagnetic Fields & Waves

2025 W1

Example Problems for

Chapter 13 – Guided Waves

in W. H. Hayt, Jr. and J. A. Buck, *Engineering Electromagnetics*, McGraw-Hill, 2019, pp. 456-514.

*The purpose of these four example problems is to help you master some of fundamental techniques used to analyze the behaviour of guided waves.*

*Please attempt the problems before we review the solutions in class. Answers should be short and to the point. Use sketches to explain your solution as required. Clarity, conciseness, and presentation all count. This problem set will not be graded; a separate take-home assignment (supplemental problems) for credit will be issued at a later date.*

1. A TE mode in a parallel-plate waveguide is observed to have two maxima in its electric field pattern between  $x = 0$  and  $x = d$ . What is the value of  $m$ ?
2. The interior of a WR-75 waveguide is 0.75 in. wide and 0.375 in. tall. What are the cut-off frequencies of the TE<sub>10</sub> and TE<sub>20</sub> modes?
3. Consider a parallel-plate waveguide with  $d = 4$  cm,  $\epsilon_r = 1$  and  $f = 15$  GHz.
  - a. Determine the wave angles  $\theta_m$  for the first three modes ( $m = 1, 2,$  and  $3$ )
  - b. What is the maximum frequency at which the guide will operate in the TEM mode only?
4. Determine the group velocity of the  $m = 1$  (TE or TM mode) in an air-filled parallel-plate waveguide with  $d = 1.0$  cm at  $f = 15, 30,$  and  $50$  GHz.