



## Arab Academy for Science and Technology & Maritime Transport

College of Engineering & Technology

Department : Electronics & Communication

Course : Wave propagation and Antennas (1)

Course No: EC 443

Lecturer : Prof. Dr. Essma Abdel-Fatah

GTA : Eng. Abdel Elah Maged

### Sheet (1): Rectangular WaveGuide

- 1- An air filled rectangular waveguide of inside dimensions  $7 \times 3.5$  cm operates in the dominant mode  $TE_{10}$  mode.
  - a- Find the cut-off frequency
  - b- Determine the phase velocity of the wave in the guide at a frequency of 3.5 GHz.
  - c- Determine the guided wavelength at the same frequency.
- 2- a- For an air-filled waveguide whose inside dimensions are  $3 \times 1.5$  inch, find the cut-off frequency and cut-off wavelength for the  $TE_{10}$  mode.
  - b- For the same waveguide, calculate the field in terms of an arbitrary  $A_{10}(H_{z_{\max}})$  for  $f = 2.45$  GHz operating in the  $TE_{10}$  mode.
- 3- The waveguide in problem (2) has a  $\lambda_g$  of 0.2 m. Find the frequency, phase velocity and group velocity.
- 4- For  $3 \times 1.5$  inch waveguide in problem (2) and (3), find the frequency range over which operation would be restricted to the dominant mode only.
- 5- a) Design an air-filled rectangular waveguide with  $b < a < 2b$ , such that when operated at 3 GHz in the dominant mode, it is 20% above the its cut-off frequency and 20% below the cut-off frequency of the next higher order mode.
  - b) How would the guide dimensions be affected, if the guide is to be filled with a dielectric with a relative permittivity  $\epsilon_r = 4$ ?
  - c) Discuss the situation when  $a > 2b$ ?
- 6- a) For  $\lambda_o = 10$  cm, design a rectangular waveguide with air dielectric so that the dominant mode will propagate with  $f_o = 1.3f_c$ , but also that the mode with the next higher cut-off frequency will be 30% below its cut-off frequency knowing that  $b/a = 0.5$ .
  - b) How would the guide dimensions be affected, if the guide is to be filled with a dielectric with a relative permittivity  $\epsilon_r = 4$ ?
- 7- A rectangular waveguide has the dimensions  $a = 3.175$  cm and  $b = 1.5875$  cm. A source generating frequencies  $f_1 = 10$  GHz and  $f_2 = 18$  GHz is connected to the input of the guide. Determine the mode in which each frequency component may propagate in the guide?
- 8- For the dominant mode, find the waveguide wavelength and impedance for a waveguide having the dimensions  $a = 2.286$  cm and  $b = 1.016$  cm for the following frequencies:  $f_1 = 10$  GHz and  $f_2 = 12$  GHz
- 9- Is it possible to propagate a TEM wave in waveguide and Why?