

Recitation Questions 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 recitation questions is to assist the reader in assessing their mastery of the key concepts introduced in this chapter. The answers can be found in the textbook. ELEC 311 students should be prepared to provide answers to these questions in class or on an exam.

Introduction

1. How does this chapter build upon the discussion in *Chapter 10 – Transmission Lines*?
2. What is the main difference between a transmission line and a waveguide?

13.1 Transmission Line Fields and Primary Constants

1. Sketch the geometry of a parallel-plate waveguide.
2. What replaces the electric and magnetic field when modelling a parallel-plate waveguide as transmission line?
3. What information is required to estimate the parameters R , L , G , C , and Z_0 of the equivalent circuit model of a parallel-plate waveguide? What are the relevant formulas?

13.1.1 Coaxial (High Frequencies)

1. Sketch the geometry of a coaxial transmission line.
2. What information is required to estimate the parameters R , L , G , C , and Z_0 of the equivalent circuit model of a coaxial transmission line? What are the relevant formulas?

13.1.2 Coaxial (Low Frequencies)

1. What are the main differences between a coaxial line at high and low frequencies?
2. What is the main challenge when modelling a coaxial line at low frequencies?

13.1.3 Coaxial (Intermediate Frequencies)

1. What is the main challenge when modelling a coaxial line at intermediate frequencies?

2. When is it necessary to assume that a coaxial line is being operated at intermediate frequencies??

13.1.4 Two-Wire (High Frequencies)

1. Sketch the geometry of a two-wire transmission line, also known as ladder line?
2. What information is required to estimate the parameters R , L , G , C , and Z_0 of the equivalent circuit model of a two-wire transmission line? What are the relevant formulas?

13.1.5 Two-Wire (Low Frequencies)

1. What are the main differences between a two-wire line at high and low frequencies?
2. What is the main challenge when modelling a two-wire line at low frequencies?

13.1.6 Microstrip (Low Frequencies)

1. Sketch the geometry of a microstrip line.
2. What are the main differences between a microstrip line and a parallel-plate waveguide?
3. What is the quasi-TEM approximation?
4. How does one estimate $\epsilon_{r, eff}$, Z_0 , and v_p of a microstrip line?

13.2 Basic Waveguide Operation

1. What are typical waveguide geometries?
2. What is the distinction between transmission lines and waveguides?

13.3 Plane Wave Analysis of the Parallel-Plate Waveguide

1. What is the main difference between propagation of a TEM mode and a waveguide mode in a parallel-plate waveguide?
2. How does zig-zag propagation of a plane wave down a parallel-plate waveguide: a) permit a TE-polarized wave to propagate and b) affect the effective or group velocity of the wave?
3. What is the significance of transverse resonance and the cut-off frequency of a mode?
4. What is the significance of the mode number, m ?
5. Why is it useful to resolve the wave vector \mathbf{k} of the plane wave into transverse and longitudinal components?
6. To what is the transverse component of the wave vector \mathbf{k} related?
7. To what is the longitudinal component of the wave vector \mathbf{k} related?
8. What is meant by the group velocity and how is it calculated?

9. What is meant by the phase velocity and how is it calculated?
10. How are the phase and group velocities related?

13.4 Parallel-Plate Guide Analysis Using the Wave Equation

1. Why is it useful to analyze a waveguide through the wave equation?
2. How, in general, does one solve the wave equation in a waveguide?

13.5 Rectangular Waveguides

1. How are rectangular waveguides similar to and different from parallel-plate waveguides?
2. Why are rectangular waveguides used, and why are they useful?

13.6 Planar Dielectric Waveguides

1. Sketch the geometry of a planar dielectric waveguide.
2. When are dielectric waveguides particularly useful?
3. How do dielectric guides differ from conducting guides?

13.7 Optical Fiber

1. What is the main difference between optical fibres and planar dielectric waveguides?