CSE311 Microwave Engineering

CHAPTER 0

Course Outline

Assoc. Prof. Dr. Moataz Elsherbini
motaz.ali@feng.bu.edu.eg

Chapter Contents

0.1 Course Description

0.2 Course Objectives

0.3 Course Administration

0.4 Course Outline

0.5 Grade Distribution

0.1 Course Description

جامعة بنها الأهلية
Benha National University
BNU

CSE311 Microwave Engineering

Theory of guided waves and the concept of “modes”. Rectangular Waveguides. Cylindrical waveguides. Losses in waveguides. Types of cavity resonators. Characteristics of elementary planar waveguide structures. The strip lines as a guiding structure.

Course goals: Ability to understand and elaborate the principles of microwave engineering. Perform the basic microwave measurements.

Course prerequisites: **CSE304** (Electromagnetic Waves)

0.2 Course Objectives

Upon a successful completion of this course, the student will be able to:

- Understanding the principles of microwave engineering and technology.
- Derive and solve the plane wave equations to determine the wave characteristics and parameters in different media.
- Derive and solve the wave equations in many microwave structures such as transmission lines and waveguides to analyze the wave propagation along them.
- Use of Smith chart for determining the wave characteristics on a transmission line and determine: the Voltage Standing Wave Ratio (VSWR), reflection coefficient (Γ), transmission coefficient (T), admittance value (Y_L) and input impedance (Z_{in}).
- Perform the impedance matching using different techniques in microwave circuits.
- Compare between planar and nonplanar transmission line structures and characteristics.
- Investigate different passive microwave components such as: power dividers/combiners, couplers, resonators and cavities.
- Measure different characteristics and parameters of microwave components.

0.3 Course Administration

- Instructors: **Assoc. Prof. Dr. Moataz Elsherbini**

  e mail: motaz.ali@feng.bu.edu.eg

  Office hours: Saturday 12:00 – 3:00

- URL: (Temporarily)

  https://www.bu.edu.eg/staff/motazali3-courses/19002

- Text: David M. Pozar, “ Microwave Engineering”,

  John Wiley & Sons, Inc., 2018

- Notes: Lecture slides and Assignments are on the web.

Lec.	Items/Topics	Assignments
2	**Chapter 0: Introduction** 0.1 Course Description 0.2 Course Objectives 0.3 Course Administration 0.4 Course Outline 0.5 Grade Distribution **Chapter 1: Microwave fundamentals** 1.1 Introduction to EM Waves 1. 1 Microwave definitions 1. 2 Electromagnetic frequency spectrum 1. 3 Advantages and disadvantages of MW 1. 4 industrial Applications of MW 1.5 Advantages and Disadvantages of MW devices 1.6 History of microwave devices 1.7 Examples of MW devices	***Problem Set*** #1 Review of Electromagnetic Fields And MW devices
3	**Chapter 2: Microwave Systems** 2.1 Mobile phone System 2.2 Mobile jamming 2.3 Signal enhancer 2.4 GPS & GSM modules 2.5 RF transceivers 1.5.2 RFID systems 2.6 GPR 2.7 Energy harvesting system 2.8 network analyzer / freq. spectrum 2.9 MW imaging 2.10 high power mw systems	***Problem Set*** #2 MW systems

0.4 Course Outline (Continued)

Week	Items/Topics	Assignments
3	**Chapter 3 Electromagnetic Plane Wave Propagation** Solution of Wave Equations in a General Medium Basic plane wave parameters Solution of Wave Equations in Free Space , a Lossless Medium and in a Good Conductor Poynting's Theorem and Wave Power Reflection of uniform plane wave	***Problem Set*** #3 Electromagnetic Plane Wave Propagation
4	**Chapter 4 General Transmission Line Theory** The Lumped–Element Circuit Model for a Transmission Line (TL) Transmission line Definition Transmission Line Circuit Model The Transmission Line Equations Wave Equations of a Transmission Line	***Problem Set*** #4 Transmission Line Theory
5	Wave Propagation on a Transmission Line Transmission Line Wave Parameters The Lossless Transmission Line Power Transmission over the Transmission Line. Wave Reflection at Discontinuities of TL Voltage Standing Wave Ratio (VSWR)	
6	Transmission Line Input Impedance Impedance Matching (L section)	***Problem Set #5 Matching***
7	Midterm 1	

0.4 Course Outline (Continued)

Week	Items/Topics	Assignments
8	Smith Chart Analysis (general view)	
9	Using Smith chart in impedance matching (matching by: L section , stub . Lambda/4 transformer)	***Problem Set #6*** Smith Chart
10	**Chapter 5 Waveguides** Introduction Field Relationships in General Waveguides General Solution for TE and TM waves TE , TM Modes in Rectangular Waveguide	
11	Circular Waveguides , Cavity resonators and straplines	***Problem Set*** #7 Waveguides
12	Midterm 2	
13	**Microwave network analysis**	***Problem Set*** #8 MW network Analysis
14	Review , applications using suitable tools	

Possible Researches

جامعة بنها الأهلية
Benha National University
BNU

1- Preparing a report in details on one of MW devices in form of review paper (in IEEE/Springer format)

2- Enhancement design for MW networks or matching circuit using suitable SW tool , Writing a research paper including simulation results (in IEEE/Springer format)

Learning Outcomes LO's

Cognitive Domain	
LO1	Explain the fundamentals of microwave transmission line theory
LO2	Analyze and solve problems related to microwave transmission lines and circuits
LO3	Recognize propagation modes and losses in rectangular waveguides and circular waveguides.
LO4	Understand Types of cavity resonators and straplines and other microwave devices
Psychomotor Domain	
LO5	Analyze impedance matching using mathematical design and smith chart
LO6	Report for microwave circuits using design, analysis and suitable S/W tool
Affective Domain	
	None

Lecture Plan

Week	Topics	Planned Hours	Learning Outcomes					
			LO1 B2-1	LO2 B2-2	LO3 B4-3	LO4 B4-4	LO5 C3-5	LO6 C3-6
W1	Microwave fundamentals	4	■					
W2	Microwave systems and devices	4	■			■		
W3	Electromagnetic Plane Wave Propagation	4	■	■				
W4	General Transmission Line Theory	4	■	■				
W5	Wave Propagation and power losses on a TL	4		■	■			
W6	Impedance matching (L section)	4			■			
W7	• Midterm 1	4	■	■	■	■		
W8	Smith chart analysis	4					■	
W9	Using smith chart in impedance matching	4					■	■
W10	Rectangular Waveguides, TE & TM	4			■			
W11	Circular waveguides , Cavity resonators and straplines	4			■	■		
W12	• Midterm 2	4			■	■	■	
W13	Microwave network analysis	4					■	
W14	Applications using suitable tools	4						■

0.5 Grade Distribution

Assessment Tools	Week	Weight
First Midterm Examination	7	15 %
Second Midterm Examination	12	15%
Final Examination	(As Schedule)	40%
Quizzes (3 times)	4 , 8 , 11	15%
Report, Mini project S/W (Lab)	10,12	10%
Attendance	All semester	5%
Total		**100** %

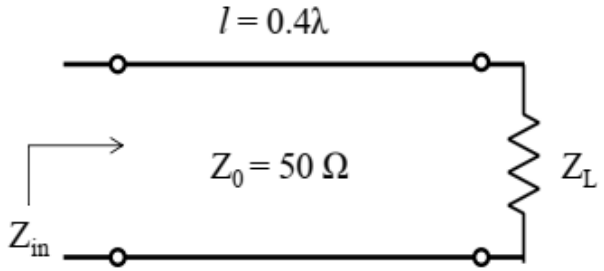
Example of Questions I

A 75 Ω coaxial transmission line has length of 2.0 cm and is terminated with a load impedance of 37.5 + j75 Ω. If the dielectric constant of the line is 2.56 and the frequency is 3.0 GHz. Find (i) the input impedance to the line, (ii) the reflection coefficient at the load, (iii) the reflection coefficient at the input and (iv) the SWR on the line.

Example of Questions II

Use the Smith chart to find the following quantities for the transmission line circuit below where $Z_L = 40 - j30\ \Omega$:

- The SWR on the line.
- The reflection coefficient at the load.
- The load admittance.
- The input impedance of the line.
- The distance from the load to the first voltage minimum.
- The distance from the load to the first voltage maximum.



Example of Questions III

An air-filed copper rectangular waveguide has dimensions a = 4.5 cm and b = 9 cm. Determine:

a) The cutoff wavelength λ_c for the dominant mode.

b) The phase velocity V_p in the waveguide at 1.6 times the cutoff frequency.

c) Repeat (a) and (b) if guide filled dielectric having (μ_r= 1 and ε_r = 1.7).