ECE 460/560
Introduction to Microwave Engineering

Overview

Course Catalog Description: Introduction to Microwave Engineering (3 credits)
This lecture/laboratory course provides essential fundamentals for rf, wireless, and microwave engineering. Topics include: wave propagation in cables, waveguides and free space; impedance matching, standing wave ratios, Z- and S-parameters

Prerequisites: C- or better in ECE 360, or equivalent (Undergrad EM through Maxwell's Eqns.)

Co-requisite: none

Textbook: D.M. Pozar, *Microwave Engineering, 3rd Edition*, New York: John Wiley and Sons, ISBN 0-471-44878-8

Class Goals: To gain a strong foundation in the fundamental concepts of microwave engineering

Course Coordinator: Professor Mark Gilmore

Table I: Objectives, Implementation, and Assessment

Objectives		Implementation	Assessment	A	B	C	D	E	F	G	H	I	J	K
O_1	Understand Maxwell's Eqns, EM Boundary Conditions	1.25 hrs. lecture in first week (review)	HW 1, Midterm Exam	X				X						
O_2	Understand the EM wave equation and plane wave solutions, EM energy and power flow, polarization, reflection & transmission	1.25 hrs. lecture in 1st week	HW 1, Midterm Exam	X				X						
O_3	Understand fundamentals of transmission lines, Smith charts, impedance matching, quarter wave transformers	5 hrs. lecture in 2nd & 3rd weeks	HW 2 Midterm Exam	X				X						
O_4	Understand physical transmission lines, including rectangular & circular waveguides; field equations in rectilinear coordinates	5 hrs lecture in weeks 4, 5	HW 3 Midterm Exam	X				X						
O_5	Understand coaxial and monolithic guiding structures (microstrip, stripline, etc)	2.5 hrs lecture in week 6	HW 4, Midterm Exam	X				X						
O_6	Understand microwave networks: Y, Z, S and ABCD matrices	7.5 hrs lecture in weeks 7,8	HW 5 Midterm Exam	X				X						

O_7	Understand waveguide coupling via apertures & probes	5 hrs lecture week 9	HW 5, Final Exam	X				X							
O_8	Understand tuning & impedance matching, impedance transformers	7.5 hrs lecture weeks 10, 11, 12	HW 6, Final Exam	X				X							
O9	Understand Basic Passive microwave components: D/C's, power dividers, hybrid couplers, resonators	7.5 hrs lecture weeks 13, 14, 15	HW's 7, 8, Final Exam	X				X							
O_{10}	Understand basic principle of operation of microwave ferrite devices	1.25 hrs lecture, week 16	HW 8, Final Exam	X				X							
O_{11}	Gain experience with modern microwave engineering CAD tools	Two CAD software laboratory assignments using Ansoft Designer SV2	CAD "laboratory" reports	X	X	X		X		X					X
O_{12}	Learn to operate basic microwave engineering components & instrumentation (spectrum & network analyzers, freq synthesizers)	Three laboratory exercises	laboratory reports	X	X			X		X					X

Table II: Expectation and Assessment Outcome
Fall 2007, Dr. M. Gilmore

Contents: This course will give a general overview of passive microwave components and engineering concepts. We will cover chapters 1 – 7, and 9 in the Pozar book, though not all of every chapter.

1. Review of Electromagnetic Theory
2. Transmission Line Theory
3. Transmission lines and Waveguides
4. Microwave network analysis
5. Impedance matching and tuning
6. Resonators
7. Power dividers and directional couplers
8. Ferrimagnetic components

Laboratory Exercises: There will be five laboratory exercises during the semester, including two computer design/simulation assignments using Ansoft Designer SV software, and three hands-on labs with actual components. A short write up will be required with each lab.

There will be no set times for "hands on" labs. Lab groups of 2–4 people will schedule lab time within a two-week period with the teaching assistant. Each lab will take approximately 3 hours to complete. The microwave teaching lab is in ECE building room 331.

Grading: Homework 20%, laboratory write ups 20%, midterm exam 30%, final exam 30%. Students registered for 460 and 560 will have identical assignments, but will be graded on different scales. 560 students will also have additional problems on the exams.

Homework: Homework assignments will be approximately every other week. Late homeworks will receive reduced credit unless prior arrangements have been made. Some homeworks will involve computer solutions and plotting, so you will need access to software with math and plotting functions, such as MATLAB, IDL, C/C++, FORTRAN, etc.

Final Exam: Thursday, Dec 13, 5:30 – 7:30 PM

Lecture and Lab Schedule

1	Tu	Aug-21	Lecture 1 - Introduction
	Th	Aug-23	Lecture 2 – Review of Electromagnetic Theory
2	Tu	Aug-28	Lecture 3 – Transmission Line Theory
	Th	Aug-30	Lecture 4 - Transmission Line Theory cont.
3	Tu	Sept-04	Lecture 5 – The Smith Chart
	Th	Sept-06	Lecture 6 – Transmission Line theory cont.
4	Tu	Sept-11	Lecture 7 – Waveguides and Transmission Lines
	Th	Sept-13	Lecture 8 – Rectangular Waveguide
5	Tu	Sept-18	Lecture 8 continued
	Th	Sept-20	Lecture 9 – Circular Waveguide
6	Tu	Sept-25	Lecture 10 – Coaxial line, stripline, microstrip
	Th	Sept-27	Lecture 11 – Microwave Networks
	Lab #1, week 1		
7	Tu	Oct-02	Lecture 12 – Y and Z Matrices, scattering parameters
	Th	Oct-04	Lecture 13 - Scattering parameters cont, ABCD matrices
	Lab #1, week 2		
8	Tu	Oct-09	Lecture 14 – Excitation of waveguides by probes
	Fall Break, Thur, Fri, Oct 11 - 12		
9	Tu	Oct-16	Lecture 15 - – Excitation of waveguides by apertures
	Th	Oct-18	Midterm Exam
10	Tu	Oct-23	Midterm Review and catch up
	Th	Oct-25	Lecture 16 – Transmission line discontinuities
	Lab #2, week 1		
11	Tu	Oct-30	Lecture 17 – Impedance Matching and Tuning
	Th	Nov-01	Lecture 18 – Stub tuning

Lab #2, week 2

12 Tu Nov-06 Lecture 19 – Double stub tuning
Th Nov-08 Lecture 20 – Impedance transformers

13 Tu Nov-13 Lecture 21 – Multisection impedance transformers cont
Th Nov-15 Lecture 22 – Power dividers
Lab #3, week 1

14 Tu Nov-20 Lecture 23 – Waveguide directional couplers
Thanksgiving Holiday, Thur, Fri , Nov 22, 23

15 Tu Nov-27 Lecture 24 – Monolithic directional couplers
Th Nov-29 Lecture 25 – Hybrid couplers
Lab #3, week 2

16 Tu Dec-04 Lecture 26 – Transmission line resonators
Th Dec-06 Lecture 27 – Cavity resonators, Microwave Ferrite Devices

Exams: Expect 75% of the students to score 70% or better on all exams.

Number of students assessed: 4 (this is primarily a graduate course (ECE 560), with only a few undergraduate students taking it as ECE 460).

Objectives		Outcome Assessment	Evaluation
O_1	Understand Maxwell's Eqns, EM Boundary Conditions	100 % of students completed HW 1 satisfactorily. 67% of students scored 70% or better on the midterm exam	Some students did not grasp basic concepts adequately
O_2	Understand the EM wave equation and plane wave solutions, EM energy and power flow, polarization, reflection & transmission	100 % of students completed HW 1 satisfactorily. 67% of students scored 70% or better on the midterm exam	Some students did not grasp basic concepts adequately.
O_3	Understand fundamentals of transmission lines, Smith charts, impedance matching, quarter wave transformers	100 % of students completed HW 2 satisfactorily. 67% of students scored 70% or better on the midterm exam	Some students did not grasp basic concepts adequately.
O_4	Understand physical transmission lines, including rectangular & circular waveguides; field equations in rectilinear coordinates	100 % of students completed HW 3 satisfactorily. 67% of students scored 70% or better on the midterm exam	Some students did not grasp basic concepts adequately.
O_5	Understand coaxial and monolithic guiding structures (microstrip, stripline, etc)	100 % of students completed HW 4 satisfactorily. 67% of students scored 70% or better on the midterm exam	Some students did not grasp basic concepts adequately.

O_6	Understand microwave networks: Y, Z, S and ABCD matrices	100 % of students completed HW 5 satisfactorily. 67% of students scored 70% or better on the midterm exam	Some students did not grasp basic concepts adequately.
O_7	Understand waveguide coupling via apertures & probes	100 % of students completed HW 6 satisfactorily. 100% of students scored 70% or better on the final exam	Marked improvement in student understanding
O_8	Understand tuning & impedance matching, impedance transformers	100 % of students completed HW 7 satisfactorily. 100% of students scored 70% or better on the final exam	Marked improvement in student understanding
O_9	Understand Basic Passive microwave components: D/C's, power dividers, hybrid couplers, resonators	100 % of students completed HW 8 satisfactorily. 100% of students scored 70% or better on the final exam	Marked improvement in student understanding
O_{10}	Understand basic principle of operation of microwave ferrite devices	100 % of students completed HW 8 satisfactorily. 100% of students scored 70% or better on the final exam	Marked improvement in student understanding
O_{11}	Gain experience with modern microwave engineering CAD tools	100% of students completed CAD assignments satisfactorily	Adequate student understanding
O_{12}	Learn to operate basic microwave engineering components & instrumentation (spectrum & network analyzers, freq synthesizers)	100% of students completed laboratory assignments satisfactorily	Adequate student understanding