

# EEE 211

## Microwave Engineering I, Fall 2004.

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Class meeting: RVR-5017, TR noon – 1<sup>15</sup>pm

Office Hours: Riverside Hall 3028, W 12-1pm, Thursday 9am-11am, or by appointment

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**Prerequisites:** EEE161

**Corequisites:**

**Text:**

**Required:** *Microwave Engineering*, by Pozar. John Wiley & Sons, Inc. ISBN 0-471-17096-8

**Reference (Not Required):** *Practical RF Circuit Design for Modern Wireless Systems*, 2nd edition by Besser and Gilmore. Artech House ISBN158053521-6

**Software:**

*Agilent Advanced Design System 2003*. This full commercial version of ADS is available in room Riverside 5017.

**Course purpose:**

EEE211 is designed for graduate electrical engineering students as an introductory microwave engineering class. This course introduces electronic circuit design, simulations and measurements at high frequencies. Passive microstrip circuits such as filters, dividers, couplers will be discussed.

**Course objectives:**

By the end of this course, you should be able to do the following:

- Use S-parameter terminology to describe circuits.
- Design microwave transmission lines.
- Describe and analyze different impedance matching techniques.
- Design impedance matching networks for specific application.
- Design, analyze and measure microstrip filter and coupler.
- Use microwave components such as isolators, couplers, circulators.
- Design microstrip circuits using Agilent ADS software.
- Use a Network Analyzer to measure passive circuits.
- Fabricate microstrip circuits.

# Course Outline

## Grading:

Course grades are based on a weighted sum of problem set scores and midterm and final examination scores, with the following weights:

**Quizzes** 5%

**Homework** – 5%

**Midterms** (Each) – 25%

**Projects** (Each) - 5%

**Project Presentation** 5%

**Final** – 25%

The whole course is worth 100%. There is 5% extra credit.

**Project** Detailed instructions for the project are given on the class web-page. The project presentations are scheduled for the last week of classes, see the schedule. Students are encouraged, but not required to work in teams of up to four students.

### Project grading:

1. Presentation 50%
2. Report 50%

## Homework:

It is **recommended** but not required that students do homework assignments in groups of two, three or four students. Students will decide who wants to be in which group. The students will be provided with the homework solutions at the same time when the homework is posted. Since we recommend that students work in groups and the homework solutions are known Late homework will not be accepted. However, the lowest homework grade will be dropped.

### Homework Team Roles *Recommendations*

Team members should individually review the solutions to HW problems. On each group assignment your team should designate a *coordinator* to organize work sessions, make sure everyone knows where and when to meet and understands who is supposed to be doing what, and one or two *checkers* to check the solutions for correctness and verify that everyone in the group understands both the solutions and the strategies used to obtain them. Each student should submit their own homework solution. The team roles should rotate on every assignment, once a team member has carried out a role, he/she should not do it again until everyone else on the team has done it.

**Homework format:** Homework will consist of set of problems (from Pozar's book) and ADS exercises. The students have to submit written solutions to the problems assigned and the printout of the ADS circuit schematics with the simulation results.

Assigned according to the schedule on page 5, due one week later by 2pm in Main office homework box. For example, if the HW is assigned on Tuesday (Thursday), it is due the following Tuesday (Thursday) by 2pm in the homework box in the Main Office. Please date stamp your homework before submitting. Date stamp is provided by the main office and is usually stationed next to the homework box. To help in handling the problem sets, please do your work on only one side of each page, staple your pages. Write your name, date, problem set number, and course number on the outside. The problem sets will be graded and returned in lecture or left in the homework box in front of instructors office RVR3028. **Please see additional recommendations for HW presentation.**

### Homework grading:

Each homework is worth 5 points, with points allocated as follows:

1. All problems written – 3
2. Most problems written – 2
3. Few problems written – 1

#### 4. Homework Not Submitted – 0

**Two (2) point will be added for neatness. Neat homework will get 2 points, if most or all problems are written, 0 points if few problems are written or if the homework is missing**

The problem set solutions will be made available on the Web page.

#### **Late Homework:**

Since we provide solutions and allow group work, **late homework** will not be accepted, however the lowest HW grade will be dropped.

#### **Quizzes:**

Quizzes are assigned most weeks on Wednesday the first 20 minutes of class. The first five minutes we recommend that students discuss quiz questions in groups of two, three or four students (students decide who they want to speak with). The students are not allowed to write anything during the 5-minute discussion period. The following 15 minutes are provided for the students to outline their own solutions. Quizzes consist of one to two problems. The quiz questions are based on the homework sets and lectures.

#### **Quiz grading:**

Each problem on a problem set is worth 3 points, with points allocated as follows:

1. Correct – 3
2. Minor Error – 2
3. Attempt – 1
4. No Attempt – 0

#### **One (1) point will be added for neatness.**

The problem set solutions will not be posted. The students are encouraged to discuss the solution to quizzes with the instructor during the office hours.

#### **Missed Quizzes:**

There will be no quiz makeups, however two lowest quiz grades will be dropped.

#### **Midterm Exams:**

Exams: There will be two midterm examinations and a final examination, given under the following schedule:

**Midterm #1:** October 5<sup>th</sup> noon - 1:15 pm, RVR-5017

**Midterm #2:** November 8<sup>th</sup> noon - 1:15 pm, RVR-5017

**Final :** TBA

The examinations will be closed book, but for the first and second midterms, and for the final exam, you will have the right to use respectively one, two, and three pages of notes (8 1/2" X 11" paper, both sides of the page, no magnifying lenses or hard copies allowed). Calculators will be allowed, but will not be critical in the examinations. Each of the two midterm examinations will cover 4 to 5 weeks of material. The final examination will cover the entire course. The midterm examinations will be held during the discussion period. Further information on examination content will be given in class prior to each examination.

#### **Missed Tests**

Giving a make-up examination is difficult, as the examination requires a considerable amount of time to prepare, and it is difficult to make this examination equivalent to the regularly scheduled one. Therefore, requests for make-up examinations will only be approved in cases where strong written justification can be provided. Acceptable justification includes illness (confirmed in written by a physician) and personal problems (confirmed by personnel at the Counseling Center). Travel arrangements are not an acceptable excuse for rescheduling the examination. You must contact the instructor before the regularly scheduled examination to request approval of a make-up examination. *If you miss the midterm or the final exam without a valid excuse, a zero will be averaged into your grade.* However, the worst grade out of the two midterms and the final examination will be counted half as much as the other two.

#### **Regrading**

If you think you deserve more points on a problem set or examination question **do not contact the instructor before or after the class to explain your case.** Please do the following:

- write and submit a short note **within seven days** following the day the graded material is available, indicating what should be reconsidered,
- attach it to the problem set or examination, and return it to the HW box in the main office.
- We will review the grading, reassign points if justified, and return the paper in class.
- Please note that the number of points can be increased as well as decreased.
- If you are still not satisfied with your score, please e-mail the instructor to make an appointment with the instructor to discuss the case.
- You must bring your exam, note and reply to the meeting.

## Calculation of the Course Grade

A weighted average grade will be calculated as follows:

97 or above is guaranteed a course grade of A+

92 or above A

80 or above at least B

70 or above at least C

60 or above at least D

*NOTICE:* We do not curve grades in this course. It is theoretically possible for everyone in the class to get an A (or an F). Your performance depends only on how you do, not on how everyone else in the class does. It is therefore in your best interest to help your classmates in every legal way possible.

### **Gray areas between guaranteed letter grades:**

There will be a 'gray area' of several points below the specified numerical cutoff grades (except 97), within which a  $\pm$  system will be used. Two people getting the same weighted average grade (say, 89) might therefore get different course grades (A- or B+). If you are in one of these gray areas, whether you get the higher or lower grade depends on whether your test performance has been improving (your grade goes up) or declining (it goes down), and whether your participation in group (and class) has been good (up) or inadequate-disruptive (down).

Lec	Date	Topic	Reading	HW	ADS Project
1	Aug 30	Intro			
2	Sept 1	Transmission Lines, Review	2.1, 2.3	1	
3	Sept 6	Smith Chart, Review	2.4		PI OUT
4	Sept 8	Quarter-Wave Transformer	2.5		
5	Sept 13	LAB, Intro to ADS	handouts	2	
6	Sept 15	Generator and load mismatches	2.6, 2.7, 2.8		
7	Sept 20	Lumped Element Impedance Matching	5.1	3	
8	Sept 22	Single Stub Matching	5.2		
9	Sept 27	$\frac{\lambda}{4}$ transformer, Binomial	5.4, 5.6	4	
10	Sept 29	Chebyshev Multisection Transformer	5.7, 5.8	PMTI	
11	Oct 4	Review	CH2, CH5		
12	Oct 6	MIDTERM I			
13	Oct 11	LAB ADS Transmission Lines			PI Due PII Out
14	Oct 13	Network Analysis, Network Analyzer	4.2, 4.34.4	5	
15	Oct 18	LAB NA calibration	Handouts		
16	Oct 20	LAB ADS		6	
17	Oct 25	Dividers and Couplers	7.1		
18	Oct 27	Wilkinson Power Divider	7.3	7	
19	Nov 1	90° Hybrid	7.5, 7.6		
20	Nov 3	Review	CH4, CH 7		PII Due PIII Out

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Lec	Date	Topic	Reading	HW	Lab
21	Nov 8	MIDTERM II			
22	Nov 10	LAB Microwave Measurements			
23	Nov 15	Filters	8.1, 8.3	8	
24	Nov 17	Filter Transformations/Implementation	8.4		
25	Nov 22	LAB Filter Synthesis in ADS			
		THANKSGIVING			
26	Nov 29	Antennas		9	
27	Dec 1	Antennas			
28	Dec 6	Project Presentations			
29	Dec 9	Project Presentations			PIII Due