

ECE 549 RF Design for Wireless

Fall 2016

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PREREQUISITES:

Graduate standing in Electrical Engineering or Computer Engineering. You must have circuits and electromagnetics at least at the the third-year undergraduate level.

TEXTBOOK:

M.B. Steer, *Microwave and RF Design: A Systems Approach*, Second Edition. (On Amazon search on steer RF microwave design) Make sure you get the second edition with the blue cover.

The course follows the book very closely and is required. This text will be used in both this class and ECE719 (Advanced Microwave Design).

COURSE OBJECTIVES:

RF and microwave systems are central to the wireless revolution that is changing our world. ECE549 is an RF and microwave circuits class that is at the subsystem and component level and covers a lot of territory. The objective is that you will understand all of the components of RF and microwave circuits and be able to make system level design decisions.

This class will be a prerequisite to ECE719 an advanced microwave design class (scheduled for Spring 2017). This class will be a prerequisite to ECE712 an RFIC design class (scheduled for Spring 2017).

COURSE DESCRIPTION:

Design of the hardware aspects of wireless systems with principle emphasis on design of radio frequency (RF) and microwave circuitry. Introduction of system concepts then functional block design of a wireless system. RF and microwave transistors, noise, power amplifiers, CAE, linearization and antennas.

COURSE DELIVERY:

The delivery for on-campus and on-line students will be the same with the lectures presented as videos. This is a hybrid class with occasional discussion sessions which will be summarized for the Engineering On-Line (EOL) class. There should be extensive discussion via the message board. Each Lecture is given using a number of short video segments. To get an idea you can look at a case study I have posted on a [bandpass filter design](#). We will be using this material in the course. The video segments vary in length from 10 minutes to 30 minutes with the number of segments per lecture varying from 1 to 12. There will be a homework for each lecture with two due dates each week. Homework will need to be scanned and submitted electronically. The first on-campus meeting will be in **EB3 Rm 2232 at 9:35am on Friday August 19, 2016**.

MODULES AND BRIEF SYLLABUS:

The class will be taught as five modules.

MODULE 1 Introduction	Introduction to the course and introduction to RF and microwave engineering. (Chapter 1)
MODULE 2 RF Systems	RF Communication systems (Chapter 4)
MODULE 3 Transmission lines	Transmission Lines; Extraordinary Transmission Line Effects; Coupled Lines (Chapters 5, 6, 7, 8)
MODULE 4 Microwave network analysis	Microwave Network Analysis; Passive Components; Impedance Matching; Filters (Chapters 9, 10, 11, 12)
MODULE 5 RF filters	Filter design and project: filter design using coupled lines (Chapters 15, 16)

COURSE REQUIREMENTS:

Homework: Approximately 18 homeworks (10%). There will be homework for nearly every lecture.

Examinations: Three quizzes (25% each).

Project: Filter design (15%, Filter design). (Covers module 5.)

Computer Software: MATLAB, AWRDE (Microwave design software). Available using NC State Virtual Computing Laboratory <http://vcl.ncsu.edu>

Computer Facilities: Students will automatically have an NC State EOS account to access the course Web Site and to access the design software.

QUIZ DATES

Quiz 1: September 9, 9:35am, EB3 Rm 2232, 90 minutes. (Covers module 2.)

Quiz 2: October 14, 9:35am, EB3 Rm 2232, 90 minutes. (Covers module 3.)

Quiz 3 (Final Exam): Monday December 5, 2016, 8:00am, 90 minutes. Location to be decided. (Covers module 4.)

COURSE OUTLINE BY TOPICAL AREAS:

Wireless Systems; Transmission Line and Substrate Technology; Impedance Matching using Lumped Elements; Scattering Parameters; Passive Microwave Components; Hybrids, Couplers and Baluns, Resonators and Filters.

STUDENTS WITH DISABILITIES

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center , Campus Box 7509, 515-7653.

http://www.ncsu.edu/provost/offices/affirm_action/dss/

For more information on NC State's policy on working with students with disabilities, please see

http://www.ncsu.edu/provost/hat/current/appendix/appen_k.html

ACADEMIC INTEGRITY

All the provisions of the [code of academic integrity](#) apply to this course. In addition, it is my understanding and expectation that your signature on any test or assignment means that you neither gave nor received unauthorized aid.

GRADING POLICY

I do not follow a strict grading rule but instead use the following guiding principles

A: Gained competence in all major and minor goals of the course.

B: Gained competence in most major and a some minor goals of the course

C: Gained competence in a minority of the major goals of the course.

D/F: Did not gain sufficient competency.

In the past several years the following table has been the average break points. I cannot guarantee that it will be the same this year as I establish different break points each year considering the difficult of the homework and quizzes relative to those in prior years. After automatic assignment of grades I look over each person's record particularly looking to see if there was just one thing that may have pulled grades down. It is not unusual for me to adjust by 1 percentage point. I do not adjust by more.

D	64
C-	71
C	74
C+	78
B-	81
B	84
B+	88
A-	91
A	94
A+	97

Lecture Viewing Schedule: At least 2 days before associated homework is due.

RF_M1T2	HW, Aug 20	41	Chapter 1	Introduction to RF and microwave engineering	Q1
RF_M2T1		6	1.3, 1.4, 2.1-2.6.3, 4.1, 4.3-4.9	RF Communication Systems	Q1
RF_M2T2	HW, Aug 24	13	1.3, 1.4	0G	Q1
RF_M2T3	HW, Aug 27	23	2.1-2.4	1G	Q1
RF_M2T4	HW, Aug 31	59	2.5-2.6.3, 2.8-2.8.2, 4.1, 4.3-4.3.2, 4.3.6, 4.7.2	2G	Q1
RF_M2T5	HW, Sep 30	35	4.3.4, 4.4-4.6, 4.7.3- 4.7.5	3G	Q1
RF_M2T6	HW, Sep 7	21	4.8	4G	Q1
RF_M2T7	none	14	4.9	5G	Q1
Quiz 1	9-Sep			Quiz covers material in Module 2	
RF_M3T1	HW, Sep 17	60	5.1-5.2.5, 5.3-5.7	Transmission Lines	Q2
RF_M3T2	HW, Sep 21	47	5.1-5.2.5, 5.3-5.3.7	The Lossless Terminated Line	Q2
RF_M3T3	HW, Sep 24	30	6.1-6.4.1, 6.5-6.7	Planar Transmission Lines, Microstrip	Q2
RF_M3T4	HW, Sep 28	31	6.1-6.4, 6.10	Planar Transmission Lines	Q2
RF_M3T5	HW, Oct 1	66	7.1-7.11	Extraordinary Transmission Line Effects	Q2
RF_M3T6	HW, Oct 5	38	8.1-4, 8.7, 8.11, 8.12	Coupled Lines	
Quiz 2	14-Oct			Quiz covers material in Module 3	
RF_M4T1	HW, Oct 19	37	9.1-9.6	Microwave network analysis	Q3
RF_M4T2	HW, Oct 22	55	10.1, 10.3, 10.4	Smith Chart	Q3
RF_M4T3	HW, Oct 26	46	10.2, 10.6	S parameter measurements	Q3
RF_M4T4	HW, Oct 29	46	11.1-17	Passive components	Q3
RF_M4T5	HW, Nov 2	41	12.1-5	Impedance matching	Q3
RF_M4T6	HW, Nov 5	35	12.6-12.9	Matching Network Design Using the Smith Chart	Q3
RF_M5T1	none	23	15.1-5, 15.7	Filters (required for project)	
RF_M5T2	none	40	15.6, 15.8,9	Filters II (required for project)	
CS_PCL		131	16.1-16.4	Case Study: Parallel Coupled-Line Comblin Filter	
Project	1-Dec			Comblin filter design project. Due December 1.	Project
Quiz 3	5-Dec			Quiz covers material in Module 4	