EEE 6328C MICROWAVE IC DESIGN, Spring 2014

Links will be installed for reading and lecture materials during the semester

Course Outline (Subject to change): Note classes are on Monday, Wednesday and Fridays

Weekly Date, (No. of Classes) Class topics,

01/6, (3) Syllabus, Permission and Survey Form, Two Port Networks (Lect. 1), Two Port Conversions, HP App Note 16, Transmission Lines Intro1,(Lect. 2), Homework 1, Lecture 2 graphics, Transmission Lines 2 (Lect. 3).

Reading: Lee Chapter 6, HP App Note 16, See web links,

In Class Notes 1, In Class Notes 2, In Class Notes 3.

Audio: Lecture 1, Lecture 2, Lecture 3

01/13, (3) Transmission Lines, Lec. 4, Transmission Lines Lec. 5 Time Domain Lec. 6, Time domain Handout

Homework 2 Assignment, Homework 1 Solution

Microsoft One Notes Access and Download

Reading, Time domain handout Lee Chapter 6, Hp App Note 16, See web Links.

In Class Notes 4, In Class Notes 5, In Class Notes 6

Audio: Lecture 4, Lecture 5, Lecture 6

01/22, (2) Martin Luther King Holiday 1/20. Time domain Lec 7., S-parameters Lec. 8.,

Homework 3 Assignment

In Class Notes 7, In Class Notes 8.

Audio Lecture 7, Audio Lecture 8

01/27, (3) S-parameters Lec. 9 S-parameters Lec. 10, Reference Lec. 10, S-parameters Lec. 11.

In Class Notes 9, In Class Notes 10, In Class Notes 11

Audio Lecture 9, Audio Lecture 10, and Audio Lecture 11.
02/3, (3) Smith Chart Lect. 12 Admittance Impedance Smith Chart Lect. 13, Impedance Matching Lect. 14,

Homework 2 Solution

In Class Notes 12, In Class Notes 13, In Class Notes 14

Audio Lecture 12, Audio Lecture 13, and Audio Lecture 14.

02/10, (3) Impedance Matching Lecture 15, Advanced Impedance Matching, Lec 16, Vector Old Exam 1, 2012 Solution, Homework 4, Quiz 1

Homework 3 solution

In Class Notes 15, In Class Notes 16

Audio Lecture 15, Audio Lecture 16.

02/17, (3), Network Analyzer Lect. 17, Calibration Lect. 18, Error Modeling, Network Analyzer Calibration, Microwave Technology (Lect. 19), SCMOS design rules, MOS Exam 1 Solution

In Class Notes 17, In Class Notes 18, In Class Notes 19

Audio Lecture 17, Audio Lecture 18, and Audio, Lecture 19.

02/24, (3) Microwave Transistors (Lect 20) Inductor Modeling (Lec. 21), MOSIS technology parameters, MOS Capacitance Lect. 22, SCMOS design rules, RF CMOS technology article, The Cadence introduction, Design Rule lecture notes, tutorial and VLSI Resistance and Capacitance lectures are in the Cadence and Design Rule folder in the Sakai resources section.

Homework 5 Assignment

Homework 4 Solution

In Class Notes 20, In Class Notes 21, In Class Notes 22

Audio Lecture 20, Audio Lecture 21, and Audio Lecture 22.

03/03, Spring Break, no classes

03/10, (3) Inductors Greenhouse Inductor & Resistor Modeling, (Lect. 23), Inductor Graphics, Inductor Mohan, Inductor Yue, Inductor Supplement, Package modeling (Lect. 24), MOS Capacitance (Lect. 25),
In Class Notes 23, In Class Notes 24, In Class Notes 25,
Audio Lecture 23, Audio Lecture 24, and Audio Lecture 25.
03/17, (3) LNA Microwave Gain (Lect. 26), LNA Compression (Lect. 27), LNA Noise (Lect. 28)
In Class Notes 26, In Class Notes 27, In Class Notes 28,
Audio Lecture 26, Audio Lecture 27, and Audio Lecture 28.

Homework 5 Solution

Microwave LNA Design Project
03/24, (3) Source Degeneration Lect. 29, Q and Matching Circuits (Lec. 30), Quiz 2
In Class Notes 29, and In Class Notes 30
Audio Lecture 29, and Audio Lecture 30
03/31, (3) CMOS Cascode Gain Analysis Lect. 31, LNA Input Cascode Design Lect. (32), LNA Output Cascode Design (Lect. 33)
LNA Design Article with Q analysis and more
High Q on Chip Capacitors Article
In Class Notes 32, In Class Notes 33, In Class Notes 34,
Audio Lecture 32, Audio Lecture 33, and Audio Lecture 34.
04/07, (3) Linearity (Lect. 34), LNA noise factor (Lect. 35), Trans. sizing (Lect. 36),
IIP3 Simulation Instructions
Exam II Solution
In Class Notes 35, In Class Notes 36, In Class Notes 37,
Audio Lecture 35, Audio Lecture 36, and Audio Lecture 37.
04/14, (3) Substrate Noise Effects (Lect. 37) Linearity and Q (Lect. 38), Quiz 3
In Class Notes 37, In Class Notes 38,
Audio Lecture 37, Audio Lecture 38,

04/21, (2) Stability (Lect. 38), Millimeter Wave Introduction (Lec. 39)

Exam 3 Solution

In Class Notes 38, In Class Notes 39,

Audio Lecture 38, Audio Lecture 39,

No Final Exam.

**Topics and Reading assignments**

Lecture 1 Introduction, 2-port network, Transmission ; Lee Chapter 6, HP App Note 16 (Gonz. 1.1-1.3)

Lecture 2 Transmission line, structure and design curves, Lee Chapter 6, HP App Note 16, (Gonz. 1.1-1.3)

Lecture 3 Voltage and currents in a transmission line, Lee Chapter 6, HP App Note 16, (Gonz. 1.1-1.3)

Lecture 4 Reflection coefficient, transmission line example, Lee Chapter 6, HP App Note, 16, (Gonz. 1.1-1.3)

Lecture 5 Transients in transmission lines (handout), HP App Note 62

Lecture 6 Transients in transmission lines (handout), HP App Note 62

Lecture 7 Scattering parameters (definitions), Lee Chapter 7, HP App Note 95 (Gonz. 2.1-2.3)

Lecture 8 Scattering parameters (2-port definitions) Lee Chapter 7, HP App Note 95 (Gonz. 2.1-2.3)

Lecture 9 Generalized Scattering parameters (handout)

Lecture 10 Smith Chart (defining equations) Lee Chapter 7, HP App Note 95 (Gonz 2.4-2.5)

Lecture 11 Transmission line on a Smith chart, Y-chart, Z-Y chart, Wikipedia link, Maxim App note 742, (Gonz. 2.4-2.5)

Lecture 12 Representation of capacitances and inductance on Z-Y chart, Wikipedia link, Maxim App note 742, (Gonz. 2.4-2.5)
Lecture 13 Matching network (quantitative analyses) Wikipedia link, Maxim App note 742, (Gonz. 2.4-2.5)

Lecture 14 Network analyzer (handout, Gonz. 1.9)

Lecture 15 MOS transistor review, Lee Chapter 5, (handout)

Lecture 16 MOS transistor cross-section, Lee Chapter 5 (handout)

Lecture 17 Inductor overview, Lee Chapter 4 (handout)

Lecture 19 Skin effects and inductor Q, Lee Chapter 4 (handout)

Lecture 20 Package model (handout)

Lecture 21 LNA overview (power gain) Lee Chapter 9 (handout)

Lecture 22 LNA overview (power gain) Lee Chapter 9 (handout)

Lecture 23 LNA overview (linearity) Lee Chapter 9 (handout)

Lecture 24 LNA overview (noise) Lee Chapter 9 (handout)

Lecture 25 LNA overview (noise, input and output matching) Lee Chapter 9 (handout)

Lecture 26 LNA overview (input and output matching) Lee Chapter 9 (handout)

Lecture 27 LNA output matching topology Lee Chapter 9 (handout)

Lecture 28 LNA input matching with emitter degeneration Lee Chapter 9 (handout)

Lecture 29 LNA input matching of a cascode amplifier Lee Chapter 9 (handout)

Lecture 30 LNA output matching design, Lee Chapter 9 (handout)

Lecture 31 LNA output matching design, Lee Chapter 9 (handout)

Lecture 32 Power gain of a cascode LNA, Lee Chapter 9 (handout)

Lecture 33 Noise in a cascode LNA, Lee Chapter 12 (handout)

Lecture 34 Noise factor, Lee Chapter 12 (handout)

Lecture 35 Transistor sizing, Noise parameters, Lee Chapter 11

Lecture 36 Linearity, Lee Chapter 12, (handout)
Lecture 37 Linearity, Lee Chapter 12, (handout)

Lecture 38 Stability of an amplifier (handout)

Lecture 39 Effects of substrate resistance (handout)

Lecture 40 Other RF blocks (handout)

---

**Microwave IC Design Contact Information**

**Professor:** William R. Eisenstadt,  
**Office:** 529 NEB  
**Telephone:** (352) 392-4946  
**Facsimile:** (352) 392-8381  
**E-mail:** wre@tec.ufl.edu  
**Web:** [http://www.tec.ufl.edu/~wre/](http://www.tec.ufl.edu/~wre/)

---

**Class Period and Location:** Monday, Wednesday and Friday, 6th periods, 12:50pm to 1:40am, Larsen 310.

**Office Hours:** Monday, Wednesday and Friday: 1:50pm to 2:50pm

**TA:** Grader TBA


**Course Materials:** I will be using the Syllabus to index of the daily class materials posted for you to review and to learn from. So, you can find most learning materials by clicking on a link from the Syllabus. I try to post all written materials and video materials used in the lectures to assist in your learning.

I post several years of old quizzes or exams a week before the in class quiz. There will be folders that contain course materials (Course Notes, Old Exams, Cadence notes, In Class Notes, etc) in the Resources section of Sakai (see tabs on the left of this section).
**Course Goals:** Develop understanding of fundamentals of design and testing of RF integrated circuits operating at microwave frequencies.

**Computer and Software Required:**
Workstations with CADENCE Design system on campus, off-campus you can use X-Windows or X-terminal on a high-speed internet link to UF Campus Computers.

All students are required to have a Gator link account and use Sakai for course handouts, grade information, course notices, etc, see e-learning and Sakai

**Course Study Requirements:**
Students are responsible to study all in class materials including those written on the board and presented orally, all Class Handouts all assigned readings, all projects and homework. Absence from class can result in missing materials tested on exams.

**Work Requirements:**

Homework: 6-10 Homework Assignments
Computer Laboratories and projects: 1 Design Project
Exams: 3 Exams during the semester, No final Exam

**Examinations:**(No Final Exam)
Exam 1: Tentatively, Second week of February
Exam 2: Tentatively, Third week of March
Exam 3: Tentatively, Friday April 18

**Make Up Exam Policy:** Students are expected to attend exams at the scheduled times. Exams can be made up if there is a genuine medical emergency with a doctor's or clinic medical note or a family emergency with some documentation.

**Passing Grades and Grade Points Effective Summer A 2009**

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>A</th>
<th>A-</th>
<th>B+</th>
<th>B</th>
<th>C+</th>
<th>C</th>
<th>C-</th>
<th>D+</th>
<th>D</th>
<th>D-</th>
<th>E</th>
<th>WF</th>
<th>NG</th>
<th>S</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade Points</td>
<td>4.0</td>
<td>3.67</td>
<td>3.33</td>
<td>3.0</td>
<td>2.67</td>
<td>2.33</td>
<td>2.0</td>
<td>1.67</td>
<td>1.33</td>
<td>1.0</td>
<td>0.67</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Preliminary Grading Policy:**
Homework and Projects - 25%
Exams - 75%

**Academic Honesty:**
All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action.
This statement is a reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others.

Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide documentation to the instructor when requesting accommodation. https://elearning2.courses.ufl.edu/access/content/group/UFL-EEE6328C-19816-12013/In%20Class%20Notes/In%20Class%20Lecture%2023.pdf