

Radio Frequency Electronics Syllabus Fall 2019

EEE 4373 Section 14AH and EEL 5374 Section 3243

Class Period and Location: LAR 310, 7th period, Tuesday, 1:55pm to 2:45pm

Class Period and Location: LAR 330, 7th and 8th Period Thursday, 1:15pm to pm, 3:50pm

Academic Term: Fall 2019

Professor: William R. Eisenstadt,	Course Assistant: Nikolas Horn
Office: 529 NEB (temp 231B)	Office: NEB 222
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Catalog Description: Fundamental RF theory (such as resonant circuits, matching, noise and transmission lines), radio operation and design of key RF circuit blocks (such as amplifiers, mixers and oscillators).

Course Pre-requisite: EEE 3308C or equivalent

Course Objectives: To develop proficiency in analyses, design and implementation of radio frequency circuits. To develop expertise in using the Agilent ADS design system for circuit design.

Course Materials and Supplies: 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

Professional Component (ABET):

This course contributes learning in the areas of engineering problem solving, engineering analysis, engineering experimentation through simulation, engineering communications, self-education, and team work. This is done through homework, computer simulation and design assignments, and a large final project which requires some independent research.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.	Medium
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.	High
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	Medium
4. An ability to communicate effectively with a range of audiences	Medium
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	Low
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.	Medium
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty	Medium

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Class Period and Location (Different Tuesday and Thursday Classrooms!!):

LAR 310, 7th period, Tuesday, 1:55pm to 2:45pm, and,
LAR 330, 7th and 8th Period Thursday, 1:15pm to pm, 3:50pm

Office Hours: Tuesday 1:00pm to 1:45pm, and 3:00pm to 4:00pm. Thursday 1:00pm to 1:45pm. NEB 529 (My temporary office will be announced in class).

TA: Nikolas Horn, nhorn9@ufl.edu, Office Hours: TBA.

Required Texts: “RF Microelectronics,” Behazad Razavi, Second Edition, Prentice Hall, ISDN 0-13-713473-8.

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. There will be folders that contain course materials (Course Notes, Audio Recordings, In Class Notes, etc.) in the Files section of Canvas (see tabs on the left of this section).

Course schedule: See below

Computer and Software Required:

PCs with Analog Design system on campus and a link to the ECE license file server, off-campus can use X-Windows or an X-terminal on a high-speed internet link to UF Campus Computers.

All students are required to have a Gator link account and use Canvas for course handouts, grade information, course notices, etc., see [e-learning support services](#)

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.

Attendance and Expectations: There is a no wireless device policy (no cell phones, smart phones, computers, tablets, etc.) during exams. There will be no attendance taken but Quizzes will be given to insure classroom learning if there is poor in class attendance. +

“Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at:
<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.”

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. Students are NOT excused from exams for job interviews and early holiday travel home. Students with other non-emergency exam scheduling issues must obtain permission from the instructor prior to missing an exam.

Work Requirements:

Homework

Computer Laboratories and projects

Quizzes:

Exams: Exam1, Exam 2 and Exam 3

Examinations:

Quizzes as assigned, (There will be quizzes if in class attendance is low)

Exam 1: Tentatively, First week of October

Exam 2: Tentatively, Second week of November

Exam 3: Tentatively, First week of December

There will be no final.

Preliminary Course Grading Policy:

Preliminary Grading Policy:

Undergraduate Exams, Laboratories and Homework will be less difficult than Graduate Exams, Laboratories, and Homework.

There will be on-line quizzes if in-class attendance is low. The quiz percentage of your grade will be transferred over to the exam percentage if the quizzes are not needed.

Assignment	Total Points	Percentage of Final Grade
Homework Sets	10 points each	10%
Project	20 points	20%
Quizzes	1 to 4 points each	0% or 5% if given for low class attendance
Exam 1	100	21% (22% if no quizzes)
Exam 2	100	22% (24% if no quizzes)
Exam 3	100	22% (24% if no quizzes)
		100%

Tentative Grading Policy, I will look carefully at each individual's class work accomplishments.

Percent	Grade	Grade Points
92.0 - 100.0	A	4.00
90.0 - 91.9	A-	3.67
87.0 - 89.9	B+	3.33
83.0 - 86.9	B	3.00
80.0 - 82.9	B-	2.67
77.0 - 79.9	C+	2.33
73.0 - 76.9	C	2.00
70.0 - 72.9	C-	1.67
67.0 - 69.9	D+	1.33
63.0 - 66.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or

<http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.

EEE 4373 and EEL 5374 Radio Frequency Electronics Syllabus Fall 2019

TA: Nikolas Horn, nhorn9@ufl.edu, Office Hours: TBA

Course Outline:

Weekly Date, (No. of Classes) Class topics, Readings, In Class Notes in pdf form.

08/20 (3) [Syllabus](#), [Permission and Survey](#), [Intro to RF Technology](#), MOS [Transistor Review](#),

MOS Amplifier Design Example

[Homework 1: Due: August 27, 2019](#)

[Apple iPhone breakdown RF Sections](#)

LTSPICE Download

LTSPICE Installation

[standard.mos](#)

[TSMC180nm CMOS model](#)

Please install LTSPICE on your PC or MAC. I will be using LTSPICE for general circuit RF circuit simulation examples in class.

Read Chapter 1, Sections 2.1 and 2.2

08/27 (3) [Amplifier Design Strategy](#), [CMOS CE, CB and Cascode Amplifier Circuits](#), MOS [Differential Circuits](#), [MOS Amp Example Practice Problem and Solution](#), RF Microelectronics Errata

Read Sections 2.2, and 2.3 of Razavi

[Homework 2: Due Sept 5, 2019](#)

[Zigbee 3.0 White paper](#)

09/3 (3) Labor Day Holiday Sept. 2, 2018 [Basic RF concepts](#), Nonlinearity, [Noise](#)

Read Sections 2.3 and 2.4 of Razavi

[Homework 3 Assigned](#)

[Homework 1 Solution](#)

[EEE 3308C lectures material for MOS Design background](#)

[MOSFET Small Signal](#)

[MOSFET Biasing](#)

[MOSFET Common Source Amplifiers](#)

[MOSFET Common Gate Amplifiers](#)

[MOSFET Common Drain Amplifiers \(Source Followers\)](#)

[MOSFET Differential Circuit Design](#)

[MOSFET Differential Amplifiers](#)

[Read Sections 2.3 and 2.4 of Razavi](#)

09/10 (3) [Noise](#), [Noise Calculations](#), [Second Noise Calculation Examples](#), [Example 2.18 noise calculations](#)

[Nonlinearity Problem worked out.](#)

Read Sections 2.5, and 2.6

[Homework 4 Assigned](#)

Please install ADS on a PC or use ADS in the 2nd Floor NEB, you can use VMware to get office campus access to the NEB PCs too. We will use ADS for the RF project and advanced RF simulations

[Agilent ADS PC Installation](#), [ADS on the 2n Floor of NEB](#),

Good starting ADS Tutorial lectures,

https://www.keysight.com/upload/cmc_upload/All/ads_video_tutorials_09-08-2016.html?cmpid=zzfindeesof-ads-tutorial-videos

Other videos on YouTube are at <https://www.youtube.com/c/keysighteesofeda>

If you register for an account on the online Keysight EEsof and EDA knowledge center there are some documents and files you can use for learning about Advanced Design system
<http://edadocs.software.keysight.com/display/support/Knowledge+Center>

09/17 (3) [Basic S-parameter Analysis](#), [MOS Amps and S-parameters Notes](#), [S-parameter Supplemental Calculations](#), [Sensitivity and Dynamic Range](#),

[Homework 5 Assigned](#)

[Homework 1 Solution](#)

[Homework 2 Solution](#)

Read Sections 3.2, 4.2.1,

tsmc25d.scs file for ADS tsmc 250nm process and SPICE models

TSMC180nm SPICE model file.

09/24 (3) [Sensitivity and Dynamic Range](#), [Analog Modulation](#), [Digital Modulation](#), Read Sections 4.1, to 4.2.3 page 186

[Exam 1 Solution 2018](#)

[Exam 1 Solution 2017](#)

[Exam 1 Study Topics](#)

[Distortion Practice Problems for Exam](#)

[Homework 3 Solution](#)

[Homework 4 Solution](#)

10/1 (3) [Basic Heterodyne Receivers](#), [Exam 1](#),

Read Sections 5.1 and 5.2

[Homework 6 Assigned](#)

[Homework 5 Solution](#)

10/8 (3) [Basic Heterodyne Receiver](#), [Modern Receivers](#), [Basic Filter Analysis](#), [Series to Parallel Conversion Examples](#), [Time Constant Analysis](#),

Read Section 5.2

[Solution to Exam 1](#)

10/15 (3) [Modern Receivers, LNA Considerations, LNA Topologies,](#)

Read Section 5.2

[Using ADS Slides from David Munzer Lecture](#)

[ADS Tutorial_Kim.pdf](#)

[ADS Design Project Assigned to Students Due December 6](#)

[tsmc25d.scs](#)

[Homework 6 Solution](#)

[Homework 7 Assigned](#)

10/22 (3), [LNA Design CS and CG, Transformers and Examples](#), Capacitive Transformer, MOS Time Constant Circuits, MOS Time Constant Circuits 1

Read Sections 5.3

10/29 (3) [Passive RF Circuits Inductor Calculation, Inductor Calculation Example 2,](#)

[Exam II Study Guide](#)

[Exam 2 Solution 2017](#)

[Exam 2 Solution 2018,](#)

[RLC QUIZ 2007, RLC QUIZ 2008, RLC QUIZ 2010, RLC QUIZ 2011](#) These are bipolar circuits but show how to calculate transformer circuit response.

[Solution to Homework 7](#)

[Homework 8 Not Assigned study](#)

Read Section 5.3, 6.1 and 6.2

11/5 (3) Passive RF Circuits, Inductor Calculation Example, Exam II,

Read Section 6.1, 6.2, 6.3 and 6.4

11/12 (3) [Passive RF Circuits Inductor Calculation Example 2](#), [Inductor Calculation Example](#), [Oscillator Basics](#), [Oscillator Design Basics](#), [Oscillator Design Basics 1A](#), [Oscillator problems Worked from the Book](#), [Chapter 7 Example Problems](#)

[Exam III Solution 2017](#),

[Exam III Solution 2018](#)

[Study Guide for Exam III](#)

Read Sections 7.2 and 7.3

Homework 8 Solution

11/19 (3) [Oscillator Basics](#), [Oscillator Design Basics](#), Exam 3

Read Chapter 8

Solution to Exam II

11/27 (1) [Oscillator Design Basics 1A](#), [Oscillator problems Worked from the Book](#), [Chapter 7 Example Problems](#), Thanksgiving Holiday, Thursday November 28, 2019.

Read Chapter 8

12/3 (1) [Introduction to Mixers](#), [Mixers Passive and Active](#), [Example Mixer problems](#), Design project due

There will be NO Final Exam.