Radio Frequency Integrated Circuits 1

EEE 4373 and EEE 5374   Section 1FE2, 2FED, and CAMP
Class Periods: Tuesday, 7th period, 1:55pm to 2:45pm and Thursday, 7th and 8th Period, 1:55pm to 3:50pm
Location: Classroom location
Academic Term: Spring 2022

Instructor:
Name: Najme Ebrahimi
Email Address: najme@ece.ufl.edu
Office Phone Number
Office Hours: Tuesday, 3:00pm to 4:00pm, Thursday, 4:00pm to 5:00pm.

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
Please contact through the Canvas website
Not defined yet

Course Description
Weekly Dates Tue/Thursday, 2 classes per week,

Course Pre-Requisites / Co-Requisites
– Strong foundation in Electronics and Circuit theory, such as EEE 5374- Radio Frequency Electronics course material and EEE 5320- Analog Integrated Circuit 1
 – Strong foundation in algebra and calculus
– Strong foundation in circuit analysis techniques: KVL/KCL
– Strong foundation in analog circuits: CE, CB, CC
– Strong foundation in microwave theory and techniques such as S-parameters

Course Objectives
In this course student will learn the radio frequency communication electronics and integrated circuit design. It will start from RF device modeling to RF circuit building blocks. Finally, the RF transceiver architecture will be studied.

Materials and Supply Fees

Required Textbooks and Software
Textbook I:
- Title: "High-Frequency Integrated Circuits,"
- Author: Sorin Voinigescu
- Publication date and edition: 2013, any edition
- ISBN number: (ISBN-13: 978-0521873024) (ISBN-10: 0521873029)
- And various publications from IEEE which will be introduced at each lectures.
Textbook II:
- Title: "RF Microelectronics,"
- Author: Behzad Razavi
- Publication date and edition: 2011, 2nd edition
- ISBN number: (ISBN-13: 978-0137134731) (ISBN-10: 0137134738)
- And various publications from IEEE which will be introduced at each lectures.

Software: Every student need to access Cadence and Virtuso with TSMC 180nm CMOS model for simulations and final exam project.

Week 1:   Introduction to RFIC and Communication Electronic, (Chapter 2 of RF Microelectronics book and High-Frequency Integrated Circuits Book)

Week 2:   Device Modeling (MOS and BJT RF Device model, transistor operation, transistor cut-off frequency), (Chapter 4 of High-Frequency Integrated Circuits Book)

Week 3:   Device Modeling, Passive Components (Inductors, capacitance, resistance performance and model at RF, (Chapter 4 of High-Frequency Integrated Circuits Book and Chapter 7 of RF Microelectronics book)
Some other references:
"Operation and Modeling of the MOS Transistor" Yannis Tsividis, Mc-Graw Hill
"MOS Transistor Modeling for RFIC Design", Enz et. al., IEEE Transaction on Solid- State Circuits, Vol. 35, 2000

Week 4:   Impedance matching and quality factor of matching network,

Week 5:   Matching network for amplifiers, L-match, Pi-match, distributed amplifiers, feedback network for matching

Week 6   Low noise amplifier (LNA) design, (Chapter 5 of RF Microelectronics book and Chapter 7 of High-Frequency Integrated Circuits Book)

Week 7:   LNA with CS, CG stage, with inductive degeneration, (Chapter 5 of RF Microelectronics book and Chapter 7 of High-Frequency Integrated Circuits Book)

Week 8:   Noise analysis of circuit (thermal noise/ flicker noise) Noise Figure

Week 9:   Linearity and non-linearity (IM3- IM2) 1dB compression, intermodulation distortion, intercept point, cross modulation.

Midterm I

Week 10:   Mixer and frequency conversion (mixer noise), passive conversion, active conversion, I/Q modulation PPF, (Chapter 9 of "High-Frequency Integrated Circuits" book, Chapter 6 of "RF Microelectronics" book)

Week 11:   different transmitter/receiver architectures. Heterodyne, homodyne, image-rejection ratio

Week 12:   VCO and Oscillators: VCO fundamentals and basic principles, Feedback view of Oscillators, Cross-coupled Oscillators, (Chapter 10 of "High-Frequency Integrated Circuits" book, Chapter 8 of "RF Microelectronics" book.
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Week 13:   Voltage controlled oscillators with wide tuning range and Varactor Q limitations, Phase noise concept and analysis, Low-noise VCO topologies (Chapter 10 of "High-Frequency Integrated Circuits" book, Chapter 8 of "RF Microelectronics" book)

Midterm II

Week 14:   Transceiver Architecture for SNR, BER, EVM and different modulations (Chapter 10 of "High-Frequency Integrated Circuits" book, Chapter 8 of "RF Microelectronics" book)

Week 15:   Transceiver Architecture and Design Example with Different Communication Modulations/Demodulations, Considerations/ **lecture 29, 30**/General Consideration in Transmitter and Receiver

architecture, Basic Heterodyne and Homodynes architecture, Direct Conversion transceiver, Zero and Low-IF transceiver, Image-Reject Receiver, On-OFF Keying Transceivers, QAM Modulation, BER and EVM. (Chapter 10 of "High-Frequency Integrated Circuits" book, Chapter 8 of "RF Microelectronics" book)

Attendance Policy, Class Expectations, and Make-Up Policy

Excused absences must be in compliance with university policies in the Graduate Catalog (https://catalog.ufl.edu/graduate/regulations/) and require appropriate documentation.

Evaluation of Grades

NOTE: Course evaluation components should include:

1. At least one component that individually evaluates each student's understanding of course material and ability to apply concepts.
2. At least one evaluation activity that takes place in class.
3. When a project is involved, evaluation rubrics should be explicitly stated.
4. When team work is expected, individual student contribution verification method should be explicitly stated.

If an in-class exam is administered then 1 and 2 are fulfilled. In the case of a project, a project report that is graded per the stated evaluation rubrics and states which work was done by each student in the project team will address both 3 and 4.

Assignment	Total Points	Percentage of Final Grade
Homework Sets (4)	2.5% each	10%
Midterm Exam I	30%	30%
Midterm Exam II	30%	30%
Final Project	30%	30%

Grading:
– Assignments {10%} Analysis/design oriented/Simulation (Hand Analysis, Cadence), 2 week turn around time
 4 Assignments, 2.5% each
– Midterm I {30%} In class open book test for 2 hours (Hand Analysis Only)
– Midterm II {30%} In class open book test for 2 hours (Hand Analysis Only)
– Project {30%} Due at final exam period with presentation.

Grading Policy

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 – 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	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/graduate/regulations/

Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, 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 suppor*t*, 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://care.dso.ufl.edu.

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