Department of Electrical and Computer Engineering
Colorado State University

ECE 536: RF Integrated Circuit Design
Fall 2019 Syllabus (1 of 3)

Revised 8/26/19

Objectives:
This course introduces the design of radio frequency integrated circuits (RFICs). RFICs have rapidly advanced in both technology and design over the past 20 years to first create and then meet a high demand for cost-effective solutions for mobile communication and ubiquitous access to information. Applications include wireless communications, passive and active remote sensing, location sensing, radar, and radio astronomy.

This course is focused on the key concepts enabling RF capability on a chip. CMOS technology and the ability to incorporate additional elements is emphasized. Parasitic effects and current device modeling will be explained. Using this foundation, the design of high-frequency analog integrated circuits will be taught, including low-noise amplifiers, voltage-controlled oscillators, phase-locked loops, mixers and power amplifiers. Along with these specific building blocks, the critical concepts of impedance transformation, filtering and power delivery will be addressed.

Outcomes:
Students successfully completing this course will be able to design and evaluate practical circuits for RFICs from an intuitive approach based on a rigorous understanding of the fundamentals. They will have designed and simulated various circuit functions to implement the need for RFICs in many of the applications. They will be able to understand the relationship and limitations of circuit topology and device characteristics to achieve competitive specifications.

Instructor: Prof. Steven C. Reising
Office: Engineering Bldg. B113
Phone: 970-491-2228, E-mail: Steven.Reising@ColoState.edu
Office Hours: TBD
Credits: 3 credits.

Prerequisite: ECE331 & ECE332 or equivalent 2-semester **rigorous** transistor-level electronics course. It is recommended that students have passed these courses with more than the minimum level of performance.

Text: *RF Microelectronics*, 2nd edition, Behzad Razavi, Prentice Hall, 2012. ISBN: 978-0-13-713473-1.

Lectures: Tuesday and Thursday, 11:00 am – 12:15 pm, Engineering B3

Lecture Notes: *Occasional* written lecture notes prepared by the instructor will be distributed to students through the ECE 536 Canvas web site in advance of the lecture in which they will be covered. *Note:* Students are responsible for all material in handouts, even if not covered in class.

ECE 536: RF Integrated Circuit Design
Fall 2019 Syllabus (2 of 3)

Revised 8/26/19

Grading: Students will be evaluated based on homework problems, a written design project, and two exams. A final grade will be calculated based on: Homework 25%, Design Project/Report 10%, Midterm Exam 30% and Final Exam 35%. (Plus/minus grading)

Midterm Exam: Thursday, October 17, 6:00 – 8:00 pm
Final Exam: Wednesday, December 18, 6:20 – 8:20 pm
(Final exams are scheduled by the CSU Registrar. See http://registrar.colostate.edu/academic-resources/final-exams/)

Software: Cadence Virtuoso will be used for this course. This software is accessible on the linux servers in the ENS computer labs as well as online on Virtual Lab. All students in the course are responsible for gaining access to these resources. Engineering Technology Services (https://www.engr.colostate.edu/ens/) is a resource for access.

Course Topics	**Sections in Razavi or Notes**
1. Introduction to RF Technology	Chapter 1
2. MOS Devices, Modeling and Simulation	Notes
3. RF Design Concepts	2.1-2.6
4. Passive Components	7.1-7.3 and 7.6
5. Communications Concepts	3.1, 3.2 and 3.6
6. Systems Considerations for Receivers	4.1, 4.2 and 2.2
7. Noise	Notes and 2.3
8. Low-Noise Amplifiers	5.1-5.3, 5.6 and 5.7
9. Receiver Partitioning	Notes
10. Mixers	6.1-6.4
11. Receiver Design Example	Notes and 3.7.5
12. Oscillators	8.1-8.3
13. Modulators	Notes
14. Power Amplifiers	12.1-12.2

ECE 536: RF Integrated Circuit Design
Fall 2019 Syllabus (3 of 3)

Revised 8/26/19

Academic Integrity: I believe that upholding academic integrity and abiding by ethical principles are fundamental to the practice and profession of electrical and computer engineering. In fact, the IEEE, the world's largest professional society with more than 420,000 members in more than 160 countries, abides by the IEEE Code of Ethics, in part: "We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree …" Please see the complete IEEE Code of Ethics online at:
http://www.ieee.org/about/corporate/governance/p7-8.html.

It is my belief that following ethical principles in this class is fundamental to your future contributions to society as electrical and computer engineers. This course, ECE 536, will adhere to the Academic Integrity Policy of the Colorado State University General Catalog and the Student Conduct Code, which states, "Colorado State University expects students to maintain standards of personal integrity in harmony with its educational goals; to be responsible for their actions; to observe national, state, local laws, and University regulations; and to respect the rights, privileges, and property of other people." The complete Student Conduct Code is available at:
https://resolutioncenter.colostate.edu/student-conduct-code/.

Specifically in ECE 536, academic integrity will be taken very seriously, and violations will be dealt with harshly. On homeworks and design projects, you are free to discuss the work from others and learn in a group setting. *However, you are representing the work you turn in as your own. Therefore, you are required to write all homework answers and design project reports yourself.* Academic penalties are decided on a case-by-case basis, and the typical penalty for cheating on a midterm or final exam is a failing grade for the course. To promote academic integrity, you will be asked to write out the CSU Student Honor Pledge on the last page of your ECE 536 midterm and final exams: "I have not given, received, or used any unauthorized assistance on this exam," and sign your name to give your promise of and commitment to academic integrity. Information on the history and current use of the CSU Student Honor Pledge is described on the TILT Academic Integrity web page at
http://tilt.colostate.edu/integrity/resourcesFaculty/pledge/.