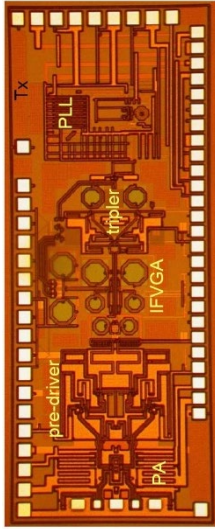


ECE 712: Integrated Circuits for Wireless Communications



Instructor: Professor Brian Floyd
brian_floyd@ncsu.edu

Course website: <https://moodle-courses2324.wolfware.ncsu.edu/course/view.php?id=7059>

***Please use the course bulletin board to ask questions about lectures, HW, projects, etc. It is the best way to broadcast questions that may be of interest to everyone.

Course Objective:

After taking this course, the student will be able to analyze and design the key integrated circuits found in modern silicon radio receivers, transmitters, and frequency synthesizers.

Course Description:

Topics will include the following: wireless system concepts, integrated active and passive components, receivers, low-noise amplifiers, noise, passive and active mixers, phase-locked loops, voltage-controlled oscillators, power amplifiers, and transmitters. Homework and projects will make use of Cadence / SpectreRF design tools.

Prerequisites:

Required: ECE 511 Analog Electronics
 Encouraged: ECE 549 RF Design for Wireless

Required Text:

- Behzad Razavi, *RF Microelectronics*, 2nd edition, Prentice Hall, New Jersey, 2012

Supplementary Texts:

- Thomas Lee, *The Design of CMOS Radio-Frequency Integrated Circuits*, Cambridge University Press, 2nd edition, 2004.
- Floyd Gardner, *Phase-lock Techniques*, Wiley, 3rd edition, 2005
- Carusone, Johns, & Martin, *Analog Integrated Circuit Design*, Wiley, 2012.
- Michael Steer, *Microwave and RF Design*, SciTech Publishing, 2010.

Grading:

Test 1	20% (tentatively scheduled for Mar 04, 2024)
Test 2	20% (scheduled for Apr 29, 2024, 8:30-11:00AM)
Homework	20% (six assignments)
Design projects	40% (two projects, due near end of March, and last day of class)

Planned Course Outline:

Lecture #	Topic
1	Course Introduction
2-4	System Concepts: Wireless Signaling, Noise Figure, Nonlinearity
5	Radio Architectures
6	Passive RLC networks
7	Impedance Matching
8-9	RF Components: Inductors, Transistors, Capacitors, Resistors
10-11	Noise: Equivalent Representations and Noise Parameters
12-14	Low-Noise Amplifiers
16-19	Mixers and Mixer-First Receivers
20-22	Voltage-Controlled Oscillators and Phase Noise
23-25	Phase-Locked Loops
26-27	Power Amplifiers and Transmitters

Homework:

Approximately six homework assignments will be assigned through the course of the semester, accounting for 20% of the grade. The lowest HW grade will be dropped.

EOL Provision: For each homework assignment, EOL students allowed to substitute a brief paragraph (2-3 sentences) for any single problem's solution, where they describe how the previous week's material relates to either their job or their interests.

→Late policy: late homework will automatically incur a 20% penalty and must be submitted no later than the end of the weekend the week they are due.

Design Project:

Two design projects are planned for this course. Students will be creating designs using available industry design kits and Cadence / SpectreRF design tools. The overall grading of the project will depend upon the quality and content of the design report and the performance of the design against specifications.

EOL Provision: There will be a reduced set of project requirements for EOL students.

→Late policy: design projects must be submitted on-line before 11:55PM on the due date. Late submissions will automatically incur a 0.5% penalty for every hour the project report is late, capped at maximum of 20% deduction.

Simulation:

SPICE-based circuit simulation will be used in the homework and projects. Students will use the Cadence design environment and the Spectre SPICE based circuit simulator, and will learn how to use these tools through provided tutorials.

Audit Students:

Any student auditing the course is expected to maintain a B average or better on all homework assignments. Audit students do not have to complete design project(s).

Academic Integrity:

Students should refer to the University policy on academic integrity found in the Code of Student Conduct (found in Appendix L of the Handbook for Advising and Teaching). *It is the instructor's understanding and expectation that the student's name/signature on any test or assignment means that the student neither gave nor received unauthorized aid.* Authorized aid on an individual assignment includes discussing the interpretation of the problem statement, sharing ideas or approaches for solving the problem, and explaining concepts involved in the problem. Any other aid would be unauthorized and a violation of the academic integrity policy. Any computer work submitted must be completed on your own personal computer or from your own NC State account to avoid confusion about the origin of the file, and no sharing of files in any way is allowed. Students found in violation of the academic integrity policy will be reported to the NC State Office of Student Conduct.

Students with Disabilities:

Reasonable accommodations will be made for students with verifiable disabilities. 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/dso>.

Supporting Fellow Students in Distress:

As members of the NC State community, we each share a personal responsibility to express concern for one another and to ensure that this classroom and the campus as a whole remains a safe environment for learning. Occasionally, you may come across a fellow classmate whose behavior concerns or worries you. When this is the case, I would encourage you to report this behavior to the NC State Students of Concern website: <http://studentsofconcern.ncsu.edu/>.

Supporting Yourself:

As a student you may experience a range of personal issues that can impede learning, such as strained relationships, increased anxiety, alcohol/drug concerns, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may impact your ability to participate in daily activities. It is very important that you have a support system and that you ask for help when you are struggling. The Counseling Center at NC State offers confidential mental health services for full time NC State students, including same-day emergency services. Please visit <https://counseling.dasa.ncsu.edu/> to get connected.

Health and Well-Being Resources:

These can be difficult times, and academic and personal stress are natural results. Everyone is encouraged to take care of themselves and their peers. If you need additional support, there are many resources on campus to help you:

- Student Health Services ([Health Services | Student](#))
- If the personal behavior of a classmate concerns or worries you, either for the classmate's well-being or yours, we encourage you to report this behavior to the NC State CARES team: ([Share a Concern](#)).
- If you or someone you know are experiencing food, housing or financial insecurity, please see the Pack Essentials Program ([Pack Essentials](#)).

Need Help?

If you find yourself in a place where you need help, academically or otherwise, please review these [Step-by-Step Help Topics](#).

Other Important Resources

- [Keep Learning](#)
- Protect the Pack [Frequently Asked Questions](#)
- NC State Protect the Pack [Resources for Students](#)
- [Academic Success Center](#) (tutoring, drop in advising, career and wellness advising)
- NC State [Keep Learning Tips for Remote Learning](#)
- Introduction to Zoom for students: <https://youtu.be/5LbPzzPbYEW>
- Learning with Moodle, a [student's guide to using Moodle](#)
- NC State Libraries [Technology Lending Program](#)