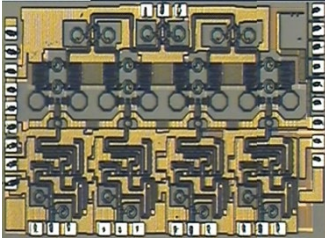


ECE 792: Design of Millimeter-Wave Circuits and Systems



Class Format: Recorded Lectures from 2024 & 2022

Instructor: Prof. Brian Floyd, brian_floyd@ncsu.edu

Office: 435 Monteith Research Center

Office Hours: TBD

Course web page TBD

****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 Objectives:

After taking this course, the student will be able to evaluate and describe requirements for millimeter-wave (mmWave) radio, radar, and radiometer systems; evaluate and describe silicon technology capabilities at mmWave frequencies; and analyze and design the key integrated circuits found in mmWave receivers, transmitters, and phased arrays.

Course Description:

Topics will include silicon IC technology at mmWave, radio link budgets, beamformers, amplifiers, phase shifters, oscillators, mixers, transmit/receive front-ends, phased-arrays, receivers, transmitters, radars, and radiometers. Emphasis is placed on differences encountered in mmWave IC design as compared to RFIC design due to technology capabilities and/or application requirements.

Course Format:

All lectures will be pre-recorded from the Spring 2022 or Spring 2024 offering of this class. The instructor will offer periodic online discussion sessions, targeting one per week, but excluding travel times. Students are expected to keep pace with the lectures at a rate of three lectures per week. One week is budgeted for a summer vacation. Please reach out to the instructor if additional accommodations are needed or if you have questions.

Prerequisites:

ECE 549 RF Design for Wireless and ECE 712 ICs for Wireless Communications

Required Text:

- Sorin Voinigescu, *High-Frequency Integrated Circuits*, 1st ed., Cambridge, 2013

Supplementary Texts:

- Hubregt J. Visser, *Array and Phased Array Antenna Basics*, Wiley, 1st ed., 2005.
- David Pozar, *Microwave Engineering*, Wiley, 4th ed., 2011.
- Merrill Skolnik, *Introduction to Radar Systems*, McGraw-Hill, 3rd ed., 2002.

Grading:

50% Homework; 50% Projects

Design Projects and Homework:

One larger design project and a few homework assignments are planned. Students will create designs using available industry design kits and Cadence, SpectreRF, and EMX.

→**Late policy:** assignments must be uploaded before 11:55PM on the due date.

Late assignments will incur a 20% late penalty, except in pre-arranged cases, which must be cleared in advance with the instructor.

Planned Course Outline and Readings:

Week	Date	Lec.	Topic	Reading Voinegescu	Reading Supplement		
1	5/19/2025	1	Introduction to mmWave	1.1-1.4		HW 1	
	5/21/2025	2	Communication Fundamentals	2.1-2.3, 2.8			
	5/23/2025	3	Radar Fundamentals 1				
2	5/26/2025	Memorial Day					
	5/28/2025	4	Radar Fundamentals 2				
	5/30/2025	5	Phased-Array 1: Beamforming		Parker I		
3	6/2/2025	6	Phased-Array 2: Nonidealities	2.8	Parker II, Lee		
	6/4/2025	7	Phased-Array 3: Architectures				
	6/6/2025	8	Transmission lines			HW 2	
4	6/9/2025	9	Couplers 1		Pozar / Steer		
	6/11/2025	10	Couplers 2				
	6/13/2025	11	Couplers 3				
5	6/16/2025	12	Cap / Inductor / Xformer	4.5	Dickson		
	6/18/2025	13	SiGe BiCMOS Techn.	4.1, 4.3			
	6/20/2025	14	SOI CMOS Techn.	4.2			
6	6/23/2025	15	mmWave LNAs	Ch. 3, 7	Floyd	Design Project	
	6/25/2025	16	mmWave PAs	Ch. 6			
	6/27/2025	17	Amplifier Examples				
7	6/30/2025	18	T/R switches				
	7/2/2025	Take a summer break somewhere during this module					
	7/4/2025	(feel free to shift earlier or later)					
8	7/7/2025	19	Active Phase Shifters		Multiple		
	7/9/2025	20	Passive Phase Shifters		Multiple		
	7/11/2025	21	mmWave Mixers	Ch. 9	Wilson		
9	7/14/2025	22	mmWave LO and VCOs	Ch. 10			
	7/16/2025	23	Frequency Multipliers	Ch. 11			
	7/18/2025	24	Frequency Dividers				
10	7/21/2025	25	mmWave Radio Systems		Floyd		
	7/23/2025	26	mmWave Radar Systems		Fujibayashi		
	7/25/2025	27	mmWave Imaging Systems		TBD		
End	7/28/2025		Final Project Presentations				

Simulations:

Circuit simulations will be performed using Cadence and SpectreRF whereas electromagnetic simulation will be conducted with EMX.

Audit Students:

Students auditing the course are expected to maintain a 90% average or better on all homework assignments and must actively attend and participate in lectures. They do not have to complete design projects but are encouraged to explore the designs.

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:

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](#))