

North Carolina State University Course Syllabus

ECE 424/524: Radio System Design

Spring Semester 2026

Course Personnel:

- *Instructor:*(office hours are 11:30-12:20 on Fridays or by appointment)
Prof. David Ricketts
MRC 433
david.ricketts@ncsu.edu
- *Teaching Assistants:* see Moodle for TA hours and locations

424 Class Schedule:

- Guided design labs (except during Live lecture): 9:35-12:20pm EB3 2124
- Live lectures: 10:00 a.m. – 11:30 a.m., EB3 2124
- Lab for building: EB2 1030/1032

524 Class Schedule:

- Guided design labs(except during Live lecture): 9:35-12:20pm EB3 2207
- Live lectures: 9:00 a.m. – 10:30 a.m., EB3 2207
- Lab for building: EB2 1030/1032

Prerequisites: ECE 302 or 303 and their prereqs. ECE 403 & 422 are helpful, but not required.

Course Description:

This course is an experimentally oriented course on the design and analysis of radio systems. The course will cover transceiver architectures, modulation schemes and hardware implementation. The course will have a mixture of lecture, hardware demonstration/labs and computer simulation labs.

Course materials:

Lecture Videos: <https://rickettslab.org/radio-system-design/lectures/lecture/>

Split videos (same as above, but cut up into smaller topics)

<https://www.youtube.com/playlist?list=PLGF140BA5wtWgW9bAd6DtF3MaYbhPtFwd>

Course materials, HWs, quiz, assignments on Moodle.

Final Project tutorials: <http://rickettslab.org/bits2waves/>

Resources: (recommended, but not required to purchase)

- Steer, Michael. Microwave and RF Design (Third Edition, 2019). NC State University, 2019. Volume 1: Radio Systems. Online at NCSU Library
- Pozar, David M, Microwave and RF Design of Wireless Systems
- Ellingson, Radio System Engineering, Cambridge (in library)

Tentative Course Calendar

Lec #	Date	Lecture	Mod # (length)	HW	Labs
1	16-Jan	Hunt Auditorium			
2	23-Jan	Introduction and Basic Definitions	1 (29:34)		Lab 0
3	30-Jan	Analog Modulation	2-3 (51:19)	1&2	Lab 1 – Analog Modulation
4	6-Feb	Digital Modulation	4-5 (57:29)	3	Lab 2 - Pulse Shaping and QAM Constellations
5	13-Feb	Transmitter	6-8 (42:04)	4	Lab 3 - Digital Tx Non-idealities
6	20-Feb	Nonlinearity (Exam 1)	9-12 (50:41)	5	Lab 4 - Nonlinearity
7	27-Feb	Capacity & Channel Propagation	13-15 (61:11)	6	Lab 5 - Channel Capacity
8	6-Mar	Receivers	16-18 (52:31)	7	Lab 6 - Receiver Design
9	13-Mar	Receivers non-idealities	19-23 (84:36)	8	Lab 7 - Noise Figure and SNR
10	20-Mar	No Class – Spring Break			
11	27-Mar	Transmission Lines, Smith & Two port networks (Exam 2)	24-27 (59:00)		Lab 9 - VNA
12	3-Apr	Passive components & Microstrip Devices	28-29 (60:18) 30-31 (27:52)		Lab 8 - Microwave T-line
13	10-Apr	Mixers	32,33, (72:21)		Lab 9 - Mixers
14	17-Apr	RF & PA Amplifiers	33E,34		
15	24-Apr	Project work (on your own)			
16	1-May	Project report due			

Assignments

All assignments other than final demo are turned in on Moodle. NO PAPER IS ACCEPTED IN LECTURE. PDF format for everything.

- **Lectures:** You will be assigned 1-3 online lectures to watch each week. They must be viewed prior to the class on Friday as you need to take a Quiz prior to class. The lectures will take between 1 and 1.5 hours to watch. You will need to take notes, the slides will not be posted.
- **Quick Quiz:** There will be a quick-quiz after each module (3-5 questions). You will have 2 chances to complete. It is due prior to the class where the material will be covered – you need to watch the virtual lecture and complete the quiz **PIOR** to class.
- **Homework:**
 - HW problems will be assigned for most modules. HW is due at the beginning of the next class after the HW is assigned. HW must be uploaded to Moodle prior to class. The upload site will disappear at the start of class. No in class submissions are allowed.
 - Self-grading of Homework: At the beginning of each class we will go through the HW solutions and an answer key provided. You will selfgrade your HW and after class go onto Moodle and complete a HW quiz, which will be the HW key you obtained in class.
- **Labs:** You will be assigned simulation or hardware labs that you will perform during class time. The lab will be posted on Moodle well before the Friday it is to be done to allow you time to read and come to class with questions. You will upload your solutions the Tuesday after the lab by 23:55. You will then be assigned two Labs from the class to peer grade. This is due by 23:55 Thursday after the lab. Some dates may change due to holidays, etc. Please see the calendar in this Syllabus. You will receive grades for both submitting the Lab and also peer grading (you get full credit if you complete the peer grading).
- **Exam:** There will be two exams that will be done on Moodle. They will not be cumulative, except that prior knowledge is needed for recent concepts. Exams will be closed book and in class. They will be on Moodle – bring your computer.
 - Exam 1: Modulation & Tx and other concepts.
 - Exam 2: RX and demodulation and other concepts
- **ECE 424 Final project:** You will form a team of 4-5 students and design and build a 0.95 GHz QAM transmitter.
 - Each student will design 1-2 components of the complete radio.
 - You will work outside of class to gather and construct prototypes of one components and submit a design report on your designs.
 - There will be no HW/Labs for the last several weeks of class to allow you to work on the project. Lectures will continue.
 - Your team will submit a final report (3 pages) on your radio and a video of operation.

- **ECE 524 Design:** You will design and build a 0.95 GHz QAM transmitter.
 - You will design all components of the radio.
 - You will work outside of class to gather and construct prototypes of each of your components and submit a design report on your designs.
 - You will create a system simulation to demonstrate your operation to include in your design report.
 - There will be no HW/Labs for the last several weeks of class to allow you to work on the project. Lectures will continue.

- **Late Policy:**
 - This course uses online quizzes, workshops and educational materials that are automatically timed. It is therefore not possible to accept any late assignments as it disrupts the entire class.
 - No late assignments are accepted. All assignments except hardware labs can be done anywhere in the world with internet access. In addition, all assignments are available to be completed early and therefore there is no need to turn an assignment in late for any conflicts or unforeseen circumstances.
 - If you have an unforeseen event that is approved by the University for consideration, please see the professor in person and bring documentation. This would be a death in your immediate family, a serious illness of multiple days with a doctor's note or a natural disaster, etc.
 - Students honoring religious holidays can do assignments early. Students who need more time to complete can do all assignments early and already have extra time since the assignments can be done outside of class.
 - The professor will not respond to requests for late assignments that are not accompanied by documentation and presented in person to the professor.

Grading Algorithm

Exam (10% each)		20%
Homework		15%
Module Quick Quiz		15%
Labs		25%
Final project		25%

Final Grade Algorithm.

Grade	Distribution
D	$<\mu-3\sigma$
C	$\mu-2\sigma$ to $\mu-3\sigma$
B-	$\mu-1.5\sigma$ to $\mu-2\sigma$
B	$\mu-1\sigma$ to $\mu-1.5\sigma$
B+	$\mu-1/2\sigma$ to $\mu-\sigma$
A-	$\mu\pm 1/2\sigma$
A	$\mu+1/2\sigma$ to $\mu+1\sigma$
A+	$\mu+1\sigma$ +

μ is mean; σ is standard deviation. Grades rounded to one significant digit, i.e. 90.149 is 90.1. Thresholds represent transition to next grade: $\mu-1/2\sigma$ is an A-, $\mu+1/2\sigma$ is an A. Algorithm may change if non-Gaussian distribution or if performance of class is well above/below standard.

Grade correction policy: Students have 7 days after the posting of a grade to ask for reconsideration due to a grading error. After 7 days the grade for the assignment stands and will not be changed, even if a grading error occurred.

Academic Integrity

Cheating includes but is not necessarily limited to:

1. Plagiarism, explained below.
2. Submission of work that is not the student's own for papers, assignments or exams.
3. Submission or use of falsified data.
4. Theft of or unauthorized access to an exam.
5. Use of an alternate, stand-in or proxy during an examination.
6. Use of unauthorized material including textbooks, notes or computer programs in the preparation of an assignment or during an examination.
7. Supplying or communicating in any way unauthorized information to another student for the preparation of an assignment or during an examination.
8. Collaboration in the preparation of an assignment. Unless specifically permitted or required by the instructor, collaboration will usually be viewed by the university as cheating. Each student, therefore, is responsible for understanding the policies of the department offering any course as they refer to the amount of help and collaboration permitted in preparation of assignments.
9. Submission of the same work for credit in two courses without obtaining the permission of the instructors beforehand.

The use of previous or current ECE424/524 student or team designs, in any form, is considered cheating. Do not share your design with others. If you wish to assist another student, discuss the general approach and concepts, not your design.

Plagiarism includes, but is not limited to, failure to indicate the source with quotation marks or footnotes where appropriate if any of the following are reproduced in the work submitted by a student:

1. A phrase, written or musical.
2. A graphic element.
3. A proof.
4. Specific language.
5. An idea derived from the work, published or unpublished, of another person.

This policy applies, in all respects, to ECE424/524.