Communication Systems and Components

EEL 4514C

Class Periods: Lecture: MWF | Period 6 (12:50 PM – 1:40 PM)
Section 0001 (Lab): M | Period 9–10 (4:05 PM – 6:00 PM)
Section 0002 (Lab): T | Period 11–E1 (6:15 PM – 8:10 PM)

Location: Lecture: LAR 239, Lab: MAE-B 226

Instructor:
Prof. John M. Shea
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(352) 575-0740
Office Hours: Mondays and Thursdays 2:30–3:30 PM, or By Appointment. In MALA 4125.

Peer Mentors:
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Course Description
Theory of communications and applications to radio, television, telephone, satellite, cellular telephone, spread spectrum and computer communication systems. Laboratory exercises. (4 credit hours)

Course Pre-Requisites / Co-Requisites
EEL 3112 (with minimum grade of C) and EEL 3850 (with minimum grade of C).

Course Objectives
Upon completion of
this course, the student should be able to
- Characterize signals in terms of energy/power, frequency domain characteristics/bandwidth, and relation to other signals
- Work with common equations for propagation and be able to answer questions about different propagation modes
- Translate between signals or impulse responses and their Fourier transforms
- Represent analog signals by digital signals that are sufficient to capture all the information and behavior of the analog signals
- Identify pros and cons of common analog and digital communication techniques
- Perform system-level design of receivers for common modulations
- Identify key techniques used in many communication systems and discuss the advantages and disadvantages of these techniques
- Compare digital modulations based on bandwidth efficiency and energy efficiency
- Build basic software-defined radio receivers using GNU Radio Companion

Materials and Supply Fees
Software-defined radio dongle for the lab : ~$20

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with	

	consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	
3.	An ability to communicate effectively with a range of audiences	
4.	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5.	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6.	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	Medium
7.	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

Title: *Modern digital and analog communication systems*
Authors: B. P. Lathi and Z. Ding
Publication date and edition: 2018, 5th edition
ISBN number: 0190686847

GNU Radio (freeware)

Recommended Textbooks:

Title: Wireless Communications: Principles and Practice
Authors: Theodore S. Rappaport
Publication date and edition: 2002, 2nd edition
ISBN number: 0130422320

Course Schedule

Class/Date	Topic	Reference
1	Overview & Introduction	
2–4	Communication channels, E&M wave propagation	3rd ed. 9.3 Rappaport, *Wireless Communications*
5–9	Signals and spectra	2-3, App. A
10–13	Amplitude modulations	4.1–4.4
14–18	Phase and frequency modulations	4.5–4.7
19–21	Sampling	5
22	Exam Review	
March 5 (Tentative)	**Mid-term Exam, 8:20 PM – 10:20 PM**	
23	Introduction to digital communications	6.1
23–26	Line coding	6.2, 6.7
28–29	Intersymbol interference & pulse shaping	6.3, 6.4, 6.6
30–34	Optimal Detection	2.5, App. C

35–36	Digital carrier modulations	6.8, 6.9
37	Digital multiplexing	5.4
38	Performance tradeoffs in digital communications	9
38–39	Multipath Distortion and OFDM	11.1, 11.7
40–42	*Advanced topics*	10, 12, 13
43	Exam 2 Review	
April 30	**Final Exam, 3:00 – 5:00 PM**	

The topics in *red* are additional material which will be covered only if time permits.

Attendance Policy, Class Expectations, and Make-Up Policy
Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies:
https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets (8)	10 each	20%
Labs (10)	100 each	25%
Midterm Exam	100	25%
Final Exam	100	25%
Participation	5	5%
		100%

Participation includes all forms of interaction with the professor, including in-class discussion, attending office hours, and communication via email, E-Learning, and the course Slack messaging system.

Grading Policy
Note that the table is given as a guideline from the university. The grade thresholds may be adjusted according to the class average.

Percent	Grade	Grade Points
90.0 - 100	A	4.00
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

Grades will be curved.

More information on UF grading policy may be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

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/.

In-Class Recording
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

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/process/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 varied perspectives and lived experiences within our community and is committed to supporting the University's core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

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

• HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
• Pamela Dickrell, Associate Dean of Student Affairs, 352-392-4524, pld@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: https://counseling.ufl.edu, 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 Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.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://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints: https://distance.ufl.edu/getting-help/; *https://distance.ufl.edu/state-authorization-status/#student-complaint*.