



ECE 4270: COMMUNICATION SYSTEMS

Section 400

SUMMER II 2021

MEETING TIME: Asynchronous except for exams.

MEETING LOCATION: Online.

INSTRUCTOR(s): Carl W. Baum, baumc@clemson.edu, 864-656-5928. Office: 304 Fluor Daniel Bldg. (Not on campus this summer.)

OFFICE HOURS AND PROCEDURES: Monday through Friday 9:00-9:50 pm EDT (evening) via Zoom. Zoom link: <https://clemson.zoom.us/j/5272686955>. Office hours are entirely elective. Attendance is NOT required.

COURSE MODALITY: ONLINE SYNCHRONOUS (synchronous for exams only).

COURSE DESCRIPTION: Study of communication systems design and analysis. Topics include signals and spectra, baseband signaling and detection in noise, digital and analog modulation and demodulation techniques, communications link budget analysis.

COURSE PREREQUISITES: ECE 3170 and ECE 3300, each with a C or better.

STUDENT LEARNING OUTCOMES: At the completion of the course, students should be able to:

1. Analyze signals and systems used in communication theory using Fourier transform techniques.
2. Analyze and design analog modulation and demodulation schemes including systems employing amplitude, frequency, phase, and pulse modulation.
3. Analyze and design systems for digital baseband communication and digital bandpass modulation.
4. Apply the tools of probability, random variables, and random processes to communication problems and applications.
5. Analyze the effects of noise on analog and digital communication systems and subsystems, including receiver noise analysis, link calculations, coherent and noncoherent demodulation, block and convolutional coding, and terrestrial radio.

REQUIRED MATERIALS:

1. No textbook is required. Detailed notes and videos are available through Canvas. The textbook *Introduction to Analog and Digital Communications 2e* by Haykin and Moher, Wiley Publishers, ISBN 0-471-43222-9 is a useful reference for most of the course material but will not be referred to directly in the course. The following textbooks are also useful for a few topics but again are not mentioned in the course: *Communication Systems 3e* by Haykin, Wiley Publishers, ISBN 0-471-57176-8, *Modern Digital and Analog Communication Systems 4e* by Lathi and Ding, Oxford University Press, ISBN 978-0-19-533145-5, and *Digital Communications Fundamentals and Applications 2e*, Sklar, Prentice Hall Publishers, ISBN 0-13-084788-7.

2. Every student is required to have a (laptop) computer, internet connectivity sufficient for reliably transmitting and receiving video, a video camera that works with Zoom, a microphone that works with Zoom, and a cell phone with software for taking a picture that immediately converts the picture to a pdf file. (Multiple free apps can do this.) A printer is not required but might be useful if you prefer to see your exam on paper while taking it.

COURSE STRUCTURE AND ATTENDANCE POLICY:

Videos are available for course lectures, and each video has a date by which it should be watched. Along with the videos are homework assignments and quizzes.

On test days, tests are SYNCHRONOUS. To take a test you must first log in to the Zoom session for that day. You then download the pdf exam and write your answers on blank or lined notebook paper. Prior to the deadline for turning in the exam, you must obtain pdf scans of your exam (using a phone with a direct-to-pdf app or a scanner) and upload them into the “quiz” on Canvas. Canvas announcements will provide additional details about testing procedures.

Timely canvas announcements and/or email will be used to inform students what to do if a technical problem (such as Zoom being down for everyone) occurs on a test day. In the event that you have a personal technical problem on a test day, call or email me *immediately*.

If a situation (such as COVID) causes you to be unable to participate in the course for a period of time, email me immediately with a description of the situation. In the unlikely event that you have a scheduled conflict with a test date, let me know in advance of the test. Decisions about whether an exam will be permitted to be made up will be made on a case by case basis.

VIDEOS:

Videos are accessed through Canvas MODULES. Video watching is essential to understanding the material in the course. Note that the modules are organized by week in a manner that matches the schedule in this syllabus.

HOMEWORK:

Homework assignments should be written up (not typed) on blank or lined notebook paper and uploaded into Canvas as a pdf. Homework must be in your own writing and be your own work. Homework questions are similar to examples given in the notes/lectures. See the OLD HOMEWORK module in Canvas for additional homework problems that are even more similar to the homework assignments. The Old Homework module also includes extremely detailed solutions.

Homework is due at 11:59 pm EDT on the assigned day. As with the videos, the due dates are listed in the course schedule at the back of this syllabus and also in Canvas (Modules). Late homework is not accepted.

QUIZZES:

Quizzes are fully online in Canvas. Quizzes have no time limit (other than when they are due) and can be taken twice; the maximum score will be kept. Quizzes can be fill-in-the blank, multiple choice, etc. Quizzes tend to emphasize conceptual understanding whereas the homework emphasizes analytical techniques. (Exams can draw from both, although there is a greater emphasis on analysis than on

concepts.) As with the videos, the due dates are listed in the course schedule at the back of this syllabus and also in Canvas (Modules). Quizzes are also due at 11:59 pm EDT. Late quizzes are not accepted.

EXAMS:

The course is divided into a brief introduction (Chapter 1) plus five major chapters (Chapters 2 through 6). Exam 1 covers Chapters 2 and 3, Exam 2 covers Chapters 4 and 5, and the final exam covers Chapters 2 through 6 with a heavier weight on Chapter 6. For Exam 1 you are permitted two 8.5x11 pages of notes, front and back. You should write all equations you need to solve the problems; no equations are included on the exam. Your note sheet can be typed if you wish. You can also include examples. For Exam 2 you are permitted to use those same two note sheets plus two more, the latter for the new material; although each exam only tests the material covered since the previous exams, the material by its nature builds on itself so you may still need the old sheets. For the final exam, you are permitted the four note sheets you have already made plus one more, for a total of five.

Calculators are permitted on exams. You are not permitted to use your computer (other than to look at the exam questions) or your phone (other than to scan your test when you are finished). For the duration of the exam you must remain in Zoom and have your computer camera pointed down towards your hands and your paper where you are writing your exam. You must also keep your microphone on. In the unlikely event you have an urgent question, use a private chat in Zoom to me.

Exams will run from 11:30 am EDT until 1:00 pm EDT followed by an extra 15 minutes to scan and upload your test (so the final deadline is 1:15 pm EDT). If you have a decent internet connection, it should not take 15 minutes to upload, especially if you use a direct-to-pdf phone app as recommended to scan your work. (Other techniques may lead to a dramatically larger pdf file that takes much longer to upload.) **Do not wait past 1pm to start the scanning and uploading process**; if you do not upload and submit by the deadline, immediately email your exam to me. But understand that there will be a **penalty of 10% per MINUTE the exam is late**, based on the received time stamp within the email.

The final exam is designed to be a full 2.5-hour exam. The exam will run from 11:30 am EDT until 2:00 pm EDT followed by an additional 15 minutes to scan and upload your work (so the final deadline is 2:15 pm EDT).

GRADING POLICY:

Grading is based on tests, homework assignments, and quizzes and is adjusted based on a participation score.

2 Tests	40%
Homework Assignments	10%
Quizzes	10%
Final Exam	40%

Participation is graded by whether you turn in homework, quizzes, and exams by their due dates and times. The total number of late or skipped activities is used to adjust your total grade as follows:

0 to 3	+5%
4 to 6	+0%
7 to 9	-10%
10 to 12	-20%

13 to 15	-30%
16 or more	-40%

For example, if your total cumulative percentage in the course is 86% and you had 2 late or skipped activities, your adjusted percentage would be 91%; if instead you had 8 late or skipped activities, your total cumulative percentage would be 76%. Note that it is easy to accrue multiple late or skipped activities on a single day. If you skip a quiz and a homework assignment for a single date, you have added two to your total “non-participation count”.

Several additional activities are required. These count for participation but are only minimally graded. These include a SYLLABUS QUIZ required at the beginning of the course and one or more PRACTICE TESTS used to make sure your equipment/scanning software is ready for the online exams. Any such requirements will be posted in Canvas announcements.

Final grades are based on the following thresholds: 90-100 A, 80-89.9 B, 70-79.9 C, 60-69.9 D, below 60 F. These thresholds might be lowered slightly, based on assessed difficulty of the exams. For example, an A might become 88-100.

TOPICAL OUTLINE:

1. Introduction
2. **The Fourier transform applied to communications:** signal concepts, Fourier transforms, energy, power, periodic signals, linear time-invariant systems, correlation, spectral densities.
3. **Amplitude, angle, and pulse modulation:** amplitude modulation with and without carriers, quadrature multiplexing, frequency and phase modulation, pulse amplitude and position modulation.
4. **Baseband data and digital bandpass modulation:** sampling and quantization, pulse code modulation, delta modulation, differential PCM, line codes, inter-symbol interference, Nyquist channel, raised cosine signaling, eye patterns, equalization, partial response signaling, signal space concepts, amplitude shift keying, phase shift keying, QPSK, OQPSK, MSK, signal design for noncoherent reception, M-ary signaling.
5. **Random signals and noise:** probability and random variables, random processes, correlation and spectral densities, effects of filtering, detection theory.
6. **Noise analysis of communication systems:** noise in AM and FM, FM pre-emphasis, coherent baseband detection, coherent bandpass detection, detection and performance with block and convolutional coding, noise figure and temperature, link calculations, terrestrial radio models.
7. Testing.

ACCESSIBILITY:

Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to a class should let the instructor know and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848 or by emailing studentaccess@lists.clemson.edu. Students who receive Academic Access Letters are strongly encouraged to request, obtain, and present these to their instructors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student’s responsibility to

follow this process each semester. You can access further information here:

<http://www.clemson.edu/campus-life/campus-services/sds/>.

TITLE IX:

Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972.

The University is committed to combatting sexual harassment and sexual violence. As a result, you should know that University faculty and staff members who work directly with students are required to report any instances of sexual harassment and sexual violence, to the University's Title IX Coordinator. What this means is that as your professor, I am required to report any incidents of sexual harassment, sexual violence or misconduct, stalking, domestic and/or relationship violence that are directly reported to me, or of which I am somehow made aware. There are two important exceptions to this requirement about which you should be aware:

Confidential Resources and facilitators of sexual awareness programs such as "Take Back the Night and Aspire to be Well" when acting in those capacities, are not required to report incidents of sexual discrimination.

Another important exception to the reporting requirement exists for academic work. Disclosures about sexual harassment, sexual violence, stalking, domestic and/or relationship violence that are shared as part of an academic project, a research project, classroom discussion, or course assignment, are not required to be disclosed to the University's Title IX Coordinator.

This policy is located at <http://www.clemson.edu/campus-life/campus-services/access/title-ix/>. Ms. Alesia Smith is the Executive Director for Equity Compliance and the Title IX Coordinator. Her office is located at 223 Holtzendorff Hall, phone number is 864.656.3181, and email address is alesias@clemson.edu.

SAFE CAMPUS:

Clemson University is committed to providing a safe campus environment for students, faculty, staff, and visitors. As members of the community, we encourage you to take the following actions to be better prepared in case of an emergency:

- a. Ensure you are signed up for emergency alerts (<https://www.getrave.com/login/clemson>)
- b. Download the Rave Guardian app to your phone (<https://www.clemson.edu/cusafety/cupd/rave-guardian/>)
- c. Learn what you can do to prepare yourself in the event of an active threat (<http://www.clemson.edu/cusafety/EmergencyManagement/>)

ACADEMIC INTEGRITY:

As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree.

Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity. Further information on Academic Integrity can be found in the [Undergraduate Announcements](#) and in the [Graduate School Policy Handbook](#).
 COPYRIGHT: Materials in this course are copyrighted. They are intended for use only by students registered and enrolled in this course and only for instructional activities associated with and for the duration of the course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the Teach Act. Students should be reminded to refer to the Use of Copyrighted Materials and “Fair Use Guidelines” policy in on the Clemson University website for additional information: <https://clemson.libguides.com/copyright>.

DUE DATES:

All items (except for tests) must be completed by 11:59 pm EDT on the dates listed below. You are welcome to work on and turn in items early.

WEEK 1:

Mon	6/28	Syllabus Video, Video 1 Syllabus Quiz	Thu	7/1	Videos 2.5, 2.6 HW 2.5-6, Quiz 2.5-6
Tue	6/29	Videos 2.1, 2.2 HW 2.1-2, Quiz 2.1-2	Fri	7/2	Videos 2.7, 2.8 HW 2.7-8, Quiz 2.7-8
Wed	6/30	Videos 2.3, 2.4 HW 2.3-4, Quiz 2.3-4			

WEEK 2: (Mon 7/5 is July 4th holiday)

Tue	7/6	MANDATORY PRACTICE TEST 11:30am Videos 3.1-3.2 HW 3.1-2, Quiz 3.1-2	Thu	7/8	Videos 3.5, 3.6 HW 3.5-6, Quiz 3.5-6
Wed	7/7	Videos 3.3, 3.4 HW 3.3-4, Quiz 3.3-4	Fri	7/9	Study for Test 1

WEEK 3:

Mon	7/12	TEST 1 on Chs. 2 & 3 11:30am	Thu	7/15	Video 4.5, 4.6 HW 4.5-6, Quiz 4.5-6
Tue	7/13	Videos 4.1, 4.2 HW 4.1-2, Quiz 4.1-2	Fri	7/16	Videos 4.7, 4.8 HW 4.7-8, Quiz 4.7-8
Wed	7/14	Videos 4.3, 4.4 HW 4.3-4, Quiz 4.3-4			

WEEK 4:

Mon	7/19	Videos 4.9, 5.1 HW 4.9-5.1, Quiz 4.9-5.1	Wed	7/21	Videos 5.4, 5.5 HW 5.4-5, Quiz 5.4-5
Tue	7/20	Videos 5.2, 5.3 HW 5.2-3, Quiz 5.2-3	Thu	7/22	Study for Test 2
			Fri	7/23	TEST 2 on Chs. 4 & 5 11:30 am

WEEK 5:

Mon	7/26	Videos 6.1, 6.2 HW 6.1-2, Quiz 6.1-2	Thu	7/29	Videos 6.6, 6.7 HW 6.6-7, Quiz 6.6-7
Tue	7/27	Videos 6.3, 6.4 HW 6.3-4, Quiz 6.3-4	Fri	7/30	Videos 6.8, 6.9 HW 6.6-8, Quiz 6.8-9
Wed	7/28	Video 6.5 HW 6.5, Quiz 6.5			

WEEK 6:

Mon	8/2	Study for Final Exam	Tue	8/3	FINAL on Chs. 2-7 11:30 am
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MODIFICATIONS:

The instructor reserves the right to modify any aspect of the syllabus at any time during the semester for reasons including but not limited to COVID-related situations.

MORE ABOUT ME:

<http://meettheprof.com/view/professors/entry/carl-baum/>

SYLLABUS VERSION AND DATE:

1.0. 5/12/2021.