EE 174: Communication Systems
Spring 2020 Syllabus

Instructor: Professor Jeff Frolik
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Office hours: I have an open door policy or please contact me to set up an appointment.

Class Time & Location:

TR 14:50-16:05	Votey 303
W 14:40-15:10	Lafayette L411
Labs	Votey 334B

Catalogue Description: Signal analysis. Fundamentals of digital communications including PCM, channel coding, pulse shaping and modulation. Wireless communications, modulation, antennas and link budgets. Application of probability. Related laboratory experience.
Prerequisite: EE 171. Co-requisite: STAT 151.

Course Goal: To provide the theoretical foundation necessary to understand modern communication systems and to introduce several modes of communications.

Learning Objectives: Upon successful completion of this course:

1. Students will be able to quantify key characteristics of baseband signals including power and bandwidth.
2. Students will be able to understand the constraints to be considered when sampling signals and reconstructing sampled signals.
3. Students will be able to analyze the quantization error in PCM systems (requires use of probability).
4. Students will be able to determine bandwidth, power and spectral characteristics for linear and exponential modulation techniques.
5. Students will be able to determine the expected performance of parabolic antennas and will use these results to create basic link budgets for wireless systems.
6. Students will be able to implement block channel coding.
7. Students will be able to determine the bit error rates for different line codes employed in an additive white Gaussian noise (AWGN) environment (requires use of probability).
8. Students will be able to construct and analyze eye diagram and constellation representations for M-ary signaling methods.
9. Students will be able to demonstrate competency in using analog and digital communication test equipment as related to concepts covered in the course.
10. Students will be able to demonstrate awareness of current advancements in communication systems.

Required Textbook: B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems*, 4 ed., Oxford University Press, 2009.

Topics and Tentative Schedule:

- Introduction to Communication Systems (CH 1 & Instructor notes - ∼2 weeks)
- Amplitude Modulation (CH 4 - ∼2 weeks)
- Exponential Modulation (CH 5 - ∼2 weeks)
- Antennas and Link Budgets (Instructor Notes - ∼1 week)
- Sampling, Quantization and PCM (CH 6 - ∼3 weeks)
- Error Correction Codes (CH 15 - ∼2 weeks)
- Digital Data Transmission (CH 7 - ∼2 weeks)

Grading :

- Quizzes [15%]
- Labs [20%]
- *In the News* presentation [10%]
- Exam 1 [15%]
- Exam 2 [15%]
- Final Exam [25%]

Grade Scale: A [90, 100]; B [80, 90]; C [70, 80]; D [60, 70]; F [0, 60].
Breaks within above ranges are used to set +/-

General: The instructor posts all assignments, solutions, and additional material on the Blackboard site for this class. This can be found at: http://bb.uvm.edu/

Homework problems will either be assigned from the text or provided by the instructor. Homework will not be collected or graded but the solutions will be available on Bb. Each week there will be a short quiz covering the previous week's materials. Students are encourage to work the homework problems in preparation for these quizzes.

Expect the first two exams to be given around the end of February and March. At least one weeks notice will be given. Should the exam be a 'take home', students will sign an honor pledge indicating that they "neither gave nor received any assistance during the exam". Failure to follow this statement will be considered an act of plagiarism and will be dealt with accordingly (see *Academic Integrity* below). All exams will have a comprehensive component.

On all quizzes and exams you will be allowed to use one sheet of notes. You may use both sides of the paper and you may put anything you want on it. No additional notes or text may be used unless specifically noted.

All graded work should be reviewed promptly by students. Any questions in regards to potential grading errors should be brought to the attention of the instructor within one week after the assignment is reviewed in class or solutions are posted. Please clearly document in writing what you believe the error to be and attach that to the original work. After one week, no score adjustments will be made. While final exams will not be returned to the students, students are welcome to review their work against a solution. Other than in the case of grading errors on the final exam, no final course grades assigned will be altered. Throughout the semester, the course instructor will endeavor to keep you abreast of your standing in the class. Students requiring more feedback should review their performance through by contacting the

instructor.

During the semester, classes may be cancelled due to scheduled travel by the instructor. These classes WILL be made up with online content provided by the instructor. Students are responsible for viewing this material in a timely fashion. The instructor will contact the students through their UVM email account and a Bb posting in advance of the relevant dates.

Lab Assignments: Working in teams of two or three, students will perform approximately five (5) labs throughout the semester to complement the material covered in class. These assignments will familiarize students with communication test equipment such as RF signal generators and spectrum analyzers. Students will investigate both analog and digital communication techniques. Assignments may require the use of MATLAB.

***In the News* Presentation**: During the semester, students will present a brief overview of an article they found pertaining to a communication system/methodology. Details on the subject matter will be detailed in class and posted on Bb.

Pre/co-requisites: This course has a pre-requisite of EE 171: *Signals & Systems* and heavily leverages that material throughout. The *Fourier transform* to used ascertain the bandwidth associated with communication signals (both baseband and modulated). The course covers digital communications and that topic is introduced to via discussion of the A/D process that begins with *sampling*. Chapters 2 and 3 of the EE 174 text (Lathi) provide a good reference for the material from signals and systems that will be needed.

This course also has a co-requisite of STAT 151: *Probability*. Communication systems operate in the presence of noise which is modeled as a *random variable*. In particular, we will leverage both the *Gaussian* and *uniform* distributions.

In addition, the course will leverage *linear algebra* when we study block error correction coding. Finally, you can be expected to conduct assignments in which you will have to utilize *programming*. You can leverage a language of your choice but recognize that the instructor in most familiar with *MATLAB*.

Calculators: There is no restriction on the type of calculator one may use. Note, however, that the instructor will emphasize concepts and techniques on the exams. Therefore, just having the correct answer will not guarantee you full credit if no work has been shown. Calculators may not be allowed on some exams. Phones may not be used during quizzes or exams as calculators. **Presence of phones during exams or quizzes will result in a zero score.**

Late Policy: Late work will not be accepted unless prior arrangements have been made with the instructor. Exam/quiz conflicts should be noted early and you should be prepared to take these in advance of the scheduled dates/times. If you miss a deadline due to an emergency, I will need an official letter from student services to allow you to make up for the work.

Expectations:

- You will attend all lectures and you will attend on time. Should you miss a class, you will get the notes from your classmates. *You* are responsible for knowing what was covered and what was discussed in class.
- You will be respectful at all times, which includes not talking to your classmates while the lecture is in session. You will not use your cell phone or work on other courses while in class.
- You will review your notes from the previous lecture *before* coming to class. You will read relevant sections of the textbook on your own.
- If you have questions, ask them.

Academic Integrity: It is expected that everything that you submit with your name on is your own work. Anything that is not 100% your own work should be clearly labeled as such (credit your sources, group members, etc.). Students who submit others' work as their own will not pass the course and will be referred to the Center for Student Ethics and Standards for further discipline. The UVM policy on academic integrity is a useful guide:
https://www.uvm.edu/policies/student/acadintegrity.pdf.

University Attendance Policy: The lecture notes will form the bulk of materials, so attendance is important. Please refer to the most recent UVM Catalogue: *"Students are expected to attend all regularly scheduled classes. The instructor has the final authority to excuse absences."*

Student Learning Accommodations: In keeping with University policy, any student with a documented disability interested in utilizing accommodations should contact ACCESS, the office of Disability Services on campus. ACCESS works with students to create reasonable and appropriate accommodations *via an accommodation letter to their professors as early as possible each semester.*
Contact ACCESS: A170 Living/Learning Center - 802-656-7753 - access@uvm.edu.

Religious Holidays: Students have the right to practice the religion of their choice. If you need to miss class to observe a religious holiday, *please submit the dates of your absence to me in writing by the end of the second full week of classes.* You will be permitted to make up work within a mutually agreed-upon time.

Use of Alcohol/Cannabis: As a faculty member, I want you to get the most you can out of this course. You play a crucial role in your education and in your readiness to learn and fully engage with the course material. It is important to note that alcohol and cannabis have no place in an academic environment. They can seriously impair your ability to learn and retain information not only in the moment you may be using, but up to 48 hours or more afterwards. It is my expectation that you will do everything you can to optimize your learning and to fully participate in this course.

ABET Outcomes: In all outcomes listed below, a contribution of 0 means little or no contribution, 1 means moderate contribution, 2 means high level of contribution.

Outcome (1): An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. **Contribution: 2**

Outcome (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. **Contribution: 0**

Outcome (3): An ability to communicate effectively with a range of audiences. **Contribution: 1**

Outcome (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. **Contribution: 1**

Outcome (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. **Contribution: 1**

Outcome (6): An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. **Contribution: 2**

Outcome (7): An ability to acquire and apply new knowledge as needed, using appropriate learning strategies. **Contribution: 1**

EE Criterion (A): The curriculum must include probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus; sciences (defined as biological, chemical, or physical science); and engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components. **Contribution: 2**

EE Criterion (B): The curriculum for programs containing the modifier "electrical," "electronic(s)," "communication(s)," or "telecommunication(s)" in the title must include advanced mathematics, such as differential equations, linear algebra, complex variables, and discrete mathematics. **Contribution: 2**