ECE 515/792-068 (on-campus and EOL 515-601)
Digital Communications

Instructor(s): Alexandra Duel-Hallen, sasha@ncsu.edu

Course Objectives: To develop fundamental design and analysis techniques necessary for understanding and working with modern digital communication systems, including wireless, wireline, and optical fiber systems.

Course Description: This is a graduate-level course in digital communications. Functions and interdependence of various components of digital communication systems will be discussed. Topics include modulation and demodulation, statistical channel modeling, optimal receiver design, performance analysis, and fundamentals of information theory. The focus of this course is on design and analysis of general communication systems. Specific communication systems will be discussed in class and addressed in group projects.

Prerequisites: (list any course or knowledge that is necessary for the course; also list any programming skills that are needed)
A graduate probability and stochastic processes course (ECE 514 or equivalent) is required for ECE 792 and is helpful, but not required, for ECE 515.
An undergraduate probability course is required for ECE 515 students..
Though not required, a background in Linear Algebra (MA 305/405 or equivalent) and signal processing is helpful for both courses.
Necessary probability/random processes and linear algebra concepts will be reviewed in the lectures and homework assignments.
Matlab background is preferred.

Textbook: (include any textbook that is used)

Proakis, G., Digital Communications, McGraw-Hill, Fourth Edition. ISBN: 0-07-232111-3 or Fifth Edition (co-authored by Salehi, M., ISBN 9780072957167).

The lectures follow the course notes and handouts posted on the course website.

The textbook is useful as a reference (in addition to the notes), and many homework assignments are related to the textbook material and problems.

Topics: (include main topics that will be covered in the course)
Images may also be helpful to include to illustrate a main point of the course

1. Basic elements of digital communication systems; communication channels; mathematical models; brief history; performance measures.
2. Bandpass Signals and Systems, Signal Space Representations, Digitally Modulated Signals.
3. Characterization of Additive White Gaussian Noise Channels; Optimum Receivers; Correlation and Matched Filter Receivers; Performance of the Optimal Receiver.
4. Introduction to Information Theory: Entropy, Source Models, Source Coding, Average Mutual Information, Channel Models and Channel Capacity.
5. Specific communication system examples: students will apply the principles learned earlier in the course to investigate specific digital communication systems in their group projects (optional for ECE 515 students); moreover, specific systems will be discussed in the lectures.

Grading: (include weight of homework, projects, exams, etc,; students like to know how many projects and exams will be in a class)

Homework	10-15% (drop the lowest score)
Peer Grading	5% (drop the lowest score)
Midterm	30%
Final exam	35%
Group project	15-20%

In ECE 515, optional work will be taken into account when determining the final course grade.

Homework and exams will differ for ECE 515 and 792. Optional problems will be provided for ECE 515 students.

For ECE 792 students, the project will have two components: (1) simulation and performance analysis of several modulation methods; (2) literature review/presentation on a selected topic, e.g., multicarrier, multiuser or multiple antenna systems, millimeter wave channels, fiber optics communication, linear predictive coding, etc. Both components are required for ECE 792 students. ECE 515 students are required to submit the first project component. The second component is optional.

Credit will not be given for both ECE 515 and ECE 792-068.