

**San José State University**  
**Electrical Engineering Department**  
**EE251, Digital Communication Systems, Fall 2017**

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<b>Office Hours:</b>	TR 15:00 – 16:00
<b>Class Days/Time:</b>	TR 18:00 – 19:15
<b>Classroom:</b>	BBC (Business Tower) 120
<b>Prerequisites:</b>	EE 210 (Linear Systems), EE 250 (Probability, Random Variables and Processes)

### **Web Page**

Located at <http://www.engr.sjsu.edu/rmorelos/ee251s14>

### **Course Description**

This is the first of two graduate courses on digital communications (EE 251 and EE 252). The first part is a review of random processes, focusing on white Gaussian noise and narrowband noise. Next, the processes of sampling, quantization and baseband pulse transmission are studied. Communication over bandlimited channels and equalization are characterized. Important concepts in signal-space analysis are covered. Digital modulation techniques are studied that apply to transmission over bandlimited channels subject to additive white Gaussian noise. The course concludes with a discussion on the tradeoffs between power and transmission rate through the channel-coding theorem.

### **Course Goals and Student Learning Objectives**

1. Understand the basic signal processing elements of a modern digital communication system.
2. Understand and analyze noise, information and random processes in communication systems.

3. Understand the concepts of correlation function and power spectral density of a stationary random process, including additive white Gaussian noise (AWGN).
4. Understand the process of analog-to-digital conversion and its applications in communication systems.
5. Analyze baseband pulse shaping techniques and derive their power spectral densities.
6. Understand basic concepts of pulse transmission and matched filtering.
7. Understand and analyze the performance of binary modulation over an ideal AWGN channel.
8. Design pulses using Nyquist criterion for intersymbol interference (ISI) cancellation and use of eye diagrams.
9. Understand, analyze and specify multidimensional digital modulation techniques for transmission over ideal bandlimited AWGN channels and their associated detectors.
10. Understand the fundamental tradeoffs between power, bandwidth and error performance in a digital communication system.

## Required Texts/Readings

### Textbook

S. Haykin, *Communication Systems*, 4th Ed., Wiley, 2001.

(NOTE: The textbook is not the same as the new fifth edition that is coauthored by Haykin and Moher. The organization of the 4th edition is more appropriate for a graduate course in digital communication systems.)

### Other Readings

1. Proakis and Salehi, *Contemporary Communication Systems Using Matlab*, PWS, 1998
2. Proakis, *Digital Communications*, 4th Ed., McGraw Hill, 2001
3. Sklar, *Digital Communications*, 2nd Ed., Prentice-Hall, 2001
4. Lathi, *Modern Digital and Analog Communication Systems*, 3rd Ed., Oxford, 1998

### Other material

Handouts either posted on the web page or distributed in class.

## Classroom Protocol

Students will turn their cell phones off or put them on vibrate mode while in class. They will not answer their phones in class. Students whose phones disrupt the class and do not stop when requested by the instructor will be referred to the Judicial Affairs Officer of the University.

## Dropping and Adding

Students are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. [Information on add/drops are available at http://info.sjsu.edu/web-dbgen/narr/soc-fall/rec-298.html](http://info.sjsu.edu/web-dbgen/narr/soc-fall/rec-298.html). [Information about late drop is available at http://www.sjsu.edu/sac/advising/latedrops/policy/](http://www.sjsu.edu/sac/advising/latedrops/policy/). Students should be aware of the current deadlines and penalties for adding and dropping classes.

## Assignments and Grading Policy

Assignments	15 %
Midterm exam 1	15 %
Midterm exam 2	25 %
Final exam	45 %
Total	100%

Notes:

- a. All exams are open book and notes.
- b. Homework assignments will be given regularly and are due one week from the assigned date. Late homework will not be accepted.

## Grading percentage breakdown

Above 90%	A
80% to 90%	B
70% to 80%	C
60% to 70%	D
Below 60%	F

## University Policies

### Academic integrity

Students should know that the University's [Academic Integrity Policy is available at http://www.sa.sjsu.edu/download/judicial\\_affairs/Academic\\_Integrity\\_Policy\\_S07-2.pdf](http://www.sa.sjsu.edu/download/judicial_affairs/Academic_Integrity_Policy_S07-2.pdf). Your own commitment to learning, as evidenced by your enrollment at San Jose State University and the University's integrity policy, require you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The website for [Student Conduct and Ethical Development is available at http://www.sa.sjsu.edu/judicial\\_affairs/index.html](http://www.sa.sjsu.edu/judicial_affairs/index.html).

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include in your assignment any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy F06-1 requires approval of instructors.

### **Campus Policy in Compliance with the American Disabilities Act**

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the DRC (Disability Resource Center) to establish a record of their disability.

### **EE Department honor code**

The Electrical Engineering Department will enforce the following Honor Code that must be read and accepted by all students.

“I have read the Honor Code and agree with its provisions. My continued enrollment in this course constitutes full acceptance of this code. I will NOT:

- Take an exam in place of someone else, or have someone take an exam in my place
- Give information or receive information from another person during an exam
- Use more reference material during an exam than is allowed by the instructor
- Obtain a copy of an exam prior to the time it is given
- Alter an exam after it has been graded and then return it to the instructor for re-grading
- Leave the exam room without returning the exam to the instructor.”

### **Measures Dealing with Occurrences of Cheating**

- Department policy mandates that the student or students involved in cheating will receive an “F” on that evaluation instrument (paper, exam, project, homework, etc.) and will be reported to the Department and the University.
- A student’s second offense in any course will result in a Department recommendation of suspension from the University.

## EE 251: Digital Communication System, Fall 2017, Course Schedule

Week	Lecture Topics
1	Green sheet. Grading policy. Introduction to communication systems. Elements of a digital communication system
2	Noise, information and random processes. Mean and autocorrelation functions
3	Stationary random processes and their power spectral density
4	Baseband pulse-shaping techniques and their power spectral densities
5	Response of LTI systems to stationary random processes. White noise and response of LTI systems to white noise
6	Analog-to-digital conversion and the sampling theorem. Optimum scalar quantization and the Lloyd-Max quantizer
7	Binary communication over an AWGN channel
8	Review session and <b>midterm exam 1</b>
9	Matched filter and its properties. Intersymbol interference (ISI) and Nyquist criterion. Raised-cosine spectrum
10	Probability of error with ISI
11	Signal space concepts. Synthesis and analysis. Geometric representation of signals. Response of a bank of correlators to AWGN
12	Optimum decision rule and probability of error
13	Review session and <b>midterm exam 2</b>
14	M-ary modulation and the union bound
15	Examples of bounds on the probability of error for QPSK modulation. Bandpass digital transmission: M-PSK, M-QAM and M-FSK modulations. Channel capacity
	<b>Final Exam Tuesday, December 14, 17:15 – 19:30</b>