San José State University
Department of Electrical Engineering
EE 161, Digital Communication Systems, Spring 2018

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Office Hours:	TR 15:00-16:00
Class Days/Time:	Tuesdays and Thursdays 16:30 – 17:45
Classroom:	ENGR 401
Prerequisites:	EE 102

Course Description

Introduction to communication systems and noise. Binary communication systems. Pulse amplitude modulation. Digital modulation of amplitude, phase and frequency of a carrier signal. Modulation and signaling for wireless communication channels. Digital wireless communication using multiple antennas.

Course Goals and Student Learning Objectives

The course offers an introduction to the principles, analysis and applications of digital communication systems. The first part of the course is an introduction to digital communication systems, including a treatment of channels subject to additive white Gaussian noise (AWGN). Binary modulations of amplitude (BPSK) and frequency (BFSK) of a carrier signal are covered. This is followed by an analysis of pulse-amplitude modulation (PAM) systems. Geometric representation of signals is then presented to enable the introduction to high-density modulation schemes, such as PSK and QAM. Multicarrier modulation (OFDM) is introduced as an instance of a multidimensional modulation system. Digital transmission over bandlimited AWGN channels is also covered (including intersymbol interference, eye diagrams and raised-cosine spectrum). An overview is presented of modern techniques for wireless communication systems, including multicarrier (OFDM) and spread-spectrum modulation techniques. The course concludes with by introducing basic concepts of multiple antenna systems for wireless communication systems.

GE/SJSU Studies Learning Outcomes (LO), if applicable

Upon successful completion of this course, students will be able to:

LO1 Demonstrate an understanding of the fundamentals of Electrical Engineering, including its mathematical and scientific principles, analysis and design.

LO2 Demonstrate the ability to apply the practice of Engineering in real-world problems.

Course Content Learning Outcomes
Upon successful completion of this course, students will be able to:

LO3 Describe baseband and passband signals and explain their associated system implementation (hardware) consequences (a, c)

LO4 Demonstrate spectral translation (downconversion and upconversion) via narrowband signal analysis and filtering (a)

LO5 Analyze signals (vector representation and power spectral density) in the presence of noise (a, m)

LO6 Analyze filtering mechanisms (e.g., low-pass, bandpass, matched, correlation) and their impact on the bit-error rate (BER) performance of a digital communications system (a, m)

LO7 Identify, formulate and solve engineering problems that arise in communications systems analysis and design (a, e)

LO8 Interpret and report on computer-based performance predictions of analog and binary modulation systems (a, e)

LO9 Practice tradeoff analyses of signal-to-noise ratios, BER and achievable data rate for digital communication systems (a, e)

L10 Deduce and predict the performance of both wired and wireless digital communications systems (a, e)

ABET outcomes

The letters in parentheses in each of the course learning objectives above refer to ABET (Accreditation Board for Engineering and Technology) criterion 3 outcomes satisfied by the objective. These are listed below as a reference:

(a) An ability to apply knowledge of mathematics, science, and engineering
(b) An ability to design and conduct experiments, as well as to analyze and interpret data
(c) An ability to design a system, component, or process to meet desired needs
(d) An ability to function on multi-disciplinary teams
(e) An ability to identify, formulate, and solve engineering problems
(f) An understanding of professional and ethical responsibility
(g) An ability to communicate effectively
(h) The broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) A recognition of the need for, and an ability to engage in life-long learning
(j) A knowledge of contemporary issues
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Required Texts/Readings

Textbook

Proakis and Salehi, *Fundamentals of Communication Systems*, Prentice Hall, 2005. (The same textbook used in EE160, either edition is fine.)

Other Readings

Proakis, Salehi and Bauch, *Contemporary Communication Systems Using Matlab*, 2nd ed., Brooks Cole, 2002.
Haykin, *Communication Systems*, 4th Ed., Wiley, 2001.
Stern and Mahmoud, *Communication Systems*, Prentice Hall, 2004.

Classroom Protocol

Students are expected to participate actively in class. Students will turn their cell phones off or put them on vibrate mode while in class. They will not answer their phones in class.

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. Information about late drop is available at 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

There are two midterm exams and a final exam. Exams cover the assigned reading materials and class lecture notes. There will be no make-up exams (only in very special circumstances, both written excuse and official proofs are required for extraordinary exams). Exam solutions will be posted in the web site of the course. Homework will be given as follows. Some homework problems require the use of a computer to perform simulations.

Assignment	Topics	Learning Outcomes
1	Pulse shaping and mapping	LO3, LO5
2	Correlation and matched filtering	LO3, LO5
3	Binary modulation	LO3, LO5
4	M-PAM	LO3, LO5
5	M-ary digital modulation	LO3, LO5, LO9
6	Bandpass modulation	LO4, LO5, LO7
7	Error Control Coding	LO5, LO6, LO7
8	Wireless channels and signaling for flat fading channels	LO7, LO8, LO9
9	Signaling for frequency-selective fading channels	LO7, LO8, LO9
10	Diversity and MIMO systems	LO8, LO9, L10

Grades

Assignments	15%
Exam 1	20%
Exam 2	30%
Final exam	35%
Total	100%

Grading Percentage Breakdown

90% and above	A
80% - 89%	B
70% - 79%	C
60% - 69%	D
Below 60%	F

University Policies

Academic integrity

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. I

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."

EE 161 / Digital Communication Systems, Spring 2018, Course Schedule

Table 1 Course Schedule (Subject to change with fair notice)

Week	Topics
1	Introduction. Wireless communication system. Pulse shaping. Binary communication.
2	Correlation receiver. Matched filter. Performance of binary PSK and FSK systems
3	M-ary pulse amplitude modulation
4	Geometric representation of signals
5	Two-dimensional M-ary modulation: M-PSK and M-QAM. M-dimensional M-ary modulation: M-FSK and M-PPM
6	Digital transmission over bandlimited channels – Part 1 **Midterm exam 1**
7	Digital transmission over bandlimited channels – Part 2. Error control coding – Part 1
8	Wireless (multipath) channel models. Classification of wireless channel models. Frequency selectivity and multipath fading
9	Error performance of binary modulations over flat fading channels. Signaling for flat-fading channels: Error control coding – Part 2
10	Noncoherent modulations for flat-fading channels
11	Signal diversity techniques for multipath channels.
12	Frequency-selective channels – Part 1: Tapped delay line channel model. The RAKE demodulator
13	**Midterm exam 2** Signaling for frequency-selective channels: Equalization
14	Signaling for frequency-selective channels: OFDM. Error control coding – Part 3.
15	Spatial diversity techniques for multipath channels and MIMO systems
	Final Exam, Thursday May 17 14:45-17:00