San José State University
Department of Electrical Engineering
EE 252, Advanced Communication Systems, Fall 2015

Instructor:	Robert Morelos-Zaragoza
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Office Hours:	TR 15:00 to 16:00
Class Days/Time:	MW 19:30-20:45
Classroom:	ENGR 301
Prerequisites:	EE 251 or instructor's consent

Course Description

Digital modulation techniques for power and bandwidth limited communication systems. Offset QPSK, GMSK, noncoherent modulation and detection. Multipath fading channels, diversity and combining methods.

Course Goals and Student Learning Objectives

The second course of the Digital Communications series covers the following topics: (1) Digital modulation for wireless channels; (2) synchronization for communication receivers and (3) digital data transmission over multipath channels. This course begins with a study of digital modulation techniques for realistic communication systems, were bandwidth and power are limited and receiver implementation cost becomes a design parameter. The second part deals with maximum likelihood estimation of unknown parameters in Gaussian noise (also known as synchronization). In the third part of the course, attention is focused on diversty techniques for digital transmission over multipath fading channels.

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 Analyze the effect of phase errors in binary modulated communication systems.

LO4 Design and analyze the performance of offset (OQPSK), p/4-shift QPSK, minimum-shift keying (MSK) and Gaussian MSK (GMSK) modulation techniques in bandpass AWGN channels.

LO5 Demonstrate, design and analyze optimum quadratic receivers.

LO6 Analyze the performance of non-coherent orthogonal and frequency-shift keying (FSK) modulation techniques in bandpass AWGN channels.

LO7 Design and analyze differential modulation techniques, such as differential binary (BPSK) modulation.

LO8 Design and analyze multicarrier (OFDM) and spread-spectrum modulation techniques in AWGN channels.

LO9 Demonstrate, design and analyze estimation techniques of parameters in Gaussian noise (synchronization), including carrier phase/frequency estimation and symbol timing estimation.

LO10 Demonstrate, identify and analyze basic models of multipath fading channels, their statistical characterization and the concept of diversity.

LO11 Identify, design and analyze diversity techniques in time, space or frequency domains, such as spread-spectrum modulation, multiple antenna systems, and multicarrier modulation, respectively.

LO12 Demonstrate and design diversity combining techniques for multipath fading channels, and analyze them in terms of signal-to-noise ratio and probability of a bit error.

Required Texts/Readings

Textbooks

A. Goldsmith, *Wireless Communications*, Cambridge University Press, 2005. (EE255 textbook)
S. Haykin, *Communication Systems*, 4th Ed., Wiley, 2001. (EE251 textbook)

Other Readings

P.M. Shankar, *Introduction to Wireless Systems*, Wiley, 2002.
H. Meyr, M. Moeneclaey and S. A. Fechtel, *Digital Communication Receivers*, Wiley, 1997.
U. Mengali and A.N. D'Andrea, *Synchronization Techniques for Digital Receivers*, Plenum, 1997.
J. Proakis and Salehi, *Contemporary Communication Systems Using Matlab*, PWS, 1998.
J. Proakis, *Digital Communications*, 4th Ed., McGraw Hill, 2001.
J.C. Liberti and T.S. Rappaport, *Smart Antennas for Wireless Communications*, Prentice Hall, 1999.

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 will be 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 discussed in class after the exam dates and 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 Objectives
1	OQPSK and pi/4-shift QPSK	LO3, LO4, LO5
2	MSK and GMSK	LO3, LO6
3	Noncoherent detection and modulation	LO3, LO7-LO9
4	Multicarrier (OFDM) modulation	LO3, LO10
5	Spread-spectrum modulation	LO3, LO10
6	Estimation and synchronization	LO11
7	Multipath channel statistics	LO12
8	Diversity concepts, techniques and performance	LO13

Grades

Assignments	25%
Exam 1	25%
Exam 2	25%
Final exam	25%
Total	100%

Grading Percentage Breakdown

90% and above	A
89% - 85%	A-
84% - 82%	B+
81% - 79%	B
78% - 75%	B-
74% - 72%	C+
71% - 69%	C
68% - 65%	C-
64% - 62%	D+
61% - 59%	D
58% - 55%	D-
below 55%	F

University Policies

Academic integrity

Students should know that the University's Academic Integrity Policy is availabe at 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.

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 252 / Advanced Communication Systems, Fall 2014, Course Schedule

(Subject to change with fair notice as announced by instructor in class)

Week	Topics
1	Introduction. Review of QPSK modulation
2	OQPSK, spectral re-growth, and pi/4-shift QPSK
3	Minimum shift keying (MSK)
4	Gaussian MSK (GMSK)
5	Effects of phase errors in BPSK and non-coherent modulation
6	Optimum quadratic receivers and differential modulation
7	Muticarrier modulation (OFDM)
8	Spread-spectrum modulation *Midterm exam 1*
9	Estimation and synchronization principles
10	Phase and timing error estimation
11	The two-path channel. Statistical characterization of multipath channels
12	Effects of fading and the concept of diversity. Time diversity using interleaving and channel coding.
13	Time diversity using spread spectrum modulation and RAKE reception. *Midterm exam 2*
14	Frequency diversity using OFDM: Channel estimation and one-tap equalization; interleaving and channel coding
15	Spatial multiplexing (MIMO). Transmit diversity with Alamouti scheme
Final Exam	Friday 12/11/15 19:45-22:00