

EE 252: Digital Data Transmission II
Department of Electrical Engineering
San Jose State University

1. Course Information

Instructor: Robert Morelos-Zaragoza

Department: Electrical Engineering
College of Engineering, San Jose State University
Spring Semester, 2007

Course Title:	Digital Data Transmission II
Course Code:	EE 252
Section:	1 (code 34951)
Class Hours & Location:	TR 16:30-17:45 in ENG 345
Office Hours:	MW 16:00-1800
Office Location:	ENG 373
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2. Course Description:

a. Course Overview and Description:

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, where 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 diversity techniques for digital transmission over multipath fading channels.

b. Prerequisites:

EE 251: Digital Data Transmission I or equivalent with instructor's permission.

c. Required and recommended texts, readers, or other reading materials:

Required:

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

P.M. Shankar, *Introduction to Wireless Systems*, Wiley, 2002.

Recommended:

- 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.

Other reading materials:

IEEE papers posted in web site of the course.

e. Student learning objectives for the course:

1. Ability to understand basic modulation techniques for wireless communication channels.
2. Ability to understand and analyze the performance of offset (OQPSK) and p/4-shift QPSK modulation techniques in bandpass AWGN channels.
3. Ability to understand and analyze the performance of minimum-shift keying (MSK) and Gaussian MSK (GMSK) modulation techniques in bandpass AWGN channels.
4. Ability to analyze the effect of phase errors in binary modulated communication systems.
5. Ability to understand and analyze optimum quadratic receivers.
6. Ability to understand and analyze the performance of non-coherent orthogonal and frequency-shift keying (FSK) modulation techniques in bandpass AWGN channels.
7. Ability to understand and analyze differential modulation techniques, such as differential binary (BPSK) modulation.
8. Ability to understand and analyze multicarrier (OFDM) modulation techniques in AWGN channels.
9. Ability to understand and analyze spread-spectrum modulation techniques in AWGN channels.
10. Ability to understand basic concepts of estimation of parameters (synchronization) in Gaussian noise, including carrier phase/frequency estimation and symbol timing estimation.
11. Ability to understand basic models of multipath fading channels, their statistical characterization and main parameters.
12. Ability to analyze the effects of fading and the concept of diversity
13. Ability to understand diversity techniques in time, space or frequency domains, including spread-spectrum modulation, multiple antenna systems, and multicarrier modulation, respectively.
14. Ability to analyze diversity combining techniques for multipath fading channels, in terms of signal-to-noise ratio and probability of a bit error

3. Course requirements:

a. Projects:

No

b. Exams:

There are two midterm exams and a final exam. All exams are open book and notes. 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.

c. Quizzes:

No

d. Homework:

Approximately seven homeworks will be given. Some homework problems require the use of a computer to perform simulations of the algorithms covered in class.

e. Class Participation:

Yes. Students are expected to actively participate in the lectures and lab sessions.

4. Tentative course calendar

(Please note that this is "subject to change with fair notice")

1. Offset QPSK modulation
2. $\pi/4$ -shift QPSK modulation
3. Minimum-shift keying (MSK) modulation
4. Gaussian MSK (GMSK) modulation
5. Noncoherent detection and modulation – part I
6. Noncoherent detection and modulation – part II
7. Multicarrier modulation – part I
8. Multicarrier modulation – part II
9. Multicarrier modulation – part III
10. Spread-spectrum modulation – part I
11. Spread-spectrum modulation – part II

MIDTERM 1: Tuesday March 6, 2007, 16:30 – 17:45

12. Estimation of unknown parameters in AWGN – part I
13. Estimation of unknown parameters in AWGN – part II
14. Phase estimation and the digital PLL – part I
15. Phase estimation and the digital PLL – part II
16. Timing estimation via interpolation – part I
17. Timing estimation via interpolation – part II
18. Statistical characterization of multipath channels – part I
19. Statistical characterization of multipath channels – part II
20. Statistical characterization of multipath channels – part III
21. Effects of fading and the concept of diversity – part I
22. Effects of fading and the concept of diversity – part II

MIDTERM 2: Thursday April 24, 2007, 16:30 – 17:45

- 23. Diversity techniques and combining methods – part I
- 24. Diversity techniques and combining methods – part II
- 25. Diversity techniques and combining methods – part III
- 26. Diversity techniques and combining methods – part IV
- 27. Applications – part I
- 27. Applications – part II

FINAL: Wednesday, May 23, 2007, 14:45 – 17:00

5. Grades:

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

a. Grading information:

Grading Percentage Breakdown

94% and above	A
93% - 90%	A-
89% - 87%	B+
86% - 84%	B
83% - 80%	B-
79% - 77%	C+
76% - 74%	C
73% - 70%	C-
69% - 67%	D+
66% - 64%	D
63% - 60%	D-
below 60%	F

6. University, College, or Department Policy Information:

a) Academic integrity statement (from Office of Judicial Affairs):

“Your own commitment to learning, as evidenced by your enrollment at San José State University and the University’s Academic Integrity Policy requires you to be honest in all your academic course work. Faculty are required to report all infractions to the Office of Judicial Affairs. The policy on academic integrity can be found at <http://www2.sjsu.edu/senate/S04-12.pdf>

b) Campus policy in compliance with the Americans with Disabilities Act:

"If you need course adaptations or accommodations because of a disability, or if you need 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 register with DRC to establish a record of their disability."

c) Cell Phones:

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 course and do not stop when requested by the instructor will be referred to the Judicial Affairs Officer of the University.

d) Academic Honesty:

Faculty will make every reasonable effort to foster honest academic conduct in their courses. They will secure examinations and their answers so that students cannot have prior access to them and proctor examinations to prevent students from copying or exchanging information. They will be on the alert for plagiarism. Faculty will provide additional information, ideally on the green sheet, about other unacceptable procedures in class work and examinations. Students who are caught cheating will be reported to the Judicial Affairs Officer of the University, as prescribed by [Academic Senate Policy S04-12.](#)

7. APPENDIX:

- In addition to my specifically posted office hours, I am available on Fridays by arrangement.
- You are responsible for understanding the policies and procedures about add/drops, academic renewal, withdrawal, etc. found at <http://www2.sjsu.edu/senate/S04-12.pdf>
- Expectations about classroom behavior; see [Academic Senate Policy S90-5](#) on Student Rights and Responsibilities.
- As appropriate to your particular class, a definition of plagiarism, such as that found on Judicial Affairs website at <http://www2.sjsu.edu/senate/plagiarismpolicies.htm>
- If you would like to include in your paper any material you have submitted, or plan to submit, for another class, please note that SJSU's Academic Integrity policy S04-12 requires approval by instructors.