San José State University Department of Electrical Engineering EE 161, Digital Communication Systems, Spring 2017

Instructor: John (JeongHee) Kim
Office Location: ENGR 263
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Email: Jeonghee.kim@sjsu.edu
Office Hours: TR 15:00-16:00 or by appointment
Class Days/Time: Tuesdays and Thursdays 13:30 – 14:45
Classroom: ENGR 303
Prerequisites: EE 102

Course Description


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 band limited 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.

<table>
<thead>
<tr>
<th>Assignment Topics</th>
<th>Learning Outcomes</th>
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<tbody>
<tr>
<td>1. Pulse shaping and mapping</td>
<td>LO3, LO5</td>
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Assignmen

TopicsLearning Outcomes
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)

**LO10** 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

Other Readings

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](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
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.

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<th>Topics</th>
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<tr>
<td>1</td>
<td>Pulse shaping and mapping</td>
<td>LO3, LO5</td>
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<tr>
<td>2</td>
<td>Correlation and matched filtering</td>
<td>LO3, LO5</td>
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<tr>
<td>3</td>
<td>Binary modulation</td>
<td>LO3, LO5</td>
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<tr>
<td>4</td>
<td>M-PAM</td>
<td>LO3, LO5</td>
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<tr>
<td>5</td>
<td>M-ary digital modulation</td>
<td>LO3, LO5, LO9</td>
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<tr>
<td>6</td>
<td>Bandpass modulation</td>
<td>LO4, LO5, LO7</td>
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<td>7</td>
<td>Error Control Coding</td>
<td>LO5, LO6, LO7</td>
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<td>8</td>
<td>Wireless channels and signaling for flat fading channels</td>
<td>LO7, LO8, LO9</td>
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**Evaluation:**

1. Homework assignments, Quizzes, Attendance, Projects
   
   \[(\text{Quiz}=\text{HW}=\text{Attendance}=\text{Projects})\]  
   
   20%

2. Two best out of three midterm exams  
   
   50% (25% each)

3. One final exam
   
   30%

**Grading Percentage Breakdown**

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

**Notes on Evaluation:**

1. **If you turn in assignments late, maximum of 10% credits will be given.** Solutions to the homework assignments and all other info are posted in group site [https://groups.yahoo.com/ groups/EE161](https://groups.yahoo.com/ groups/EE161). Everyone must join in this site to get necessary info (Exam sol, Qz sol, HW assignments & sol, and other announcements).

2. **If 75% of combined HW, quizzes, & attendance are not done by end of semester, you will get F grade automatically.**

3. HW has to have cover page given in the group site otherwise you will not get any credits or deducted up to 100 percent. Final solutions on HW and exam must be boxed. Otherwise you will not get credits. Only one side of page must be used in the HWs. (No HW sending through an email will be accepted.) HW should be clean, legible, stapled on top left corner and proper paper should be used.

4. All exams are closed book and note. Only one 8.5 x 11 cheat sheet (both pages) is allowed for each exam (3 midterm exams). You can bring all three cheat sheets in the final exam (3 cheat sheet for the final exam).

5. **No make-up exams (no excuse will be accepted-that is why you get one extra exam), quizzes, HW (no acceptance through an email), Attendance at all. No incomplete grades will be given.** HW must be turned in on a given date only, otherwise it will not be accepted. Most likely, one quiz will be given once a week.

6. **If unreasonable or out of common sense behavior happens in the class, one will be asked to leave from the class and will be given “F” grade.** (No feet on a table or chair, taking hat off, no cellphone use or web surfing, no talking with neighbors). And I will drop you from the class if the class is disturbed unreasonably with my right.

7. **Attendance will be checked randomly (will be considered as one HW) and will be counted as part of HW & Qz grading.**

8. **No food is allowed (Water is ok).** It is mandatory to have a scientific calculator by within two weeks of semester and you need to carry it all the time. All the exams and quizzes are done in the class and only allowed to use pencil and eraser (no pen)
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 regrading
• Leave the exam room without returning the exam to the instructor.”
# Course Schedule

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