
EE558 – DIGITAL COMMUNICATIONS

FALL 2016
21205

COURSE INFORMATION

Class Days: Tuesdays and Thursdays
Class Times: 12:30 – 13:45
Class Location: ENS-291

Office Hours Times: Tue 14:00 - 16:00 or by
appointment
Office Hours Location: ENG-408

INSTRUCTOR INFORMATION

Instructor: Dr. Duy Nguyen

- Office: ENG-408
- Phone: 619-594-2430
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- Webpage: <http://engineering.sdsu.edu/~nguyen/EE558/index.html>

Grader: Ms. Srilakshmi Alla

- Email: shrilaksmialla94@gmail.com

COURSE OVERVIEW

This course examines the transmission of information (voice, video or data) over a noisy channel and presents the ideas and techniques fundamental to both analog and digital communication systems. Emphasis is placed on system design goals and the need for trade-offs among basic system parameters such as signal-to-noise ratio, probability of error, and bandwidth expenditure. Topics include noise characterization, sampling, quantization, binary baseband/passband digital data transmission, M-ary modulation techniques (M-ASK, M-PSK, M-QAM and M-FSK), matched filter receivers, signaling over band-limited channels and methods to deal with intersymbol interference (ISI). Advanced topics of equalization and OFDM are introduced (if time permits).

ENROLLMENT INFORMATION

- Prerequisites: EE 458 – Analog and Pulse Communications Systems, and MATLAB programming skills.

COURSE MATERIALS

- Recommended Materials:
 1. B. Sklar, *Digital Communications: Fundamentals and Applications*, 2nd Ed., Prentice Hall, 2001.
 2. H. Nguyen and E. Shwedyk, *A First Course in Digital Communications*, 1st Ed., Cambridge University Press, 2009. (optional)

The textbook is recommended but not required. Lecture slides are prepared with selected material from the textbook and posted on the course website. The textbook and lecture slides (without student's excessive notes) are allowed in both midterm and final exams. Lecture notes might be provided to complement the lecture slides, if needed.

COURSE STRUCTURE AND CONDUCT

- Style of the Course: Traditional lectures.
- Technology Utilized in the Course: Blackboard.

COURSE ASSESSMENT AND GRADING

The methods of assessment and their respective weightings are given below:

- **Homework:** There will be 7 bi-weekly homework assignments. 6 best scores out of 7 will be counted toward the final score. Weight: 25%
- **Quizzes:** Every 4 weeks, Total: 3 (25 minutes each). Weight: 15%.
- **Midterm Exams:** on Weeks 7 and 11. Total: 2 (1 hour and 15 minutes each). Weight: 30%.
- **Final Exam:** Weight: 30%. Date: Thursday, Dec 15, 2016. Time: 10:30--12:30.

NOTES OF HOMEWORK, QUIZZES, AND TESTS

The methods of assessment and their respective weightings are given below:

- For each homework assignment, several problems will be assigned. You are required to turn in all problems in the end of the scheduled lecture on the day that is due without penalty for late submission. Maximum 1-day late submission is permitted with 20% score deducted.
- The quizzes are at the beginning of the scheduled lecture dates. Each quiz consists of 1 or 2 short questions that are similar to the preceding returned/marked homework.
- The midterm exams take the whole scheduled lecture slots. Each midterm consists of 3 to 4 questions that are similar to the preceding 2 returned/marked homework assignments.
- Final exam takes place in classroom ENS-291. 40% of the final exam will cover the material in Homework 6 and 7 and the other 60% will cover the material in Homework 1 to 5.
- All quizzes and exams: textbook and lecture slides are allowed. Hand calculator is allowed but all other electronic devices are not.

COURSE SCHEDULE

TABLE 1 - COURSE SCHEDULE WITH DATE, ACTIVITY, AND ASSIGNMENT

Date	Activity	Assignment
Tue, Aug 30	First day of class	
Tue, Sep 6	Homework 1 out	HW1
Tue, Sep 20	Homework 1 due, homework 2 out	HW2
Thu, Sep 29	Quiz 1	
Tue, Oct 4	Homework 2 due, homework 3 out	HW3
Thu, Oct 13	Midterm exam 1	
Tue, Oct 18	Homework 3 due, homework 4 out	HW4
Thu, Oct 27	Quiz 2	
Tue, Nov 1	Homework 4 due, homework 5 out	HW5
Thu, Nov 10	Midterm exam 2	
Tue, Nov 15	Homework 5 due, homework 6 out	HW6
Thu, Nov 24	Thanksgiving (no class)	
Tue, Nov 29	Homework 6 due, homework 7 out	HW7
Thu, Dec 1	Homework 7 due	
Thu, Dec 15	Final exam in class	

Important Dates:

- Tuesday, Aug 30, 2016: EE558 class begins
- Thursday, Oct 13, 2016: Midterm exam 1
- Thursday, Nov 10, 2016: Midterm exam 2
- Thursday, Dec 16, 2016: Final Exam – 10:30 – 12:30

COURSE OUTLINE

1. Introduction and Review (3 weeks)
 - Analog Communications versus Digital Communications
 - Block Diagram of a Digital Communications System
 - Review of Probability and Random Processes
 - Review of Signals and Systems
2. Sampling and Quantization (1.5 weeks)
3. Link Budget Analysis (2 weeks)
4. Optimal Receiver for Binary Data Transmission (2.5 weeks)
 - Geometric Representation of Signals
 - Representation of the Noise
 - Optimum Receiver
 - Receiver Implementation
 - Receiver Performance Analysis
5. Baseband Data Transmission (2 weeks)
 - Baseband Signaling Schemes: NRZ, RZ, Manchester and Miller
 - Error Performance
 - Power Spectrum Density
6. Digital Passband Modulation (2 weeks)
 - Binary Amplitude Shift Keying (ASK), Binary Phase Shift Keying (PSK)
 - Frequency Shift Keying (FSK)
 - Quadrature Phase Shift Keying (QPSK)
 - Error Performance
 - Power Spectral Density
7. Signaling Over Band-limited Channels (1 weeks)
 - Nyquist Criterion for Zero ISI
 - Design of Transmitting and Receiving Filters
 - Digital Implementations of a QAM Passband System
8. Orthogonal Frequency-Division Multiplexing (OFDM) Modulation Technique (1 week)
 - Input/Output Relationship in the Time Domain
 - Input/Output Relationship in the Frequency Domain
 - Implementation with IFFT/FFT

STUDENT OUTCOME

- Students will be able to explain how to represent signals and noise using the signal space concept.
- Students will be able to develop an optimal detection rule for binary communication systems under additive white Gaussian noise, perform probability of error analysis and optimize the signal set under a transmitted power constraint. The student will be able to explain the implementation of the optimal receiver.

- Students will be able to explain different baseband modulation schemes and their advantages and disadvantages in terms of error performance, timing synchronization and bandwidth requirement.
- Students will be able to explain different binary passband modulation schemes and their advantages and disadvantages in terms of error performance, bandwidth requirement and phase uncertainty.
- Students will be able to explain how to use M-ary modulation schemes to trade power for bandwidth and vice versa. Students will be able to decide on what modulation schemes to use in certain application scenario.
- Students will be able to explain how a band-limited communication channel can cause inter-symbol interference (ISI) and what can be done to avoid or deal with ISI.
- Students will be able to explain the benefits and challenges of using orthogonal frequency division multiplexing (OFDM) modulation for multipath communication channels.

ACADEMIC HONESTY

The University adheres to a strict [policy regarding cheating and plagiarism](http://studentaffairs.sdsu.edu/srr/cheating-plagiarism.html). These activities will not be tolerated in this class. Become familiar with the policy and what constitutes plagiarism (<http://studentaffairs.sdsu.edu/srr/cheating-plagiarism.html>). Any cheating or plagiarism will result in failing this class and a disciplinary review by the University. These actions may lead to probation, suspension, or expulsion.

Examples of Plagiarism include but are not limited to:

- Using sources verbatim or paraphrasing without giving proper attribution (this can include phrases, sentences, paragraphs and/or pages of work)
- Copying and pasting work from an online or offline source directly and calling it your own
- Using information you find from an online or offline source without giving the author credit
- Replacing words or phrases from another source and inserting your own words or phrases
- Submitting a piece of work you did for one class to another class

TURNITIN

Students agree that by taking this course all required papers may be subject to submission for textual similarity review to [Turnitin.com](http://www.turnitin.com) for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. You may submit your papers in such a way that no identifying information about you is included. Another option is that you may request, in writing, that your papers not be submitted to www.turnitin.com. However, if you choose this option you will be required to provide documentation to substantiate that the papers are your original work and do not include any plagiarized material.

TECHNICAL SUPPORT FOR BLACKBOARD

Student support for Blackboard is provided by the Library Computing Hub, located on the 2nd floor of Love Library. They can be reached at 619-594-3189 or hub@mail.sdsu.edu

STUDENTS WITH DISABILITIES

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. You can also learn more about the services provided by visiting the [Student Disability Services](#) website.

To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that accommodations based upon disability

cannot be provided until you have presented your instructor with an accommodation letter from Student Disability Services. Your cooperation is appreciated.

STUDENT SERVICES:

A complete list of all academic support services is available on the [Academic Success](#) section of the [SDSU Student Affairs](#) website.

For help with improving your writing ability, the staff at the SDSU [Writing Center](#) is available in person and online.

[Counseling and Psychological Services](#) offers confidential counseling services by licensed psychologists, counselors, and social workers. More info can be found at their website or by contacting (619) 594-5220. You can also Live Chat with a counselor http://go.sdsu.edu/student_affairs/cps/therapist-consultation.aspx between 4:00pm and 10:00pm, or call San Diego Access and Crisis 24-hour Hotline at (888) 724-7240.