ELC 5396: Digital Communications

12:30–1:45 PM Tuesday, Thursday

Rogers ECS Building 210

Dr. Liang Dong

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Office Location: Room 301B (Rogers ECS Building)
Office Hours: TR 2:00 – 3:30 PM; Other by appointment

Course Description:
This course is designed to serve as a first-year graduate-level course on digital communications. First, the course provides the mathematical underpinnings of digital communications, including introductions to stochastic processes and information theory. Second, the course teaches in-depth digital modulation and coding, carrier and symbol synchronization, adaptive equalization, spread spectrum signaling, and digital communication over additive-white-Gaussian-noise channels, band-limited channels and fading channels. Third, the course explores engineering principles and key technologies of multiple-antenna systems, multiuser communications, green communications, and next-generation wireless systems and networks. The theories are validated through extensive computer simulations and hands-on classroom demonstrations.
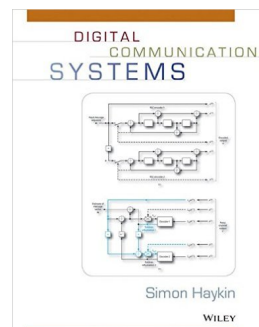
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Prerequisite(s):	ELC 4350 – Principles of Communication
	ELC 4351 – Digital Signal Processing
Credit Hours:	3
Textbook 1:	*Digital Communication Systems*
	John Wiley & Sons, 2013
Author(s):	Simon Haykin
ISBN-13:	9780471647355

Textbook 2: *Contemporary Communication Systems Using MATLAB*
  Cengage Learning, 3rd edition, 2012
Author(s): John G. Proakis, Masoud Salehi, and Gerhard Bauch
ISBN-13: 9780495082514
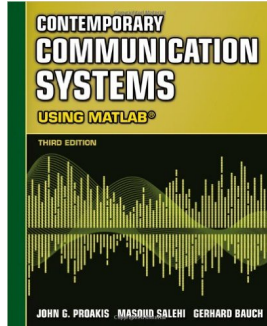
Course Objectives:
At the completion of this course, you will be able to:

1. Prepare mathematical background for communication signal analysis.
2. Understand the building blocks of a digital communication system.
3. Understand and analyze the signal flow in a digital communication system.
4. Analyze error performance of a digital communication system in presence of noise and other interference.
5. Analyze the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency.
6. Understand concept of spread spectrum communication system.
7. Understand concept of multiple-input multiple-output communication systems.
8. Understand concept of multiuser communications.
9. Understand concept of green communications.

Computer Usage:
Matlab and Simulink Communications Toolbox (available on computers of College of Engineering and Computer Science).

We will use computers extensively to program and verify classroom examples, homework assignments, and class projects. Various software tools are available at the Baylor Engineering Computer Center and a student version can be downloaded from Baylor Information Technology Services. To effectively implement and analyze digital communications algorithms, we will program in Matlab (or C++ if you so prefer).

Classroom Demonstration:
Classroom demo will be carried out with the NI/Ettus Research's USRP (Universal Software Radio Peripheral) testbed. It is a flexible transceiver that connects to a standard PC and makes a wireless prototyping system.

Reading Assignment, Homework, and Quiz:
There will be biweekly reading assignments. Reading assignments include textbook reading and technical paper reading. The outcome of your reading assignments will be evaluated through class-

room discussions and quizzes.

There will be homework assignments every two to three weeks. Homework may include written problems and computer programming problems.

There will be frequent in-class quizzes. Each quiz has a few questions that are related to the knowledge covered in the previous classes and/or the current class. The quiz serves as a vehicle to measure your classroom attendance and learning effectiveness.

Midterm Exams:
There will be two in-class midterm exams. The dates for the midterm exams are as follows.

- Midterm Exam 1:   Thursday, Oct. 13, 2016

- Midterm Exam 2:   Thursday, Nov. 17, 2016

Final Project:
There will be a final project. You need to do your project independently. Start your final project early in the semester. You can discuss with me about the papers you read and choose a project topic that is relevant to cutting-edge researches on digital communications.

The outcomes of the project should clearly show your understanding of the subject (from the papers you read) and your own novel and created contributions. Your work should be revealed through theoretical analysis and verified through simulation or experiment.

Grade Distribution:

Reading Assignment	10%
Homework Assignments	10%
Quizzes	10%
Midterm Exam 1	20%
Midterm Exam 2	20%
Final Project	30%

Letter Grade Distribution:

>= 93.00	A		73.00 - 76.99	C
90.00 - 92.99	A-		70.00 - 72.99	C-
87.00 - 89.99	B+		67.00 - 69.99	D+
83.00 - 86.99	B		63.00 - 66.99	D
80.00 - 82.99	B-		60.00 - 62.99	D-
77.00 - 79.99	C+		<= 59.99	F

Course Policies:

- **Quizzes and Exams**

    - Quizzes and exams are closed book, closed notes.

    - The two lowest quiz scores will be dropped.

    - **No makeup quizzes or exams will be given.**

- **Homework Assignments**

  - You are expected to work independently. **Offering** and **accepting** solutions from others is an act of **plagiarism**, which is a serious offense and **all involved parties will be penalized according to the Academic Honesty Policy**. Discussion amongst students is encouraged, but when in doubt, direct your questions to the professor and the teaching assistant.
  - **No late assignments will be accepted**.

- **Attendance and Absences**

  - This course relies heavily on peer critique and discussion, so it really helps to have the entire class present and ready to engage with the material. I also understand that some conflicts are unavoidable, which is why each of you are being given three (3) free absences. There is no judgment or direct impact on grades from these absences.
  - You are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.
  - In the event that you accrue four (4) absences (two full weeks of classes), your final grade will automatically be lowered a full 10 points. Two tardy marks will be considered the same as an absence and will count towards your allotted amount.

Academic Honesty Policy Summary:

Introduction

In addition to skills and knowledge, Baylor University aims to teach students appropriate Ethical and Professional Standards of Conduct. The Academic Honesty Policy exists to inform students and faculty of their obligations in upholding the highest standards of professional and ethical integrity. All student work is subject to the Academic Honesty Policy. Professional and Academic practice provides guidance about how to properly cite, reference, and attribute the intellectual property of others. Any attempt to deceive a faculty member or to help another student to do so will be considered a violation of this standard.

Unauthorized/Excessive Assistance

The student may not give or get any unauthorized or excessive assistance in the preparation of any work.

Authorship

The student must clearly establish authorship of a work. Referenced work must be clearly documented, cited, and attributed, regardless of media or distribution. Even in the case of work licensed as public domain, the student must provide attribution of that work in order to uphold the standards of intent and authorship.

Declaration

Online submission of, or placing one's name on an exam, assignment, or any course document is a statement of academic honor that the student has not received or given inappropriate assistance in completing it and that the student has complied with the Academic Honesty Policy in that

work.

Consequences

An instructor may impose a sanction on the student that varies depending upon the instructor's evaluation of the nature and gravity of the offense. Possible sanctions include but are not limited to, the following: (1) Require the student to redo the assignment; (2) Require the student to complete another assignment; (3) Assign a grade of zero to the assignment; (4) Assign a final grade of "F" for the course. A student may appeal these decisions according to the Academic Grievance Procedure. Multiple violations of this policy will result in a referral to the Conduct Review Board for possible additional sanctions.

Title IX:

TITLE IX OFFICE — If you or someone you know would like help related to an experience of sexual violence including sexual assault, harassment, domestic violence, dating violence, stalking or other type of non-consensual sexual conduct, please contact Patty Crawford, the Title IX Coordinator at Baylor University, by email (Patty_Crawford@baylor.edu) or phone (254-710-8454).

Anonymous reporting for students or third parties is also available on the Title IX website, www.Baylor.edu/TitleIX.

The Title IX office understands the sensitive nature of these situations and can provide information about available on- and off-campus resources, such as counseling and psychological services, medical treatment, academic support, university housing and other forms of assistance. Staff members at the office will also explain your rights and the judicial process options, if you choose to file a complaint with the University. You will not be required to share your experience, and the Title IX Office will keep any information private. The Title IX Office exists to support and empower students, while allowing them to remain in control. If you or someone you know feels unsafe or may be in imminent danger, please call the Baylor Police Department (254-710-2222) or Waco Police Department (9-1-1) immediately.

Tentative Course Outline:

The weekly coverage might change as it depends on the progress of the class.

Week	Content
Aug 23, 25	• Introduction to digital communications • Fourier analysis of signals and systems
Aug 30, Sept 1	• Probability theory and Bayesian inference • Stochastic processes
Sept 6, 8	• Signal over AWGN channels
Sept 20, 22	• Signal over AWGN channels • Signaling over band-limited channels
Sept 27, 29	• Signaling over band-limited channels
Oct 4, 6	• Signaling over fading channels
Oct 11, 13	• Signaling over fading channels • Midterm Exam I
Oct 18, 20	• Multicarrier modulation and OFDM
Oct 25, 27	• Channel capacity and coding
Nov 1, 3	• Multiple antenna systems
Nov 8, 10	• Multiuser communications
Nov 15, 17	• Carrier and symbol synchronization • Midterm Exam II
Nov 22	• Topics on green communications
Nov 29, Dec 1	• Topics on next-generation wireless systems and networks