Faculty of Engineering and Technology
Department of Electrical and Computer Engineering
Second Semester 2019/2020

Modern Communication Systems ENEE 3306
Course Outline

Instructor: Dr. Wa'el Hashlamoun **Second Semester 2019-2020**

General Information

Instructor

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Office Hours

To be announced in class and posted both on ritaj and on the office door.

Textbook

Ha H. Nguyen and Ed Shwedyk, A First Course in Digital Communications, Cambridge University Press, 2009, ISBN: 9780521876131

References

1. C. Nassar, Telecommunications Demystified, LLH Technology Publishing (2001).
2. S. Haykin, Communication Systems, 3rd Edition (Wiley)
3. M. P. Fitz, Fundamentals of Communications Systems, McGraw-Hill, 2007.
4. J. G. Proakis and M. Salehi, Fundamentals of Communication Systems, Prentice Hall, 2005.
5. J. G. Proakis and M. Salehi, Contemporary Communication Systems Using Matlab, 2nd Ed., Thomson-Engineering, 2003

6. S. Haykin, Communication Systems, 4th Edition, Wiley, 2000.
7. J. D. Gibson, Principles of Digital and Analog Communications, 2^{nd} Edition, MacMillan, 1989.
8. M. K. Simon, S. M. Hinedi, and W. C. Lindsey, Digital Communication Techniques, Prentice Hall, 1994.
9. R. E. Ziemer and W. H. Tranter, Principles of Communications: Systems, Modulation, and Noise, 6^{th} Edition, Hoboken, NJ : Wiley, 2009.
10. B.P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, Fourth Edition, Oxford University Press, New York, 2009.
11. L. W. Couch,II, Digital and Analog Communication Systems, 8^{th} Edition, Pearson, 2013.
12. Bruce Carlson, Paul B. Crilly and Janet C. Rutledge, Communication Systems: An Introduction to Signals and Noise in Electrical Communications, 4th Edition, McGraw-Hill, 2002.
13. Nevio Benvenuto, Roberto Corvaja, Tomaso Erseghe, and Nicola Laurenti, Communication Systems: Fundamentals and Design Methods, John Wiley & Sons, 2006.

Prerequisites

- ENEE 2307, Probability and Engineering Statistics.
- ENEE 3303, Principles of Communication Systems

ENEE 3306: A Core Course for the Electrical Engineering Curriculum.

Course Description

This course introduces the students to the fundamental concepts pertaining to the transmission of a message signal from a source point to a destination point via digital means. The course starts by reviewing the steps involved in converting an analog signal into a digital stream of binary digits through the process of sampling, quantization, and encoding. Here, we will come across uniform quantization, non-uniform quantization, companding, regular pulse code modulation (PCM), differential PCM, and delta modulation. Then, we will consider the techniques employed in transmitting the binary digits over a channel corrupted by additive white Gaussian noise (AWGN). We will design the optimum receiver, which minimizes the error rate over the channel. Some of the schemes that we consider are binary ASK, binary PSK, and binary FSK. We compare these schemes in terms of error probability, power spectral density, and transmission bandwidth. Next, we generalize the binary transmission schemes to M-ary schemes, where a block of binary digits are considered as one symbol represented by a distinct signal. Then, we consider the transmission of data over a bandlimited channel corrupted by AWGN. The conditions for no inter-symbol interference are established and the optimum design of the receiver is derived. The course also exposes students to multiple-access techniques where a number of users utilize one common channel, such as TDMA, FDMA, and CDMA. Finally, the course briefly introduces the elements of spread spectrum communication.

Intended Learning Objectives

1. To understand the general block diagram of a digital communication system and to be able to explain the function of each block.
2. To learn how a continuous time signal can be converted into a digital signal through sampling, quantization and encoding.
3. To understand what is meant by an optimum receiver for binary data transmission and be able to analyze its performance and apply it to some binary modulation techniques.
4. To be introduced to some baseband signaling schemes such as unipolar, polar, bipolar, and Manchester encoding, and to know how to evaluate their probability of error, power spectral density and bandwidth requirements.
5. Be introduced to some bandpass signaling techniques such as coherent BASK, BPSK, BFSK and QPSK. For each scheme, the student should know how to evaluate the

probability of error, power spectral density and bandwidth requirement.

6. Be introduced to some M-ary modulation techniques such as M-ary ASK, PSK, FSK and quadrature carrier modulation. For each scheme, the student should know how to evaluate the probability of error, power spectral density and bandwidth requirement.
7. To understand the effect of transmitting binary data over a bandlimited channel corrupted by AWGN.
8. Be exposed to some multiple access techniques such as time division, frequency division, and code division multiple access techniques.
9. To understand, compare, and apply the advanced modulation techniques.

Course Outcomes

At the end of this course, the students should

- Be able to know how an analog signal can be converted into a digital signal with minimum distortion when reconstructed at the receiver.
- Have developed an understanding of both binary and M-ary digital modulation and demodulation techniques.
- Have developed an understanding of the effect of transmitting binary data over a bandlimited channel when AWGN is present.
- Understand how one common channel can be utilized by multiple users.
- Understand what spread spectrum means and know how and when to apply it.

(ABET) Relationship of Course to Electrical Engineering Program Student Outcomes

- (a) Ability to apply mathematics, science and engineering principles (outcome to be assessed; second semester 18-19).
- (c) Ability to design a system, component, or process to meet desired needs.

- (k) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Subject to be Covered

Topic	Estimated number of lectures
Introduction to the Course	1
1. Sampling and Quantization (Chapter 4) Ideal Sampling, Natural Sampling, Flat-Topped Sampling, Aliasing, Uniform Quantizer, Optimal Quantizer, Robust Quantizer, Signal to Quantization Noise Ratio, Differential Quantizers, Pulse Code Modulation, Delta Modulation, Data Rate of a PCM System.	3
2. Optimum Receiver for Binary Data Transmission (Chapter 5) Representation of Noise, The Optimum Receiver (the matched filter), Receiver Implementation with One Correlator, Power Spectral Density of the Digital Modulation Waveform.	4
3. Binary Baseband Data Transmission (Chapter 6) Modulation and Demodulation, Error Performance, Power Spectral Density and Bandwidth Requirements for the Following Baseband Binary Signaling Schemes: Polar Non-return to Zero and Manchester Coding.	2
4. Binary Bandpass Data Transmission (Chapter 7) Modulation and Demodulation, Power Spectral Density and Bandwidth Requirements for Some Binary BandPass Modulation Techniques, Like Binary Amplitude Shift Keying (BASK), Binary	4

Phase Shift Keying (BPSK), Coherent and Non-Coherent Binary Frequency Shift Keying (BFSK), and Quadri-Phase Shift Keying (QPSK).	
5. M-ary Signaling Techniques (Chapter 8) Signal Space Representation of Signals, Optimum Receiver for *M*-ary Signaling, *M*-ary Coherent Amplitude-Shift Keying (*M*-ASK), *M*-ary phase-shift keying (*M*-PSK), *M*-ary Quadrature Amplitude Modulation (*M*-QAM), *M*-ary Coherent Frequency-Shift Keying (*M*-FSK), Comparison of *M*-ary Signaling Techniques.	4
6. Signaling over Band-Limited Channels (Chapter 9) Introduction to Inter-symbol Interference (ISI), Nyquist Criterion for Zero ISI, Design of Transmitting and Receiving Filters	3
7. Multiple Access Techniques and Spread Spectrum (Chapter 11) Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Code Division Multiple Access (CDMA).	3
8. Advanced Modulation Techniques (Ch. 11) Spread Spectrum, Pseudorandom Sequences: Generation and Properties, Autocorrelation and Cross-Correlation of the Signature Waveforms, Trellis Coded Modulation (TCM), Generation and Demodulation of a TCM waveform, Error Performance of TCM,	2
9. Signaling over Fading Channels (Ch. 10) – If Time Permits Demodulation with Random Amplitude, Demodulation with Random Phase, Detection with Random Amplitude and Random Phase: Rayleigh Fading Channel.	

Course Assessment

Quizzes	12%
Attendance and Class Performance	4%
Project	10%
Midterm Exam	32%
Comprehensive Final Exam	42%

Absence:
Every unexcused absence results in **-1.0 grade, 4 absences results in a 0 out of 4** in the attendance and class performance.

Missed Quizzes: Four quizzes will be given during the course, out of which the highest three will be counted. **Makeup of missed quizzes will NOT be possible**. Exact time of each Quiz will be announced at least one week in advance.

Missed Midterm: Makeup of missed midterm exams is only possible in extremely exceptional situations, provided there is an extremely compelling reason (such as verifiable medical emergencies).

Course Policy
It is the responsibility of each student to adhere to the principles of academic integrity. (you can find all about academic integrity on Ritaj). Academic Integrity means that the student should be honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. **Cheating will not be tolerated in this course.** University regulations will be pursued and enforced on any cheating student.