BIRZEIT UNIVERSITY
Faculty of Engineering

Faculty of Engineering and Technology
Department of Electrical and Computer Engineering
2nd Semester 2022/2023
Communication Systems ENEE 3309
Course Outline

Instructor: Dr. Ashraf Al-Rimawi and Dr. Al-Hareth Zyoud

General Information

Instructor of the course

Dr. Ashraf Rimawi
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Office Hours

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

Textbook

Introduction to Analog and Digital Communications, 2nd Edition, Simon Haykin and Michael Moher, John Wiley & Sons Inc., New York, 2007.

References

1. M. P. Fitz, Fundamentals of Communications Systems, McGraw-Hill, 2007.
2. J. G. Proakis and M. Salehi, Fundamentals of Communication Systems, Prentice Hall, 2005.
3. J. G. Proakis and M. Salehi, Contemporary Communication Systems Using Matlab, 2nd Ed., Thomson-Engineering, 2003
4. S. Haykin, Communication Systems, 4th Edition, Wiley, 2000.
5. J. D. Gibson, Principles of Digital and Analog Communications, 2nd Edition, MacMillan, 1989.
6. M. K. Simon, S. M. Hinedi, and W. C. Lindsey, Digital Communication Techniques, Prentice Hall, 1994.

7. R. E. Ziemer and W. H. Tranter, Principles of Communications: Systems, Modulation, and Noise, 6th Edition, Hoboken, NJ : Wiley, 2009.
8. B.P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, Fourth Edition, Oxford University Press, New York, 2009.
9. L. W. Couch,II, Digital and Analog Communication Systems, 8th Edition, Pearson, 2013.
10. 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.
11. Nevio Benvenuto, Roberto Corvaja, Tomaso Erseghe, and Nicola Laurenti, Communication Systems: Fundamentals and Design Methods, John Wiley & Sons, 2006.

Prerequisites

- Knowledge of linear systems (ENEE 2302: Signals and Systems)
- Knowledge of basic probability theory (ENEE 2307 Probability and Engineering Statistics).

Course Description

This course introduces the student to the principles of transmitting an information bearing signal from a source point to a destination point with little or no distortion. To achieve this general goal, the course presents models and techniques for representing the information signal and its characteristics both in the time and frequency domains. The course explains in detail the transmission of the message signal using analog modulation techniques, such as amplitude and frequency modulation. The focus is on the methods employed for the generation and demodulation of the information bearing signal, as well as bandwidth and power requirements. The course also, considers the transmission of an analog signal via digital techniques. In this regard, the course highlights the steps involved in this process like sampling, quantization, binary encoding, baseband and bandpass modulation and demodulation techniques. Finally, the course analyses the performance of the various transmission schemes in terms of signal-to-noise ratio, bandwidth requirement, and error performance.

Intended Learning Objectives

1. To understand the general block diagram of a communication system and be able to explain the function of each block.
2. To be introduced to the concepts of power spectral density, energy spectral density, signal bandwidth, and time-bandwidth product.

3. To learn in detail how to modulate, demodulate, and analyze the spectrum of the following amplitude modulation techniques: normal AM, DSB-SC, SSB-SC.
4. To learn in detail how to modulate, demodulate, and analyze the spectrum of a frequency modulated signal.
5. To learn how a continuous time signal can be converted into a digital signal through sampling, quantization and encoding.
6. 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.
7. To be exposed to some bandpass signaling techniques such as: coherent BASK, BPSK, BFSK and QPSK, and to know how to evaluate their probability of error, power spectral density and bandwidth requirements.
8. To understand the performance of some analog modulation techniques in AWGN.

Course Outcomes

At the end of this course the student:

- Should be familiar with both the time and frequency domain representation of signals and systems.
- Have developed an understanding of continuous wave linear and non-linear modulation and demodulation techniques.
- Have developed an understanding of digital modulation and demodulation techniques.
- Have developed an understanding of the effects of noise in communication systems.

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

- (a) Ability to apply mathematics, science and engineering principles.
- (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

1. Spectrum Analysis (just four lectures will be allocated to this part)
   Signal Classifications, Fourier Series, Parseval's Power Theorem, Fourier Transform, Properties of Fourier Transform, Rayleigh

Energy Theorem, Rise-time, Bandwidth, Time-Bandwidth Product, Filters.

2. Amplitude Modulation (AM) Systems

- Normal AM: Definition, Spectrum, Bandwidth, Power efficiency, Modulation Index, Generation and Demodulation

- Double Sideband Suppressed Carrier Modulation (DSB-SC): Definition, Spectrum, Bandwidth, Coherent Demodulation, Effects of Carrier Non-coherence on the Demodulated Signal, Generation and Demodulation

- Single Sideband Suppressed Carrier Modulation (SSB): Definition, Spectrum, Bandwidth, Generation using the Filtering and Phasing Methods. Coherent Demodulation, Effects of Carrier Non-coherence on the Demodulated Signal (Constant Phase Difference and Constant Frequency Difference).

3. Angle Modulation: Frequency and Phase Modulation

   Basic Definitions for a Phase (PM) and Frequency Modulated (FM) Signals, Single Tone FM, The FM Modulation Index, Spectrum of a Single Tone FM Signal, Power and Bandwidth Relations for an FM Signal, Carson's Rule. Generation and Demodulation of an FM Signal.

4. Pulse Code Modulation

   Ideal Sampling, Natural Sampling, Flat-Topped Sampling, Aliasing, Uniform Quantization, Signal to Quantization Noise Ratio, Companding, Line Coding Techniques, Delta Modulation, Data Rate of a PCM System.

5. Beseband and Bandpass Data Transmission

   The Matched Filter, Modulation and Demodulation, Power Spectral Density and Bandwidth Requirements for Some Baseband and BandPass Modulation Techniques, Like Polar Non-return to Zero, Manchester Coding, Amplitude Shift Keying (ASK), Phase Shift Keying (PSK), Coherent and Non-Coherent Binary Frequency Shift Keying (FSK), Quadri-Phase Shift Keying (QPSK).

6. Performance of Communication Systems in Noise

   Noise and its Properties, The Additive White Gaussian Noise (AWGN), Performance of Analog and Digital Modulation Techniques Transmitted Over a Channel Corrupted by AWGN.

Course Assessment (assuming regular teaching model)

▪ Quizzes	20%
▪ Midterm Exam (30/05/2023)	35%
▪ Comprehensive Final Exam	45%

Missed Quizzes: **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.