ECE 403 (405) - Digital & Data Communications (with Laboratory)

Credits: 3, **Contact Hours:** two 75 minute lecture sessions per week

Credits: 4, **Contact Hours:** two 75 minute lecture sessions per week and one 160 minute laboratory session per week

Coordinator: C. Zhou, Associate Professor of ECE

Textbook: J. G. Proakis and M. Salehi, *Fundamentals of Communication Systems*, Pearson Prentice Hall, 2014.

2019 Catalog Data: ECE 403: Digital & Data Communications. Credit 3.
Introduction to Amplitude, Phase, and Frequency modulation systems. Multiplexing and Multi-Access Schemes; Spectral design considerations. Sampling theorem. Channel capacity, entropy; Quantization, wave shaping, and Inter-Symbol Interference (ISI), Matched filters, Digital source encoding, Pulse Modulation systems. Design for spectral efficiency and interference control. Probability of error analysis, Analysis and design of digital modulators and detectors. Lecture: 3 Lab: 0 Credits: 3 Satisfies: ECE Professional Elective (P)

. ECE 405: Digital & Data Communications with Laboratory. Credit 4.
Introduction to Amplitude, Phase, and Frequency modulation systems. Multiplexing and Multi-Access Schemes; Spectral design considerations. Sampling theorem. Channel capacity, entropy; Quantization, wave shaping, and Inter-Symbol Interference (ISI), Matched filters, Digital source encoding, Pulse Modulation systems. Design for spectral efficiency and interference control. Probability of error analysis, Analysis and design of digital modulators and detectors. Lecture: 3 Lab: 1 Credits: 4 Satisfies: ECE Professional Elective (P)

Prerequisites or co-requisites by topic: ECE 308

Enrollment: Elective course for CPE and EE majors

Specific outcomes of instruction:

After completing ECE 403, the student should be able to do the following:

1. Determine the frequency spectrum and bandwidth of AM and FM signals.
2. Perform noise analysis of AM and FM receivers with power spectral densities.
3. Apply the sampling theorem to analog signals.
4. Design uniform and non-uniform quantizers for Gaussian sources.
5. Represent digital signal using orthonormal functions.
6. Design a receiver for baseband digital modulation formats.
7. Recover digital signals using distance and correlation metrics.
8. Understand coding and decoding using linear block codes.

After completing ECE 405, the student should be able to do the following:

1. Determine the frequency spectrum and bandwidth of AM and FM signals.
2. Perform noise analysis of AM and FM receivers with power spectral densities.
3. Analyze frequency and time division multiplexing systems.
4. Apply the sampling theorem in pulse amplitude modulated systems.
5. Compute channel bit rate and bandwidth needed for pulse code modulated systems.
6. Generate and analyze ASK, FSK, and BPSK
7. Complete an engineering design incorporating engineering standards and realistic constraints.
8. Prepare an informative and organized design project report.

Relationship of ECE 403 & 405 specific outcomes of instruction to student outcomes:

	Student Outcomes	ECE 403 Goals	ECE 405 Goals
1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	1, 2, 3, 4, 5, 6, 7, 8	1, 2, 3, 4, 5, 6, 7
2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	4, 6	5, 7
3	An ability to communicate effectively with a range of audiences		8
4	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts		
5	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives		8
6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions		1, 2, 3, 4, 5, 6, 7
7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies		

Topics:

- Introduction to Digital Communications (1 week)
- Review of signals, probability, and Fourier Transform (1 week)
- Amplitude Modulation (2 week)
- Angle Modulation including Frequency Modulation and Phase Modulation (2 weeks)
- Analog-to-Digital conversion (2 week)
- Information, Entropy, Huffman Source Coding (2 weeks)
- Discrete channel model and channel capacity (1 weeks)
- Channel coding theorem and linear block codes (2 weeks)
- Pulse Amplitude Modulation (1 week)
- Digital modulation and detection, including ASK, FSK, and PSK (1 weeks)

Laboratory topics (ECE 405 only):

- Introduction to TIMS systems (1 week)
- Implement multiplexing (1 week)
- DSBSC generation (1 week)
- Determine the frequency spectrum, bandwidth, envelope, and recovery of AM (2 weeks)
- SSB generation and demodulation (1 week)
- Analyze FM signal using VCO (2 week)
- Analyze the performance of PCM (1 week)
- Digital modulation, including ASK, FSK, and BPSK (2 weeks)
- Final design project, presentation, demonstration, and report (4 week)

Prepared by: C. Zhou **Date:** February 26, 2020