ECE4601 Course Syllabus

ECE4601

Communication Systems (3-0-0-3)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Elective for the EE degree.

Lab Hours
0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Ji,Chuanyi

Prerequisites
(ECE 3020 [min C] or ECE 3040 [min C] or ECE 3084 [min C]) and (CEE/ISYE/MATH 3770 or ISYE 2027 or ECE 3077)

Corequisites
None

Catalog Description
To present the fundamentals of modern digital communication systems and evaluate their performance with realistic channel models.

Textbook(s)
Simon Haykin, *Digital Communication Systems*, Wiley, 2014. ISBN 9780471647355 (required)

Course Outcomes
Upon successful completion of this course, students should be able to:

1. Work with the basics of random processes including ensemble and time averaging, deriving autocorrelation functions and power spectra, and the filtering of random processes.
2. Describe fundamental elements and processes in digital transmission systems including matched filtering, baseband pulse shaping, intersymbol interference, noise, and equalization.
3. Describe bandpass signals and systems and their representations, basic channel models, and signal space respresentations.
4. Implement various types of binary and M-ary digital modulation schemes, including both single-carrier and multi-carrier modulation schemes, and basic spread spectrum techniques.
5. Evaluate the performance of digital signaling on additive white Gaussian noise channels with various types of detectors, including coherent, non-coherent and differentially coherent detectors.
6. Implement basic block and convolutional error correction coding and decoding schemes.

Student Outcomes

In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
“LN” for “little to none” indicates that the course does not contribute significantly to this outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (LN) 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
3. (LN) An ability to communicate effectively with a range of audiences
4. (LN) 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. (LN) 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
6. (LN) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (M) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

Prerequisites: (ECE 3020 [min C] or ECE 3040 [min C] or ECE 3084 [m

Review of Probability and Random Processes
- Basics of Probability
- Statistical Averages
- Some Useful Distributions
- Random Processes
- Statistical Characterization of Random Processes
- Power Spectral Density
- Random Processes Through Linear Systems
- Gaussian Random Processes

Baseband Pulse Transmission
- Matched Filters
- Probability of Error due to Noise
- Intersymbol Interference
- Nyquist Pulse Shaping
- Partial Response Signaling
- M-ary PAM Transmission
- Linear Equalizers
- Adaptive Equalizers

Digital Bandpass Transmission
- Representations of Bandpass Signals and Systems
- Signal-space Representations
- Detection of Known Signals in AWGN

- Correlation and Matched Filter Receivers
- Error Probability for Binary Signals
- Detection of Signals with Unknown Phase
- Differential Detection
- M-ary Modulation Techniques

Spread Spectrum Modulation
- Pseudo-noise Sequences
- Direct-Sequence Spread Spectrum
- Frequency-Hopped Spread Spectrum
- Code Division Multiple Access

Information Theory - as time allows
- Uncertainty, Information, Entropy
- Source coding Theorem
- Data Compaction
- Discrete Memoryless Channel
- Mutual Information
- Channel Capacity

Error Control Coding - as time allows
- Linear Block Codes
- Convolutional Codes
- The Viterbi Algorithm