EEE 455 Communication Systems (4) [F,S]

Course (Catalog) Description:
Signal analysis techniques applied to the operation of electrical communication systems.
Introduction to and overview of modern digital communications.
Lecture, lab. Technical Elective.
Prerequisites:
EEE 203, EEE 350.

Textbook:
B. P. Lathi and Zhi Ding, *Modern Digital and Analog Coimmunication Systems*, Fourth Edition,
Oxford University Press, 2009; ISBN-13: 978-0195331455.

Coordinator:
Daniel W. Bliss

Prerequisites by Topic:
1. Fourier analysis
2. Random Signal Theory

Course Objectives:
1. Students will be able to analyze basic digital communication systems
2. Students will be able to determine the suitability of a particular communication system to a given problem

Course Outcomes:
1. Students can analyze basic digital communication systems
2. Students can use basic communications bounds on information
3. Students can understand the concept of "noise" in analog and digital communication systems
4. Students can understand the trade-offs (in terms of bandwidth, power, and complexity requirements) between basic digital communication systems
5. Students can understand the concepts of up/down conversion and modulation
6. Students can understand simple block forward error correction codes
7. Students can understand basic dispersion compensation concepts
8. Students can design basic digital communication systems to solve a given communications problem

Course Topics:
1. Introduction to communications, history, Open System Interconnection (OSI) functional layers, functional blocks of the Data Link and Physical Layer (0.5 weeks)
2. Review of Fourier theory, deterministic and random signals, signals energy and power spectral density (1.5 week)
3. Sampling, digital information sources, entropy (1 weeks)
4. Quantization and source coding (2 weeks)
3. Analysis of up/down conversion and complex baseband representation (1 week)

6. Signal spaces in band-limited complex channels, constellations, optimum receiver design and error probability over Additive White Gaussian Noise (AWGN) channels, Shannon limit over AWGN channels. (4 weeks)
7. Block forward-error-correction codes (2 weeks)
8. Asynchronous reception, Inter Symbol Interference channels and Multipath propagation (1 week)
9. Orthogonal Frequency Division Multiplexing (OFDM) and Spread-Spectrum modulations, examples of current standards (e.g. 802.11g and 802.11a, LTE, GPS) (2 weeks)

Computer Usage:
Lab 2: Write a MATLAB program for digital analysis
Lab 3: Write a MATLAB program for digital communication simulation
Lab 4: Write a MATLAB program for simple over-the-air digital modulation and analysis
Lab 5: Write a MATLAB program for over-the-air digital modulation and analysis
Lab 6: Write a MATLAB program for over-the-air digital modulation and analysis

Laboratory Experiments:
1. Students meet weekly for a three-hour laboratory under the guidance of a TA.
2. MATLAB digital signal analysis
3. MATLAB software-defined radio over-the-air digital modulation transmission
4. MATLAB software-defined radio over-the-air digital modulation, acquisition, and detection
5. MATLAB software-defined radio over-the-air OFDM modulation
6. MATLAB software-defined radio over-the-air OFDM modulation acquisition, and detection

Course Contribution to Engineering Science and Design:
Contribution to Engineering Science: The course is an excellent example of how a complicated mathematical theory (e.g., linear systems, and random signal theory) is used in an engineering problem (of communication system design and analysis).
Contribution to Engineering Design: The laboratory assignments help the students design-specific communication systems.

Course Relationship to Program Outcomes:
a: Through the use of mathematical tools and selected (advanced) topics in communications that are covered in class.
b, c,e: Through the laboratory experiments.
k: Through the computer assignments as part of the homework assignments and laboratory experiments

People preparing this description and date of preparation: Daniel W. Bliss, Cihan Tepedelenlioglu, Anna Scaglione, Feb. 2015.