Title: DIGITAL COMMUNICATIONS

Credits: 3 (3 lecture - 0 lab)

Coordinator: Abdulhameed Al-Sanie, Associate Professor, Electrical Engineering

Textbook: Communication Systems, 4th edition, S. Haykin, John Wiley & Sons, Inc., 2001. ISBN 0-471-17869-1

Prerequisites by Topic:
Strong background in continuous and discrete-time signals and systems, basic knowledge of analog communication systems, as well as working knowledge of probability theory and statistics.

Course Learning Objectives
Students are expected to demonstrate the ability to:

1. Learn the fundamental concepts of a digital telecommunication system.
2. Characterize sampling and quantization of analog signals to generate pulse modulation.
3. Analyze baseband transmission of digital signals.
4. Study the geometric representation of signals.
5. Analyze and design passband digital communications techniques.
6. Describe the architecture of common digital communication systems.
7. Determine the bit error rate of basic modulation formats when operating in white Gausian Noise environments.
8. Determine the advantages of error correcting codes on the performance of digital communication systems.
9. Design digital communication systems to operate in noisy environments and to achieve basic system specifications on bandwidth usage, data rate, and error rate performance.
10. Understand basic concepts of source coding.

Topics:
- Review of probability theory and random variables.
- Random Processes
- Baseband Transmission.
- Digital Passband transmission.
- Coherent Digital Modulation Schemes.
- Non-coherent Digital Modulation Schemes.
- Information Theory.
- Error Control Coding.

Course Structure:
The class meets for three lectures a week, each consisting of 50 minute sessions. There is regular homework and two midterm exams.

Week	Topics
1	Review of probability theory and random variables. Random Processes
2-3	**Baseband Transmission** ▪ Detection of binary signals in Gaussian noise - Maximum likelihood receiver structure. - The matched filter. - Correlation realization of the matched filter - Bit Error probability performance of binary signaling. ▪ Inersymbol Interference - Pulse shaping to reduce ISI. - Nyquist Bandwidth constraint.
4	**Digital Digital Passband transmission** ▪ Passband Transmission model. ▪ Gram-Schmidit Orthogonalization Procedure. ▪ Geometric Representation of signals.
5-7	**Coherent Digital Modulation Schemes** ▪ Introduction to coherent modulation schemes. ▪ Binary Phase Shift Keying (BPSK). ▪ Binary Frequency Shift Keying (BFSK). ▪ Binary Amplitude Shift Keying (BASK). ▪ M-ary Modulation schemes (M-PSK, M-FSK, M-QAM). ▪ Power Spectra of Binary PSK signals. ▪ Power Spectra of Binary FSK signals. ▪ Power Spectra of M-PSK signals. ▪ Power Spectra of M-FSK signals. ▪ Bandwidth Efficiencies of M-FSK and M-PSK signals. ▪ Performance and comparison between different modulation techniques.
8	**Non-coherent Digital Modulation Schemes** ▪ Binary DPSK. ▪ Noncoherent binary FSK.
9-11	**Information Theory** ▪ Uncertainty, information, and Entropy. ▪ Source Coding. ▪ Discrete memoryless channels. ▪ Channel capacity.
12-13	**Error Control Coding** ▪ Linear Block codes.

	▪ Convolutional code. ▪ Viterbi decoder for convolutional codes.

Grading:

- First Exam 20%
- Second Exam 20%
- Homework and Quizzes 20%
- Final Exam 40%

Attendance Policy:
According to KSU policy, every student should attend at least 75% of the course classes (including the tutorials). Those who fail to fulfill this condition will fail in the course.

Outcome Coverage:

a. Apply math, science and engineeringThis course has extensive mathematical modeling of various elements of Digital communication systems.. Understand baseband pulse transmission, including matched filtering, and signal design for intersymbol interference channels. Understand digital modulation and demodulation, including analysis of their performance in noise and calculate probability of bit error for various systems. Understand basic concepts of source and channel coding.
b. An ability to design and conduct experiments, as well as to analyze and interpret data.
None

c. An ability to design a system, component, or process to meet desired needs.
Explain the parameters and tradeoffs involved in communication system design. Give examples for various system tradeoffs (e.g., transmission rate vs. bandwidth). Design coherent and noncoherent receivers, calculate probability of bit error for various systems and select the appropriate modulation technique to meet the required performance and channel bandwidth.

e. Identify, formulate and solve engineering problems

H. Broad education necessary to understand the impact of engineering solutions in a global and societal context
Familiarity with current and future applications of digital communications, and their larger impact on society.
J. Knowledge of contemporary issues.
Attention is given on contemporary issues such as the application of adaptive modulation techniques in some of the new communication systems.

Preparer: Abdulhameed Al-Sanie

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