ECE 4112: Digital Communications and Networks

Credits and contact hours: 3 Credits (Three 50-minute lectures per week)

Instructor: Shengli Zhou

Textbook: Digital Communication Systems, Haykin (2014)
Communication Networks: A Concise Introduction, Walrand & Parekh (2010)

a. *Other supplemental materials* : none

***Specific course information*:**

a. *Catalog Description*: Fundamentals of digital communication systems. Encoding of analog signals for digital transmission. Basic information theory. Source encoding techniques. Baseband data transmission. Digital carrier modulation schemes. Multiplexing techniques. Basic error control coding.

b. *Prerequisite*: ECE 3101 and STAT 3345Q or MATH 3160

c. *Required, elective, or selected elective:* Selected elective

***Specific goals for the course*:**

a. *Specific outcomes of instruction*: Student learn to analyze binary and *M*-ary digital modulation/demodulation scheme (with its performance analysis, source and channel coding with their fundamental limits), the OSI "Data Link," and the "Network" layers. Students will be able to apply the probability tools (STAT 3345Q/MATH 3160) and the system theory (ECE 3101) to digital communications and networks.

b. *ABET Criterion 3 Student Outcomes addressed by the course*:

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
Students learn to apply techniques from statistics and optimization to engineering problems. Students translate specifications in terms of probability of error and throughput, and constraints in terms of bandwidth, power and cost into operational requirements. Students are required to use the computer to analyze and simulate a digital communication system, particularly their probabilities of error and efficiency.

(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
n/a

(3) an ability to communicate effectively with a range of audiences
n/a

(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
n/a

(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
n/a

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
n/a

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
Students use the web, library databases, and other resources to enhance their learning.

Topics covered:

- review of statistics, with special attention to fundamental probability concepts, and to Bernoulli, Poisson and Gaussian random variables
- maximum a-posteriori (MAP) decision rule for minimum probability of error
- signal space
- optimal coherent receiver (matched filter)
- exact and approximate (union bound based) performance analysis
- optimal noncoherent receivers and performance analysis (e.g. of DPSK)
- entropy and source coding: Huffman and Lempel-Ziv
- channel capacity
- block coding, syndrome decoding and performance analysis
- convolutional coding, Viterbi decoding, and performance analysis
- OSI network layer definitions and structure
- data link layer: re-transmit protocols
- medium access control: ALOHA, Ethernet, token ring, etc.
- introduction to Poisson processes and analysis of queues
- optimal routing via Bellman Ford and its variants