16:332:545 Digital Communications

Instructor: Prof. Athina Petropulu
Office: Core 510
Email:athinap@rutgers.edu

Instructor Office Hours: Monday 1-3 pm

About the Course

Digital communication systems offer advantages such as reliable long-distance transmission, resistance to noise, and seamless integration with digital data processing systems. Widely applied in technologies like the internet, mobile communications, digital television, and computer networks, digital communication systems play a pivotal role in modern communication.

A digital communication system transmits information in a digital form from a source to a destination. The transmission occurs over a physical medium, referred to as channel, which could be a wired medium (like a fiber optic cable) or a wireless medium. The key components of the system include the source coder, which converts the source analog signal into a digital format through sampling and quantization; the channel encoder, adding redundancy for error detection and correction; and the modulator, converting the digital signal into a format suitable for transmission over the channel, for example into Phase Shift Keying (PSK) or Quadrature Amplitude Modulation (QAM) formats. At the receiver, the demodulator reverses the modulation process, and the channel decoder removes redundancy and corrects errors. The source decoder then restores the original signal.

This course covers the fundamental principles governing the analysis and design of digital communication systems.

Course Schedule: Tuesday and Friday 12:10-1:30

Prerequisites: Knowledge of probability and stochastic processes, linear systems, digital signal processing.

Text: J. G. Proakis and M. Salehi, Digital Communications, Fifth Edition, McGraw-Hill Book Company, New York, NY, 2008.

TENTATIVE COURSE OUTLINE

Review of Probability and Stochastic Processes

Source Coding
Measures if Information, coding for discrete sources

Representation of Digitally Modulated Signals
Representation of bandpass signals, signal space representation, representation of digitally modulated signals, spectral characteristics of digitally modulated signals

Optimum Demodulation Methods for Digital Communications over Additive White Gaussian Noise (AWGN) Channels
correlation demodulator, matched-filter demodulator, optimum detector, maximum-likelihood sequence detector, probability of error

Carrier and Symbol Synchronization
Carrier phase estimation, symbol timing estimation

Channel Capacity and Coding
Achieving channel capacity with orthogonal signals, channel reliability functions

Communication Through Band-Limited Linear Filter Channels
Optimum receiver for channels with intersymbol Interference (ISI) and AWGN, linear equalization, decision feedback equalization

Emerging Trends and Technologies
5G and beyond, Orthogonal Frequency Division Multiplexing (OFDM), Orthogonal Time Frequency Space (OTFS), multi-access systems, Rate-Splitting Multiple Access (RSMA), Machine Learning in Digital Communications