RUTGERS UNIVERSITY
The State University of New Jersey
School of Engineering
Department of Electrical and Computer Engineering

332:545 Digital Communications Systems Spring 2014

This course is an introduction to digital communication theory and systems. Topics to be covered include: orthonormal expansions, effect of additive noise in electrical communication systems, vector channels, waveform channels, matched filters, bandwidth and dimensionality. Review of statistical decision and estimation fundamentals, detection of known signals in noise. Optimum receiver structures and probability of error.

The functional characterization of digital signals and transmission facilities will be highlighted along with band-limited and time-limited signals, modulation and demodulation techniques for digital signals, carrier recovery methods and symbol synchronization techniques for bandpass systems. Intersymbol interference and equalization methods will also be presented.

INSTRUCTOR: Dr. D. G. Daut, EE Building, Room 232, 732-445-5393
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CLASS HOURS: Monday and Wednesday, 5:00-6:20 p.m., ARC, Room 105

PREREQUISITES: 16:332:541 Stochastic Signals and Systems. A background in linear systems and transform theory.

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

REFERENCES:

J. G. Proakis, M. Salehi and G. Bauch, *Contemporary Communication Systems Using MATLAB and Simulink*, Second Edition, Thomson Engineering, 2004.

R. E. Ziemer and R. L. Peterson, Introduction to Digital Communications, Second Edition, Prentice-Hall, Inc., Upper Saddle River, NJ, 2001.

J. M. Wozencraft and I. M. Jacobs, *Principles of Communication Engineering*, Waveland Press, Inc., IL, (c.1965) 1990.

J. R. Barry, E. A. Lee and D. G. Messerschmitt, *Digital Communications*, Third Edition, Kluwer Academic Publishers, Norwell, MA, 2004.

TOPICAL OUTLINE:

Characterization of Digital Signals and Transmission Facilities
- Representation of Bandpass Signals and Systems
- Orthonormal Signal Expansions
- Signal Design and Gram-Schmidt Procedure
- Representation of Bandpass Stationary Stochastic Processes

Basic Information Measures
- Source Models and Source Encoding
- Channel Models and Channel Capacity

Digital Modulation Schemes
- Linear and Nonlinear Modulation Classes
- Spectral Analysis of Digitally Modulated Signals

Classical Statistical Decision and Estimation Concepts
- Binary and Composite Hypothesis Tests
- Detection of Binary and M-ary Signals in White Noise

Optimum Receiver Principles
- Vector Channels, Waveform Channels, and Probability of Error

Digital Carrier Modulation and Demodulation Schemes
- Baseband and Bandpass Receiver Systems
- Binary Schemes: BASK, BPSK, BFSK and MSK
- Non-Binary Schemes: MASK, MPSK and MFSK
- Coherent and Non-Coherent Signal Detection

Modulator and Demodulator Error Probability Analysis
- Uncoded System Performance in Presence of Noise

Carrier Recovery Schemes
- Square-Law and Costas Loop Methods
- Phase Locked Loops

Timing Recovery Schemes
- Maximum Likelihood and Heuristic Techniques

Intersymbol Interference (ISI) - Its Effects on System Performance and Techniques to Minimize ISI:
- Band-limited Channels
- Signal Design and Spectrum Shaping
- Partial Response Signaling

Equalization Techniques
- Peak Distortion and Mean-Square-Error Criteria
- Decision-Feedback and ML Sequence Estimation