Department of Electrical Engineering
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ELEG 5693 Wireless Communications
Test 2 Review

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CODING

- **Introduction**
  - Source code, channel code; only in digital communication system.
- **Source code**
  - Convert analog signal to digital signal; reduce redundancy in digital signal representation.
  - Loseless source code; source code without loss.
  - Sampling theorem: sampling rate >= 2 x maximum bandwidth
  - PCM: sampling and quantization
  - Entropy: how to calculate entropy.
  - Speech coding:
    - waveform coder (PCM)
    - Vocoder: encoding by extracting the parameters of speech signal (LPC)

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CODING

- **Channel coding**
    - Protect the transmitted information by adding redundancy.
    - Error detection, error correction
    - Channel capacity: the maximum data rate supported by a channel given bandwidth and SNR.
- **Convolutional code**
    - (n, k, K). # of states
    - Register representation; input-output table; state transition diagram; trellis diagram.
    - Encoding
    - Optimum hard decoding: find the codeword with the smallest Hamming distance
    - Viterbi algorithm
- **Interleaving**
    - What is interleaving? Why does it help?
    - Block interleaving and deinterleaving

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EQUALIZATION

- **Introduction**
  - Intersymbol interference in frequency selective fading

$$y_k = \sum_{l=0}^{L-1} h_l(k) x_{k-l} + n_k$$

  - equalization: signal processing employed at receiver to mitigate ISI.
  - Linear equalization: ZF, LMS, etc.
  - Nonlinear equalization: DFE, MLSE, etc. (MLSE is the optimum one)
- **MLSE**
  - Cost function of maximum likelihood sequence estimation. (Euclidean distance)
  - State representation of ISI system: # of states; register representation; trellis diagram
  - Viterbi algorithm: minimize the accumulated Euclidean distance.

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DIVERSITY

- **Introduction**
  - What is diversity. (multiple replica, statistical independent channel)
  - Utilizing the properties of fading (time varying, frequency selective)
- **Classification**
  - Time diversity (channel coherence time).
    - Example: interleaving
  - Frequency diversity (coherence bandwidth)
    - Example: frequency selective fading with equalization
  - Space diversity
    - Receive diversity, transmit diversity
    - SIMO, MISO, MIMO

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DIVERSITY

- **Space diversity**
  - Instantaneous SNR of non-diversity system
  - Selection diversity: operation; instantaneous SNR
  - MRC (optimum one): operation; instantaneous SNR
  - EGC: operation; instantaneous SNR.

- **Orthogonal space time block coding**
  - 2 Tx, 1 Rx (operations, SNR)
  - 2 Tx, M Rx (operations, SNR)

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MULTICARRIER

- **Introduction**
  - MCM
  - Why MCM?
  - Frequency diversity, time diversity
- **OFDM**
  - DFT, IDFT, linear convolution, circular convolution
  - Cyclic prefix
  - Transmitter and receiver structure of OFDM
  - Matrix representation of OFDM
- **Challenges**
  - PAPR
  - Frequency and timing offset
- **IEEE 802.11a**

CDMA

- **Fundamentals**
  - What is CDMA?
  - Classifications: DSSS, FHSS
  - Inner product, orthogonal
  - Operations: transmitter, receiver, multiple access
  - PN code: auto-correlation (noise like), cross-correlation (small)
  - MAI:
    - users are not perfectly synchronized;
    - spreading code not perfectly orthogonal.
    - Near-far effect.
  - Bandwidth: spread spectrum
  - Processing gain (narrow band interference)

CDMA

- **PN sequence**
  - Walsh code
    - How to generate
    - Demonstrate that two codes are orthogonal.
  - M-sequence:
    - Shift register
    - Sequence length
    - Long sequence, short sequence
- **Rake receiver**
  - Rake finger
  - Due to the low correlation between the shifted version of the same signal, each finger can be treated as flat fading.
    - No equalization needed.
- **Advantages of CDMA**
  - Resistant to narrow band interference; No equalization; multiple users share the same spectrum; good security.

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WIRELESS NETWORK

- **Ad-hoc wireless network**
  - Concept: ad hoc v.s. infrastructure
- **Protocol layers**
  - Vertical: service
  - Horizontal: Protocol
  - Concepts: network architecture, protocol, protocol stack, PDU
  - OSI model: physical, data link (MAC sublayer), network, transport, session, presentation, application
- **Cross-layer design**