ECE 717 -- Information Theory and Coding, Spring, 2004

Instructor: Prof. Stephen Wilson, C-319, Thornton Hall, sgw@virginia.edu

Text: Elements of Information Theory, Cover and Thomas

References (on reserve):
- Gallager, Information Theory and Reliable Communication
- Lin and Costello, Error Control Coding
- Wilson, Digital Modulation and Coding

Objectives: This course seeks to convey the basic principles of information theory (more specifically Shannon theory), namely the concepts of entropy, mutual information, channel capacity, and rate-distortion theory and what they reveal about efficient information transfer. Applications of the theory to source coding, or data compression, and to channel coding, or error control coding, will be made. Though the material has strongest connections to communication systems, we’ll try to provide links to fields in computer science, systems engineering, and biology, dependent on interests of the class.

Assessment: about 7 homeworks sets (45%), a mid-term exam (25%) and a final exam (30%). Students are allowed to collaborate on concepts involved in homework.

Prerequisites: facility in probability theory, for both discrete and continuous variables (density functions, moments, conditional density, law of large numbers, etc). Familiarity with random process concepts (Markov chains and correlation function/power spectrum in particular) is helpful but not essential. EE 611 or equivalent is certainly adequate preparation. The course does not rely strongly on a background in EE.

Syllabus:

0. The Big Picture for Information Transmission

1. Definitions and Properties of Entropy, Relative Entropy (Divergence) and Mutual Information for Discrete Ensembles (Chapter 2)

2. Asymptotic Equipartition Property (Chapter 3)

3. Entropy Rates of Random Processes (Chapter 4)

4. Source Coding for Discrete Sources (Shannon, Huffman and Lempel-Ziv)
5. Channel Capacity (Chapter 8); Converse to Noisy Channel Coding Theorem and Noisy Channel Coding Theorem, Joint Source/Channel Coding Theorem

6. Block Coding for Noisy Channels (Wilson text)

7. Extensions to Sources and Channels with Continuous Random Variables; the Gaussian Channel (Chapters 9/10)

8. Rate Distortion Theory and Data Compression Revisited (Chapter 13)

9. Multi-User Information Theory (Chapter 14) (time permitting)