Northwestern University
Department of Electrical and Computer Engineering

ECE 428: Information Theory   Spring 2004

Information Sheet:

Instructor:

Prof. Randall Berry
Office: M318 Technological Institute
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Office Hours: TBA

Time and Place:

T-Th 9:30-11:00 am, Rm L158.

Prerequisites:

- ECE 422, ECE 378.
- Good understanding of probability and mathematical maturity.

Text:

Cover & Thomas, *Elements of Information Theory*, John Wiley & Sons, 1991.

Course Overview:

In 1948, Claude E. Shannon published a two-part paper entitled "A Mathematical Theory of Communication." This paper established the field of information theory. Shannon original work addressed the fundamental limits of communication systems. Since that time, information theory has expanded and impacted numerous fields including probability, statistics, finance and linguistics. In this course, our focus will be on those aspects of information theory that are most relevant to communication systems; other aspects of this theory will also be addressed as time permits. In this context, two basic problems will be addressed: (1) the binary representation of an information source and (2) the transmission of data over a communication channel. The first problem concerns source coding or compression, the second problem concerns channel coding or reliable communication. Information theory provides a unified framework for addressing both of these questions. In this course, we will precisely formulate each of these problems and study their information theoretic solutions. Our goal is to understand the basic models and results of information theory as well as the methods used to attain these results. If time permits, some advanced topics may also be discussed.

Course Handouts:

Handouts not picked up during class and other announcements will be available on the course web site at http://www.ece.northwestern.edu/~rberry/ECE428/.

Problem Sets:

Problem sets will be assigned on a quasi-weekly schedule. In making up the exams, it will be assumed that you have worked all the problems. Working together in small groups on the problem sets is encouraged, however each person should write up their own solution to hand in.

The problem sets are intended to help you learn the material and whatever maximizes learning for you is desirable. As in any course, after completing the problems, you should spend time thinking about what the point of the problem and understanding any general principals that are involved – this is by far more important than simply getting the correct answer!

Problem sets must be handed in by the end of the class in which they are due. Late problem sets will not be accepted.

Course Grade:

Your final grade in the course is based upon our best assessment of your understanding of the material. The weightings used to determine the final grade are:

Midterm	35%
Final Exam	40%
Problem Sets	25%

Exams:

There will be a one midterm and one final exam in this class. The midterm exam will be on **Tuesday, May 4** during class. The exams will be closed book, but you may bring one page of size 8.5x11 paper containing handwritten notes to the midterm and two pages to the final.

Reference Texts:

R.G. Gallager, *Information Theory and Reliable Communication*, John Wiley & Sons, 1968.

R. J. McEliece, *The Theory of Information and Coding*, 2nd Ed., Cambridge University Press, 2002.

C.E. Shannon, "A Mathematical Theory of Communication",
Available at: http://cm.bell-labs.com/cm/ms/what/shannonday/paper.html
Originally appeared in *Bell Systems Technical Journal*, July and Oct. 1948.

Most recent work in information theory is published in the
IEEE Transactions on Information Theory.

Syllabus (tentative):

I. Introduction
II. Information measures - entropy, relative entropy, the AEP, entropy rates.
III. Data Compression – Kraft inequality, Huffman codes, Universal source codes.
IV. Channel capacity – Discrete channels.
V. Channel capacity - Gaussian channels – differential entropy.
VI. Rate distortion theory.