

**EECS 651**  
**Source Coding Theory**  
**Winter 2005**

**Synopsis**

Source coding (i.e. data compression) is the process of creating binary representations of the data from sources such as speech, images, audio, video or English text. This course gives a broad introduction to the theory and practice of lossy coding (i.e. quantization), where perfect reproductions are not possible or require too many bits (e.g. speech, images, audio, video) and some introduction to lossless coding, where perfect reproductions are required (e.g. text). The lossy codes include scalar, vector, predictive (e.g. DPCM), transform (e.g. JPEG, MPEG, H.26X), subband (e.g. MP3, wavelet, JPEG2000), predictive and adaptive quantizers (e.g. CELP); and the theory is mainly high-resolution quantization theory. The lossless techniques include Huffman, run-length, Lempel-Ziv, and arithmetic codes; and the theory is entropy theory. Particular attention is paid to coding speech and images. Students will gain experience in source coding through a term project. The course is oriented toward first and second year graduate students, i.e. it is taught at the "500" level. It is a kernel course for both communications and signal processing. No previous introduction to source coding is presumed.

**Rough Syllabus**

Introduction

Lossless coding

Block and conditional variable-length coding

Entropy theory

Chap. 2,3, plus notes

Lossy coding

Scalar quantization, Chap. 9 plus notes

Vector quantization, Chap. 10, plus notes

Differential encoding, Chap 11, plus notes

Transform coding, Chap. 12, 13, plus notes

Selected additional topics from the following

Lossless coding

Arithmetic coding, Chap. 4

Lempel-Ziv coding, Chap. 5

Lossy coding

Subband coding, Chap. 14

Wavelet coding (especially images), Chap. 15

Audio coding, Chap. 16

CELP coding of speech, Chap. 17

Motion compensated video coding, Chap. 18

## Course Details

Time: MW 1:30-3:00

Room: 104 EWRE

Credit hours: 3

Likely next offering: Winter 2009

Class web page: [www.eecs.umich.edu/courses/eecs651](http://www.eecs.umich.edu/courses/eecs651)

It will contain homework assignments, solutions, course notes, etc.

Instructor: Prof. David L. Neuhoff, 4215 EECS, 764-6586, [neuhoff@umich.edu](mailto:neuhoff@umich.edu)

Office hours: M-W 3:00-3:30 plus additional hours to be determined.

However, either now or later you can also make appointments at mutually convenient times.

Contact me by phone, by email, or by coming to my office. If by email, indicate the times at which you are available.

Office hours are a good time for general discussions about class material, as well as specific questions about homework or exams.

Email questions:

I try to respond to all email, but cannot guarantee a timely response. email is best for short inquiries. Conceptual questions, which generally require interaction, are best left to face-to-face discussions.

Prerequisite: EECS 501, Probability and Random Processes

Text: K. Sayood, Introduction to Data Compression, 3rd Edition

Lecture notes:

From time to time lecture notes will be posted on the class website as they are needed.

Notes from the 2005 offering of EECS 651 are available on the class website. Since in 2005 no text was required, it is not clear how much of the 2005 notes will be relevant this year.

Reference books:

To be posted on the class website. Asterisks in the reference list indicate those that will be placed on reserve in the Media Union.

Honor Code: The UM College of Engineering Honor Code applies.

You should be familiar with it. Links to it are contained on the class website.

Homework: Roughly weekly.

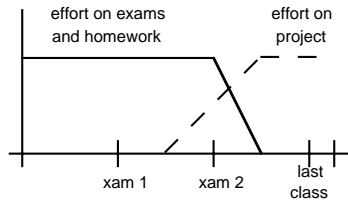
Collaboration policy: Homework assignments are to be completed on your own. You are allowed to consult with other students during the conceptualization of a solution, but all written work, whether in scrap or final form, is to be generated by you, working alone. Also, you are not allowed to use, or in anyway derive advantage from, the existence of solutions prepared in prior years. Violation of this policy is an honor code violation. If you have questions about this policy, please contact me.

Exams: Two midterm exams at roughly one-third and two-thirds through the semester. No final exam.

Term Project: Students will begin thinking about the project roughly halfway through the course.

A written proposal will be required at the appropriate time. A written project report is due the last day of finals. Oral presentations to the class will be made at the end of the term at a time to be determined, probably during the period of April 16 through 18. Group projects will be encouraged.

Work load:



Course Grade: 15% Homework, 25% Exam 1, 25% Exam 2, 35% Term Project.

Homework is important and counts enough so that you should take it seriously, but not so much that you cannot afford mistakes.

After each exam is graded, I will announce the scores that represent the threshold between A and B performance and the threshold between B and C performance. At the end of the semester, thresholds will also be established for the average homework score and the project score. To determine your course grade, your average exam and homework scores (weighted as indicated above) will be compared to the average of the A/B thresholds and the average of the B/C thresholds. The A and B ranges will also be divided into thirds to determine “-” and “+” scores. For example, if your course average lies just above the average A/B threshold, you will receive an A-, while if it lies in the upper third of the B range, you will receive a B+.

Class email list:

Many important announcements (e.g. homework hints, corrections, exam schedules, changes to office hours etc.) will be emailed to the class. **You MUST enroll in the class email list right away by sending email to [eecs651-request@eecs.umich.edu](mailto:eecs651-request@eecs.umich.edu) with the word "subscribe" in the subject line.** You should receive a confirming email. I will send one or more test emails, which will be announced in class. Let me know if you do not receive them. (If you have difficulties, please check to make sure you have typed the address and subject line exactly as indicated above, and try again. If this still doesn't work, please try again, but this time with a copy to me, and a note of explanation.)