Department of Electrical and Computer Engineering
McMaster University

Information Theory and Coding

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Course Description:
This course will provide an introductory look into the broad areas of information theory and coding theory. As stated in the course text,

> Information theory answers two fundamental questions in communication theory: what is the ultimate data compression (answer: the entropy H) and what is the ultimate transmission rate of communication (answer: the channel capacity C).

In later stages of the course, coding techniques will be discussed which approach these ultimate limits.

Tentative Outline (time permitting):

- ◇ Entropy: entropy, relative entropy, mutual information, chain rules, data processing inequality, the asymptotic equipartition property, entropy rates for stochastic processes.
- ◇ Data Compression: the Kraft inequality, Shannon-Fano codes, Huffman codes, arithmetic coding.
- ◇ Channel Capacity: discrete channels, random coding bound and converse, Gaussian channels, coloured Gaussian noise and optimal "water-pouring" power allocation.
- ◇ Error Control Coding: linear block codes and their properties, hard-decision decoding, cyclic codes, convolutional codes, soft-decision decoding, Viterbi decoding algorithm.
- ◇ Advanced Coding Techniques: lattice codes, trellis coded modulation, coset codes, multi-level codes/multi-stage decoding, iterative decoding.

Course Text:	Thomas M. Cover and Joy A. Thomas, *Elements of Information Theory*, John Wiley & Sons, 1991. (ISBN 0-471-06259-6)
Reference Materials:	Stephen B. Wicker, *Error Control Systems for Digital Communication and Storage*, Prentice-Hall, 1995. (ISBN 0-13-200809-2) Papers from the literature cited by instructor.
Assessment:	Project – 50%, Assignment(s) – 25%, Final Exam – 25%.

Policy Reminders:

The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem, that cannot be resolved by discussion among the persons concerned, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.

Students are reminded that they should read and comply with the Statement on Academic Ethics and the Senate Resolutions on Academic Dishonesty as found in the Senate Policy Statements distributed at registration and available in the Senate Office.

Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at

`http://www.mcmaster.ca/senate/academic/ac_integrity.htm`

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.