ECE 723
Information Theory and Coding

COURSE OUTLINE

Please refer to course website for updated information.

CALENDAR DESCRIPTION

Entropy and mutual information. Discrete memoryless channels and discrete memoryless sources, capacity-cost functions and rate-distortion functions. The Gaussian channel and source. The source-channel coding theorem. Linear codes. BCH, Goppa, Reed-Solomon, and Golay codes. Convolutional codes. Variable-length source coding.

SCHEDULE And MODE OF DELIVERY

Lecture: Wednesday 9:30am – 12:20pm

INSTRUCTOR

Dr. Jun Chen
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Office: ITB/A221
Phone: 905-525-9140 ext. 20163
Office Hours**:** By appointment

COURSE WEBSITE

http://avenue.mcmaster.ca

COURSE OBJECTIVES

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

ASSUMED KNOWLEDGE

Undergraduate senior-level ECE courses in: mathematics, probability, stochastic processes and communications systems.

COURSE MATERIALS

Textbooks/Reference:

Thomas M. Cover and Joy A. Thomas, Elements of Information Theory, John Wiley & Sons, 1991. (ISBN 0-471-06259-6)

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.

COURSE OVERVIEW (APPROXIMATE)

Week	Topic
1	Entropy: entropy, relative entropy, mutual information, chain rules, data processing inequality
2	The asymptotic equipartition property (AEP), typical sets
3	Data Compression: bounds on codeword length, source coding theorem
4	Data Compression: Prefix codes, Kraft-McMillan inequality, Shannon-Fano codes
5	Data Compression: Huffman codes, optimal binary codes, universal source coding
6	Entropy rates of stochastic processes
7	Channel Capacity: discrete channels, random coding bound and converse
8	Channel Capacity: continuous channels, Gaussian channels, coloured Gaussian noise and optimal “water-pouring” power allocation
9	Channel Capacity: sphere packing, channel coding theorem for Gaussian channels, bandlimited channels
10	Error Control Coding: introduction, linear block codes and their properties
11	Error Control Coding: hard-decision decoding, cyclic codes, elements of abstract algebra, BCH and RS codes
12	Error Control Coding: convolutional codes, soft-decision decoding, Viterbi decoding algorithm
13	Advanced Coding Techniques: lattice codes, trellis coded modulation, coset codes, multi-level codes/multi-stage decoding, iterative decoding

At certain points in the course it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

ASSESSMENT

Component	Weight	Due Date
Quizzes	10%	

Project	15%
Midterm	25%
Final	50%
Total	100%

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EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

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The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf.

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