Instructor: Professor Amir H. Banihashemi, Office: 7034MC, Tel: 520-2600, Ext. 8026, Email: ahashemi@sce.carleton.ca.

Lectures: Monday and Wednesday, 11:30 a.m.– 1:00 p.m.

Office Hours: Wednesday, 10:30 – 11:30 a.m.

Course Description: Measure of information: entropy, relative entropy, mutual information, asymptotic equipartition property, entropy rates for stochastic processes; data compression: Huffman code, arithmetic coding; channel capacity: random coding bound, reliability function, Blahut-Arimoto algorithm, Gaussian channels, coloured Gaussian noise and 'water-filling'; rate distortion theory; network information theory.

Prerequisites: SYSC 5503 (ELG 6153) or EACJ 5109 (ELG 5119) or equivalent. The students need to have a solid background on probability theory and stochastic processes.

Course Objectives: Information theory, also referred to as "Theory of Communications," discusses the fundamental limits on data compression and data transmission in a communication system. These limits are respectively "entropy" and "channel capacity." The objectives of this course are to discuss these fundamental limits and how they can be approached/achieved for different sources and communication channels.

Learning Outcomes: A solid understanding of source entropy and channel capacity for different sources and communication channels, respectively, their calculation, and to understand and be able to devise the source and channel coding techniques discussed in the course for different sources and communication channels.


Grading Scheme: Composition of final mark: Final exam: 60%  
Quizzes: 40%

Assignments: There will be eight problem sets. The solutions will be posted on the web regularly. It is strongly recommended that the students first work on the problems on their own, and if unsuccessful, discuss it with others, before looking at the solutions.
Quizzes: There will be four closed-book quizzes, each worth 10% of the total mark. They will be given on September 13, October 2, October 30 and November 20, during the first 30 minutes of the lecture time.

Final Exam: The final examination is for evaluation purposes only and will not be returned to students. You will be able to make arrangements with the instructor or with the department office to see your marked final examination after the final grades have been made available. The final exam has 60% of the total mark. It is open book and covers all the material discussed during the lectures and in the assignments.

Week-by-Week breakdown

W1 Entropy and its properties
W2 Conditional and relative entropy and mutual information
W3 Properties of mutual information and data processing and Fano inequality
W4 Asymptotic equipartition property (AEP) and data compression, entropy rate of stochastic processes
W5 Source coding and Kraft inequality, Bounds on optimal codeword lengths
W6 Huffman coding and other source coding techniques including arithmetic coding
W7 Channel capacity of discrete memoryless channels and its properties
W8 Channel coding theorem
W9 Converse of channel coding and some practical codes
W10 Feedback capacity, differential entropy and AEP for continuous random variables, joint and conditional differential entropy
W11 Capacity of Gaussian channels
W12 Rate distortion theory
W13 Rate distortion function and a brief discussion on network information theory

General Regulations

Student Responsibility: It is the student's responsibility to remain informed of all rules, regulations and procedures required by their program and by the Faculty of Graduate and Postdoctoral Affairs. Ignorance of regulations will not be accepted as a justification for waiving such regulations and procedures.

Academic Integrity: Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: https://carleton.ca/registrar/academic-integrity/. This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

Plagiarism: Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated.
Deferred Term Work: Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three (3.0) working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. For more information, see the current Graduate Calendar, Academic Regulations of the University, Section 9.3.

Academic Accommodation: You may need special arrangements to meet your academic obligations during the term. You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at http://www.carleton.ca/equity/ For an accommodation request, the processes are as follows:

- **Pregnancy or Religious obligation:** Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details see https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf

- **Academic Accommodations for Students with Disabilities:** The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your **Letter of Accommodation** at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). Requests made within two weeks will be reviewed on a case-by-case basis. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) for the deadline to request accommodations for the formally-scheduled exam (if applicable).

- **Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton’s Sexual Violence Policy. For more information about the services available at the university and to obtain
information about sexual violence and/or support, visit: https://carleton.ca/sexual-violence-support/.

- **Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf

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**Health and Safety:** Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: http://sce.carleton.ca/courses/health-and-safety.pdf

**Students from the University of Ottawa:** You can request to have access to cuLearn: please see http://gradstudents.carleton.ca/forms-policies/