

ECE 612: Information Theory

Department of Electrical and Computer Engineering
University of Waterloo
Winter 2023

Course details

Course description

This is a first course in information theory. It covers basic concepts in some details such as entropy, mutual information, channel capacity and rate distortion theory.

Course schedule/staff

- [REDACTED]
- **Instructor:** Oussama Damen, mdamen@uw, [REDACTED]
- **Office hours:** By email appointment
- **Course website:** On LEARN

Marking scheme

- Midterm: 35%
- Final: 65%
- Assignments are not graded but are essential to understanding the material
- If you miss the exams, we need official papers to justify a supplementary exams or deferral
- **No alternative marking scheme on a case by case basis.** The instructor reserves the right to change the marking scheme for all if judged beneficial
- Requirements for auditing: (1) register for the course; (2) attend every class; and (3) complete all assignments.

Required textbook

T. M. Cover and J. A. Thomas, Elements of Information Theory, Wiley, New York, 2nd Edition, 2006.

Prerequisite

Probability theory and elementary stochastic processes and some mathematical maturity

Covered material

The following material will be covered from the textbook.¹

- 1 **Entropy, Relative Entropy, and Mutual Information (ch. 2)**: Entropy, mutual information, chain rules, Jensen's, log sum and data processing inequalities
- 2 **Asymptotic Equipartition Property (ch. 3)**: AEP theorem, high probability sets and the typical set
- 3 **Entropy Rates (ch. 4)**: Markov chains, entropy rate
- 4 **Data Compression (ch. 5)**: Kraft inequality, optimal codes, Huffman codes

¹The lectures will closely follow the textbook but not verbatim, additional examples, explanations, interpretations will be given when necessary.

Covered material (cont'd)

- ⑤ **Channel Capacity (ch. 7):** Binary symmetric channel, channel coding theorem, zero-error codes, feedback capacity, source-channel separation theorem
- ⑥ **Differential Entropy (ch. 8):** AEP for continuous random variables, relation of differential entropy to discrete entropy, joint and conditional differential entropy
- ⑦ **Gaussian Channel (ch. 9):** Converse to the coding theorem for Gaussian channels, bandlimited channels, parallel Gaussian channels, Gaussian channels with feedback
- ⑧ **Rate Distortion Theory (ch. 10):** Quantization, calculation of the rate distortion function, achievability and computation of the channel capacity and the rate distortion function

Other Items

- The exams are closed-book
- If you miss the exams without a verifiable and valid reason you will receive a 0 on that exam
- Solutions to assignments will be available on Waterloo LEARN

Required inclusions

- Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility.
- Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.
- Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about “rules” for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties check Guidelines for the Assessment of Penalties.

Required inclusions (continued)

- Appeals: A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals).
- Note for students with disabilities: The AccessAbility Services, located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the AccessAbility Services at the beginning of each academic term.