Motivation and overview: The modern field of digital communication was pioneered by Claude Shannon in 1948. The theory he developed, today known as information theory, delineates the fundamental limits of efficient data compression and reliable transmission. This course is an introduction to information theory from the perspective of point-to-point communication with a focus on core concepts, theorems and their proofs, and simple examples. Bits are now well-known as the “currency” of information and this course will put this notion on sound mathematical footing.

Syllabus/Catalog-description: Discrete memoryless stationary sources and channels; Information measures on discrete and continuous alphabets and their properties: entropy, conditional entropy, relative entropy, mutual information, differential entropy; Elementary constrained convex optimization; Fundamental information inequalities: data-processing, and Fano’s; Block source coding with outage: weak law of large numbers, entropically typical sequences and typical sets, asymptotic equipartition property; Block channel coding with and without cost constraints: jointly typical sequences, channel capacity, random coding, Shannon’s channel coding theorem, introduction to practical linear block codes; Rate-distortion theory: Shannon’s block source coding theorem relative to a fidelity criterion; Source and channel coding for Gaussian sources and channels and parallel Gaussian sources and channels (water-filling and reverse water-filling); Shannon’s source-channel separation theorem for point-to-point communication; Lossless data compression: Kraft’s inequality, Shannon’s lossless source coding theorem, variable-length source codes including Huffman, Shannon-Fano-Elias, Arithmetic, and Ziv-Lempel codes; Applications

Prerequisites: This course assumes knowledge of probability at the undergraduate level (e.g., ENG EC 381) as well as the basics of undergraduate linear algebra and signals and systems. In particular, students should be familiar with the notions of joint and conditional probability distributions, conditional expectation, independence, Gaussian random vectors, and the sampling theorem for bandlimited signals. During the first week, we will review some of these topics, but at an aggressive pace meant to establish notation and serve as a reminder for those already familiar with the topics covered.

If you have not already taken these classes (or their equivalent) or have any doubts about your understanding of these concepts, please discuss them with the instructor. In addition to the formal prerequisites, it is assumed that you have the interest, commitment, and maturity for understanding concepts in depth. Your responsibilities may involve seeking out information outside the regular course materials for additional reference.
Logistics:

Instructor: Prof. Alex Olshevsky
Office: PHO531
Email: alexols@bu.edu
Web: http://sites.bu.edu/aolshevsky

Lectures: Tuesday and Thursday 3:30–5:15 pm in CAS 229

Web site: http://learn.bu.edu/


Grading: Homework: 20%
First midterm exam: 25%
Second midterm exam: 25%
Final exam: 30%

If your final exam grade is higher than one of your midterm scores, I will replace one of your midterm scores with your final exam grade.

References: In addition to the main textbook, the following books may be helpful for you:

- C. E. Shannon and W. Weaver, The Mathematical Theory of Communication, University of Illinois Press, Urbana, 1962. (Also available online, see blackboard.)
- R. W. Yeung, A First Course in Information Theory, Kluwer Academic/Plenum Publishers, New York, 2002. (Also available online, see blackboard.)

Homework: Each student must submit an original set of solutions to the instructor at the beginning of class on the due date. Requests for late submissions and/or extensions will not be entertained (except under exceptional circumstances which must be discussed with the instructor).

Collaboration policy: You are required to independently solve and write your own solutions. You should approach the instructor for clearing your doubts. While you may discuss homework problems with other students for clarifying your understanding, you are required to solve homework problems on your own. Contact the instructor if you are not sure whether the extent of your collaboration...
with other students is acceptable. You will be cheating yourself if you simply copy your friend’s solution without understanding it. When detected, the penalties can be severe.

**General advice:** The primary function of homework is to clarify concepts and develop proficiency, depth, and rigor through practice. Working on the homework problems is a crucial part of the learning process and will have a major impact on your understanding of the material and, in turn, on your exam performances. If you miss a problem, study the solutions. Do not wait until the last minute before doing the homework.

**Exams:** Exams are closed-book and closed-notes. Calculators, computing, and communication devices are neither needed nor permitted. However, you are allowed to bring one 8.5 × 11-inch sheet of handwritten notes (both sides) to the first midterm exam, two sheets (all four sides) to the second midterm exam, and three sheets (all six sides) to the final exam. If you want to bring your sheet from the first exam to the second, then you have only one additional sheet for the second exam. Similarly, if you want to bring both your sheets from the second exam to the final, then you have only one additional sheet for the final exam.

**General policies**

**Academic misconduct**

The student handbook defines academic misconduct as follows.

Academic misconduct occurs when a student intentionally misrepresents his or her academic accomplishments or impedes other students’ chances of being judged fairly for their academic work. Knowingly allowing others to represent your work as theirs is as serious an offense as submitting another’s work as your own.

This basic definition applies to ENG EC 517 A1. If you are ever in doubt as to the legitimacy of an action, please talk to me immediately. The penalty for academic misconduct at BU is severe. For further information on the BU College of Engineering Academic Code of Conduct, visit the following website:
http://www.bu.edu/eng/grad/conduct/

**Make-up exams**

As such, there will be no make-up exams. If there is a legitimate reason for missing an exam, such as illness as supported by a doctor’s note, then the scores of other exams will be used appropriately to compensate for the missed exam. If there is no legitimate reason provided for missing an exam, a grade of zero will be assigned for the missed exam.

**Incomplete grades**

Incomplete grades will not be given to students who wish to improve their grade by taking the course in a subsequent semester. An incomplete grade may be given for medical reasons if a doctor’s note is provided. The purpose of an incomplete grade is to allow a student who has essentially completed the course and who has a legitimate interruption in the course, to complete the remaining material in another semester. Students will not be given an opportunity to improve their grade by doing “extra work”.

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Drop dates

Students are responsible for being aware of the drop dates for the current semester. Drop forms will not be back-dated.