ECE 5311: Information Theory & Coding

Spring 2012

Professor:	Andy Klein
Office:	AK307
Phone:	508.831.5718
email:	klein@ece.wpi.edu
Office Hours:	Mon 4-5p, Tue 4-5p, other times by appointment
Teaching Assistant:	Min Ni, minni@wpi.edu
TA Office Hours:	Tue 1-2p in AK218, Wed 4-5p in AK 318
Lectures:	Thu 6:00-8:50p, AK233
Prerequisites:	ECE 502 or equivalent
Course Website:	`http://aspect.wpi.edu/ece5311`
Required Textbook:	*Elements of Information Theory*, 2nd Ed. Thomas M. Cover and Joy A. Thomas. Wiley, 2006. ISBN: 0471241954
Optional Textbook:	*Fundamentals of Wireless Communication*[1] David Tse and Pramod Viswanath. Cambridge University Press, 2005. ISBN: 0521845270

Course catalog description: This course introduces the fundamentals of information theory and discusses applications in compression and transmission of data. Measures of information, including entropy, and their properties are derived. The limits of lossless data compression are derived and practical coding schemes approaching the theoretical limits are presented. Lossy data compression tradeoffs are discussed in terms of the rate-distortion framework. The concept of reliable communication through noisy channels (channel capacity) is developed. Techniques for practical channel coding, including block and convolutional codes, are also covered. (Prerequisite: background in probability and random processes such as in ECE502 or equivalent).

Academic Honesty: The WPI Academic Honesty Policy will be in effect. Please review this policy at `http://www.wpi.edu/Pubs/Policies/Honesty/policy.html`.

Students with Disabilities: If you need course adaptations or accommodations because of a disability, or if you have medical information to share with me, please make an appointment with me as soon as possible. If you have not already done so, students with disabilities who believe that they may need accommodations in this class are encouraged to contact the Disability Services Office (DSO) to ensure that such accommodations are implemented in a timely fashion. The DSO is located in Daniels Hall, 508.831.5235.

[1] You will be asked to read several sections of this book. A freely available (non-printable) pdf is available online at `http://www.eecs.berkeley.edu/~dtse/book.html`. In addition, there is a copy on reserve at Gordon Library.

Grading, Exams, Homework, Project:

Homework	15%	
Project	15%	(assigned 22-Mar-2012, due 19-Apr-2012 6:00p)
Midterm	30%	(held 01-Mar-2012 6:00-8:50p)
Final	40%	(held 26-Apr-2012 6:00-8:50p)

Homework will be assigned weekly, to be handed in at the beginning of the next class. Each problem will be graded out of 3 points (0=nothing, 1=tried, 2=pretty close, 3=correct). No late material (project, homework) will be accepted unless prior arrangements have been made well in advance of the due date; such situations will be handled on a case-by-case basis. When completing the homework, you may consult with other classmates; if you choose to do so, please indicate their name(s) on the top of your homework. A student's submitted assignment must be his/her own work, and reflect his/her own understanding of the material. There will be no opportunities for extra credit. Exams will be open-book, though the use of laptops will not be permitted.

Date	Section(s)	Subject(s)
19-Jan	1.1, 2.1-2.4	Overview, history of information theory & coding, review of random processes & Markov chains. Information measures, entropy, mutual information, relative entropy.
26-Jan	2.5-2.6	More probability review. Chain rules, convexity. Jensen's inequality.
02-Feb	2.7-2.11, 3.1-3.3	Log-sum inequality, data processing inequality, Fano's inequality, and their consequences. Typicality, the AEP.
09-Feb	5.1-5.8	Data compression, Kraft inequality, Huffman coding, variable-length codes.
16-Feb	7.1-7.7	Capacity introduction & examples, joint typicality. Random codes, the channel coding theorem & achievability.
23-Feb	7.8-7.13	Zero-error codes, converse to channel coding theorem. Hamming codes, feedback capacity, source-channel separation coding theorem.
01-Mar	—	**Midterm exam**.
15-Mar	8.1-8.6, 9.1-9.2	Continuous random variables, differential entropy, continuous AEP. Capacity of Gaussian channel.
22-Mar*	9.2-9.5	Extension to bandlimited Gaussian channels, waterfilling, channels with memory.
29-Mar	—	Introduction to practical channel coding, convolutional codes. MAP vs. ML, minimum distance concepts, hard vs. soft decoding, the Viterbi algorithm.
05-Apr	—	Linear block codes, examples of linear block codes, performance bounds. Overview of turbo codes, LDPC codes, Trellis-coded modulation.
12-Apr	10.1-10.5	Introduction to rate distortion theory. Rate distortion theorem, achievability & converse.
19-Apr	T&V 2.4, 5.3, 7.1	**Project due**. Capacity of SIMO, MISO, and MIMO channels. Other special topics as time permits.
26-Apr	—	**Final Exam**

Note: This syllabus is subject to change. Also, it is likely that the 22-Mar class will (exceptionally) be held on a different evening; arrangements will be made for those who cannot attend.