COURSE SYLLABUS

Subject: Electrical Engineering
Course Number: 89366
EE 568: Topics in Information Theory

Course Introduction

Credit Hours: 3

Prerequisite Courses: EE 513 Stochastic Systems Theory or its equivalent

Method of Instruction: lecture

Instructor: Natalia A. Schmid, Professor

Class Meets: TR from 12:30 pm to 1:45 pm in EVC - E412

Course Description:
Mathematical description of channels and sources; entropy, information, data compression, channel capacity, Shannon's theorems, rate-distortion theory, maximum entropy principle, and large deviations theory.

Learner Support

Instructor Office Location: AERB 354

Office Hours: TBA

Instructor Email: Natalia.Schmid@mail.wvu.edu

Phone: (304) 293-9136

Method of Making Appointment: Please send an e-mail

ITS (Technical Support): If you need assistance, please call the ITS Service Desk at 304-293-4444, email ITSHelp@mail.wvu.edu or visit it.wvu.edu/help.

Instructional Materials

Required Instructional Materials:

- T. M. Cover and J.A. Thomas, Elements of Information Theory, John Wiley & Sons, New York, 2006.

Optional Instructional Materials:

- R. G. Gallager, Information Theory and Reliable Communication, John Wiley & Sons, 1968.
- R. E. Blahut, Principles and Practice of Information Theory, Addison-Wesley, 1988.

- Kullback, Information Theory and Statistics, Dover, 1997.
- D. J. C. MacKay, Information Theory, Inference, and Learning Algorithms, Cambridge University Press, 2003. Available at: http://www.inference.phy.cam.ac.uk/mackay/itila/
- J. A. Bucklew, Large Deviation Techniques in Decision, Simulation, and Estimation, New York: Wiley, 1990.

Computer Usage: Several homework problems and the final project will require computer usage. You may select any computer system and programming language to address these problems.

Course Learning Objectives

- Know the definition of measures of information
- Understand the role of information inequalities
- Be able to state and prove Asymptotic Equipartition Property
- Understand how to state and solve a constrained optimization problem (Lagrange Multipliers method)
- Know the limits of lossless source coding
- Explain the difference between Huffman, Ziv-Lempel, Arithmetic, and Shannon-Fano codes
- Be able to encode a binary message using the four lossless codes
- Understand how to apply Kraft inequality
- Be able to state and interpret Shannon's source coding theorem
- Understand the definition of jointly typical sequences
- Understand the intention and use of Fano's inequality
- Be able to state and prove Shannon's channel coding theorem and its converse
- Be able to define differential entropy and explain its application
- Be able to derive the capacity of various channels involving Gaussian models for signals and noise
- Define and explain the intension of Rate Distortion Theory
- Be able to derive rate distortion results for Gaussian channel
- Be able to formulate the maximum entropy principle and apply it to different estimation problems
- Understand the basics of Large Deviations theory
- Be able to find the exponential rates of the probability of false alarm and of miss detection
- Draw the analogy between Neyman - Pearson detector and the results of Stein's lemma

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Course Activities

Major Learning Activities:
This is a lecture class. We will introduce and discuss new concepts in class.

Assessment

Major Assignments/Assessments:
Homeworks: There will be approximately 6 homework assignments. No late homework will be

accepted. From each homework set, 3 problems will be selected at random and graded. The contribution of homework assignments towards the final grade will be based on the average of all homework grades.

Examinations: There will be a midterm examination and a final examination. The date of the midterm exam will be announced in advance.

Ethics:
Interaction among students in EE568 for the purpose of understanding concepts and developing solution strategies on homework assignments is permitted and very much encouraged but submitted homework solutions should be your own effort.

Weight/Distribution of Course Points:
The final grade for the EE568 will be based on the following factors, which will be weighted as indicated.

Homeworks	40%
Midterm Examination	30%
Final	30%

Topics and Tentative Schedule:
We will cover material in Ch. 1-3, 5, 7-10 of Cover and Thomas (Ed. 2006). Ch. 11 and 12 will be covered as the time permits. The reference material from the textbook is as follows (tentatively):

- Introduction (0.5 weeks)
- Measures of Information and Information inequalities (2 weeks)
- Convergence of sequences of random variables. AEP (1 week)
- Lagrange Multipliers (1.5 weeks)
- Lossless data compression (Huffman, Ziv-Lempel, Arithmetic, Shannon-Fano codes): Kraft inequality, Shannon's source coding theorem (3 weeks)
- Channel capacity: jointly typical sequences, Fano's inequality, Shannon's channel coding theorem and its converse (2 weeks)
- Differential entropy (1 weeks)
- Gaussian channels (1.5 weeks)
- Rate distortion (2.5 weeks)
- Maximum entropy principle (as the time permits)
- Testing Hypotheses (as the time permits)

Response Time and Feedback Plan:
Graded assignments and tests will be returned to students not later than one week after they were handed to the instructor.

Final Grading Scale:
A is guaranteed: 90-100 points
B is guaranteed: 80-90 points
C is guaranteed: 65-80 points

Course and Institutional Policies

Attendance Policy:
Attendance will not be taken. However, you will be responsible for all material covered in class, even if it is not in the textbook. It is your responsibility to make sure that you are present for all tests, that all assignments are turned in on time, and that you are aware of all announcements made in class.

- Please arrive to class on time.
- Please silence your cell phones.

Late Assignment and Missed Exam Policy:
You are expected to attend the midterm and the final exams at the scheduled times and dates. If you have an unavoidable conflict, please let me know as soon as possible, but no later than one week before the exam. If you miss an exam without first having your absence approved, then you will be given the opportunity to make it up only if you have received approval from the Associate Dean of Academic Affairs.

Institutional Policies:
Students are responsible for reviewing policies on inclusivity, academic integrity, incompletes, sale of course materials, sexual misconduct, adverse weather, as well as student evaluation of instruction, and days of special concern/religious holiday statements.