ECE728 - Spring 2010
Random Processes in ECE
Professor Yariv Ephraim
Engineering Building Room 3229

Time: Monday 4:30 - 7:10 pm
Place: Innovation Hall 204
Span: 1/25 - 5/3; No class on 3/8 (Spring Break)
Final Exam: Mon. 5/10, 4:30 - 7:15 pm

Office Hours: Monday: 7:10-8:10 pm
Wednesday: 6:10-7:10 pm
Other time by appointment
Contact: yephraim@gmu.edu

Course Description:

This course covers some fundamentals of probability theory and random processes. The subject is encountered in many areas of electrical engineering such as statistical signal processing, communications, control, and computer networks. One of the goals of this course is to provide students with essential tools which will enable them to read current literature such as the IEEE Transactions on Information Theory and the IEEE Transactions on Automatic Control. The course builds upon ece528 or equivalent course. We start by reviewing basic concepts usually covered in ECE528 from a measure theoretic viewpoint, and proceed to more advance material as outlined below. Examples from detection, estimation and information theory will be used to demonstrate aspects of the theory.

Prerequisite: ECE 528 or equivalent. Students who do not have this prerequisite may only audit this class.

Course Outline:

- Probability Spaces (Weeks 1-2) [ G&D Chap. 2 ]
  1. Sample spaces
  2. Event spaces (Borel)
  3. Probability measures
  4. Discrete probability spaces
  5. Continuous probability spaces
  6. Product spaces
  7. Independence
  8. Elementary conditional probability
  9. Total probability and Bayes’ Rule

- Random Variables (Weeks 3-4) [ G&D Chap. 3 ]
  1. Definition and inverse image
2. Distributions of random variables
3. Distributions of Random vectors
4. Consistency of distributions
5. Derived Distributions
6. Independent random variables
7. Conditional distributions
8. Expectation
9. Markov Inequality (Chebyshev and Chernoff bounds)

- Random Processes (Week 5) [ G&D Chap. 3 ]
  1. Definition
  2. The Kolmogorov Extension Theorem
  3. Discrete time Markov processes
     - Binary autoregressive process
     - Binomial process
     - Random walk
     - Wiener process

- Lebesgue Integration (Weeks 6-7)
  1. Lebesgue integral
  2. Lebesgue vs. Riemann
  3. Lebesgue Monotone Convergence Theorem
  4. Lebesgue Dominated Convergence Theorem
  5. Fatou’s Lemma
  6. The Radon-Nikodym Theorem

- Conditional Expectation (Weeks 8-9)
  1. The Projection Theorem in norm spaces
  2. Conditional expectation in $L^2$ and in $L^1$
  3. Conditional expectation on a sigma-field
  4. Properties
  5. Implications to linear and non-linear Estimation

- Take home Mid-term: 3/29. There will be no class on 3/29. We will have a review session on Thursday 3/25, 4:30-7:10pm.

- Convergence of Random Variables (Weeks 10-11)
  1. Modes of convergence and their inter-relations
  2. Weak law of large numbers
  3. Strong law of large numbers
4. Mean Ergodic Theorem

- The Ergodic Theorem (Week 12) [G&S Section 9.5]
  1. Stationary and ergodicity of random processes
  2. The Birkhoff-Khinchin Theorem

- Introduction to Martingale processes [G&S Sections 7.7-7.8]
  1. Doob’s Decomposition
  2. Martingale convergence theorem

- Markov Chains (Weeks 13-14) [G&S Sections 6.1-6.4]
  1. Chapman-Kolmogorov Equations
  2. Classifications of States
  3. Classification of Chains
  4. Decomposition Theorem
  5. Stationarity distribution and the limit theorem
  6. Conditions for stationarity and ergodicity

- Introduction to hidden Markov processes (Week 14)

Text Books:


Other Reference Books:


2. To be provided per topic.

Attendance and homework:

1. Students are encouraged to attend all classes and to submit all homework assignments.

2. Homework assignments are due the week following their assignment.
Communication:

Announcements, homework assignments, course material, etc, will be emailed to your GMU email address which is on file at the GMU Registrar. If you wish to have your course material delivered to another email address, you may include a .forward command in your GMU directory. Please make sure that your mail box is not full. For each email message that you will be sending me, please write ece728 on the subject line.

Grading:

Two take-home exams, first exam 40%, second exam 50%; Homework 10%.