

ECE 604 : Stochastic Processes Fall 2013

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Lecture Schedule: Mondays 14.30-17.20 hrs in EIT 3151

Class website: <http://www.ece.uwaterloo.ca/~mazum/ECE604>

Office hours: When not busy in my office or by appointment (please send me an e-mail to set up an appointment).

Pre-requisite: ECE316 or an undergrad probability course

Aims: Stochastic processes is a core course for graduate studies in electrical engineering and a must for those who wish to specialize in communications, controls, signal processing, and networking. The subject matter is also very useful for other fields such as algorithm design.

The principal aim of this course is to introduce the students to a rigorous and fairly comprehensive view of probability, random variables and random signals (or stochastic processes). The first part of the course will begin with a comprehensive view of probability and random variables. The notions of conditional probabilities and expectations will be studied. Once the basics have been seen we will then study important results needed in the study of random phenomena as they present themselves in the modeling of signals and noise namely the notions of independence, normality etc. Based on these we will then study key results such as the Central Limit Theorem, Laws of Large Numbers and convergence concepts. The latter third of the course will be devoted to the study of important signal models especially the so-called theory of wide sense stationary processes. The course will conclude with an introduction to Markov chains.

The overall aim is to provide the student with a good understanding of the underlying structure associated with stochastic processes and gain the necessary background to have a solid foundation to work in applications involving stochastic phenomena.

COURSE OUTLINE

1. Review of Probability: Distributions, Expectations, Conditioning, Bayes' Theorem, Independence, Random Variables, Bounds: Markov, Chebychev, Chernov. Borel-Cantelli Lemmas.
2. Discrete-probability- counting arguments, branching processes.
3. Gaussian Random Variables, Conditioning, Conditional Expectation
4. Stochastic Processes : Classification: Gaussian, Poisson, Markov, Stationarity- Weak and strong laws. CLT, Convergence, Ergodic Theorems.
5. Wide sense stationary processes- L2- Theory of Stochastic Processes: Bochner's Theorem, Spectral Theory, Shannon sampling, Karhunen-Loeve Expansions. AR and MA Approximations. Wold decomposition and prediction of 2nd. order stationary processes.

6. Independent increment processes: Wiener process, Poisson Processes. Gauss-Markov processes.
7. Introduction to Markov chains: Classification, invariant distributions, ergodicity.
8. Introduction to martingales- the discrete-time case. Martingale convergence theorem. Doob's optional sampling. Wald's lemma. (If time permits)

TEXT AND REFERENCES

There is no text for this course. Typed class notes are posted on the website and updated versions will be posted from time to time. The following references are useful to expand on the notes

References:

There are a number of books that cover the material but with variable treatment of the topics. S. M. Ross: Introduction to Probability Models, 4th Edition, Academic Press, 1989 (good for refreshing probability but lacks wide sense theory)

G. Grimmett and D. R. Stirzaker: Probability and random Processes, 3rd. Edition, Cambridge University Press, 2002. (excellent book but a bit advanced and not enough on wide-sense theory)

Course Evaluation

Bi-weekly problem sets will be posted on the website. The problem sets will be graded according to a randomized algorithm as follows: for every problem set, a problem will be randomly chosen for grading. At the end of the course your corrected problems will be assigned a score. Once the solution has been posted for the problem set have not turned in you will lose credit for one problem. You can collaborate with classmates but everyone must turn in their own homework indicating with whom they have collaborated. Homework will constitute 10% of the course grade.

Marks distribution: Problem sets= 10 %, Midterm= 40%, Final Exam = 50%

Auditors will be required to turn in homework, take the midterm exam and achieve a pass mark.

Additional remarks

- All exams will be closed book. You will be allowed to bring in one page of summary.
- If you miss the midterm exam no make-up exam will be given. If you have a valid reason then your final marks will be based on your performance in the rest of the course.
- Students are advised to be regular and turn in the problem sets.
- Dishonesty will be dealt with harshly according to the rules of the university.