Information Sheet:

Instructor:
Prof. Randall Berry
Office: M318 Technological Institute
Tel: 491-7074, E-mail: rberry@eecs.northwestern.edu
Office Hours: TBA or by appointment

Time and Place:
MW 3:30-5:20 pm, Room L170 Tech

Course Overview: Probability and random processes are central fields of mathematics and are widely applied in many areas including risk assessment, statistics, machine learning, data networks, operations research, information theory, control theory, theoretical computer science, quantum theory, game theory, finance, and neurophysiology. This course will provide an introduction to mathematical probability and random process with a focus on techniques that are useful in studying communication and control systems as well as in many other domains. We will begin with a thorough review of basic probability theory including probability spaces, random variables, probabilistic inequalities, and laws of large numbers. We then will study a number of basic random processes including Poisson Processes, Markov Chains and Gaussian Processes. Basics of estimation and filtering of random processes will also be covered.

Prerequisites
- The official prerequisite is one undergraduate course in probability (e.g., EECS 302). If you have not had this, then you should discuss your background with the instructor. This is a fairly mathematical course and so a degree of comfort with mathematical arguments (i.e. proofs) is also assumed. Some familiarity with linear systems and Fourier transforms is also helpful but not required (e.g., EECS 222).

Text:

Reference Texts:
There are numerous books on probability and random processes. Below I list a selected few of these that may be a useful references.

   An on-line draft of this book is also available at:
   [http://www.ifp.illinois.edu/~hajek/Papers/randomprocesses.html](http://www.ifp.illinois.edu/~hajek/Papers/randomprocesses.html)
   This book is a good alternative reference for many of the topics covered here.
   This book is for an introductory course on probability and is a good reference for reviewing the prerequisite material.

   Another book that provides a nice introduction to probability theory with some interesting examples.


   An extensive introduction to probability and random processes at a slightly more mathematical level than this course.


   A timeless and comprehensive overview of probability and random processes.


   This book provides some nice computer science applications of probability and random processes.


   This book focuses mainly on operations research applications.

**Course Handouts:**

Handouts not picked up during class and other announcements will be available on the course web site at [http://www.eecs.northwestern.edu/~rberry/EECS422/](http://www.eecs.northwestern.edu/~rberry/EECS422/)

**Studying:**

A goal of this course is to understand of probability and random processes so that you can apply the ideas to problems in a variety of different research areas. Successfully doing this requires you to develop solid intuition and insight into random process, which does not come naturally to most people. This requires you to not simply do “plug and chug” calculations, but to instead spend time understanding the concepts and proofs behind the results. In particular, you are encouraged to not simply focus on completing the homework, but to also spend time reading over and thinking about the material.

**Problem Sets:**

Problem sets will be assigned on a quasi-weekly schedule. In making up the exams it will be assumed that you have worked all the problems. Working together in small groups on the problem sets is encouraged, however each person should be sure to understand and write up their own solution to hand in. The problem sets are intended to help you learn the material and whatever maximizes learning for you is desirable. Problem sets must be handed in by the end of the class in which they are due. Late problem sets will not be accepted.

**Exams:**

There will be a one midterm exam and one final exam.
Course Grade:
Your final grade in the course is based upon our best assessment of your understanding of the material. The weightings used to determine the final grade are:

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<tr>
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<th>Percentage</th>
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<tbody>
<tr>
<td>Midterm</td>
<td>35%</td>
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<tr>
<td>Final</td>
<td>40%</td>
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<tr>
<td>Problem Sets</td>
<td>25%</td>
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Syllabus (tentative):
- Probability review: probability spaces, axioms of probability, conditional probabilities, independence, random variables, expectation, conditional expectation, inequalities.
- Limit theorems – laws of large numbers, central limit theorems
- Poisson Process – memoryless properties, alternative definitions, combining and splitting.
- Finite State Markov chains – first passage time analysis, steady-state analysis
- Gaussian Processes – jointly Gaussian random variables, covariance matrices, filtered processes, power spectral density.
- Bayesian Estimation – MMSE criteria, estimation and Gaussian random vectors, linear least squares estimation.