EE 126 Probability and Random Processes: Course Syllabus

1 Administrative Info

- **Instructors**:
  - Prof. Abhay Parekh, `parekh@eecs.berkeley.edu`
  - Prof. Jean Walrand, `walrand@berkeley.edu`
- **Lectures**: Tuesday/Thursday, 12:30 - 2 p.m., 100 Genetics & Plant Bio
- **GSIs**:
  - Sinho Chewi, `chewisinho@berkeley.edu`
  - Avishek Ghosh, `avishek_ghosh@berkeley.edu`
- Note: All emails that do not start with **'[EE126]' followed by a space** will not be answered.
- **Discussions**:
  - Sinho and Avishek will hold each week's discussions alternatively.
  - Section 201: Monday, 2:00 - 3:00 p.m., 521 Cory Hall
  - Section 202: Monday, 3:00 - 4:00 p.m., 521 Cory Hall
  - If you are enrolled in discussion sections 203 or 204, please attend either 201 or 202 instead.
- **Office Hours**:
  - The instructors' office hours will be posted on the course website.
  - Sinho: Wednesday, 3:00 - 4:00 p.m., 521 Cory Hall
  - Avishek: Wednesday, 2:00 - 3:00 p.m., 521 Cory Hall
- **Homework Parties**:
  - Sinho and Avishek will hold homework parties.
  - Wednesday, 5:00 - 7:00 p.m., 531 Cory Hall
  - **Course Website**: TBD / Piazza

2 Course Info

- **Description**: Probability is a mathematical discipline that allows one to reason about uncertainty: it helps us to predict uncertain events, to make better decisions under uncertainty, and to design and build systems. Throughout the course, we will teach you the fundamental ideas of probability and random processes along with the mini-labs. The hands-on assignments are carefully designed so that they demonstrate how the mathematical concepts can be used to design and build modern systems in many engineering fields: communication systems and networks, signal processing systems, and control systems.
- **Textbooks** :
  - (BT) Dimitris P. Bertsekas and John N. Tsitsiklis, Introduction to Probability, 2nd Edition, Athena Scientific, 2008.

- (W) Jean Walrand, Probability in Electrical Engineering and Computer Science: An Application-Driven Course, Amazon, 2014. (e-book available)

- **Course Outline**: The course consists of 4 modules as follows.

  1. M1. The Fundamentals of Probability / 4 weeks / Main reference: BT
     - Lab: Auctions
     - Discrete Random Variables, Continuous & General Random Variables
     - Random Vectors
     - Functions of Random Variables
     - Expectation, Variance, Conditional Expectation
     - Bounds: Jensen, Markov, Chebyshev, Chernoff
     - Law of Large Numbers, Central Limit Theorem: Confidence Intervals, Multiplexing
  2. M2. Random Processes / 3.5 weeks / Main reference: BT & W
     - Lab: Viterbi Algorithm
     - Discrete Markov Chains - PageRank
     - LLN for Markov Chains
     - Poisson Process
     - Continuous Markov Chains & Queues
     - Random Graphs
  3. M3. Inference / 3 weeks / Main reference: BT & W
     - Lab: Kalman Filter
     - Detection & Bayes Rule
     - Neyman-Pearson Theorem
     - Estimation
     - LLSE, MMSE
     - Hidden Markov Chains
     - Expectation Maximization & Clustering
  4. M4. Advanced Materials and Other Applications / 2.5 weeks / Main reference: BT & W
     - Lab: TBD
     - Proof of LLN & CLT
     - Proof of Big Theorem
     - Applications

3 Grade / Homework / Discussion Forum / Exams / Schedule

- **Course Grading**:
  - Homework (15%)
  - Midterm 1 (20%)
  - Midterm 2 (25%)
  - Final (40%)

- **Homeworks**
  - Weekly homeworks will be assigned every Thursday, and must be submitted by **9 a.m. of the following Thursday**, as **a PDF file for the theory part and an ipynb file for the mini-lab part**.
  - Homeworks, solutions, and general announcements will be posted on the course website.
  - Each homework should be self-graded and the self-graded score should be submitted online by **5 p.m. of the following Monday.** For detailed description of self-grading policies, please refer to Section 4.
  - We will automatically drop 2 homeworks with the lowest scores.

- **No late submission or self-graded score accepted.**
- Any homework that is hard to read gets 0 score.

- **Discussion Forum**
  - We will be using Piazza for class discussion only. Rather than emailing questions to the GSIs, we encourage you to post your questions on Piazza. GSIs will answer some of unresolved questions on the forum on every Monday and Wednesday. Find our class page at: `https://piazza.com/berkeley/fall2017/eleng126/home`

- **Midterms**
  - Midterm 1: Thursday, September 21 (in-class)
  - Midterm 2: Thursday, October 26 (in-class)
  - Final: Thursday, December 14, 3-6 p.m.

- **Course Schedule (subject to change)**

w	Materials	Reference
1	Probability Space, Conditional Probability, Bayes' Rule, Independence, Counting / Discrete RVs(prob. mass functions), Expectation and Variance, Joint PMF	BT Ch.1-2
2	Conditioning and Independence, General RVs, CDFs and Normal random variables	BT Ch.2-3
3	Joint PDFs and conditioning, Covariance, Transforms	BT Ch.3-4
4	Transforms (cont.), Chebyshev, Weak Law of Large number, Central Limit Theorem, Midterm # 1 (Tuesday evening)	BT Ch.4-5
5	Review and Applications, Binary Erasure Channel and Shannon Capacity	Lecture notes
6	Discrete Time Markov Chains	W Ch.1, Ch.13.3, BT Ch.7.1-7.4
7	Poisson Processes, Continuous Time Markov Chains	W Ch.13.4, Ch.13.5, BT Ch.6, Ch.7.5
8	Continuous Time Markov Chains, Random Graphs, Review and Applications	Lecture notes
9	Detection, Bayes' Rule	W Ch.5
10	Neyman-Pearson Theorem	W Ch.5
11	Estimation, LLSE, MMSE, Holiday (Tue), Midterm# 2 (Thursday evening),	W Ch.7
12	Hidden Markov Chains, Viterbi Algorithm	W Ch.9
13	Expectation Maximization, Clustering	W Ch.9
14	Thanksgiving (Thur), Speech Recognition	W Ch.9
15	Applications, Review (Thur), RRR (Tue)	-

4 Homework Policy

- **Collaboration**: Discussions about homeworks are allowed and encouraged, but each student is expected to write his/her own solutions.

- **Self-Grading**: Students should make a photocopy of each assignment for self-grading and future reference. One copy will be turned online by the due date. The solutions will then be posted on bCourses on the same day, and the students will use the second copy to grade their own assignment.

  You can earn one of 4 possible scores for a problem: `0`, `1`, `2`, and `3`. If your solution is entirely correct, you get `3` points. If your solution is more than 66% correct on a single-part problem, or if you solve at least two-thirds of the parts entirely correctly for a multi-part problem, you get `2` points. If your solution is more than 33% correct on a single-part problem, or if you solve at least one-third of the parts entirely correctly for a multi-part problem, you get `1` point. Otherwise you get `0` points for the problem.

  We sample and grade the submitted copies and check for inconsistencies with the self-graded scores. Please note the department policy on academic dishonesty: `http://www.eecs.berkeley.edu/Policies/acad.dis.shtml`

- **Submission of Homework and Self-Grades**: For each homework, one has to submit both a PDF file for the theory part and an ipynb file for the mini-lab part through Gradescope. After grading each assignment based on a posted solution, self-graded scores will be submitted via Google Forms, to which a link will be provided with each solution.