EECS 126 Probability and Random Processes: Course Syllabus

1 Administrative Info

- **Instructors**:
  - Prof. Kannan Ramchandran, `kannanr@eecs.berkeley.edu`
  - Prof. Abhay Parekh, `parekh@eecs.berkeley.edu`
- **Lectures**: Tuesday/Thursday, 11 - 12:30 p.m., 105 Stanley (no webcast)
- **TAs**:
  - Kurtland Chua, `kchua@berkeley.edu`
  - Payam Delgosha, `pdelgosha@eecs.berkeley.edu`
  - William Gan, `wjgan@berkeley.edu`
  - Avishek Ghosh, `avishek_ghosh@berkeley.edu`
  - Justin Hong, `jjhong922@berkeley.edu`
  - Nikunj Jain, `nikunj.jain@berkeley.edu`
  - Katie Kang, `katiekang1998@berkeley.edu`
  - Kanaad Parvate, `kanaad@berkeley.edu`
  - Ray Ramamurti, `ray.ramamurti@berkeley.edu`
  - Amay Saxena, `amaysaxena@berkeley.edu`
- **Readers**:
  - Raghav Anand, `raghav98@berkeley.edu`
  - Adarsh Karnati, `akarnati@berkeley.edu`
  - Eric Liu, `eliu454@berkeley.edu`
- Note: All emails that do not start with **'[EECS 126]' followed by a space** will not be answered.
- **Discussions**:
  - Section 201: Monday, 2:00 - 3:00 p.m., 12 Haviland
  - Section 202: Monday, 3:00 - 4:00 a.m., 310 Hearst Mining
  - Section 203: Monday, 4:00 - 5:00 p.m., 182 Dwinelle
  - Section 204: Wednesday, 2:00 - 3:00 p.m., 204 Wheeler
  - Section 205: Wednesday, 3:00 - 4:00 p.m., 88 Dwinelle
  - Section 206: Wednesday, 4:00 - 5:00 p.m., 182 Dwinelle
  - Section 207: Friday, 2:00 - 3:00 p.m., 103 Moffit
  - Section 209: Wednesday, 1:00 - 2:00 p.m., 299 Cory Hall
  - Section 210: Friday, 1:00 - 2:00 p.m, 299 Cory Hall
- **Office Hours**:
  - As posted on the course website
- **Homework Parties**:
  - Monday, 6:00 - 8:00 p.m., 540AB Cory Hall (DOP Center)
  - Thursday, 6:00 - 8:00 p.m., 400 Cory Hall
- **Course Website**: `https://inst.eecs.berkeley.edu/~ee126/fa18/`

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 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 and scientific fields including communication systems and networks, machine learning, signal processing, computational biology, and control systems.
- **Prerequisite**: Knowledge of probability at the level of CS 70 or STAT 134. Familiarity with linear algebra.
- **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 3 modules as follows. *Note*: The labs listed below are tentative.
  1. M1. Fundamentals of Probability / 4 weeks / Main reference: BT
     - Labs: Introduction, Auctions, Huffman Codes/Active Learning
     - Review: Discrete & Continuous Probability
     - Conditioning, Convolution, Transforms
     - Bounds, Convergence of Random Variables, Information Theory
  2. M2. Random Processes, Coding / 4.5 weeks / Main reference: BT & W
     - Labs: Coding, Sampling, Random Graphs
     - Markov Chains (Discrete Time, Continuous Time), Queuing
     - Poisson Process
     - Random Graphs
  3. M3. Inference, Learning / 4 weeks / Main reference: BT & W
     - Labs: Project, Viterbi Algorithm, Kalman Filter, EM Algorithm
     - Detection, Hypothesis Testing, Communication
     - Estimation, Hidden Markov Chains, Kalman Filter
     - Expectation Maximization & Clustering

3 Grade / Homework / Discussion Forum / Exams / Schedule

- **Course Grading**:
  - Homework (10%)
  - Lab (5%)
  - Project (5%)
  - Midterm 1 (20%)
  - Midterm 2 (20%)
  - Final (40%)
- **Homework**
  - Weekly homeworks will be assigned every Thursday, and must be submitted by **11.59p.m. of the following Wednesday**, as **a PDF file on Gradescope**. Lab assignments will released on Friday and will be due on **the following Friday at 10.a.m.**, and both **PDF and IPYNB files are submitted to Gradescope**. It is your responsibility to ensure that all assignments are submitted on Gradescope by the deadline. We will not accept late assignments due to technological issues, so please submit two hours earlier than the official deadline to give yourself time to resolve these issues.

- Homeworks, solutions, and general announcements will be posted on the course website.
- A link to a self-grading form will be provided in the solutions. 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 illegible or too difficult to read will get a 0.

- **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: `piazza.com/berkeley/fall2018/eecs126`.

- **Exams**
  - Midterm 1: Wednesday, September 19 (8-10 p.m.)
  - Midterm 2: Wednesday, Nov 7 (8-10 p.m.)
  - Final: Wednesday, Dec 12 (8-11 a.m.)

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

#	Materials	Reference
1	Introduction, Probability Spaces, Conditional Probability, Bayes Rule, Independence, Discrete Random Variables & Distributions, Expectation, Joint Distributions	BT 1-2
2	Variance, Indicators, Coupon Collection, Continuous Probability	BT 2
3	Continuous Random Variables & Distributions, Convolution, Gaussians	BT 3
4	Transforms, Inequalities (Markov, Chebyshev, Chernoff), Law of Large Numbers, Central Limit Theorem	BT 4-5
5	Entropy, Relative Entropy, Capacity of the BEC, Shannon's Theorem, Midterm 1	Notes
6	Discrete Time Markov Chains: Hitting Time, Classification of States	W 1, BT 7.1-7.4
7	Discrete Time Markov Chains: Stationarity, Convergence, Reversibility, Bernoulli Process, Poisson Process	W 1, 13.4, B-T 6.1-7.4
8	Poisson Process: Merging, Splitting, Conditioning, Continuous Time Markov Chains, Queueing	W 13.3-13.4, B-T 6.2-6.3, 7.5
9	Random Graphs, Maximum Likelihood Estimation, Maximum A Posteriori Estimation	W 5.1-5.4, B-T 8.2, 9.1, Notes
10	Coding, Communication	Notes
11	Detection, Hypothesis Testing, Neyman-Pearson Paradigm, Least Squares Estimation (LLSE, MMSE)	W 5.5, 6.5, 7.1-7.5, B-T 8.3-8.4, 9.3-9.5, Notes
12	Cramér-Rao Bound, Fisher Information, Midterm 2	
13	Joint Gaussians, Kalman Filter	W 6.3-6.4, 7.6-8.2, Notes
14	Thanksgiving	
15	Hidden Markov Chains, Viterbi Algorithm, Expectation Maximization, Clustering	W 9

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 submit a pdf or 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:

  `https://eecs.berkeley.edu/resources/students/academic-dishonesty`.

- **Submission of Homework and Self-Grades**: You must submit both a PDF file for each homework and an IPYNB file and a PDF file for each lab 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.