EE 126 Probability and Random Processes: Course Syllabus

1 Administrative Info

- **Instructor**: Prof. Kannan Ramchandran, 269 Cory Hall, `kannanr@eecs.berkeley.edu`
- **Lectures**: Tue/Thu, 9:30 am - 11:00 am, 241 Cory Hall. No webcasts.
- **GSIs**:
  - Kabir Chandrasekher (head), `kabirc@berkeley.edu`
  - Ashvin Nair, `anair17@berkeley.edu`
  - Note: Any email that does not start with **'[EE 126]' followed by a space** will *not* reach us.
  - **Discussions**:
    - Kabir and three qualified volunteer graduate students/postdoc (Dong Yin, Kangwook Lee, and Ramtin Pedarsani) will alternate holding Section 101.
    - Section 101: Thurs., 8:30 - 9:30 am, 521 Cory Hall
    - Kabir will hold Section 102.
    - Section 102: Fri., 9:00 - 10:00 am, 521 Cory Hall
  - **Office Hours**:
    - Kannan Ramchandran: Tue, 11:00am - 12:00 pm, 258 Cory Hall
      (Exception: On 2/2, 504 Cory Hall)
    - Kabir and Ashvin: Wed., 4:00 pm - 5:00 pm, 258 Cory Hall
  - **Homework Parties**:
    - Kabir and Ashvin will hold homework parties.
    - HW Party: Tue, 6:30 pm - 8:00 pm, 293 Cory Hall
      (Exception: On 4/12, 521 Cory Hall)
  - **Course Website**: bCourses / Piazza / inst.eecs.berkeley.edu/∼ee126/sp16/ (for public release)

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 prove 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.
- **Prerequisite**: CS 70 preferred but not required. 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, 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
     - Discrete Random Variables, Continuous & General Random Variables
     - Random Vectors
     - Function of Random Variables
     - Expectation, Variance, Conditional Expectation
     - Bounds: Jensen, Markov, Chebyshev, Chernoff
     - Law of large numbers, Central limit Theorem: Confidence Interval
     - *Labs: Intro. to Python, Insurance for Cloud Storage, Multimedia Compression and Transmission*
  2. M2. Random Processes / 3.5 weeks / Main reference : BT & W
     - Discrete Time Markov Chains - PageRank
     - Law of large numbers for Markov Chains
     - Poisson Process
     - Continuous Time Markov Chains & Queues
     - *Labs & Project: Search Engines (PageRank), Stochastic Optimization, 'Coded' Machine Learning*
  3. M3. Inference / 3 weeks / Main reference : BT & W
     - Detection & Bayes Rule
     - Neyman-Pearson Theorem
     - Estimation
     - LLSE, MMSE
     - *Labs: GPS, Random Graphs, Community Detection*
  4. M4. Algorithms / 2 weeks / Main reference : W & Notes
     - Kalman Filter
     - Viterbi Algorithm
     - Expectation Maximization & Clustering
     - *Labs: Tracking, RNA sequencing, WiMAX (Viterbi algorithm)*

3 Grade / Homework / Discussion Forum / Exams / Schedule

- **Course Grading** : Homework assignments (10%), project (5%), midterm 1 (20%), midterm 2 (25%), and final exam (40%)
- **Homeworks**
  - Weekly homeworks will be assigned every Thursday, and must be submitted by **8 a.m. of the following Thursday** as **a PDF file for the theory part and an ipynb file for the mini-lab part**.
  - Homework assignments, solutions, and general announcements will be posted on bCourses.
  - Each homework should be self-graded and the self-graded score should be submitted online by **5pm of the following Monday.** For detailed description of self-grading policies, please refer 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 as time permits. Find our class page at: piazza.com/berkeley/spring2016/ee126

- **Exams**
  - Midterm 1: Tuesday, February 16, 7-9pm, Location: 20 Barrows, 101 Moffitt
  - Midterm 2: Thursday, March 31, 7-9pm, Location: 2070 VLSB, 101 Morgan
  - Final exam: Wednesday, May 11, 11:30am-2:30pm, Location: TBA
- **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,	BT Ch.4-5
5	Review and Applications, Binary Erasure Channel and Fountain Codes, Midterm#1 (February 16 evening)	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	W Ch. 13.5, Lecture notes
9	Detection, Bayes' Rule, Neyman-Pearson Theorem	W Ch.5
10	Spring Break	-
11	Estimation, LLSE, MMSE, Midterm#2 (March 31 evening)	W Ch.7
12	Hidden Markov Chains, Viterbi Algorithm	W Ch.9
13	Expectation Maximization, Clustering	W Ch.9
14	Applications	W Ch.9
15	Applications, Review	-

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.

  We use the CS70 self-grading system as follows. You can earn one of 5 possible scores for a problem: `0`, `2`, `5`, `8`, and `10`.
  - 0 = didn't attempt or very very wrong,
  - 2 = off in the wrong direction or no clear direction,
  - 5 = right direction and got half-way there,
  - 8 = mostly right but a few minor things missing or wrong,
  - 10 = 100% correct.

  Note that *all partial credit must be justified with a comment*; without a comment, no partial credit will be allowed.

  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-graded score**: 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 bCourses. After grading each assignment based on a posted solution, students will submit their score through online. Self-graded score has to be submitted via Google Forms, of which link will be provided with each solution.