EE5137 : Stochastic Processes (Spring 2022)

Vincent Y. F. Tan

1 Teaching Staff

The instructor for this class is Vincent Y. F. Tan.

- Office: E4-06-06 (or S17-05-20)
- Office Hours: 4.00pm–5.00pm each Thursday at E4-06-06 (Please make use of this resource!)
- Email: vtan@nus.edu.sg
- Graders: Fengzhuo Zhang (fzzhang@u.nus.edu) and He Yuan (he.yuan@u.nus.edu)
- Class time: 6pm–9pm each Friday (with a 10-15 min break in between)
- Location: LT4

2 General Information

This is a course on stochastic processes. The emphasis of this course is on *mathematical rigor* of principles and concepts in stochastic processes with an eye towards modeling of real-world systems. Students are expected to do simple proofs in addition to rudimentary calculations.

We will use the book by Robert G. Gallager "Stochastic Processes: Theory for Applications". Specifically, we will spend approximately 2-3 weeks each on probability review (Chapter 1), Poisson processes (Chapter 2), finite-state Markov chains including Markov decision theory and dynamic programming (Chapter 4), and detection theory (Chapter 8). The rough schedule can be found at Section 7.

All the information for this class can be found on LumiNUS.

3 Assessments

- Homeworks (15%)
- Quiz 1 on 5 Feb (12%)
- Quiz 2 on 12 March (18%)
- Final Exam on 30 April (55%)

4 Homeworks

- There will be nine graded homework assignments due approximately *once every week*.
- No extensions will be allowed because solutions will be posted once the homeworks are due.

- You are strongly encouraged to collaborate with each other in solving the homework problems but you must write up the solutions on your own. These are meant to help improve your understanding of the subject matter, and you should treat the homework very seriously in order to gain the most out of this course.
- A strict subset of the compulsory problems will be graded.
- There will be many problems labelled as *optional*. You don't have to do these problems but they are meant as an important vehicle for learning.
- Solutions to all (compulsory and optional) problems will be provided.
- Each homework set will be graded coarsely. You will receive one of four numerical grades–0, 1, 2, 3. 0 means that the homework was not turned in and 3 means that the homework was done almost perfectly. 1 and 2 interpolate in between.
- You're allowed to drop two homework sets that have the worst numerical scores in the final computation of your homework grade. Thus, I'll not entertain any requests to turn in the homeworks late.

5 Quizzes and Final Exam

- There will be two one-hour quizzes (on 4th Feb 2022 and 11th Mar 2022) during the course of the semester. They will be held at 8pm at the lecture theatre.
- The final exam is scheduled on the finals week and will be comprehensive, i.e., covering all topics in the course.
- For each of the two quizzes and the final exam, you are allowed ONE A4-cheat sheet (double sided). Quizzes will be **in person** at LT4.
- Past year quizzes and exams and their solutions will be posted at appropriate times.

6 Prerequisites

This is a serious course that will train you to *think* precisely and to do mathematical proofs as well as calculations. To fully appreciate this course, you are expected to have a *very* firm grasp of undergraduate probability and statistics. You should know what is a random variable, probability mass functions, joint and conditional distributions, Markov chains, probability bounds (such as Markov and Chebyshev inequalities), laws of large numbers, conditional independence, etc. Even though we will have a thorough review of the material in the first three classes, we will proceed at a pace that is too fast if one is not already familiar with these concepts taught in a good undergraduate probability class.

7 Tentative Schedule (Subject to Change)

- Week 1 (14 Jan): Introduction and review of probability (Sections 1.1–1.3)
  Homework 1 Posted
- Week 2 (21 Jan): Introduction and review of probability (Sections 1.4–1.6)
  Homework 2 Posted; Homework 1 Due
- Week 3 (28 Jan): Introduction and review of probability (Sections 1.7–1.8)
  Homework 3 Posted (not due); Homework 2 Due

- Week 4 (04 Feb): Poisson processes (Sections 2.1–2.2.2)
  Quiz 1 at 8pm (on Probability)
  Homework 4 Posted
- Week 5 (11 Feb): Poisson processes (Sections 2.2.3–2.3.1)
  Homework 5 Posted; Homework 4 Due
- Week 6 (18 Feb): Poisson processes (Section 2.3.2, 2.5, Exercises on Poisson Processes)
  Homework 6 Posted; Homework 5 Due
- *Recess Week (26 Feb): No class*
- Week 7 (04 Mar): Finite-state Markov chains (Sections 4.1–4.2)
  Homework 7 Posted; Homework 6 Due
- Week 8 (11 Mar): Finite-state Markov chains (Section 4.3)
  Quiz 2 at 8pm (on Poisson Processes)
  Homework 8 Posted; Homework 7 Due
- Week 9 (18 Mar): Finite-state Markov chains (Sections 4.4–4.5.1)
  Homework 9 Posted; Homework 8 Due
- Week 10 (25 Mar): Markov decision theory and dynamic programming (Sections 4.5.2–4.6)
  Homework 10 Posted; Homework 9 Due
- Week 11 (01 Apr): Detection theory (Sections 8.1–8.2.2)
  Homework 11 Posted (not due); Homework 10 Due
- Week 12 (08 Apr): Detection theory (Sections 8.2.3–8.3)
- *Week 13 (15 Apr): Public holiday (no class, replaced with consultation)*
- **Exam (29 Apr 2022): 9am – 12noon**

8 References

All students are to have a copy of Gallager's book (posted on LumiNUS) as assignments will be taken from the problems therein.

- Robert G. Gallager, "Stochastic Processes: Theory for Applications", Cambridge University Press, 2014

Ross' book is also a classic and can be used as a secondary reference.

- Sheldon Ross, "Stochastic Processes", Wiley, 2nd Edition, 1995