Syllabus
MATH 4410/6410: Introduction to Stochastic Models
Fall 2020, Section 001

Instructor: Brian H. Fralix

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Office Hours: 3:30PM - 4:30PM MTWR, through Zoom.

Course Location and Meeting Time: Daniel 216, 2:30PM - 3:20PM MWF (and ONLINE)

All of our 'mathematical' lectures will take place asynchronously, through the use of videos that will be accessible to you within Canvas. Our 'in-person' synchronous sessions (which will also be recorded) will address questions you may have about the material, interesting problems that involve important concepts from the course, as well as topics related to both statistical software (R) and document preparation software (LaTeX). I suspect that during the first few weeks of our 'in-person' lectures, I will go over various aspects of both R and LaTeX, but later in-person lectures will focus more on math problems related to course material.

Note: the 'in-person' lectures will not be used to cover additional course material, meaning we will not be 'doubling-up' on the amount of material you have to learn. You should think of these lectures as unofficial 'recitation-like' lectures, where you will see examples that better illustrate the theory you learn from the videos, and get exposed to software that can be used to (a) make the subject 'come alive through simulation' with R, and (b) present mathematical work clearly with LaTeX. You will not need to learn very much of R and LaTeX for our purposes, and many of you will find this software useful for both other courses, as well as for your career after college.

Course Web Site: All course information and materials (including your grades) will be stored in Canvas.

Required Textbook: The following textbook will be the main text we use in this course.

- *Essentials of Stochastic Processes*, Third Edition, by Richard Durrett (Springer)

Recommended Textbooks: We will also occasionally make use of the following textbooks as well:

- *Simulation*, Fifth Edition, by Sheldon Ross (Academic Press)
- *Introduction to Probability, Simulation, and Gibbs Sampling with R*, by Eric A. Suess and Bruce E. Trumbo (Springer)
- *Practical LaTeX*, by George Grätzer (Springer)

All of these textbooks can be downloaded (legally) through Cooper Library. To download the three Springer books, go to the library home page (libraries.clemson.edu), click on Databases, click S, click on SpringerLink, then search for each text. Likewise, you can download Ross's text through Databases by clicking on ScienceDirect, then search for the text (the fifth edition was published in 2013).

I will also provide you with lecture notes that very closely represent the way in which I will cover course material in the online lectures. These notes will be available to you for free, through Canvas. I will add material to these notes, and make constant revisions, as we progress through the semester.

Software: We will spend a considerable amount of time learning the basics of both R (a statistical software package) and LaTeX (a document preparation system that can be used to write up documents containing mathematical statements).

Prerequisites: MATH 4000 (Theory of Probability), or an equivalent course on undergraduate-level probability. Examples of probability texts that are at a suitable level include

- *A First Course in Probability* by Sheldon Ross
- *Introduction to Probability* by Joseph Blitzstein and Jessica Hwang

and there are many, many others that are similar to these two.

I will spend the first couple of weeks covering concepts from probability theory: some of this material will consist of things you have seen before, but some of it will most likely be new to you.

Attendance Policy: I will keep track of your attendance through our 'in-person' Zoom meetings, as well as through the assignments/projects you turn in.

Late Instructor: If the instructor is late, students should wait 15 minutes before leaving.

Course Description: (*From the Undergraduate Announcements*) "Introductory treatment of stochastic processes, finite-state Markov chains, queueing, dynamic programming, Markov decision processes, reliability, decision analysis, and simulation. Both theory and applications are stressed."

I plan to cover the majority of Chapters 1, 2, 3, and 4 of Durrett's text, as well as some extra material not found in his text.

Goals and Objectives: Upon completion of the course, students will be able to do the following:

- Discuss both the Weak and Strong Law of Large Numbers, understand how they can be proven rigorously under strong assumptions (such as when all random variables are bounded), as well as how they justify why Monte Carlo simulation can be used to estimate both probabilities and expectations.
- Understand the concept of a limit at a sufficiently rigorous level, meaning students will understand how to rigorously prove when a sequence of real numbers has a limit.
- Understand the concept of an indicator variable, i.e. indicator function, and how they can be used effectively in modeling.
- Explain what it means for a sequence of discrete random variables to be a discrete-time Markov chain, and know how to use the tools of probability to calculate quantities that can be used to describe the time-dependent behavior of these chains.
- Understand how to calculate stationary distributions and limiting distributions of Discrete-Time Markov chains, and explain when these things exist.
- Understand how to work with basic properties of Poisson processes.
- Understand how the theory of discrete-time Markov chains carries over to the theory of continuous-time Markov chains.
- Use LaTeX to typeset mathematical documents at a sufficiently readable level, and make presentation slides that contain a significant amount of mathematics.
- Use R to perform basic tasks associated with random number generation, and Monte Carlo simulation.

Grading Policy: Given our current situation with COVID-19, along with the fact that this is a fairly advanced senior-level course, I have decided to have your course grade be based entirely on Written Homework Assignments (60 percent), Projects (30 percent), and the Final Project (10 percent). My use of the word 'Project' here is meant to be vague, and instead of assigning one large project for you to work on throughout the semester, I will instead assign a number of small projects that will require the use of both R and LaTeX, as well as the actual course material. The final project will be due on the day at which we are scheduled to have a Final Exam (i.e. it will serve as our Final).

Your end-of-semester grades will be assigned according to the following scale: $[90, 100] \to A$, $[80, 90) \to B$, $[70, 80) \to C$, $[60, 70) \to D$, and $[0, 60) \to F$. The instructor has the right to curve grades upward, i.e. a score of 90 represents *at least* an A, a score of 80 represents *at least* a B, etc..

Homework: Homework assignments will be announced during the 'in-person' synchronous lectures, as well as through e-mail, and they will also be posted in Canvas. All assignments (Homework and Projects) will be submitted through Canvas.

MATH 6410 Students: Students enrolled in MATH 6410 should expect to have slightly more difficult homework assignments, and will be expected to perform at a higher level on all projects.

Official Statement of Academic Integrity: (*From the Undergraduate Announcements*) "As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

Disability Access Statement: "Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to a class should let the professor know, and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848, by emailing studentaccess@lists.clemson.edu, or by visiting Suite 239 in the Academic Success Center building. Appointments are strongly encouraged – drop-ins will be seen if possible, but there could be a significant wait due to scheduled appointments. Students who receive Academic Access Letters are strongly encouraged to request, obtain and present these to their professors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to follow this process each semester. You can access further information here: http://www.clemson.edu/campus-life/campus-services/sds/."

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Ms. Alesia Smith is the Clemson University Title IX Coordinator and the Executive Director of Equity Compliance. Her office is located at 110 Holtzendorff Hall, 864.656.3181 (voice) or 864.656.0899 (TDD).