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Course Description: A brief introduction to calculus-based probability theory, as well as a study of the main discrete- and continuous-time stochastic processes. Topics include Markov chains, martingales, Poisson processes, renewal processes, continuous-time Markov chains, and Brownian motion. A portion of the course is devoted to modeling stochastic processes using computer software. Emphasis will be placed on refinement of problem-solving and mathematical modeling skills.

Prerequisites: MATH202 and one of MATH113, MATH141, or MATH391; or Instructor Consent.

Textbook: *Introduction to Stochastic Processes with R*, by Dobrow. We will cover chapters 1 through 8. Reading assignments will be given on frequent basis, so daily access to the textbook is highly recommended. A free online copy of the textbook is available through the Reed library website.

Course Website: Documents, a daily schedule, assignments, and discussions will be posted on our Moodle page at `https://moodle.reed.edu`.

Technology: We will make frequent use of the R programming language to perform routine calculations and create probability models. Instructions for using R and RStudio are available on the course Moodle page. Calculators may be used on problem sets, but unless otherwise noted, no calculators or other electronic devices may be used on exams.

Communication: If you would like to contact me, I can most easily be reached by email weekdays between 10am and 6pm. While I try to answer email as soon as possible, in some cases, I may not be able to respond until the following school day. You are also welcome to stop by my office outside of office hours—I usually have at least a few free minutes to help.

Course Outcomes: By the end of the course, a student should be able to:

1. Describe probability models using the language of events and random variables, and manipulate equations involving random variables and probabilities using conditional probability, conditional expectation and independence.
2. Determine whether a given process is a Markov chain, and provide examples and non-examples of Markov chains.
3. Use matrix algebra to calculate relevant quantities of Markov chains.
4. Describe and analyze the long-term behavior of a Markov chain using the stationary and limiting distributions, as well as the ergodic properties.
5. Analyze extinction events in branching processes using both direct and moment methods.
6. Simulate probability distributions using the Markov chain Monte Carlo method.
7. Model a Poisson process using three alternate definitions: as a counting process, as an arrival process, and using an infinitesimal description.
8. Construct and analyze continuous-time Markov chains using generating functions.
9. Define Brownian motion, and discuss several counter-intuitive phenomena exhibited by this process.
10. Create and sample from probability models using the R programming language.

Grading Criteria:
Your grade in the class will be determined by your proficiency in each of the *Course Outcomes*, as demonstrated in the following assessments:

1) Daily Readings 2) Homework 3) Midterm Exams 4) Final Exam 5) Project

Daily Reading / Participation: Mathematical knowledge takes time to develop, and understanding deepens upon revisiting a concept a 2^{nd}, 3^{rd}, or n^{th} time. Studying basic terminology and elementary examples in the textbook before class means that lectures can be spent clarifying and expanding ideas, rather than introducing them. Daily reading assignments will be posted on the Moodle course page. These assignments will list the specific section(s) to read for each day, along with several basic questions to check comprehension. Answers are due by 8am each day of class (to give me time to review them before class), and can be submitted by following the same link on Moodle where the assignment was found and then either a) uploading a typed assignment or a clear and legible picture of a handwritten assignment, or b) typing directly into the text-box. Up to three daily reading assignments may be missed without penalty.

Homework: Each week, a written assignment will be posted on Moodle, to be completed and submitted on paper in my office or electronically on Moodle by 5pm on the following Friday. These assignments will usually include one or two longer or more challenging problem, along with several more routine problems and exercises. Solutions to each problem may be either hand-written or typed, must be in complete sentences, and must include a brief explanation of reasoning. Up to twice throughout the term, you may request a five day extension on your homework. Except in extraordinary circumstances, requests must be made prior to an assignment's due date.

Midterm Exam: Two midterm exams will be given during the term. The first will be an in-class 50-minute exam, tentatively scheduled for Monday, October 7 (Week 6). The second will be a take-home exam assigned Friday, November 8 (Week 10) and due Monday, November 11 (Week 11). If you foresee a conflict with the scheduled time for the exams, please notify me during the first week of class so that appropriate arrangements can be made. Except in extraordinary circumstances, the exam cannot be made up after the exam date. However, if an emergency prevents you from taking an exam, *notify me as soon as possible.*

Final Exam: A cumulative final exam will be given during Finals Week, as scheduled by the Registrar.

Project: Throughout the term, you will work with a group to independently research and model a stochastic process not covered in our course. At the end of the term, you will deliver a brief presentation outlining your findings, and will submit a longer research paper containing your full analysis.

Accessibility: Reed College is dedicated to creating inclusive learning environments. Please notify me as soon as possible if there are aspects of the instruction or design of this course that result in disability-related barriers to your participation. You are also encouraged to contact Disability Support Services at disability-services@reed.edu, and to peruse the services offered on their website at `https://www.reed.edu/disability_services/`.

Academic Integrity: Students are allowed and encouraged to collaborate on most in-class and homework assignments. However, any work that you turn in for grading must be your own. You are welcome to use internet resources to supplement content we cover in this course, with the exception of solutions to homework problems. Copying solutions from the internet is an Honor Principle violation. Exams will be closed book, closed notes, and closed colleague, unless otherwise specified. All written work that references material outside of the textbook or lecture should be accompanied by an appropriate citation.

Tentative Schedule: (Section numbers are from Dobrow's *Intro to Stochastic Processes with R*)

Week	**Sections Covered**	**Week**	**Sections Covered**
1	Probability	9	6.1 - 6.4
2	Random Variables, 1.4, 1.5	10	6.5 - 6.7 (Midterm 2)
3	2.1 - 2.5	11	7.1 - 7.3
4	3.1 - 3.4	12	7.4 - 7.6
5	3.5 - 3.9	13	8.1 - 8.3
6	4.1 - 4.4 (Midterm 1)	14	8.4 - 8.5
7	5.1 - 5.3	15	Presentations
8	Fall Break (No Class)	16	Final Exam