Instructor:	Jonathan "Nate" Wells	**Email:**	wellsj@reed.edu
Classroom:	https://zoom.us/j/98676422293	**Office:**	https://zoom.us/my/wellsj392
Virtual Office Hours:	T 6-7p; W 10-11a; Th 2-3p; F 10-11a or by appointment		

Course Description: This course is a comprehensive introduction to the abstract theory of probability, as a language for interpreting and analyzing problems in statistics, natural and social sciences, and philosophy. Emphasis will be placed on refinement of problem-solving and mathematical modeling skills.

Prerequisites: MATH113 and MATH202, or Instructor Consent.

Distribution Requirements: This course can be used towards your Group III, "Natural, Mathematical, and Psychological Science," requirement. It accomplishes the following learning goals for the group:

> Use and evaluate quantitative data or modeling, or use logical/mathematical reasoning to evaluate, test or prove statements; Given a problem or question, formulate a hypothesis or conjecture, and design an experiment, collect data or use mathematical reasoning to test or validate it; Collect, interpret and analyze data

This course does not satisfy the "primary data collection and analysis" requirement.

Textbook: *Introduction to Probability*, 2nd Edition by Blitzstein and Hwang. We will cover chapters 1 through 11. Reading assignments will be given on frequent basis, so daily access to the textbook is necessary. A free online copy of the textbook is available on the author's website: `http://probabilitybook.net/`

Course Resources: The following web-based resources will be used for communicating class information:

- Slack `reedmath391fall2020.slack.com` (*announcements, discussions, direct messaging*)
- Moodle `https://moodle.reed.edu` (*documents, a daily schedule, assignments, videos*).
- Gradescope `https://www.gradescope.com/` (*Homework & daily assignment submissions*)

Technology: Our class will be conducted primarily online using Zoom. You will need the following during our scheduled class time: a computer with stable internet access, a webcam and microphone, a location where you can carry out a conversation at normal volume. Additionally, to facilitate group discussions and share work, you will need to have a touch-screen device that you can comfortably write on using a stylus. A tablet or graphics tablet is most preferred, but touch-screen laptops and smart phones can also work.

We will make frequent use of the R programming language to perform routine calculations and create probability models. R and RStudio are free to use, and can either be installed locally on your computer, or can be accessed using the Reed RStudio Server: `https://rstudio.reed.edu/`

Communication: If you would like to contact me, I can most easily be reached via Slack message weekdays between 8am and 6pm. While I try to answer messages as soon as possible, in some cases, I may not be able to respond until the following school day. If you'd prefer to talk live, send me a message and we can schedule a time to chat on zoom.

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

1. Describe uncertainty and randomness using the axiomatic language of sets and functions.
2. Incorporate new observations into a probability model using conditional probability and independence.
3. Quantify, predict, and analyze the outcomes of random experiments using both discrete and continuous random variables.
4. Calculate the expected value, variance and quantiles of common discrete and continuous random variables.
5. Summarize and specify a random variable using its moments and moment generating function.
6. Compare and describe multiple random variables using joint, marginal, and conditional distributions, along with covariance and correlation.
7. Obtain and analyze new random variables by applying transformations to a class of elementary distributions.
8. Estimate outcomes of experiments based on existing evidence, and describe the result using conditional expectation and conditional variance.
9. Determine the limit of a sequence of random variables, and characterize the limit's mean and fluctuations using inequalities.
10. Create and sample from probability models using the R programming language.

Format: The course will be taught using in a group-based and problem-focused model. A typical class day will involve the following:

- *Reading/Video Assignment:* Every class will have an assigned reading and pre-recorded lecture video. At least an hour before the class period covering the given material, you will complete a Gradescope Quiz on those topics. You are also encouraged to submit any questions you have on the readings/videos, or requests to review a particular topic.
- *Active Class Session:* Our 50-minute virtual meetings will include mini-lectures by the instructor, along with collaborative group work with your peers. The mini-lectures will provide supplementary content to the assigned readings/videos, while the group work will allow you to delve deeper into key problems and exercises.
- *Homework*: After each class session, several homework problems will be assigned, due by the start of class, two class periods later.

In light of the constraints of a virtual classroom, and acknowledging that learning may be disrupted at an individual or class-wide level this semester, this format is designed to maximize the time available for live discussion and collaboration, while still providing a considerable amount of content that can be explored outside of regularly scheduled hours. But beyond the realities imposed by the ongoing pandemic, Probability is fundamentally a problem-based subject, and is best studied by actively working on subtle problems.

Workload: A prepared student will attend class for 50 minutes per day, three days each week, and spend about two to three hours per day of class on work outside the classroom (reading, watching lecture videos, doing homework, discussing, studying, etc.). Together, this represents a 9 - 12 hour per week commitment.

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 Assignments 2) Homework 3) Participation 4) Midterm Exams 5) Final Exam

Daily Assignment: 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 class can be spent clarifying and expanding ideas, rather than introducing them. Daily reading assignments will be posted on the Moodle course page, and will list the specific section(s) to read for each day, along with a link to a pre-recorded lecture. A brief quiz on the readings/videos will be posted on Gradescope, to be completed by 8am each day of class (to give me time to review them before class). The quiz questions are not intended to be overly difficult, but should help both you and I highlight topics that need further review. The quiz will be assessed primarily on the basis of completion. No extensions on daily reading will be given, but up to three daily reading assignments may be missed without penalty.

Homework: Homework will be due at the start of nearly every class meeting, and should be submitted online to Gradescope. Solutions to each problem may be either hand-written or typed, must be in complete sentences, and should be thorough enough that another student in the class can follow your reasoning without question. Up to three times throughout the term, you may request an extension on your homework (usually until the next class period). Except in extraordinary circumstances, requests must be made prior to an assignment's due date.

In-class Participation: Because of the collaborative nature of this course, it is essential that you strive to attend class every day. But if you aren't able to attend class for any reason, please notify me, as well as your group members, before the start of class. You may miss up to three classes throughout the term without penalty, but more frequent absences will be reflected in your final course grade. Additionally, you are expected to make at least two significant contributions to the Slack workspace each week. Examples of significant contributions can be found on Slack.

Midterm Exams: Three take-home exams will be given during the term, and will be made available on a Friday, to be completed before class the following Monday. Tentatively, the first is scheduled for Friday, September 25th (Week 4), the second for Friday, October 23 (Week 8), and the third for November 13th (Week 11). The exams are intended to take between 3 and 4 hours to complete, allow reference to course notes and the textbook.

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

If illness or other circumstances prevent you from participating in class for 3 or more class days, please let me know as soon as possible so we can make appropriate arrangements for missed work.

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 & Accessibility Resources at dar@reed.edu, and to peruse the services offered on their website at `https://www.reed.edu/disability-resources/`.

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 explicitly mention what resources may be consulted. All written work that references material outside of the textbook or lecture should be accompanied by an appropriate citation.

Tentative Schedule: (Section numbers from Bltizstein and Hwang's *Intro to Probability*)

Week	**Sections Covered**	**Week**	**Sections Covered**
1	1.1 - 1.6	9	7.1 - 7.5
2	2.1 - 2.8	10	8.1 - 8.3
3	3.1 - 3.9	11	8.4 - 8.6, 9.1 - 9.5 (Exam 3)
4	4.1 - 4.6 (Exam 1)	12	10.1 - 10.4
5	4.7 - 4.9	-	Thanksgiving Break
6	5.1 - 5.4	13	11.1 - 11.4
7	5.5 - 5.7	14	Reading Week
8	6.1 - 6.6 (Exam 2)	15	Final Exam