Math 436 Spring 2026

Topics in Probability:
Stochastic Processes

MWF 12:00-12:50PM Keyes 102

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"These motions were such as to satisfy me, after frequently repeated observation, that they arose neither from currents in the fluid, nor from its gradual evaporation, but belonged to the particle itself." – Robert Brown

"In stochastic processes the future is not uniquely determined, but we have at least probability relations enabling us to make predictions." – William Feller

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Course Description: Welcome to the amazing world of Stochastic Processes. In its essence, this subject is about understanding the evolution of randomness in time. We aim to answer questions such as: If a particle moving randomly visits a location at some time, what is the probability that it will visit that same location (or some other specified one) at a later time? This, of course, can be mapped to a question that an investor might care about: If a stock has value X_0 at time 0, what is the probability that it will be worth more (or less) at a later time t? In this seminar-style course, we will begin our study with Markov chains; these are stochastic processes where time is taken in discrete increments and probabilities are updated based on a special kind of conditioning called the Markov property[1]. Following the wonderful text of Grimmett and Stirzaker, we will study further stochastic processes in both discrete and continuous time, including Weiner processes, renewal processes, Martingales, and diffusion processes. Time permitting, we will study applications of the above to physics and mathematical finance.

Prerequisites: Mathematics 381.

Textbook: Probability and Random Processes, Grimmett and Stirzaker. Fourth Ed.

Supplementary Course Material: When learning a subject, it is often helpful to have several resources available to compare, contrast and get different perspectives as you process material. To this end, you may want to look at the following resources: Essentials of Stochastic Process by Rick

[1]Named after the 19th Century Russian Mathematician, Andrey Markov

Durrett (text here), *Introduction to Stochastic Processes* by G. Lawler, 2nd edition. and *Stochastic processes without measure theory* by B. Schmuland.

Grading: Your grade will be calculated as follows:

Class Participation and Attendance:	15%
Weekly homework assignments:	20%
Presentations:	40%
Final project:	25%

Presentation: This is a seminar-style class and thus all students will present material regularly. We will take turns presenting material, with each presentation lasting 25 minutes (half of a class period). I understand that presenting mathematics is a difficult skill and takes a while to get good at; however, it is arguably the best way to learn any material: to be able to teach it yourself. As we progress through the semester, I will work with all of you individually and help you develop your presentation skills (as well as answering any questions you have about your presentations and the material before your scheduled time). I am confident that this will be a very rewarding experience for you and I am looking forward to working with you as you learn this subject and develop your presentation skills.

Attendance and Class Participation: You are required to attend each class session. This means that you need to be on time to class, seated (when you are not presenting), and ready to learn (take notes, participate, discuss, and engage). As presentation is an essential component of this class (and a very difficult skill to develop), it is imperative that we support and respect each other in developing this skill. The most minimal requirement for this is everyone's on-time attendance. Only absences for religious reasons or for official Colby activities are permitted as long as you communicate with me clearly beforehand.

The following rules apply:

1. You are tardy when you arrive t minutes late for $0 < t \leq 5$; here, the minutes start at exactly 12:00 PM.

2. If you arrive more than 5 minutes after the start of the hour, you are considered absent and I ask that you not enter the room so that you do not distract the presenter or your peers from their learning.

3. Each instance of tardiness or absence will count against your final grade (a tardy costs 5% and an unexcused absence costs 10%). Numerous deductions can result in failing the courses and, if absences/instances of tardiness are particularly egregious, I reserve the right to have the registrar remove you from the course.

In-Class Policies: As discussed above, when you are in class, you are expected to be fully engaged with material and the class presentation/discussion. For this reason, you should not have laptops or cell phones out during class; these should be stored away throughout the entirety of the class period. For those students who take notes on digital tablet/notebooks, the tablet/notebooks should always be placed flat on the desk (like a paper notebook) and not propped up like a laptop. Your tablet/notebook screen should always be visible to me. I ask that you stay seated throughout the class period, unless you are presenting, to minimize the distraction of your peers. It is essential

for the classroom to be a place where people can focus, learn, and explore mathematics without distraction.

Homework: Homework is an important part of this course. It is where you will grapple with new ideas, come up with creative solutions and communicate your thoughts and understanding to others. Consequently, it is crucial that you take homework very seriously. You should start homework early and work diligently. If you are having substantial difficulty with a particular exercise, please come talk to me during office hours. I am here to help! You are permitted and encouraged to discuss homework with your classmates, however, when it comes time to write up your solutions, you are required to do so independently and away from your peers (in another room, preferably). You are also permitted to consult other textbooks and, in this case, please give full details (beyond what's in our textbook). If you work with peers or consult material outside the textbook, you are required to cite your sources (including naming the peers with whom you worked); failure to do so is a matter of academic dishonesty and will result in grade penalties and/or reports of academic negligence/dishonesty. Your solutions should communicate your individual process and understanding of the material. What you turn in must be your own.

I expect homework solutions to be written out correctly and presented in good mathematical prose. Your grade will depend on the correctness of your solutions and the quality of your writing. This means that your writing should follow a coherent logical structure which makes use of complete sentences and follows standard rules of grammar. Please do not submit solutions containing incoherent and unstructured calculations. You should be proud of the material you turn in!

Homework Structure and Schedule: Assignments will be posted to the course website and are to be submitted in class on their due date. It is crucial to keep up with the homework in this course. Therefore, short of the circumstances discussed in the attendance policy above, late homework will not be not accepted. I will drop your lowest homework score on the condition that you attend one department colloquium and write a short (one paragraph) summary.

Homework Policies:

1. All write-ups are to be submitted in hard copy and should be single-sided and stapled.
2. You are encouraged to typeset your write-ups (and paper for the project) in LaTeX(I can help you set this up if you are interested and unfamiliar with LaTeX). It is however completely acceptable to submit handwritten write-ups provide your handwriting is clear and legible.
3. Each paper you turn in should have your name and the due date printed clearly at the top.
4. Your write-ups should be stapled. It is your responsibility to make sure that your homework is complete and all pages are accounted for.
5. If you used technology in the solution of the problem, please provide the complete printout showing all code, inputs and outputs in sequence, and annotate the printout with comments explaining what is being done in each step.

Final project: An important part of this course is a project to be completed by the end of the semester. The primary goal of the project is to give you an opportunity to demonstrate what you've learned throughout the semester and to experiment with new ideas beyond what we've covered in

class. Toward the middle of the semester, we will meet to discuss and select a project aligned with your interests. Though the nature (and specifics) of each project will differ from student to student, the projects will culminate in a paper and presentation.

Office Hours: You are strongly encouraged to attend office hours and do so regularly. Office hours are the perfect venue for asking questions, getting help, and having real one-on-one time with me. For my office hours to be most beneficial to you and fair to your peers, my office-hour policies are as follows:

- If you are attending office hours to get help with the homework, you first must first have spent a considerable amount of time ($\geq$ 30 minuets) thinking about/attempting a solution/proof. In particular, you must have parsed through the definitions, read the relevant sections of the textbook(s), compared the problem against what we've done in class and similar examples from the textbook(s), and made an earnest attempt at a solution/proof and be prepared to show me your attempt.
- To be most effective in helping students with homework problems, I will sometimes work with students individually and other times work with students in groups. If you prefer to talk with me individually, please let me know (and be patient).

Open Door Policy: I maintain an "open door policy." This means that, if you find my (inner) office door open and I'm inside, I am likely available to chat and help. In that case, please and ask if I am available. If my door is closed, it's a signal that I am busy (if I am there) and am therefore not able to help. If you see my inner door closed, please do not knock.

My Email Policy: I love talking about mathematics and I always prefer to do it in person. For this reason, I like to, whenever possible, reserve email for logistical things. However, when you are stuck and cannot come see me in person, please feel free to email me. I am here to help!

As my life is busy and I have many responsibilities, I usually only check and respond to email once per day and sometimes not at all on weekends. For this reason, I try to uphold the following 24-48 hour rule: If you send an email Sunday through Thursday, I will do my best to respond within 24 hours. If you send an email on Friday or Saturday, I will do my best to respond within 48 hours. If I do not respond within these windows, feel free to email me again as I may have missed it.

On AI: Colby provides access to professional versions of Google Gemini. Many industries now require their employees to use AI on a regular basis in order to increase efficiency and outsource rote tasks. So by all means, familiarize yourself with AI, including by consulting non-AI sources concerning the enormous ethical, social, and philosophical issues surrounding it. But in this course, efficiency of output is not our objective. Our objective is to learn mathematics and learn how to communicate our understanding as thoroughly as we can. Yes, AI systems "know" differential equations. But in the days before AI, other people knew differential equations too. Indeed the only reason AI systems are at all decent at some mathematics is because humans taught them both by making their intellectual work available online and by directly teaching the AI (aka "reinforcement learning"). This does not change the fact that humans need to know mathematics, even less does it obviate the need to develop mathematical ways of thinking. Indeed, the imperative is even greater. AI systems, above all else, are excellent at sounding convincing. Only by becoming a well educated person yourself, will you be able to tell when it is wrong or be able to think

up a more creative solution to some problem than the "common online wisdom" that AI defaults to.

How does one become educated? By working hard both by oneself and in community. "There is no royal road to geometry." (Euclid? 300BCE). The good news is that, if you are doing what you are supposed to, the work will be rewarding and it will pay off.

Academic Integrity: Honesty, integrity, and personal responsibility are cornerstones of a Colby education and provide the foundation for scholarly inquiry, intellectual discourse, and an open and welcoming campus community. These values are articulated in the Colby Affirmation and are central to this course. You are expected to demonstrate academic honesty in all aspects of this course. If you are clear about course expectations, give credit to those whose work you rely on, and submit your best work, you are highly unlikely to commit an act of academic dishonesty.

Academic dishonesty includes, but is not limited to: violating clearly stated rules for taking an exam or completing homework; plagiarism (including material from sources without a citation and quotation marks around any borrowed words); claiming another's work or a modification of another's work as one's own (results from AI, internet searches, or online forums count as "another's work"); buying or attempting to buy papers or projects for a course; fabricating information or citations; knowingly assisting others in acts of academic dishonesty; misrepresentations to faculty within the context of a course; and submitting the same work, including an essay that you wrote, in more than one course without the permission of the instructors.

Academic dishonesty is a serious offense against the college. Sanctions for academic dishonesty are assigned by an academic review board and may include failure on the assignment, failure in the course, or suspension or expulsion from the College.

The Colby Affirmation

Colby College is a community dedicated to learning and committed to the growth and well-being of all its members.

As a community devoted to intellectual growth, we value academic integrity. We agree to take ownership of our academic work, to submit only work that is our own, to fully acknowledge the research and ideas of others in our work, and to abide by the instructions and regulations governing academic work established by the faculty.

As a community built on respect for ourselves, each other, and our physical environment, we recognize the diversity of people that have gathered here and that genuine inclusivity requires active, honest, and compassionate engagement with one another. We agree to respect each other, to honor community expectations, and to comply with college policies.

As a member of this community, I pledge to hold myself and others accountable to these values.