



MTH 446/546 Stochastic Processes
Fall 2023

3 Credits
Tu/Th 8-9:20

Instructor
Brian Spencer

Email: spencerb@buffalo.edu
Office Phone: 716-645-8805

Office Hours & Location
Tu/Th 9:30-10:30 in Math 319
+ by appointment (send email
with 3 possible times to meet)

Course Description

Stochastic processes describe the dynamics of systems which evolve in time according to probabilistic laws, rather than deterministic laws. We particularly study Markov processes which have the property that the future only depends on the present, not on the past. Topics to be covered are discrete Markov chains, Poisson processes, continuous Markov chains, Brownian motion, and other more advanced topics. The course emphasizes concepts, applications, and computations, rather than rigorous proofs. In particular, measure theory is not employed.

Prerequisites: MTH 241 (or MTH 251) and MTH 411 (or STA 301).

Learning Outcomes

Outcome	Method of Assessment
Model random events by mathematical models	Homework, exams
Develop the mathematical analysis of such models	Homework, exams
Understand the uses and limitations of results	Homework, exams

Course Materials

Texts:

- *Introduction to Stochastic Modeling* by Mark A. Pinsky and Samuel Karlin, Academic Press, 4th edition (2010 ISBN 0233814167).
- *Lecture Notes for Stochastic Processes* by J. Dimock (posted on UBLeads).

Pinsky and Karlin [PK] is the primary text. Dimock [D] is a supplemental set of notes for reference as needed.

UBLeads: Contains syllabus, homework assignments, important announcements, digital copies of handouts, exam solutions, and relevant web links. The content is updated each class.

Handouts: I use handouts in class sometimes for things like: long mathematical derivations that are too tedious to be writing out in class, notes that are mainly definitions, figures/illustrations, etc. I bring paper copies of the handout to class and I post the handout on UBLeads before class if you prefer to work with a digital version.

Zoom: My office hours are in-person, but I can also meet on Zoom if necessary. The Zoom link is posted on UBLearn. This Zoom link will also be used if class needs to be remote.

Course Requirements

Exams: There are two exams. The Midterm Exam is given in class during week 6. The Final Exam is given during finals week and covers the material after the Midterm Exam. Material covered in the exams is based on the homework, lectures and textbook. The class prior to each exam is a review for the exam. See the exam schedule below for more information.

Date	Location	Subject
Tue Oct 3 in class	Math 150	Midterm exam on ch 3
Thu Dec 14, 8-11am	Math 150	Final exam on ch 4, 5, 6, 8 and stochastic integrals

Homework:

- **Exercises vs Problems:** There are two types of homework problems in the textbook: *exercises* are straightforward calculations to promote active learning and familiarity with the lecture concepts, *problems* are more difficult and involve modeling and sometimes clever or lengthy calculations. Each class will have assigned homework consisting of exercises and problems.
- **Homework Sets:** A subset of the assigned homework will be due as a weekly Homework Set. You submit a paper hardcopy of your solutions (either handwritten or typeset using Word, LaTeX, etc). The Homework Set for a given week will generally be due on Tuesday of the following week. Homework is due at the beginning of class on the due date.
- **Format for HW Set Solutions:** At the top of the first page please print your name and the HW Set number. Please submit a clear exposition of your solution (including sentences to explain your work where appropriate) as if it were an assignment for a job. Please submit problems in the order assigned and staple in the upper left corner.
- **Late Homework Policy:** Late assignments are accepted with the following penalties:
 - turned in on due date by 5pm: -10%
 - turned in next day by 5pm: -20%, then -20% per day for every school day thereafter.Late assignments are to be submitted to my office. If I am not in, put your assignment under my office door and let me know by email that you submitted it.

Participation/Attendance: I expect/encourage you to attend every class. Active engagement through notetaking, asking and thinking about questions, and interacting with other students is an important educational component. As an added incentive to attend, a small part of your grade (5%) is based on participation/attendance. I take attendance (almost every class) by passing around a sign-in sheet; each of those classes you attend completely is worth 1 point. The grading scale for attendance is A = 90-100%, B = 80-90%, C = 70-80%, D = 60-70%, F = 0-60%. Excused absences are not counted against the participation grade (see below for how to report excused absences).

Grading Policy

Course Grades: The course grade is determined from averaging your exam and homework grades using the following weights:

Midterm Exam	20%
Final Exam	40%
Homework	35%
Participation	5%

I will provide midterm grade estimates after the midterm exam, and another grade estimate about 2/3 of the way through the semester.

Grading Rubric: Points for homework and exam questions are allocated using the following guidelines (assuming 5-point question):

5/5 - Correct method, clearly presented, correct answer. No significant mistakes (grade A work).

4/5 - Correctly captures the essential method or idea in the solution of the problem, is clearly presented, but has one or more minor errors (grade B work).

3/5 - Displays some understanding of the underlying concepts and ideas but the solution contains significant errors in execution of the details (grade C work).

2/5 - Questionable understanding of the underlying concepts and ideas and/or major errors (grade D work).

1/5 - Minimal progress, but some parts of the solution are not totally incorrect (grade F work).

0/5 - The solution has no redeeming features (grade F).

Point scores are scaled proportionally for problems of 10 points, 15 points, etc.

Each exam grade and the overall homework grade will be determined from the total points using a grading scale similar to the rubric above.

5-point grading scale: For keeping track of course grades on exams and homework a 5-point scale is used:

A+ = 4.67-5.00	A = 4.33-4.66	A- = 4.00-4.33
B+ = 3.67-4.00	B = 3.33-3.66	B- = 3.00-3.33
C+ = 2.67-3.00	C = 2.33-2.66	C- = 2.00-2.33
D+ = 1.67-2.00	D = 1.33-1.66	D- = 1.00-1.33
F = 0 - 1.00		

+/- grades will be used in assigning course grades. Note the university does not permit final course grades of A+ or D- for undergraduates or A+, D+, D- for graduate students; in these cases (A+, D-, D+) will convert to (A, D, D).

MTH 546: In accordance with Graduate School policy regarding dual-listed 400/500 level courses for the same amount of credit, students taking the course for graduate credit will be assigned additional homework questions and/or additional questions on exams. MTH 446 and MTH 546 students will have separate grading scales.

Lecture Schedule

week	day	lecture	homework
1	tue 8/29	syllabus, intro to stochastic processes	
	thu 8/31	ch 1-2 probability review	
2	tue 9/5	ch 3 discrete Markov chains	
	thu 9/7	ch 3 discrete Markov chains	
3	tue 9/12	ch 3 first step analysis	
	thu 9/14	ch 3 first step analysis	
4	tue 9/19	ch 3 branching processes	
	thu 9/21	ch 3 branching processes	
5	tue 9/26	ch 3 more examples	
	thu 9/28	review for exam	
6	tue 10/3	midterm exam on ch 3	
	thu 10/5	ch 4 regular Markov chains	
7	tue 10/10	no class - fall break	
	thu 10/12	ch 4 regular Markov chains	
8	tue 10/17	ch 4 general Markov chains	
	thu 10/19	ch 4 general Markov chains	
9	tue 10/24	ch 5 Poisson processes	
	thu 10/26	ch 5 Poisson processes	
10	tue 10/31	ch 6 continuous time Markov processes	
	thu 11/2	ch 6 continuous time Markov processes	
11	tue 11/7	ch 6 birth and death processes	
	thu 11/9	ch 6 birth and death processes	
12	tue 11/14	ch 8 Brownian motion	
	thu 11/16	ch 8 Brownian motion	
13	tue 11/21	ch 8 first passage time and applications	
	thu 11/23	no class - Thanksgiving break	
14	tue 11/28	ch 8 first passage time and applications	
	thu 11/30	[notes] stochastic integrals	
15	tue 12/5	[notes] stochastic integrals	
	thu 12/7	review for exam	
finals	thu 12/14	final exam on ch 4, 5, 6, 8, stochastic integrals	

Important Dates

Tue Sep 5 - Last day to drop the course - no record appears on transcript.

Fri Nov 10 - Last day to resign from the course - an 'R' appears on transcript.

University Statement on Academic Integrity: Academic integrity is critical to the learning process. It is your responsibility as a student to complete your work in an honest fashion, upholding the expectations your individual instructors have for you in this regard. The ultimate goal is to ensure that you learn the content in your courses in accordance with UB's academic integrity principles, regardless of whether instruction is in-person or remote. Thank you for upholding your own personal integrity and ensuring UB's tradition of academic excellence. The academic integrity policy is available at buffalo.edu/academic-integrity.

Instructor's Statement on Academic Integrity: You are expected to adhere to the letter and spirit of academic honesty. For homework assignments, you can discuss assignments with other students, but the details of the written solution you turn in are originally yours. Cheating, plagiarism, or misrepresentation of your work will result in formal charges. For more information on the university policy on academic honesty and the procedure for violations see <https://www.buffalo.edu/academic-integrity.html>

Prohibited Use of AI: Any use of generative AI (e.g., ChatGPT) is prohibited in this class and will be considered a violation of UB's academic integrity policy. If you are unsure if a resource or tool is allowable, be sure to ask.

Protecting Course Materials Disclaimer: All materials prepared and/or assigned by me for this course are for the students' educational benefit. Other than for permitted collaborative work, students may not photograph, record, reproduce, transmit, distribute, upload, sell or exchange course materials, without my prior written permission. "Course materials" include, but are not limited to, all instructor-prepared and assigned materials, such as lectures; lecture notes; discussion prompts; study aids; computer codes; tests and assignments; and presentation materials such as *PowerPoint* slides, and course packets or handouts. Public distribution of such materials may also constitute copyright infringement in violation of federal or state law. Violation of this policy may additionally subject a student to a finding of "academic dishonesty" under the Academic Integrity Policy and/or disciplinary charges under the Student Code of Conduct.

Excused absences: The university policy on excused absences is here:
<https://catalog.buffalo.edu/policies/attendance.html>

If you have an excused absence, send me email with subject "MTH 446/546 excused absence", the reason for the absence, date(s) you missed, and provide appropriate documentation.

Religious Holy Days: On those religious holy days when members of a faith observe the expectation of their religion that they be absent from school or work, individual students will be excused from class without penalty if expressly requested.

Covid: Having Covid or quarantining due to Covid is an excused absence. See the university page on Covid safety and policies here:

<https://www.buffalo.edu/coronavirus/health-and-safety/health-safety-guidelines.html>

Make-up Exams: If you will not be able to take an exam due to severe circumstances beyond your control (car accident, illness, death in the family, etc), please email or call me immediately (before the exam) and let me know your situation. If you have a valid excuse and can present adequate documentation we can make arrangements for a make-up exam, usually to be taken at the end of the semester.

Incompletes: Incompletes will be given only under extraordinary circumstances (like surgery during the last week of class). A student must have a passing grade to petition for an incomplete.

Accessibility Resources: If you have any disability which requires reasonable accommodations to enable you to participate in this course, please contact the Office of Accessibility Resources in 60 Capen Hall, 716-645-2608, and also the instructor of this course during the first week of class. The office will provide you with information and review appropriate arrangements for reasonable accommodations, which can be found on the web at: <http://www.buffalo.edu/studentlife/who-we-are/departments/accessibility.html>