THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

SYLLABUS: STAT 7540
STOCHASTIC PROCESSES
SPRING 2024

Course overview

Instructor

Instructor:	David J. Sivakoff
Email address:	dsivakoff@stat.osu.edu
Class Website:	Carmen
Lectures:	MWF at 10:20-11:15am in Bolz Hall 128
Office hours:	M, Th 9-10am and by appointment (please schedule appointments at least 24 hours in advance). Office in CH 440A.

Course description

STAT 7540 is an introduction to stochastic processes using the measure theoretic foundations of probability theory developed in Stat 7201. Students will learn about advanced probability models, which are used to describe dependence between random variables, such as temporal or spatial dependence, and methods to analyze the properties of these models. Specific topics include:

- Martingales: Convergence, optional stopping theorem, concentration inequalities.
- Markov chains: Recurrence and transience, stationary measures, ergodicity, Strong Markov property, mixing.
- Poisson processes and continuous time Markov chains.
- Gaussian processes and Brownian motion: Definition, construction and path properties.

We will cover additional topics as time permits.

Course learning outcomes

By the end of this course, students should successfully be able to:

- understand discrete and continuous stochastic models,
- analyze stochastic processes using modern probability techniques,
- connect probability concepts and results to their statistical and computational applicability.

Course materials

I will provide my lecture slides, which are based on the following references.

References

A First Course in Stochastic Processes, Second Edition, by Karlin & Taylor, Academic Press, 1975.

Probability: Theory and Examples, 5th Edition, by R. Durrett. Available online: *https://services.math.duke.edu/~rtd/PTE/pte.html*

Markov Chains by J. R. Norris, Cambridge University Press, 1998.

Brownian Motion by P. Mörters and Y. Peres. Available online: https://people.bath.ac.uk/maspm/book.pdf

Continuous Time Markov Processes: An Introduction by T. Liggett, American Mathematical Society, 2010.

Course delivery

Lectures will be delivered live in person. Office hours are in person, but appointments can be made to meet via Zoom, and I can turn on Zoom during regular office hours as needed.

Grading and faculty response

Homework, Quizzes and Exams

Assignment or category	Percentage
Homework	**25**
Quizzes	**25**
Midterm Exam	**20**

Assignment or category	Percentage
Final Exam	**30**
Total	**100**

Grades will be recorded on the class website.

Homework: Homework will be assigned approximately every 2 weeks and will be due at 11:59pm on the day it is due. Typically, no late homework will be accepted. However, if you are unable to complete an assignment on time, please get in touch with me as soon as possible so we can discuss your situation.

You are encouraged to work together with classmates on the homework, but do not copy any solutions. Each student must produce their own homework solutions to be submitted electronically. Students are not permitted to look up or request solutions to homework problems in online forums or websites, including use of generative AI.

All homework must be submitted online as a PDF file through the class website (Carmen). Feel free to ask me for help during my office hours after you have earnestly attempted the problems. I plan to have one or two problems per homework graded in detail, and the rest of the grade will be for completeness, clarity, and organization. I will provide solutions with sufficient detail for the remainder of the problems.

Quizzes: Approximately once every two weeks, there will be a short (up to 15 minutes) quiz on the material covered recently in the lecture, readings, or homework. These quizzes are closed book and closed note, and students are not permitted to collaborate. Dates of the quizzes will be posted in Carmen.

Exams: There will be in-class Midterm and Final exams, which will both be closed book and closed note. The Midterm will be on **Wednesday, February 28** and the Final will be on **Thursday, April 25 at 10:00-11:45am** in our regular classroom.

Disclaimer

This syllabus should be taken as a fairly reliable guide for the course content. However, you cannot claim any rights from it, and I reserve the right to change due dates or the methods of grading and/or assessment if necessary. Any changes will be communicated to you through official course announcements.

Tentative Schedule of Topics

Week	Topics
1	Review of probability, Radon-Nikodym Theorem, Conditional expectation; Introduction to Martingales
2	No class Monday (MLK), Martingales, stopping times, predictable sequences
3	Martingale convergence theorem, Uniform integrability
4	Optional Stopping Theorems, concentration inequalities, applications
5	Markov chains: construction, examples, Strong Markov property
6	Classification of states, Random walks
7	Stationary measures, asymptotic behavior
8	Rates of convergence for Markov chains and sampling
9	Poisson processes
10	Spring Break (no class)
11	Continuous time Markov chains
12	Brownian Motion: definition, construction
13	Stopping times, Strong Markov Property, path properties of BM
14	Donsker's Theorem, applications to random walk
15	Gaussian Processes

Other course policies

Potential disruptions to instruction

- As much as is possible, students will have access to course materials online if they are unable to attend class.
- In the (hopefully) unlikely event that an instructor does not arrive on time for a live meeting, please wait beyond the scheduled start time. If the instructor still does not arrive, please look for an announcement on Carmen specifying a makeup time or a virtual or recorded alternative for the missed activity.
- In the event of a weather or other emergency, please check Carmen for an announcement regarding a virtual lecture or alternative activity to replace a missed class period.

Copyright disclaimer

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Please **do not disseminate any course materials, including any lecture videos, assignments, and solutions** outside of the course.

Academic integrity policy

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

Religious accommodation

It is Ohio State's policy to reasonably accommodate the sincerely held religious beliefs and practices of all students. The policy permits a student to be absent for up to three days each academic semester for reasons of faith or religious or spiritual belief.

Students planning to use religious beliefs or practices accommodations for course requirements must inform the instructor in writing no later than 14 days after the course begins. The instructor is then responsible for scheduling an alternative time and date for the course requirement, which may be before or after the original time and date of the course requirement. These alternative accommodations will remain confidential. It is the student's responsibility to ensure that all course assignments are completed.

Statement on title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu.

Accessibility accommodations for students with disabilities

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

If you are isolating while waiting for a COVID-19 test result, please let me know immediately. Those testing positive for COVID-19 should refer to the Safe and Healthy Buckeyes site for resources. Beyond five days of the required COVID-19 isolation period, I may rely on Student Life Disability Services to establish further reasonable accommodations. You can connect with them at **slds@osu.edu**; 614-292-3307; or **slds.osu.edu**.

Accessibility of course technology

This course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor. Carmen (Canvas) accessibility.

Mental health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing.

If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting **ccs.osu.edu** or calling 614-292-5766. CCS is located on the 4th floor of the Younkin Success Center and 10th floor of Lincoln Tower. You can reach an on-call counselor when CCS is closed at 614-292-5766 and 24-hour emergency help is also available through the 24/7 by dialing 988 to reach the Suicide and Crisis Lifeline.