Syllabus: stat 7540
stochastic processes
spring 2025

# 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: MW 9-10am and by appointment (please schedule appointments at least 24 hours in advance). Office in CH 440A.

## Course descriptionSTAT 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*](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 |
| 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 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 **Friday, February 28** and the Final will be on **Thursday, April 24 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 | Martingales, stopping times, predictable sequences  |
| 3 | No class Monday (MLK), 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 (as time allows) |
| 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

## 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/>.

## 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.

## 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**](http://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**.

## 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. SLDS contact information: slds@osu.edu; 614-292-3307; [slds.osu.edu](http://slds.osu.edu/); 098 Baker Hall, 113 W. 12th Avenue.

### 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.](https://community.canvaslms.com/docs/DOC-2061)

## Religious accommodation

## Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

## With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

## A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

## If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Office of Institutional Equity (equity@osu.edu). (Policy: [Religious Holidays, Holy Days and Observances](https://oaa.osu.edu/religious-holidays-holy-days-and-observances))