

Worcester Polytechnic Institute  
Department of Mathematical Sciences  
Professor: Stephan Sturm  
Teaching Assistant: Dane Johnson

Fall 2023 - B Term

## MA 4237

# Probabilistic Methods of Operations Research

## Syllabus

### 1. Contact & drop-in hours:

#### **Stephan Sturm**

Salisbury Labs 405B

Tuesday, 2:00–2:50pm

Thursday, 10:00-10:50am

and upon request per calendly: <https://calendly.com/ssturm-2>

(508) 831-59 21

[ssurm@wpi.edu](mailto:ssurm@wpi.edu)

<https://users.wpi.edu/~ssturm/>

#### **Dane Johnson**

Salisbury Labs 412

Monday, 3:00-4:30pm

Wednesday, 10:30-12:00am

Friday upon request

[djohnson3@wpi.edu](mailto:djohnson3@wpi.edu)

These hours are reserved for you and your questions. Not only about homework, but to help you with the understanding of the course material. Please use them, and use them wisely: try first to figure out what specifically it is what you are struggling with and come with specific questions and explain what you already tried to figure them out.

2. **Lecture:** Mon, Tue, Thu, Fri, 1:00-1:50 p.m., Rec Center 412

### 3. Textbook:

No textbook is needed for the class I will provide lecture notes along with the slides of the class. Recommended books that will be referred to in class and are discussing the topics from different angles are

- Sheldon M. Ross, *Introduction to Probability Models*. Academic Press, Oxford. 11<sup>th</sup> edition, 2014. ISBN 978-0-12-407948-9.  
[Online available via WPI Gordon library](#)
- Frederick S. Hillier, Gerald J. Lieberman, *Introduction to Operations Research*. McGraw Hill, Boston. 10<sup>th</sup> edition, 2005. ISBN 978-0077298340. Hardcopy available at WPI Gordon library
- James R. Norris, *Markov Chains*. Cambridge University Press, Cambridge. 1997. ISBN 978-0-521-48181-6.  
[Online available via WPI Gordon library](#)
- Ronald W. Shonkwiler, Franklin Mendivil, *Explorations in Monte Carlo Methods*. Springer, New York. 2009. ISBN 978-0-387-87836-2.  
[Online available via WPI Gordon library](#)
- Paul Glasserman, *Monte Carlo Methods in Financial Engineering*. Springer, New York. 2003. ISBN 978-1-4419-1822-2.  
[Online available via WPI Gordon library](#)
- Mor Harchol-Balter, *Introduction to Probability for Computing*. Cambridge University Press, Cambridge. 2023. ISBN 978-9-7810-0930-9073.

### 4. Resources:

- Homework problems will be posted on the course site on piazza, <https://canvas.wpi.edu/courses/52101>. Solutions to homework problems will not be published, but students who do not understand the problem after receiving the graded homework are *highly encouraged* to discuss it in instructor's office hours.
- A discussion forum will be hosted on piazza, <https://piazza.com/class/lnz0xsjh3mk215>. The forum supports different formatting options, and in particular the inclusion of mathematical symbols via L<sup>A</sup>T<sub>E</sub>X. See <https://piazza.com/help/formatting.html> for the general formatting guidelines and <https://en.wikibooks.org/wiki/LaTeX/Mathematics#Symbols> for a list of commands for specific symbols. While discussions (also about homework) are encouraged, please refrain from giving complete solutions of homework questions. Giving hints is okay, providing a solution is *dishonest* and will be treated as violation of the academic honesty policy, see 11. Instructors will endorse correct student answers and provide only answers if there is no student answer in reasonable time.
- Grades will be posted on Canvas, <https://canvas.wpi.edu/courses/52101>

5. **Course description** as per course catalog:

This course develops probabilistic methods useful to planners and decision makers in such areas as strategic planning, service facilities design, and failure of complex systems. Topics covered include: decisions theory, inventory theory, queuing theory, reliability theory, and simulation. Recommended background: Probability theory at the level of MA 2621 or MA 2631. This course will be offered in 2023–24, and in alternating years thereafter.

6. **Preliminary course outline:**

*Topic 1:* Probability Theory: Review, Computational Perspective, and Simulation

*Topic 2:* Markov Chains in Discrete Time

*Topic 3:* Markov Chain Monte Carlo and Metropolis Algorithm

*Topic 4:* Queuing Theory

7. **Homework:** There will be 6 homework sets in total. They will be given out when the topic has been covered in class, students will have usually one week for finishing the problem set. The problem sets will be posted on

<https://canvas.wpi.edu/courses/52101>. *Tentative* submission deadlines are Thursday 11/02, 11/09, 11/16, 11/30, 12/07, 12/14 (final submission deadlines are provided when homework is posted).

Guidelines:

- Graded homeworks that do not earn full points can be resubmitted in revised form. Resubmitted homework can earn up to 50% of the outstanding grade.
- Late submission policy: One extensions of the deadline will be granted as long as they are requested per email at least 24 hours in advance. All other late homework (when submitted before the corrected homeworks of the other students are returned) will be graded with a reduction by 50% of the points.
- The homework submission has not only to contain the result, but carefully developed calculations and proofs that can actually be followed by a reader.
- Whereas the discussion of homework problems in (small) groups is not only okay but encouraged, the final write-up has to be done individually. Any copying of homework is a violation of the academic honesty policy (see below) and will be treated as such.
- Some homework problems will require (moderate) programming skills. Coding can be done in any higher programming language (while instructor will focus in class on `python` and support in `MATLAB` is available).

8. **Projects:** There will be three projects in total: A midterm and final project that explore the application of the course content to real-world data from the campus environment. An exploration project will familiarize you with material on probabilistic methods for OR beyond what is taught in the lectures. The midterm project is an groupproject due on Tuesday, November 21. The exploration project is individual and due on December 8. The final project is a group project due on December 15. Group projects are done in groups of 2-3 students. Project reports are supposed to be professionally written documents, preferably typed in L<sup>A</sup>T<sub>E</sub>X.
9. **Programming Language:** We will use Python with Numpy for numerical implementation. The language can be downloaded at <https://www.continuum.io/downloads>. An introductory crash course will be given by *Albert Enyedy* ([ajenyedy@wpi.edu](mailto:ajenyedy@wpi.edu)) during the first week of class. There will also be support for Matlab through *Ram Krishnamurthy* ([ramnarak@mathworks.com](mailto:ramnarak@mathworks.com)) and *Yuchen Dong* ([yuchend@mathworks.com](mailto:yuchend@mathworks.com)) from MathWorks. Submissions in other higher programming languages are accepted, but no support is provided.
10. **Grading:** The total score will be composed from the individual scores by using the following weighting:
- 40% Problem sets — lowest result will be dropped
  - 20% Midterm project
  - 20% Final project
  - 20% Exploration project
- The achievement of the following total score will be sufficient for the stated letter grades:
- A 90%
  - B 80%
  - C 65%
11. **Students with Accessibility Needs:** Students with approved academic accommodations should plan to submit their accommodation letters through the Office of Accessibility Services Student Portal. Should you have any questions about how accommodations can be implemented in this particular course, please contact me as soon as possible. Students who are not currently registered with the Office of Accessibility Services (OAS) but who would like to find out more information regarding requesting accommodations and what that entails should plan to contact them via email: [AccessibilityServices@wpi.edu](mailto:AccessibilityServices@wpi.edu) and/or via phone: (508) 831-4908.

12. **Academic Honesty:** Each student is expected to familiarize him/herself/themself with WPI's Academic Honesty policies which can be found at <https://www.wpi.edu/about/policies/academic-integrity/dishonesty>. All acts of fabrication, plagiarism, cheating, and facilitation will be prosecuted according to the university's policy. If you are ever unsure as to whether your intended actions are considered academically honest or not, please contact your instructor in advance. Further information is available via <https://www.wpi.edu/about/policies/academic-integrity>. Let me highlight in particular the definition of plagiarism:

*Plagiarism:* Using as one's own the words, ideas, data, code, or other original academic material of another without providing proper citation or attribution. Plagiarism can apply to any assignment, including final or drafted copies. Examples include, but are not limited to:

- Misrepresenting the work of another as one's own,
- Inaccurately or inadequately citing sources,
- Paraphrasing (using the ideas of others in your own words) without citation.

Note that this includes in particular the use of generative learning AI models such as ChatGPT. If you use such tools you will have to provide both prompt and answers received as an appendix (as well as check the claims independently!).

13. **Further Resources:** Even the best of learners need help along the way. WPI has some great resources to support you in this class and beyond. Here are some to check out:
- Academic Resource Center, <https://arc.wpi.edu/>
  - IT Service & Support, <https://www.wpi.edu/offices/services-support>
  - Student Development and Counseling Center, <https://www.wpi.edu/offices/student-development-counseling-center>
  - Accessibility Services, <https://www.wpi.edu/offices/office-accessibility-services>
  - Health Services, <https://www.wpi.edu/student-experience/health-counseling/health-services>
  - Multicultural Affairs, <https://www.wpi.edu/offices/office-multicultural-affairs>
  - LGBTQ+ Support, <https://www.wpi.edu/student-experience/resources/lgbtq-support>
  - International House, <https://www.wpi.edu/offices/international-house>

Enjoy the Course!