

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

Summer 2021 - E2 Term

# MA 3231

# Linear Programming

Section E162

## Syllabus

### 1. Contact & office hours:

**Stephan Sturm**

Stratton Hall 202C

(508) 831-59 21

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

Thursday, 5–6pm via zoom: <https://wpi.zoom.us/my/ssurm/>

and upon request via <https://calendly.com/ssurm-2>

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

**Dane Johnson**

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

Upon request per email

<https://www.wpi.edu/people/doctoral-student/djohnson3>

### 2. Class and conference:

Lectures will be asynchronous, video will be put on Canvas.

Given that this is a summer course without a conference, I am planning to have the office hours a bit "conference style" and provide additional problems that can be prepared for and discussed in the office hours, but of course any questions are welcome (and attendance is of course not mandatory). For students who cannot participate, office hour problems and slides will be posted on Canvas and can be discussed on piazza. If participants agree, I am also happy to record and post the recordings on Canvas. The office hour is intended for active participation, please look at the problems beforehand and contribute to the solutions resp. ask questions.

### 3. Textbook (recommended):

Robert J. Vanderbei, *Linear Programming. Foundations and Extensions*. Springer. 5<sup>th</sup> edition, 2020. ISBN 978-3-030-39414-1

This book is available through the Gordon Library, unfortunately only in the 3<sup>rd</sup> edition: <https://link-springer-com.ezpv7-web-p-u01.wpi.edu/book/10.1007%2F978-0-387-74388-2> Differences are not huge, and were new material has been added, e.g., in applications to data science, I will provide the sections via Canvas.

### 4. Expectations:

The time spent in class is a **small** fraction of the time you should work for the class. WPI expects about 17h work/week for a 1/3 unit course. As MA 3231 Linear Programming) for the *average* student. As the organized part consists of 4h class instruction per week, it follows that 13h / week are expected for work **outside** the (virtual) classroom: revision, conference, office hours, **homework**, preparation.

### 5. Resources:

- The learning management system for the course is Canvas, <https://canvas.wpi.edu/courses/26093>. Homework and lecture notes will be posted there. 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. Problems that are challenging to several students might be discussed in a special video upon several students' request.
- A discussion forum will be hosted on piazza, [piazza.com/wpi/summer2021/ma3231e21e261/home](https://piazza.com/wpi/summer2021/ma3231e21e261/home). 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
- Non-WPI students are **strongly encouraged** to either associate their main email address with the Canvas account or integrate the WPI email address to their main email device to not miss important information pertaining the class.

## 6. **Help:**

You have not only the possibility to ask for help, you are encouraged to do so. However, it is expected that you invest a major effort (i.e., several hours of work) in your work and you provide an explanation about what you have done and tried so far. Sources for help are in particular.

- Discussions with peers
- Online discussions on piazza
- Office hours by the professor (best for fundamental questions about the material learned)

Questions per email are **explicitly discouraged**, please post instead your questions on piazza (you can do this anonymously or semi-anonymously)

## 7. **Course description** as per course catalog:

The mathematical subject of linear programming deals with those problems in optimal resource allocation which can be modeled by a linear profit (or cost) function together with feasibility constraints expressible as linear inequalities. Such problems arise regularly in many industries, ranging from manufacturing to transportation, from the design of livestock diets to the construction of investment portfolios. This course considers the formulation of such real-world optimization problems as linear programming problems, the most important algorithms for their solution, and techniques for their analysis. The core material includes problem formulation, the primal and dual simplex algorithms, and duality theory. Further topics may include: sensitivity analysis; applications such as matrix games or network flow models; bounded variable linear programs; interior point methods. Recommended background: Matrices and Linear Algebra (MA 2071, or equivalent).

## 8. **Preliminary course outline:**

*Topic 1:* Introduction

*Topic 2:* The Simplex Algorithm

*Topic 3:* Duality Theory

*Topic 4:* Sensitivity Analysis

*Topic 5:* Applications: Game Theory, Data Science and Network Flows

*Topic 6:* Interior Point Methods (– tentative, if time permits)

## 9. **Homework:** There will be one homework problem sets per week. The problem sets will be posted on Canvas and homeworks will be submitted via the SpeedGrader on Canvas as single .pdf files. Preliminary homework due dates will be: 07/16, 07/23, 07/30, 08/06, 08/13 at noon.

Guidelines:

- Late submission policy: I understand that summer courses might pose a problem to timing (e.g., summer jobs or vacation), so I am happy to be more lenient and happy to accept up to two (2) late submissions. However, as these should not be accidents but results of intentional planning, the extensions of the deadline will be granted ONLY as long as they are requested per email at least 24 hours in advance to the professor. All other late written homework (when submitted before the corrected homeworks of the other students are returned) will be graded with a reduction by 50% of the points. This excludes of course extenuating circumstances such as long, severe illness, in which case you contact the instructors as soon as possible.
- 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.

10. **Projects:** There will be two projects, one practical one on implementing linear programming computationally, and a second one in exploring an additional topic in the field. The first one will be a short report (including the code), the second one (done in teams) a short video followed by an Q&A. The report of the individual project will be due on 08/13, at noon, the presentations of the team project on 08/11 at noon, with Q&A discussions to be scheduled on 08/12 and/or 08/13.

11. **Grading:** The total score will be composed from the individual scores by using the following weighting:

- 35% Problem sets — lowest result will be dropped
- 5% Piazza participation (correct answers or good questions)
- 30% Project 1 (practical implementation)
- 30% Project 2 (additional topic)

The achievement of the following total score will be sufficient for the stated letter grades:

- A 85%
- B 75%
- C 60%

12. **Electric Recordings:** If you wish to record any meeting, you will have to ask all participants for permission and can do so only if permission is granted. All recordings are for strictly for personal use only and any distribution is not permitted.
13. **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 us 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.
14. **Academic Honesty:** Each student is expected to familiarize him/herself 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 us 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.

15. **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>