Worcester Polytechnic Institute

MA 3231: Linear Programming
Department of Mathematical Sciences
A Term 2024

Instructor	Learning Assistants
Professor Marcel Blais	Teodor Hellgren, tnhellgren@wpi.edu
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Class:

Section A01   Mon, Tues, Thurs, & Fri   10am-10:50am   Innovation Studio 205
Section A02   Mon, Tues, Thurs, & Fri   1pm-1:50pm   Stratton Hall 201

Textbook:
- *Linear and Nonlinear Optimization, Second Edition* by Griva, Nash, and Sofer.
    o **Not required**

Course Delivery:

This course is offered in-person on the WPI campus. Asynchronous video materials will occasionally be used to supplement in-class meetings.

All in-person meetings will be video captured and will be posted on the course Canvas site.

- The video materials can be used by students who may need to transition to remote learning.

All resources & course assignments will be posted in the Modules section of the Canvas course webpage. The Modules section organizes the course content chronologically, with all assignments included. All deliverables for the course will appear in the Modules section.

Course Description:

The goal of this course is to introduce the student to the theory, algorithms, and applications of linear optimization.

Requiring only a background in linear algebra, we will explore a range of linear programming problems. The general theme is to minimize or maximize an objective function, such as cost or profit, subject to some set of linear constraints. We develop the theory by examining algebraic structures, geometric objects, and algorithmic issues related to solving such problems.

Topics will include: modeling, polyhedra, the simplex method, the revised simplex method, duality, sensitivity analysis, parametric analysis, applications, and if time permits, modern algorithms.

Prerequisite Material:

Knowledge of introductory linear algebra is needed. Experience with computer programming will be helpful but is not necessary.

Additional References:
- *Numerical Optimization*, by Nocedal and Wright (available online through Gordon Library).
  This book gives a more advanced treatment of the optimization and is considered a classic text in the discipline.

Learning Outcomes:

By the completion of this course, learners will be able to:
- Mathematically formulate linear optimization problems
- Prove theorems involving linear optimization
- Construct the dual of a linear optimization problem
- Use the simplex method and the dual simplex method to numerically find and identify extrema of linear optimization problems
- Model real-world problems using tools of linear optimization
- Conduct sensitivity analysis on an optimization problem
- Model and solve real-world linear optimization problems using software

Communication:

The primary interface for communication with the instructor will be email, the Canvas course website, office hours, & Piazza. All information about the course will be maintained on the course web page in WPI's Canvas system.

Check your *WPI* email daily.

The use of Piazza in Canvas is *strongly* encouraged for discussion with the instructor and peer students. It provides a forum where students can post questions anonymously if preferred.

Students can expect a response to email questions within 24 hours on weekdays and within 48 hours on weekends.

Office Hours:

These are interactive sessions with the instructor or learning assistants that will be managed in the Canvas course calendar & will be held either in-person or online using Zoom. Students are *strongly* encouraged to attend office hours.

Course Approach:

This is a 7 week course delivered over 8 weeks.
- Each week begins on Thursday at 6am US Eastern Time and ends on the following Wednesday at 11:59pm US Eastern Time.
- The Canvas course webpage will be used to manage all aspects of the course. Content will be managed primarily in the announcements, modules, assignments, calendar, & Piazza sections of the Canvas page.
- Each week the course will consist of:
  o Four in-person lectures as per the course schedule
  o Office hours
  o One written homework assignment
  o Exams on weeks 5 and 8
- All written homework will be submitted in a *single-file* PDF upload to Canvas.
- There are two exams.
- There will be a course project. Students are **required to work in teams** on projects and to submit professional quality project reports, complete with formal references & citations.
  o Project teams will create a video presenting their project work.

Course Requirements:

1. **Assignments**
   There are two primary assignment categories for this course:

   o **Written Homework**
     These assignments involve handwritten solutions to problems and some use of software. Solutions should be second draft and thoroughly demonstrate solutions, derivations, and proofs including justifications of steps. These assignments are to be submitted as scanned PDF files in Canvas. Each assignment should be submitted as *one* PDF file.

     Students are encouraged to discuss the homework problems with other students & in discussions on Piazza, but all homework assignments must be completed, written, and submitted independently.

     Some homework assignments will require the use of MATLAB & Excel programming. Guidance on how to use these tools will be provided.

Written Homework Assignment Rubric:

Each homework problem is graded out of 10 points according to the criteria below:

Grade	
10	Completely correct, clear, & thorough write-up of problem solution, citing appropriate rules & theorems where appropriate. Quality is neat and easily readable.
9	Correct, clear, & thorough write-up of methodology & problem solution, citing appropriate rules & theorems where appropriate, with 1 minor mistake or omission. Quality is neat and easily readable.
6-8	Mostly correct write-up of methodology & problem solution with a few minor mistakes or omissions. Quality is neat and readable.
2-5	Incorrect solution. Partial credit is given according to key insights for the problem. Quality is readable.
0-1	Little to no work shown, giving only answers.

o **Projects**

Students will work in teams of 2-3 people on course project work. Real data will be used to implement models covered in class in a real-world setting.

Students are required to compose a professional quality project report. Each project report should

- Include visual representations of the models and results, such as graphs, tables, histograms, or charts.
- Include a formal references section with formal citations using MLA format to those references where appropriate. Note that **any** work that is not the students' own original work **must be properly cited**. WPI's policies on citations can be found here: https://libguides.wpi.edu/friendly.php?s=citingsources

3. **Exams**

There are two exams in this course:

Midterm Exam	Thursday, September 19	In-Class
Final Exam	Friday, October 11	In-Class

4. **Late Work Policy**

Extensions for assignments may be granted on a case-by-case basis. If you feel like you need an extension on an assignment, I strongly encourage you to communicate with me about this as early as possible. Reasonable extension requests will be granted. Late assignments without approved extensions from the instructor will receive a grade of zero.

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POLICIES

Grading Policy:

The numerical course grade will be determined scheme below:

Category	Weight
Midterm Exam	25%
Final Exam	25%
Homework Average	35%
Project	15%

Each homework grade will be converted to a percentage, and then those percentages are averaged to compute the homework average.

Final course letter grades are based on a student's performance as follows:

Letter Grade	Percentage
A	90 - 100
B	80 - 89
C	70 - 79
NR	0 - 69

The instructor may adjust these grade cutoffs at the end of the course, but such an adjustment can only happen in the students' favor. For example, the minimum score for a grade of B could be decreased from 80 to 79, but it would never increase above 80.

Course incompletes may be granted if a major part of the course work is completed. In addition, in the case of an incomplete, the student is responsible for handing in the final work within the WPI required timeframe of one (1) year. After this time, an incomplete grade changes to an NR grade.

Accessibility Services:
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, documentation guidelines, and what that all entails should plan to contact them either via email *AccessibilityServices@wpi.edu* or via phone (508) *831-4908.*

Mental Health:
We are embarking on this course during a difficult time, one during which many are experiencing mental health issues. As your course instructor, I am invested in your success in this course and in your well-being, and I will support you to help you succeed.

Mental health challenges, including significant stress, anxiety, mood changes, excessive worry, or problems with eating and/or sleeping can interfere with learning. The source of issues like these might be related to your course work; if so, please meet with me to discuss these issues.

WPI provides mental health services to support the well-being and academic success of students. The Student Development & Counseling Center (*SDCC*). offers free, confidential services to help you manage personal challenges.

In the event I suspect you need additional support, I will express my concerns and the reasons for them and remind you of resources that might be helpful to you. It is not my intention to know the details of what might be bothering you, but simply to let you know I am concerned and that help, if needed, is available.

Getting help is a smart and courageous thing to do -- for yourself and for those who care about you.

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Respect for Diversity:
It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. If any of our class meetings conflict with your religious events, please let me know so that I can make arrangements for you.

Academic Integrity:
You are expected to be familiar with the *WPI Academic Integrity Policy,* which can be found here. Consequences for violating the Academic Honest Policy range from earning a zero on the assignment, failing the course, or being suspended or expelled from WPI.

Common examples of violations include:
- Copying and pasting text directly from a source without providing appropriately cited credit
- Paraphrasing, summarizing, or rephrasing from a source without providing appropriate citations
- Collaborating on individual assignments
- Turning in work where a good portion of the work is someone else's, even if properly cited

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 your input prompt and the answers received as an appendix (as well as check the claims independently!)

This syllabus is subject to change at the professor's discretion.