

The University of Oklahoma  
CS 4433/5433: Computational Methods in Discrete Optimization  
Spring 2023

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<b>Instructor:</b> Sina Khanmohammadi	<a href="mailto:sinakhan@ou.edu">sinakhan@ou.edu</a>
<b>Lecture Time:</b> M/W/F 9:30-10:20 AM	<b>Location:</b> Carson Engr Ctr 0438
<b>Office Hours:</b> W/F 10:30-11:30 AM or by Appointment	DEH 235

\* All times are in Central Time (CT)

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**Prerequisites:**

- MATH 3333 (Linear Algebra I).
- CS 4413 (Algorithm Analysis).
- or Permission of Instructor.

**Course Description:** This course will focus on mathematical formulation of discrete optimization problems and computational methods to solve them. Topics to include are: Linear programming: simplex method for LP problems, degeneracy and anticycling strategies, duality theory and complementary slackness conditions, revised simplex method, sensitivity analysis and simplex method for general LP problems. Network optimization: the transshipment problem, network simplex method, shortest path algorithms, the maximum flow problem, and the primal dual method.

**Learning Outcome:**

- Formulate optimization problems as a linear programming model.
- Identify different types of linear programming problems.
- Choose suitable algorithms to solve linear programming problems.
- Implement basic algorithms in linear optimization.

**Course Materials:**

Required Textbook:

- Dimitris Bertsimas and John N. Tsitsiklis, *Introduction to Linear Optimization*, Athena Scientific, 1997. [Website](#)

Other References:

- Edwin K. P. Chong and Stanislaw H. Zak, *An Introduction to Optimization 4/e*, Wiley, 2013. [Website](#)
- Robert J. Vanderbei *Linear Programming Foundations and Extensions 5/e*, Springer, 2020. [Website](#)
- Mykel J. Kochenderfer and Tim A. Wheeler *Algorithms for Optimization*, The MIT Press, 2019. [Website](#)
- Gerard Sierksma and Yori Zwols *Linear and Integer Optimization 3/e*, CRC Press, 2015. [Website](#)
- Roy H. Kwon *Introduction to Linear Optimization and Extensions with MATLAB 1/e*, CRC Press, 2014. [Website](#)
- Singiresu S. Rao, *Engineering Optimization Theory and Practice 4/e*, Wiley, 2009. [Website](#).
- Juraj Hromkovic, *Algorithmics for Hard Problems 2/e*, Springer, 2004. [Website](#)

**Grading:**

CS 4433: <ul style="list-style-type: none"><li>• Class Activity (5%)</li><li>• Homework x6 (30%)</li><li>• Midterm Exam (30%)</li><li>• Final Exam (35%)</li></ul>	CS 5433: <ul style="list-style-type: none"><li>• Class Activity (5%)</li><li>• Homework x6 (30%)</li><li>• Midterm Exam (20%)</li><li>• Final Exam (25%)</li><li>• Individual Project (20%)</li></ul>	Project Breakdown: <ul style="list-style-type: none"><li>• Proposal (2%)</li><li>• Presentation (8%)</li><li>• Report (10%)</li></ul>	Grade Scale: <ul style="list-style-type: none"><li>• A (90-100)</li><li>• B (80-89)</li><li>• C (70-79)</li><li>• D (60-69)</li><li>• F (<math>\leq 59</math>)</li></ul>
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**Tentative Schedule (Subject to change):**

Week1	1/18-1/20	Introduction (Chapter 1)
Week2	1/23-1/25-1/27	Introduction (Chapter 1)
Week3	1/30-2/1-2/3	The Geometry of Linear Programming (Chapter 2)
Week4	2/6-2/8-2/10	The Geometry of Linear Programming (Chapter 2)
Week5	2/13-2/15-2/17	The Simplex Method (Chapter 3)
Week6	2/20-2/22-2/24	The Simplex Method (Chapter 3)
Week7	2/27-3/1-3/3	The Simplex Method (Chapter 3)
Week8	3/6-3/8-3/10	Duality Theory (Chapter 4)
Week9	*3/13-*3/15-*3/17	Duality Theory (Chapter 4)
Week10	3/20-3/22-3/24	Duality Theory (Chapter 4)
Week11	3/27-3/29-3/31	Sensitivity Analysis (Chapter 5)
Week12	4/3-4/5-4/7	Sensitivity Analysis (Chapter 5)
Week13	4/10-4/12-4/14	Network Flow Problems (Chapter 7)
Week14	4/17-4/19-4/21	Network Flow Problems (Chapter 7)
Week15	4/24-4/26-4/28	Network Flow Problems (Chapter 7)
Week16	5/1-5/3-5/5	Project Presentation

\* Spring Break. No class between March 11-19.

**Important Dates (Tentative):**

Homework 1	.....	2/3 @ 11:59 PM
Homework 2	.....	2/17 @ 11:59 PM
Homework 3	.....	3/10 @ 11:59 PM
Project Proposal	.....	3/10 @ 11:59 PM
Midterm Exam	.....	3/24 @ 9:30 AM
Homework 4	.....	3/31 @ 11:59 PM
Homework 5	.....	4/14 @ 11:59 PM
Homework 6	.....	5/3 @ 11:59 PM
Project Report	.....	5/5 @ 11:59 PM
Final Exam	.....	5/8 @ 8:00 AM

\* All the times are in CDT.

**Coursework:****Class Activity:**

- The class activities include attendance, discussion, feedback, course evaluation, and quizzes.

**Homework Assignments:**

- There will be six homework assignments, each worth 100 points.
- Your total homework grade will be the average of your grades in these six homework assignments.
- Your answers should be accompanied by complete, clear, and accurate supporting work.
- An answer with no work or large gaps in the work will receive minimal credit. You need to showcase your knowledge and effort by writing the answers in your own way.
- You are free to collaborate with others to complete your homework, but you're not allowed to simply copy answers from other students or resources (see "Academic Misconduct" section for more details).

**Exams:**

- There will be two exams (midterm and final).
- Both exams will be closed-book written exams (you are not allowed to bring any notes or resources).
- Cheating in any form will not be tolerated (check university academic integrity policies for more details).
- You are not allowed to use calculators, laptops, tablets, cell phones, headphones, or other electronic devices during the exams.

**Project:**

- Students who are taking this course at a graduate level should submit an individual project.
- The individual project involves solving a real-world problem using one technique you learned in the class.
- The project proposal is due in the middle of the semester and the final project package (including report, poster, and code) will be due at the end of the semester.
- You will need to present your project (poster) during the last week of classes.
- Exact format of the presentation and project report will be provided in Canvas.
- The project code and write-ups must be written exclusively by you (see "Academic Misconduct" section for more details).

**Course Policies:** The instructor reserves the right to add, remove, or change any element of class policy at any time and for any reason, within the limits of University policy.

**Academic Misconduct:**

- If you work in a group, seek assistance from a tutor, or use one of the resources on campus, the work you turn in must be in your own words, demonstrating your own understanding of the material that you have gained through the learning process. This includes putting written work into your own words and citing your sources, as appropriate to avoid plagiarism. Plagiarism as defined by the OU Integrity Office includes:
  - Copying words and presenting them as your own writing.
  - Copying words, even if you give the source, unless you also indicate that the copied words are a direct quotation “”.
  - Copying words and then changing them a little, even if you give the source.
  - Even if you express it in your own words, it is plagiarism to use someone else’s idea as your own.
- Copying any downloaded code or solutions (whether documented or undocumented) is considered academic misconduct and will be treated as such.
  - Exceptions to this policy (such as a course project that builds on an existing open-source project) may be requested in advance to be granted by the instructor.
- Check out the “Academic Integrity” sections of the university policy to become more familiar with what constitutes as academic misconduct.

**Attendance:**

- Regular attendance is expected and will be monitored.
- Signing in for someone else is not permitted.
- Student will not be given attendance credit if they arrive more than 15 minutes late to the class.
- Each student has three slack days (automatically excused absence) for missing a class. Prior notification of the instructor is not required to use the slack days.
- The slack days cannot be used for presentation or exam days. Any assignments that are due on the day would still need to be completed in accordance with our no late work policy.
- Additional excused absence will be considered for legitimate and serious reasons such as a medical emergency (including mental or physical, with a doctor’s, counselor’s, or ADRC note), family emergencies (such as illness or death in a close relation), university sponsored activities (including provost approved or director of athletics approved activities), and legally required activities (such as emergency military service and jury duty).

**Classroom Conduct:**

- All electronic devices, including cell phones and laptops, should be muted and put in silent mode before the beginning of class.
- Using electronic devices, including cell phones and laptops, for anything other than course work (attending class remote sections, taking notes, checking references, and submitting quizzes) is not allowed.
- Disruptions of the class by exhibiting erratic or irrational behavior is not permitted.
- Making physical or verbal threats to a faculty member, teaching assistant, or class members will not be tolerated.
- Failure to comply with the classroom conduct policy may cause the student being asked to leave the classroom and/or reported for possible violation of the [student rights and responsibilities code](#).

**Communication:**

- Check [Canvas](#) and your [OU email](#) at last every 24 hours for announcements and updates such as changes in deadlines, syllabus, homework assignments, etc.
- It is your responsibility to be aware of information and notices given via Canvas or email. If you face any difficulties accessing these services, contact [OU IT support](#) to get it resolved as soon as possible.
- Please [turn on your Canvas notifications](#) so that you receive announcements automatically via email/text.
- You could contact the instructor using Canvas or email with the following subject line:  
[CS 4433/5433]-[NAME]-[REASON].
- Please allow at least 48 hours to get a response to your email.

**Grading:**

- The actual distribution of scores could affect the thresholds used to convert to letter grades.
- All the grades will be uploaded to Canvas online grade book. It is your responsibility to verify that the grades on Canvas are correct.
- You may appeal any grades (homework, project, and class activity) within one week of receiving your grade in Canvas.

**Makeups:**

- Makeup assignments will be only available when required by University policy (such as having three or more exams scheduled for the same day).
- If you miss an assignment because of a medical emergency (including mental or physical, with a doctor's, counselor's, or ADRC note), family emergencies (such as illness or death in a close relation), university sponsored activities (including provost approved or director of athletics approved activities), or legally required activities (such as emergency military service and jury duty), necessary arrangements will be made for your accommodation.

**Remote Session:** If for any reason the lectures needed to be provided online, the following policies apply:

- You are encouraged to share your video for the entire duration of the lecture to help maximize engagement.
- If you don't like to show your surroundings in the zoom meetings, you may use one of the zoom virtual backgrounds provided by [OU](#).
- All the public zoom sessions, including lectures and presentations, are subject to recording.
- You will not get attendance credits for watching recorded videos, you have to attend the live zoom session during the actual class time.
- During lectures, you can unmute and ask questions by holding the "space" key on your keyboard.
- If the instructor experiences any technical difficulties and loses connection, you should stay in the zoom meeting for at least 15 minutes. If the problem persists, you can log out and the instructor will provide a pre-recorded video for that session.
- If you need to join the office hours remotely, make sure you notify me before the office hours so I could arrange the zoom session.

**Student Feedback:**

- My goal is to create a positive and productive learning experience in which everyone is welcome, included, and able to learn and succeed. As such, suggestions and comments for improvement of the course are always welcomed.
- Apart from the informal feedback, there is also the formal course evaluation process at the end of each semester. The College of Engineering and Faculty members take these evaluations seriously for making promotions, giving awards, and improving teaching effectiveness. Please take a time and respond to these questions as honestly and precisely as possible.

**Submissions:**

- For homework, you can either submit scanned version of your handwritten answers or typeset them in [L<sup>A</sup>T<sub>E</sub>X](#). The project report must be written L<sup>A</sup>T<sub>E</sub>X.
- To scan the handwritten answers you can use the [Gradescope mobile app](#) or a desktop scanner.
- The final homework submission to Gradescope should be one PDF file with one question per page (do not include solutions to multiple questions in one page).
- Late submission without an excused reason (even for few minutes) will result in a grade of zero for that assignment.
- Please allocate sufficient time before the deadline to avoid any technical difficulties.

**University Policies:** In case of any conflicts between course policy and the university policy, the university policy takes precedence.

**Academic Integrity:** Cheating is strictly prohibited at the University of Oklahoma, because it devalues the degree you are working hard to get. As a member of the OU community it is your responsibility to protect your educational investment by knowing and following the rules. For specific definitions on what constitutes cheating, review the Student's Guide to Academic Integrity at <http://integrity.ou.edu>.

**Adjustments for Pregnancy/Childbirth Related Issues:** Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact your professor or the Disability Resource Center at [405/325-3852](tel:4053253852) as soon as possible. Also, see the Institutional Equity Office [FAQ on Pregnant and Parenting Students' Rights](#) for answers to commonly asked questions.

**Armed Subject/Campus Intruder:** If you receive an OU Alert to shelter-in-place due to an active shooter or armed intruder situation or you hear what you perceive to be gunshots:

1. *Avoid:* If you believe you can get out of the area WITHOUT encountering the armed individual, move quickly towards the nearest building exit, move away from the building, and call [911](tel:911).
2. *Deny:* If you cannot flee, move to an area that can be locked or barricaded, turn off lights, silence devices, spread out, and formulate a plan of attack if the shooter enters the room.
3. *Defend:* As a last resort fight to defend yourself.

For more information, visit [OU's Emergency Preparedness site](#).

[Shots Fired on Campus Procedure - Video](#)

**Copyright Syllabus Statement for In-Person or Online Courses:** Sessions of this course may be recorded or live-streamed. These recordings are the intellectual property of the individual faculty member and may not be shared or reproduced without the explicit, written consent of the faculty member. In addition, privacy rights of others such as students, guest lecturers, and providers of copyrighted material displayed in the recording may be of concern. Students may not share any course recordings with individuals not enrolled in the class or upload them to any other online environment.

**Covid-19 Policy:** For the well-being of the entire university community it is important that everyone demonstrate the appropriate health and safety behaviors outlined in the University COVID Policies available at <https://www.ou.edu/together>. Students who do not follow the university COVID policies will be instructed to exit the classroom.

**Emergency Protocol:** During an emergency, there are official university [procedures](#) that will maximize your safety.

**Severe Weather:** If you receive an OU Alert to seek refuge or hear a tornado siren that signals severe weather:

1. **LOOK** for severe weather refuge location maps located inside most OU buildings near the entrances.
2. **SEEK** refuge inside a building. Do not leave one building to seek shelter in another building that you deem safer. If outside, get into the nearest building.
3. **GO** to the building's severe weather refuge location. If you do not know where that is, go to the lowest level possible and seek refuge in an innermost room. Avoid outside doors and windows.
4. **GET IN, GET DOWN, COVER UP.**
5. **WAIT** for official notice to resume normal activities.

Additional [Weather Safety Information](#) is available through the Department of Campus Safety.

**Final Exam Preparation Periods:** Pre-finals week will be defined as the seven calendar days before the first day of finals. Faculty may cover new course material throughout this week. For specific provisions of the policy please refer to OU's ([Final Exam Preparation Period policy](#)).

**Fire Alarm/General Emergency:** If you receive an OU Alert that there is danger inside or near the building, or the fire alarm inside the building activates:

1. *LEAVE* the building. Do not use the elevators.
2. *KNOW* at least two building exits.
3. *ASSIST* those that may need help.
4. *PROCEED* to the emergency assembly area.
5. *ONCE* safely outside, *NOTIFY* first responders of anyone that may still be inside building due to mobility issues.
6. *WAIT* for official notice before attempting to re-enter the building.

[OU Fire Safety on Campus](#)

**Land Acknowledgment Statement:** Long before the University of Oklahoma was established, the land on which the University now resides was the traditional home of the “Hasinai” Caddo Nation and “Kirikiri?s” Wichita & Affiliated Tribes. We acknowledge this territory once also served as a hunting ground, trade exchange point, and migration route for the Apache, Comanche, Kiowa and Osage nations. Today, 39 Tribal nations dwell in the state of Oklahoma as a result of settler and colonial policies that were designed to assimilate Native people. The University of Oklahoma recognizes the historical connection our university has with its Indigenous community. We acknowledge, honor and respect the diverse Indigenous peoples connected to this land. We fully recognize, support and advocate for the sovereign rights of all of Oklahoma’s 39 Tribal nations. This acknowledgement is aligned with our university’s core value of creating a diverse and inclusive community. It is an institutional responsibility to recognize and acknowledge the people, culture and history that make up our entire OU Community.

**Mental Health Support Services:** If you are experiencing any mental health issues that are impacting your academic performance, counseling is available at the University Counseling Center (UCC). The Center is located on the second floor of the Goddard Health Center, at 620 Elm Rm. 201, Norman, OK 73019. To schedule an appointment call (405) 325-2911. For more information please visit <http://www.ou.edu/ucc>.

**Reasonable Accommodation Policy:** The Accessibility and Disability Resource Center is committed to supporting students with disabilities to ensure that they are able to enjoy equal access to all components of their education. This includes your academics, housing, and community events. If you are experiencing a disability, a mental/medical health condition that has a significant impact on one or more life functions, you can receive accommodations to provide equal access. Possible disabilities include, but are not limited to, learning disabilities, AD(H)D, mental health, and chronic health. Additionally, we support students with temporary medical conditions (broken wrist, shoulder surgery, etc.) and pregnancy. To discuss potential accommodations, please contact the ADRC at 730 College Avenue, (ph.) (405) 325-3852, or [adrc@ou.edu](mailto:adrc@ou.edu).

**Religious Observance:** It is the policy of the University to excuse the absences of students that result from religious observances and to reschedule examinations and additional required classwork that may fall on religious holidays, without penalty. [[See Faculty Handbook 3.15.2](#)].



**Title IX Resources and Reporting Requirement:** Anyone who has been impacted by gender-based violence, including dating violence, domestic violence, stalking, harassment, and sexual assault, deserves access to resources so that they are supported personally and academically. The University of Oklahoma is committed to offering resources to those impacted, including: speaking with someone confidentially about your options, medical attention, counseling, reporting, academic support, and safety plans. If you would like to speak with someone confidentially, please contact [OU Advocates](#) (available 24/7 at [405-615-0013](#)) or another confidential resource (see “[Can I make an anonymous report?](#)”). You may also choose to report gender-based violence and discrimination through other means, including by contacting the [Institutional Equity Office](#) ([ieo@ou.edu](mailto:ieo@ou.edu), [405-325-3546](#)) or police (911). Because the University of Oklahoma is committed to the safety of you and other students, I, as well as other faculty, Graduate Assistants, and Teaching Assistants, are mandatory reporters. This means that we are obligated to report gender-based violence that has been disclosed to us to the Institutional Equity Office. This includes disclosures that occur in: class discussion, writing assignments, discussion boards, emails and during Student/Office Hours. For more information, please visit the [Institutional Equity Office](#).

**List of University Resources:**

I would like to encourage you to connect with and utilize the following resources as appropriate:

- **24-Hour Reporting Hotline:** If you are experiencing, have experienced, or witnessed bias, discrimination, or harassment, please notify the university.
- **Accessibility and Disability Resource Center:** If you are experiencing a disability, a mental/medical health condition that has a significant impact on one or more life functions, you can receive accommodations to provide equal access.
- **Action Tutoring:** The Student Learning Center, a department of University College (UC), offers free tutoring sessions through UC Action.
- **Campus Safety:** Our Mission is to assist in providing a safe environment for the University's students, faculty, staff, and visitors through education, planning, monitoring, enforcement codes, regulations and standards.
- **Compass Network:** You can self-refer to this network of support, which will get you connected to someone who can help you consider how to navigate a range of personal challenges.
- **Gender + Equality Center:** The Gender + Equality Center houses OU Advocates, which serves folk impacted by gender-based violence who are members of the OU campus community. It also houses LGBTQ+ programs to help build awareness, education and community.
- **Institutional Equity Office:** The Institutional Equity Office reports to the President and Board of Regents and handles discrimination claims, affirmative action plans, claims involving the Sexual Misconduct, Discrimination and Harassment Policy and gender equity issues related to athletics.
- **International Student Service:** International students may connect with their advisor or the range of programs and events that will help build community.
- **Math Center:** The Math Center tutors strive to help students be more efficient, effective, and ultimately more independent in their learning of mathematics.
- **Multicultural Programs and Services:** These programs are open to everyone and may be of particular interest for folk looking for community around diversity and inclusion, as well as cultural, intercultural, and heritage celebrations.
- **OU Food Pantry:** All you need is an OU ID to access the food pantry, which provides free food, clothing, menstrual products, and books. Please visit their website to stay up to date with their open hours and location.
- **OU Student Financial Center:** For financial and budget assistance please contact the OU student financial center.
- **OU Together:** OU together provides the latest protocols and policies for campus health screening and reporting.
- **Project Threshold:** – If you are a first generation college student, economically disadvantaged (per federal guidelines) or disabled (with appropriate documentation), you may benefit from connecting with Project Threshold for advising or tutoring.
- **University Counseling Center (UCC):** The University Counseling Center provides comprehensive mental health services at the University of Oklahoma within the Division of Student Affairs.
- **Veteran Support Alliance:** If you are active military, veteran, or military service-connected, the Veteran Support Alliance has information about resources and support to help you be successful.
- **Writing Center:** The writing consultants at the writing center are able to talk with you about your writing—at any stage in the process and for any course you are taking.