

CS 4433/5433: COMPUTATIONAL METHODS IN DISCRETE OPTIMIZATION
The University of Oklahoma, School of Computer Science
Spring 2022

Instructor: Sina Khanmohammadi Lecture Time: M/W/F 9:30 AM-10:20 AM Office Hours: M/W 2:00-3:00 PM or by Appointment * All times are in Central Time (CT)	sinakhan@ou.edu Location: Carson Engr Ctr 0438 DEH Room 430 or via Zoom
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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](#)

Optional Textbooks:

- 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">• Class Activity (5%)• Homework x3 (30%)• Midterm Exam (30%)• Final Exam (35%)	CS 5433: <ul style="list-style-type: none">• Class Activity (5%)• Homework x3 (30%)• Midterm Exam (20%)• Final Exam (25%)• Individual Project (20%)	Project Breakdown: <ul style="list-style-type: none">• Proposal (10%)• Presentation (40%)• Report (50%)	Grade Scale: <ul style="list-style-type: none">• A (90-100)• B (80-89)• C (70-79)• D (60-69)• F (≤ 59)
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Tentative Schedule (Subject to change):

Week1	1/19-1/21	Introduction (Chapter 1)
Week2	1/24-1/26-1/28	Introduction (Chapter 1)
Week3	1/31-2/2-2/4	The Geometry of Linear Programming (Chapter 2)
Week4	2/7-2/9-2/11	The Geometry of Linear Programming (Chapter 2)
Week5	2/14-2/16-2/18	The Simplex Method (Chapter 3)
Week6	2/21-2/23-2/25	The Simplex Method (Chapter 3)
Week7	2/28-3/2-3/4	Duality Theory (Chapter 4)
Week8	3/7-3/9-3/11	Duality Theory (Chapter 4)
Week9	3/21-3/23-3/25	Sensitivity Analysis (Chapter 5)
Week10	3/28-3/30-4/1	Sensitivity Analysis (Chapter 5)
Week11	4/4-4/6-4/8	Large Scale Optimization (Chapter 6)
Week12	4/19-4/21	Large Scale Optimization (Chapter 6)
Week13	4/11-4/13-4/15	Network Flow Problems (Chapter 7)
Week14	4/18-4/20-4/22	Network Flow Problems (Chapter 7)
Week15	4/25-4/27-4/29	Network Flow Problems (Chapter 7)
Week16	5/2-5/4-5/6	Project Presentation

* Spring Break. No class between March 12-20.

Important Dates (Tentative):

Homework 1	.....	2/14 @ 11:59 PM
Midterm Exam	.....	2/28 @ 9:30 AM
Project Proposal	.....	3/7 @ 11:59 PM
Homework 2	.....	4/4 @ 11:59 PM
Homework 3	.....	5/2 @ 11:59 PM
Project Report	.....	5/6 @ 11:59 PM
Final Exam	.....	5/9 @ 8:00 AM

* All the times are in CDT.

Assessment:

Class Activity: The class activities are part of the final grade and include attendance, discussion, feedback, course evaluation, and quizzes.

Homework Assignments: There will be three homework assignments, each worth 100 points. Your total homework grade will be the average of your grades in these three homework assignments.

Exams: There will be two exams (midterm and final). Both exams will be closed-book written exams in the class where we have our regular meetings.

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 at the middle of the semester. The final report and presentation will be due at the end of the semester. The exact format of the presentation and project report will be provided towards the end of semester.

Course Policies:**Attendance:**

- Regular attendance is expected and will be monitored.
- Signing in for someone else is not permitted.
- Each student has two slack days. Prior notification of the instructor is not required to use the slack days.

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 (taking notes, checking references, and submitting quizzes) is not allowed.
- Eating food in the classroom is not allowed except for health reasons such as blood sugar regulation. A written request accompanied by supporting documentation is required to get permission for food consumption in the classroom.
- 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](#) .

Collaboration:

- 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 submission policies for more details).
- No collaboration is allowed on exams.

Communication:

- Check [Canvas](#) and your [OU email](#) regularly for announcements and updates such as changes in 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.
- Students can contact the instructor by email using the following subject line:
[CS 4433/5433]-[NAME]-[REASON].
- Please allow at least 48 hours to get a response to your email.

Exams:

- You must follow the university academic integrity policies (see academic integrity section for more details) during the exams. Cheating in any form will not be tolerated.
- You are not allowed to use calculators, laptops, tablets, cell phones, headphones, or other electronic devices during the exams.
- The exams will be closed book, but you may use one hand written note sheet (letter size).
- The note sheet can not include solutions of particular problems, it can only include general concepts and formulations.
- The note sheet must be your own work and submitted along the exam.

Feedback:

- The 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.

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, exam, project, and class activity) within 48 hours of receiving your grade in Canvas.

Make-ups:

- Makeup exams will be only available when required by University policy. Missing an exam without a previously approved excuse will result in a grade of zero, unless there are extenuating circumstances (such as verified illness or emergency).
- If you miss an assignment because of verified illness or emergency, a grade will be estimated for the missed assignment based on your other grades and the average of the class.
- In case of missing project deadlines because of exceptional circumstances, necessary arrangements will be made so that you can submit your project material, including final report and presentation.

Projects:

- The project code and write-ups must be written exclusively by you.
- Use of any downloaded code or code taken from a book (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.

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

- You must share your video for the entire duration of the class except for facing technical difficulties such as poor internet connection.
- 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 exams, are subject to recording.
- During lectures, you can unmute and ask questions by holding the "space" key on your keyboard.
- If you cannot attend the live session, you need to watch the whole recorded video on Kaltura (not zoom) within 48 hours of the original lecture time to get attendance points.
- If the instructor experiences any technical difficulties and loses connection, you should stay in the zoom meeting for at least 15 minutes before leaving the meeting.

Submissions:

- 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 can either submit scanned version of your handwritten answers or typeset them in [L^AT_EX](#). I highly recommend [L^AT_EX](#) if you are planning to do research in the future.
- To scan the handwritten answers you can use a scanning app (many available for [free](#)) or a desktop scanning app with a traditional scanner.
- Homework assignments must be uploaded to Gradescope with one question per answer sheet (do not include multiple solutions in one page).
- Late submission is not allowed for any of the assignments. Late submission 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:

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 as soon as possible. Also, see <http://www.ou.edu/eoo/faqs/pregnancy-faqs.html> 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. GET OUT: 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. 2. HIDE OUT: 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. TAKE OUT: As a last resort fight to defend yourself. For more information, visit <http://www.ou.edu/emergencypreparedness.html>.
[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. [Link to Severe Weather Refuge Areas](#)
[Severe Weather Preparedness - Video](#)

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 (<https://apps.hr.ou.edu/FacultyHandbook#4.10>).

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?:" 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](tel:405-325-2911). For more information please visit <http://www.ou.edu/ucc>.

Reasonable Accommodation Policy: Students requiring academic accommodation should contact the Accessibility and Disability Resource Center for assistance at [\(405\) 325-3852](tel:405-325-3852) or TDD: [\(405\) 325-4173](tel:405-325-4173). For more information please visit <http://www.ou.edu/drc/home.html>. Any student in this course who has a disability that may prevent him or her from fully demonstrating his or her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities.

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. [\[See Faculty Handbook 3.15.2\]](#).

Syllabus Attendance Policy: A temporary university policy has been established to protect the OU community by ensuring that students who are ill or required to isolate feel encouraged to remain at home. Missing a class session or other class activity due to illness or isolation will not result in a penalty for the absence, and the student will not be asked to provide formal documentation from a healthcare provider to excuse the absence. This policy is based on all students and faculty adhering to the principles of integrity, honesty, and concern for others. Students who are experiencing symptoms of COVID-19, including cough, fever, shortness of breath, muscle pain, headache, chills, sore throat, loss of taste or smell, congestion or runny nose, nausea or vomiting, or diarrhea or who have been in close contact with others who have symptoms should:

- Remain at home to protect others.
- Ensure that any needed screening has been conducted ([COVID-19 Screening and Reporting Tool](#)) and any needed treatment obtained.
- Contact the instructor prior to absence or inability to participate, if possible, and provide an honest report of the reason for which you cannot attend class or complete a course activity.
- Continue to complete coursework to the extent possible, using Canvas, zoom, and other online tools.
- Submit assignments electronically to the extent possible and as directed by the instructor.

- Communicate with the instructor to arrange modifications to deadlines or work requirements or reschedule exams or other important course activities, when it is necessary.

Title IX Resources and Reporting Requirement: For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/domestic violence, or stalking, the University offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at [405/325-2215](tel:4053252215) (8 to 5, M-F) or esmo@ou.edu. Incidents can also be reported confidentially to OU Advocates at [405/615-0013](tel:4056150013) (phones are answered 24 hours a day, 7 days a week). Also, please be advised that a professor/GA/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office. Inquiries regarding non-discrimination policies can be directed to University Equal Opportunity Officer and Title IX Coordinator at [405/325-3546](tel:4053253546) or esmo@ou.edu. For more information, visit <http://www.ou.edu/eoo.html>.

* The instructor reserves the right to add, remove, or change any element or policy of this course, including evaluation percentages, at any time and for any reason, within the limits of University policy.

** In case of any conflicts, the university policy takes precedence over all course policies.