THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

Introduction to Optimization, Spring 2026
Department of Statistics and Operations Research

Instructor:

- Ali Mohammad Nezhad

- Email: alimn@unc.edu

- Homepage: `https://alimn.stor.unc.edu/index.html`

- Office: Hanes 330

- Office hours: Tuesday and Thursday 2:30 - 4:00 PM

Lecture:

- STOR 415-001 (1419):   Time: Tuesday and Thursday 9:30 - 10:45 PM   Location: GA 105

Course homepage: `https://alimn.stor.unc.edu/STOR-415.html`

Canvas: `https://edtech.unc.edu/service/canvas/`

Teaching Assistant:

- Beichen Wan (bcwan@unc.edu)

- Office hours: Monday and Friday 2:30 - 3:30 PM at Hanes B-26

Course Description

Lectures

Optimization models and software are widely used in industry and science to support data-driven decision making. Most Fortune 500 companies rely on optimization to plan inventory and workforce needs, manage finances and investments, and solve problems in logistics, transportation, supply-chain design, and machine learning.

This course provides a solid introduction to the foundations of optimization. Students will learn how to formulate real-world optimization problems and solve them using modern optimization software. The course also covers fundamental algorithms for optimization, along with the underlying theory and geometry. Finally, it equips students with essential concepts and computational tools relevant to fields such as operations research, statistics, machine learning, computer science, engineering, applied mathematics, data science, and modern AI.

This course focuses primarily on linear programming, emphasizing modeling, solution methods, and duality and sensitivity analysis. It then covers integer programming as an extension of linear programming, followed—time permitting—by an introduction to nonlinear programming and basic nonlinear optimization methods.

I proceed with the sections as scheduled, and I teach by writing on the blackboard. The tentative course schedule can be found on the course webpage.

- I will upload the lecture notes to Canvas.

- If we are not able to meet in person (e.g., due to an unprecedented situation or a decision made by the university), then we may continue with the lectures as scheduled over Zoom. Details will be announced on Canvas.

- If there is any overlap between the office hours and your course schedule, please come to talk to me after the lecture or send me an email.

Prerequisites: This course is designed for undergraduate students in Statistics and Analytics, Mathematics, Computer Science, Physical Sciences and other majors and minors. This is a self-contained course, but I assume that the students are familiar with basic linear algebra (linear independence, rank, solving linear systems of equations, Gauss-Jordan elimination, matrix inverse) and multivariate calculus (partial-order derivatives, the Hessian matrix etc). Familiarity with proof techniques (e.g., MATH 381, STOR 315, or COMP 283) is a plus. I will always provide the necessary background whenever needed. Some review materials will be posted on Canvas

Course materials: The course materials are (almost always) selected from the following references, but none of which is required for this course (the class will be based on course notes). Nevertheless, you are strongly encouraged to buy the hard copy of the first reference, which covers all the topics relevant to this course. The other three references are recommended for further reading and can be found either at the UNC Library or are available as free PDFs online.

Please note: The lecture notes are internally used for this course, and they must not be distributed without permission of the Instructor in any way and any form. Slides and coding examples will be used in this course and provided on Canvas.

References:

- **Highly recommended**: B. Guenin, J. Könemann, and L. Tunçel . A Gentle Introduction to Optimization. Cambridge University Press, 2014.

- R. J. Vanderbei. Linear Programming: Foundations and Extensions. Third Edition. Springer, NY, USA, 2008.

- D. G. Luenberger and Y. Ye. Linear and Nonlinear Programming. Third Edition. International Series in Operations Research and Management Science. Springer, NY, 2008.

- L. A. Wolsey. Integer programming. John Wiley & Sons, 2020.

In this course, the following topics will be covered:

- **Introduction to Mathematical Optimization**: Mathematical optimization and fundamental concepts, motivating examples and real-world applications

- **Linear Programming**: Linear programming modeling, standard form of linear programming, applications of linear programming (blending, transportation, assignment, inventory), solving 2D linear programming problems, basic solutions and basic feasible solutions, Simplex method (in tableau and matrix forms), Big-M and Two-phase simplex methods, unboundedness, infeasibility and multiple optimal solutions, duality and sensitivity analysis in linear programming, solving linear programming with GAMS Modeling Language

- **Introduction to Integer Programming**: Integer programming modeling, set covering, assignment, and scheduling problems, logical modeling tricks, solving integer programs, complexity, branch and bound, transshipment and traveling salesman problems, shortest route and max flow problems

- **Introduction to Nonlinear Programming (if time permits)**: Nonlinear programming models, applications, unconstrained optimization, constrained optimization

Please note: This course is different from STOR 305. Although there are some similarities, for example, when we formulate linear programs, STOR 415 goes into much more depth.

Optimization Software

We will be using GAMS Modeling Language to model and solve optimization problems. GAMS has an interface where you code your mathematical model and then run a solver to solve the problem (it has a variety of solvers to choose). You can download GAMS and request a free academic license here.

Learning Objectives

By successfully completing this course, you will

- learn how to model optimization problems, formulate their mathematical models, and solve them using a state of the art optimization software;

- learn duality in linear programming and how to interpret the sensitivity of an optimal solution;

- learn how the Simplex method works on linear programming and you will understand its computational complexity;

- learn the basics of integer programming formulations, algorithms, and how linear programming is used in integer programming;

- learn lots of applications of linear programming and integer programming in real life decision making problems;

- time permitting, learn how linear programming is generalized to nonlinear programming and how to obtain a (local) optimal solution for a nonlinear program.

Overall, upon a successful completion of this course, you will enhance your ability to formulate and solve a wide class of decision making problems.

Assignments

You will be given twelve (12) handwritten homework assignments, almost every week (depending on the instructor). The problems will be posted on Gradescope. You need to write down the solution(s) to the specified questions on a paper, create a scanned copy of your solution in PDF format (or you can use MS Word/Latex or any similar interface on your laptop/iPad/Tablet) and then upload the PDF file to Gradescope. An introductory document for Gradescope can be found on the course webpage.

- The deadlines will be always announced to you via Canvas.

- Please make sure to upload your solutions according to the Gradescope instructions. The grader may take off points for incorrectly uploaded homework solutions.

- Your two lowest scores from the homework assignments will be dropped at the end of the semester.

Quizzes

There will be four (4) in-class quizzes, each 20 minutes long, on the recent homework assignments and examples that we solve in the class. The quizzes will be given at the end of the class. Please see the course webpage for the schedule.

- Your lowest score from the quizzes will be dropped at the end of the semester.

Exams

There will be two (2) 75-min in-class midterm examinations and a 3-hour in-class final exam as follows:

Midterm Exam #1: Date: Tuesday 02/17/2026   Time: 09:30 - 10:45 AM   Location: GA 105
Midterm Exam #2: Date: Tuesday 03/31/2026   Time: 09:30 - 10:45 AM   Location: GA 105
Final Exam: Date: Thursday 05/07/2026   Time: 08:00 - 11:00 AM   Location: GA 105

- There will be two review sessions on 02/12 and 03/26 during the normal class time.

- There will be a comprehensive review session on 04/23 during the normal class time.

- All exams will be closed book and closed notes, and calculators, electronic devices, laptop etc. are NOT allowed during the exams.

- The final exam will be comprehensive.

Grading Policy

Your final grade is calculated based on the following formula:

Homework	20%
Quizzes	10%
Midterms	36%
Final exam	34%

Your total score = Homework × 0.2 + max{Midterm 1, Midterm 2} × 0.26 + min{Midterm 1, Midterm 2} × 0.1 + Quiz × 0.1 + Final × 0.34.

Grading scale   A total score of 93% is guaranteed an A, 90% an A-, 87% a B+, 83% a B, 80% a B-, 77% a C+, 73% a C, 70% a C-, 67% a D+, and 60% a D. A student with a total score meaningfully less than 60% gets an F.

Please note: I do not round grades, and there will be no potential for additional credit after the final exam. However, the boundaries (based on the class average on the final exam scores) **might** be lowered at the end of the semester. For example, if your total score is 88%, then your B+ is guaranteed, but you may also end up with a higher grade like A-.

How to succeed in this course

You are expected to 1) attend and be actively involved in all classes, 2) take advantage of the office hours, 3) take the homework assignments very seriously and complete them by the deadline, and 4) get prepared well for the quizzes and exams. I strongly encourage you to study the lecture notes and the textbook before starting to work on the assignments.

- You are strongly encouraged to attend the class on a regular basis and be always on time (studying lecture notes alone may not be enough). You are welcome to raise your hand and ask questions if anything comes to your mind. Please do not talk to the students around you as this could cause distraction.

- I am more than happy to help you with the homework problems, and you are always welcome to come to the office hours to discuss those problems (assuming that you have already thought about those problems).

Course Policy

You are allowed to work on the homework problems together and feel free to use the references that I mentioned or any other textbook that can be useful. However, you are NOT allowed to use online resources or AI tools to solve the homework problems (although you can still use AI or online resources to further understand the topics). Further, you must write down your solutions in your own words all by yourself. In case of collaboration, you should explicitly cite the references that you used or spell out the extent of help and your classmate(s) that you worked with on the problems. No points will be taken off for such disclosures. However, you will get zero on an assignment, if your solution is recognized to be identical to that of another student, or if you provide a solution which is not yours. Please also see the sections on Code of Conduct and Policy on Use of Artificial Intelligence.

- Please note that a frequent unauthorized use of help will be more a learning issue rather than a cheating issue. If you always get the answers from other sources it will affect your learning.

Deadline: A homework will be assigned to you, almost always on Thursdays, and it will be due in a week or so at 11:59 PM. Please see the course schedule on the course webpage for details.

- Late submissions are NOT accepted. If you are not able to meet a deadline (due to illness or a university-approved excuse) and you need an extension, please contact me at your earliest convenience before the deadline. I then will decide on a case by case basis.

Use of electronic devices You may use your electronic devices during the lectures, but only for this class purposes (e.g., note taking). Please note that an inappropriate use of your electronic devices will cause distraction for the students around you.

Make-up quizzes: Your lowest quiz grade will be dropped at the end of semester. For that reason, there will be NO make-up quiz.

Make-up exams: If you are not able to attend an exam due to an illness, in the event of an emergency or other reasons, 1) you need to contact me at your earliest convenience before the exam, and 2) you need to provide a university-approved letter (a letter from your doctor or primary care provider is also acceptable). In that case, I will schedule a make-up exam for you. Otherwise, your absence will not be acceptable, and your grade on that exam will be zero.

Regrade request   You have two weeks from the release date of the grades to submit a regrade request on Gradescope. No further requests will be accepted after this deadline.

Announcements: Please stay tuned for announcements in Canvas. All course related information, including the deadline for all assignments, will be announced in Canvas.

Syllabus Changes

The instructor reserves the right to make changes to the syllabus including project due dates and test dates. These changes will be announced as early as possible.

Policy on Use of Artificial Intelligence

Use of generative AI tools of any kind (ChatGPT, Bing Chat, Claude, Google Bard, or any other automated assistance) is not allowed in this course. More precisely, students are not allowed to submit text that is generated by AI systems for any classwork or assessments. This includes using AI to generate answers to assignments, quizzes, exams, or using AI to complete any other course-related tasks. Using AI in this way undermines your ability to develop critical thinking, writing, or research skills that are essential for this course and your academic success. Further, any unauthorized use of these tools will be considered an instance of academic dishonesty and will be referred to Student Conduct.

Students may use AI as part of their research and preparation for assignments, or as a text editor, but text that is submitted must be written by the student. For example, students may use AI to learn about various topics in the course, learn general problem solving strategies, and such. Students should also be aware of the potential benefits and limitations of using AI as a tool for learning and research. AI systems can provide helpful information or suggestions, but they are not always reliable or accurate. Students should critically evaluate the sources, methods, and outputs of AI systems.

If you have any questions about this policy or if you are unsure whether a particular use of AI is acceptable, please do not hesitate to ask for clarification.

Code of Conduct

Students are bound by the Honor Pledge and University policy in completing academic coursework. Such policies are effective at all times, and the submission of work signifies understanding and acceptance of those requirements. Plagiarism will not be tolerated. Please consult with me if you have any questions about course requirements, academic misconduct, or the Student Code of Conduct. You can also find additional information at `https://studentconduct.unc.edu/`.

University Compliance Office - Accommodations

University Compliance Office (UCO) Accommodations Team (Accommodations – UNC Compliance) receives requests for accommodations for disability, pregnancy and related conditions, and sincerely held religious beliefs and practices through the University's Policy on Accommodations. UCO Accommodations team determines eligibility and reasonable accommodations consistent with state and federal laws.

Counseling and Psychological Services

UNC-Chapel Hill is strongly committed to addressing the mental health needs of a diverse student body. The Heels Care Network website is a place to access the many mental health resources at Carolina. CAPS

is the primary mental health provider for students, offering timely access to consultation and connection to clinically appropriate services. Go to the CAPS Website or visit their facilities on the third floor of the Campus Health building for an initial evaluation to learn more. Students can also call CAPS 24/7 at 919-966-3658 for immediate assistance.

Title IX Resources

Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Reports can be made online the UCO at `https://eoc.unc.edu/accommodations/` or by contacting the University's Title IX Coordinator (Elizabeth Hall, titleixcoordinator@unc.edu) or the Report and Response Managers in the University Compliance Office (UCO) (reportandresponse@unc.edu). Please note that I am designated as a Responsible Employee, which means I must report to the UCO any information I receive about the forms of misconduct listed in this paragraph. If you'd like to speak with a confidential resource, those include Counseling and Psychological Services, the University's Ombuds Office, and the Gender Violence Services Coordinators (gvsc@unc.edu). Additional resources are available at `https://safe.unc.edu/`.

Attendance Policy

As stated in the University's Class Attendance Policy, no right or privilege exists that permits a student to be absent from any class meetings, except for these University Approved Absences:

1. Authorized University activities: University Approved Absence Office (UAAO) website provides information and FAQs for students and FAQs for faculty related to University Approved Absences.

2. Disability/religious observance/pregnancy/short-term military service, as required by law and approved by the University Compliance Office or in the case of short-term military service, the Dean of Students.

3. Significant health condition and/or personal/family emergency as approved by the Office of the Dean of Students, Gender Violence Service Coordinators, and/or the University Compliance Office.