COURSE INFORMATION: Spring 2024
MATH 435 & MATH 535 Linear Optimization

Time and Place: 5pm-6:15pm, Monday & Wednesday at Pritzker Science Ctr 129.

Instructor: Hemanshu Kaul, kaul@iit.edu.

Office: Rettaliata Engg Center 125C.

Office Hours: Monday and Wednesday at 12-1pm. And by appointment in-person or through Zoom (send email). Emailed questions are also encouraged.

TA Office Hours: Alaittin Kirtisoglu, Monday and Wednesday 3:30pm-5pm at RE 129 or through Zoom link at Math Tutoring Center.

Course Communications: **Course Webpage**.
Check the course webpage regularly for homework assignments, announcements, and a lecture log (useful when you miss a class and when reviewing for an exam).
I often send emails with comments regarding HW problems, Exams, etc. Make sure your IIT email account is active and working.

Prerequisites: Math 332 at IIT, or its equivalent undergraduate course in Linear Algebra. You need to be familiar with topics like - System of linear equations, Row operations for solving systems of linear equations, $\mathbb{R}^n$ as a vector space, Subspace, Span, Linear Independence, Basis, Dimension, Nullspace of a matrix, Matrix rank, Affine subspaces.

Course Description: The primary aim of this course is to develop a deep and comprehensive understanding of various algorithms used for solving Linear Optimization problems. This course will lay the foundation for you to do non-trivial applications of these optimization problems and their algorithms.
This aim cannot be achieved without studying and understanding the numerous mathematical structures and concepts that underlie such problems and algorithms. Consequently, mathematical arguments a.k.a. proofs will be an integral part of this course. This leads to our second, and equally important, aim: development of good habits of understanding, communicating, and writing mathematics.

Also see the separate document **'My Aim for this Course'**.

An official description of the lecture topics and the course objectives is available at
https://www.iit.edu/applied-math/student-resources/course-syllabi

Textbook: D. Bertsimas and J. Tsitsiklis, *Introduction to Linear Optimization*, Athena Sc., 1997.

Grade Break-down: (subject to change)
Math 435: Homework and participation worth 25%; Two mid-term exams 35% total; Final exam 40%. The grading scale will be no more strict than A:85-100, B:75-84, C:65-74, D:55-64.
Math 535: Homework and participation worth 15%; Project 10%; Two mid-term exams 35% total; Final exam 40%. The grading scale will be no more strict than A:85-100, B:75-84, C:65-74.

Weekly Schedule: On *Monday and Wednesday* of each week, we will hold the lectures which will include discussion and other group activities. By *Thursday* morning, a weekly HW, due a week later, will be uploaded to the course webpage. A lecture log and recommended readings will be available for review.
There might be minor modifications to this schedule at the beginning or end of the semester and before or after exams/holidays.

Class Attendance and Participation: You are expected to attend the lectures on Monday and Wednesday, and participate in the class discussions. You are also expected to read the textbook, including examples not covered in class, and review topics done in class. The multitude of concepts introduced and developed in each class, as well as the importance of proofs in this course makes it critical to attend lectures and participate in class discussions.
Multiple absences from the lectures without permission from instructor will result in **deductions from your score** *at the discretion of the instructor.*

Examinations: The exam dates and their precise topics will be announced on the course webpage. The final exam will be on all the topics covered during the semester. Make-up exams will be given only in case of a documented emergency.

Project for MATH 535: Students will do a project on a topic approved by the instructor. Project topics can include (computational) applications of the course material to student's own research area; development of a computer implementation of one of the algorithms covered in class; or an expository paper (with proofs) on material (from the book or elsewhere) not covered in class. A specific proposal after consultation with the instructor must be submitted by February 25st. Each project can be done by teams of 1-2 students. The final submission will consist of a project report and a presentation to the instructor, which would be done before the last day of classes.
Students registered for MATH 435 can replace a portion of their HW scores by doing a similar project after explicit permission from the instructor.

Homework Assignment: Homework problems will be assigned once a week (typically on Wednesday evening) which will be due one week later. In addition, I will assign reading homework during lectures or on the course webpge. It is in your best interest to do this reading before the next lecture.

It is your responsibility to check the course webpage for assignments and their due dates. Homework needs to be submitted through the appropriate webpage on *Blackboard Assignment*. You will upload a single PDF file of your submission - either typed solutions (use LaTeX), or a scanned copy of your handwritten solutions.
HW solutions must be written following the rules described in the section below.

HW Discussion and Solution Rules: You are allowed to discuss homework problems **only with your classmates, course TA, and me**. However, the solutions should be written by you alone and, if you discussed HW problems with a classmate or TA, you have to **write their name at the top of the HW submission as a collaborator**. Any incident of plagiarism/ cheating (from a person or from any online resource) will be strictly dealt with according to University rules.

Homework Solutions must be written clearly, legibly, and concisely, and will be graded for both mathematical correctness and presentation. Points will be deducted for sloppiness, illegible handwriting, incoherent or insufficient explanation, or for lack of supporting rationale. It is your responsibility to convince the grader of the correctness of your argument in a systematic manner. Solutions can only be graded on basis of what is written in your submission and not based on your unwritten intention.

When grading your work, we pay close attention to the following **fundamental aspects of a solution**:

1. Is your proof mathematically correct? Does it start from the correct assumptions and does it conclude in the correct final statement? Is each intermediate statement correct? Is the logical implication in each of your steps correct? Does your proof contain any gaps? Are there any unjustified assumptions? Are there any aspects of the problem that you have not considered?

2. Have you justified the reasons for each of your steps and intermediate statements? Have you clearly explained the thinking and logic underlying your solution? Can the reader follow your

justification and explanation? Will the reader be convinced by the detail of your explanation?

3. Does your writing clearly express the mathematical content of your solution? We can only grade based on what you have explicitly written, and not based on your underlying/unexpressed intent. Have you explicitly defined the notation, the variables and the functions you are working with? Have you included appropriate introductory or concluding comments that give context to the problem and your solution?

4. Is your solution readable, particularly, is your handwriting legible and have you used proper indentation and typesetting? Have you corrected any obvious misspellings or incorrect grammar?

'Why and How' of Homework? Homework serves as an opportunity for students to practice communicating written mathematics with clarity of thought and language. In any course like this, learning good communication skills in mathematics is very important. As significant is the opportunity that a homework provides you to test your understanding of the material covered in class that week. Mathematics cannot be learned by listening or just reading a book - you have to do it. Considering the varying pace of learning of students in class and the lack of class time to explore every detail of every concept/Theorem, working through problems in the HW (both written and reading HWs) is an easy way for you to make sure that you are keeping up with the class. This is why homework is given a lot of importance in this course - dedicate enough time to it every week.

To improve your mathematical writing quickly, start by writing draft solutions to homework early. A day or two later after you have had time to forget what you wrote, read it. If it doesn't make sense or convince you, rewrite it. **Writing a solution** requires saying what you mean and meaning what you say. Be intellectually honest. Intellectual dishonesty includes: 1) stating a "reason" without understanding its relevance. 2) Claiming a conclusion when you know you haven't proved it. 3) Giving an example and claiming you have proved the statement for all instances. **Include enough detail in your solutions so that your explanation is convincing to someone who hasn't thought about the problem before.** The proofs/ arguments should be presented so that your classmates could read them and follow the logic (step-by-step).

Every homework will contain some straightforward exercises and a few slightly more challenging problems. Do not be disheartened if some problems take a while to solve. Such problems help develop your mathematical creativity. Discuss such problems with your classmates, and/ or ask me for help, but only after you have given them sufficient thought. Please remember that **homework is NOT meant to be an examination**, it is meant to assist in your learning and development. Unlike an exam, if you need help with a HW problem, don't hesitate to ask.

Ask for Help: You are encouraged to ask questions during the *Lectures*, during the *Office Hours*, during the *TA office hours at Math Tutoring Center*, or through *Email to me*. If you are having trouble solving a homework problem, I will be glad to direct you in the right direction. The same goes for any reading in the book, or any concept you have difficulty understanding.

Don't hesitate to ask for help! I cannot help you if you don't take the initiative.

Accommodations through the Center for Disability Resources:

Reasonable accommodations will be made for students with documented disabilities. In order to receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources and email me to make an appointment to speak with me as soon as possible. See the CDR website for more details.

Illinois Tech's Sexual Harassment and Discrimination Information:

Sexual harassment, sexual misconduct, and gender discrimination by any member of the Illinois Tech community is prohibited. This includes harassment among students, staff, or faculty. Sexual harassment by a faculty member or teaching assistant of a student over whom they have authority or by a supervisor of a member of the faculty or staff is particularly serious. Such conduct may easily create an intimidating, hostile, or offensive environment.

Illinois Tech encourages anyone experiencing sexual harassment or sexual misconduct to speak with the Title IX Office for information on the resolution process and support options.

You can file a complaint electronically, which may be completed anonymously. You may also file a complaint in-person by contacting the Title IX Coordinator, Virginia Foster at 312.567.5725/ foster@iit.edu or the Deputy Title IX Coordinator 312. 567.5726/ eespeland@iit.edu.

If you are not ready to file a formal complaint but wish to learn about your rights and options, you may contact Illinois Tech's Confidential Advisor service at 773.907.1062. You can also contact a licensed practitioner in Illinois Tech's Student Health and Wellness Center at 312.567.7550

For a comprehensive list of resources regarding counseling services, medical assistance, legal assistance and visa and immigration services, you can visit the Title IX Office's website.