



CpE 608WS Applied Modeling and Optimization

School of Engineering and Science

Instructor: K.P. (Suba) Subbalakshmi

Course Schedule: Monday - Friday

Contact Info: ksubbala@stevens.edu

Virtual Office Hours: Thursday 10 pm to 1 pm (EDT)

Prerequisite(s): Background in Calculus and Linear Algebra. MATLAB, Python or equivalent scientific programming skills.

Corequisite(s): None

Cross-listed with: None

COURSE DESCRIPTION

This is an introductory course on mathematical modeling of optimization problems and techniques for finding solutions. The course covers mathematical modeling, unconstrained optimization problems, constrained optimization, convex optimization, non-convex optimization, linear and non-linear optimization, line search, gradient descent, penalty function and barrier methods, convergence analysis, applications in machine learning, decision making, wireless communications, signal processing, and other areas.

STUDENT LEARNING OUTCOMES

After successful completion of this course, the student will be able to

- Model an optimization problem
- Solve unconstrained and constrained optimization problems
- Recognize a convex optimization problem
- Apply numerical techniques such as gradient descent
- Choose a software toolbox to solve an optimization problem
- Apply optimization techniques to machine learning and other areas
- Write project reports clearly articulating project goals, the optimization method used, the reason for the choice of optimization method, potential drawbacks, and suggested future work.
- Work in teams and clearly articulate the role of each team member in the work.

COURSE FORMAT AND STRUCTURE

This course is fully online. To access the course, please visit stevens.edu/canvas. For more information about course access or support, contact the Technology Resource and Assistance Center (TRAC) by calling 201-216-5500.

Course Logistics

- You are encouraged to “mentally enroll” in this course as if it occurred on Mondays. In other words, our weeks will run from Monday to Friday. I will post information (online activities, discussion starters, etc.) for the upcoming week periodically, so that when you log in on Monday, you can begin the new week.
- When assignments are due, they are due by midnight EST on the due date listed in the course schedule.
- Deadlines are an unavoidable part of being a professional and this course is no exception. Course requirements must be completed and posted or submitted on or before specified due date and delivery time deadline. Due dates and delivery time deadlines are defined as Eastern Standard Time (as used in Hoboken, NJ). Please note, students living in distance time zones or overseas must comply with this course time and due date deadline policy. Avoid any inclination to procrastinate. To encourage you to stay on schedule, due dates have been established for each assignment; 20% of the total points will be deducted for assignments received 1-6 days late; assignments received more than 1 week late will receive 0 points.
- An assignment file should be appended by your username, such as “assignment1_kim53.doc”. This will make it easier for me to manage assignment files.

Instructor’s Online Hours

I will be available via email and will respond as soon as I am available (generally within 24-48 hours. For the online discussions, I will check in about once per week. Keep in mind that it is not possible for me to respond to every single posting every week (nor is it pedagogically appropriate). You can also email me, if you have any specific question about the course. When emailing me, please place in the subject line the course number/section and the topic of the email (i.e. EE 608 WS – Assignment 2 Question). This will help me tremendously in locating your emails quicker when I scan the hundreds of emails that seem to make it into my box each day.

Virtual Office Hours

Virtual office hours will be conducted via Zoom. The best way to do this, is to send me an email, and we will work out a mutually convenient time for it.

Online Etiquette Guidelines

Your instructor and fellow students wish to foster a safe online learning environment. All opinions and experiences, no matter how different or controversial they may be perceived, must be respected in the tolerant spirit of academic discourse. You are encouraged to

comment, question, or critique an idea but you are not to attack an individual. Our differences, some of which are outlined in the University's inclusion statement below, will add richness to this learning experience. Please consider that sarcasm and humor can be misconstrued in online interactions and generate unintended disruptions. Working as a community of learners, we can build a polite and respectful course ambience. Please read the Netiquette rules for this course:

- Do not dominate any discussion. Give other students the opportunity to join in the discussion.
- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular and/or slang language. This could possibly lead to misinterpretation.
- Keep an “open-mind” and be willing to express even your minority opinion.
- Think and edit before you push the “Send” button.
- Do not hesitate to ask for feedback.

TENTATIVE COURSE SCHEDULE

Changes to the schedule will be notified via Canvas

Week or Module	Topic(s)	Readings	Assignment
Week/Module 00 (Orientation Week)	Introduction and Course Overview	Required: None Optional: None	
Week/Module 01	Introduction to optimization	Required: Lecture notes Optional: Calculus for optimization and videos	
Week/Module 02	First order conditions for Optimization	Required: Lecture notes Optional: Linear algebra, linear independence, and videos	
Week/Module 03	Constrained optimization	Required: Lecture notes Optional: Lagrange optimization, KKT examples, and videos	
Week/Module 04	Convex optimization	Required: Lecture notes Optional: Convex sets, cones, and videos	
Week/Module 05	Exam 1 Review	Required: Review lecture notes Optional: None	
Week/Module 06	Exam 1	Required: Closed book/notes exam Optional: None	
Week/Module 07	Steepest descent, Newton method, penalty and barrier algorithms	Required: Lecture notes Optional: Steepest descent application in linear regression, penalty and barrier method examples, and videos	

Week/Module 08	Conjugate direction method, duality	Required: Lecture notes Optional: Duality examples and videos	
Week/Module 09	Duality, subgradients	Required: Lecture notes Optional: Subgradient, subgradient optimization, and videos	
Week/Module 10	Subgradient algorithm and linear programming	Required: Lecture notes Optional: Linear programming, linear programming duality, and videos	
Week/Module 11	Linear programming, regularization, and least squares	Required: Lecture notes Optional: Regularization, regularization in machine learning, and videos	
Week/Module 12	Exam 2	Required: Open book/notes exam Optional: None	
Week/Module 13	Norms, quadratic forms, SOCP, SDP	Required: Lecture notes Optional: videos	
Week/Module 14	Final Project	Required: Final Project report submission Optional: None	

COURSE MATERIALS

Textbook(s): Class notes will be provided. No required textbook.
 Other Readings: Convex Optimization <https://web.stanford.edu/~boyd/cvxbook/>
 Materials: Supplementary reading material will be posted on Canvas

COURSE REQUIREMENTS

Exams: Two non-cumulative mid-term exams will be conducted. You will solve the first exam individually. The second exam is a “hackathon”, i.e., a small group (of up to 3 students) will collaborate to solve the second exam. It may involve some programming. You will be submitting your code and results for this second exam.

Project(s): Final project topic is chosen by the students. You will do the project in a small group (up to 3 students per group). Each group will identify an application area and a related optimization problem within that area. The project will involve mathematical modeling and programming. Each team will submit a final project slide deck. A template and instructions will be provided. A list of example projects will also be provided. You can either choose one of those, or you can bring one of your own.

TECHNOLOGY REQUIREMENTS

Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Canvas

Technology skills necessary for this specific course

- Live web conferencing using Zoom

Required Equipment

- Computer: current Mac (OS X) or PC (Windows 10+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed
- Microphone: built-in laptop or tablet mic or external microphone

Required Software

- MATLAB (Stevens License)
- Python (free/open source)
- Microsoft Word
- Microsoft PowerPoint

GRADING PROCEDURES

Grades will be based on:

Exam 1	30%
Exam 2	30%
Project	40%

Late Policy

20% of the total points will be deducted for assignments received 1-6 days late; assignments received more than 1 week late will receive 0 points

Other Grade Related Policies

- Re-exams will not be given if you miss an exam unless you have an extraordinary reason. Sufficient documentation must be provided if you miss an exam.
- If you need to take an exam you missed because of the above reason, you need to bring this to the attention of the professor as soon as you are well enough to go about your life but before two weeks from the date of your return.
- If you need to appeal your grade in any of the midterms, it needs to be done within the week after the graded midterms are returned to you. No changes past this deadline.
- Final letter grade will be based on relative scores.

Academic Integrity

Please Note:

- Students are bound by the Graduate Student Code of Academic Integrity.

Graduate Student Code of Academic Integrity

All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at www.stevens.edu/provost/graduate-academics.

EXAM CONDITIONS

Exam 1 will be closed book/notes. Exam 2 will be open book/notes and may contain programming. Final Project will involve programming.

LEARNING ACCOMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other such disabilities in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

For more information about Disability Services and the process to receive accommodations, visit <https://www.stevens.edu/office-disability-services>. If you have any questions please contact: Phillip Gehman, the Director of Disability Services Coordinator at Stevens Institute of Technology at pgehman@stevens.edu or by phone 201-216-3748.

Disability Services Confidentiality Policy

Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written

consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

INCLUSIVITY

Name and Pronoun Usage

As this course includes group work and class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your name and/or pronouns, please inform the instructor of the necessary changes.

Inclusion Statement

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester. Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements.

You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

MENTAL HEALTH RESOURCES

Part of being successful in the classroom involves a focus on your whole self, including your mental health. While you are at Stevens, there are many resources to promote and support mental health. The Office of Counseling and Psychological Services (CAPS) offers free and confidential services to all enrolled students who are struggling to cope with personal issues (e.g., difficulty adjusting to college or trouble managing stress) or psychological difficulties (e.g., anxiety and depression). CAPS is open daily from 9:00 am – 5:00 pm M-F. Evening hours are available by appointment in the Fall / Spring semesters and up-to-date information regarding the availability of evening appointments can be found by visiting www.stevens.edu/CAPS. To schedule an appointment, call 201-216-5177.

Due to the pandemic, in-person appointments may be limited until further notice. Up-to-date information about the availability of in-person services can be found at www.stevens.edu/CAPS. Teletherapy (therapy via secure video platform) is available to registered students physically located in the states of New York or New Jersey. Students located outside of NY / NJ are encouraged to pursue local treatment through their personal health insurance. To learn more about the process of finding a therapist please visit the CAPS webpage on [Seeking Help Off-Campus](#).

EMERGENCY INFORMATION

In the event of an urgent or emergent concern about the safety of yourself or someone else in the Stevens community, please immediately call the Stevens Campus Police at 201-216-5105

or on their emergency line at 201-216-3911. These phone lines are staffed 24/7, year round. For students who do not reside near the campus and require emergency support, please contact your local emergency response providers at 911 or via your local police precinct. Other 24/7 national resources for students dealing with mental health crises include the National Suicide Prevention Lifeline (1-800-273-8255) and the Crisis Text Line (text "Home" to 741-741). If you are concerned about the wellbeing of another Stevens student, and the matter is *not* urgent or time sensitive, please email the CARE Team at care@stevens.edu. A member of the CARE Team will respond to your concern as soon as possible.