MATH 707: ST: Optimization
Fall 2025 Course Syllabus

NJIT Academic Integrity Code: Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: NJIT Academic Integrity Code.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

COURSE INFORMATION

Course Description: Course Description : This graduate course covers modern topics in continuous optimization. Starting with theoretical foundations, the course develops a working knowledge of state-of-the-art algorithms, and concludes with applications in engineering and the applied sciences.

Math 707 covers three key areas:

1. Developing a rigorous treatment of convex analysis (include conditions for optimality). Convex analysis forms the mathematical underpinnings for much of modern optimization.

2. A systematic development of interior-point methods. Interior-point methods are state-of-the-art algorithms for solving (continuous) optimization problems, such as those that arise in physical applications of applied mathematics.

3. Exposure to modern applications of optimization in applied mathematics, e.g., obstacle problems, image processing, compressed sensing of signals, stochastic gradient descent and Tikhonov regularization using norms.

Number of Credits: 3

Prerequisites: This course draws extensively on linear algebra (Math 631) and multivariable calculus (Math 213). The course makes some use of some undergraduate analysis (Math 480-481) and numerical methods (Math 613-614). Students may also seek permission from the instructor for enrollment.

Course-Section and Instructors:

Course-Section	Instructor
Math 707-002	Professor D. Shirokoff

Office Hours for All Math Instructors: Fall 2025 Office Hours and Emails

Required Textbook: There is no required textbook for this class. We will use resources from several resources.

1. S. Boyd, L. Vandenberghe, Convex Optimization , Cambridge University Press, 1st Ed., 2004.

This book is freely available at: https://web.stanford.edu/~boyd/cvxbook/

2. D. P. Bertsekas, Convex Optimization Theory , 1st Ed., Athena Scientific, 2009.

The book website is here: www.athenasc.com/convexduality.html

Much of the text material is available in course notes on the authors website:

www.athenasc.com/Convex_Slides.pdf

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, November 10, 2025**. It will be strictly enforced.

COURSE GOALS

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Homework	70%
Project/Presentations	30%

Your final letter grade will be based on the following tentative curve.

A	90 - 100	**C+**	60 - 69
B+	80 - 89	**C**	50 - 59
B	70 - 79	**F**	0 - 49

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy.

Religious Observance: NJIT is committed to supporting students observing religious holidays. Students must notify their instructors in writing of any conflicts between course requirements and religious observances, ideally by the end of the second week of classes and no later than two weeks before the anticipated absence.

Homework: No late homework will be accepted. You are encouraged to work together on the homework, but do not copy any part of the homework or look up/request solutions to homework problems in online forums or websites. Each student must submit their own homework to be submitted online as a PDF file through Canvas. Include on the homework submission the names of anyone who you collaborated with on the homework.

Feel free to ask me for help during my office hours after you have made an attempt at the question.

Exams: This class does not have exams. However, project presentations may be scheduled to occur during the exam period.

Final Exam Period	December 14 - December 20, 2025

Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

AI Usage: This course expects students to work without artificial intelligence (AI) assistance in order to better develop their skills in this content area. As such, AI usage is not permitted throughout this course under any circumstance.

ADDITIONAL RESOURCES

Further Assistance: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

Accommodation of Disabilities: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please If you need an accommodation due to a disability please contact the Office of Accessibility Resources and Services at oars@njit.edu. The office is located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Office of Accessibility Resources and Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website at:

https://www.njit.edu/accessibility/

Important Dates (See: Fall 2025 Academic Calendar, Registrar)

Date	Day	Event
September 1, 2025	Monday	Labor Day
September 2, 2025	Tuesday	First Day of Classes
September 8, 2025	Monday	Last Day to Add/Drop Classes
November 10, 2025	Monday	Last Day to Withdraw
November 25, 2025	Tuesday	Thursday Classes Meet
November 26, 2025	Wednesday	Friday Classes Meet

November 27 to November 30, 2025	Thursday to Sunday	Thanksgiving Recess - Closed
December 11, 2025	Thursday	Last Day of Classes
December 12, 2025	Friday	Reading Day 1
December 13, 2025	Saturday	Saturday Classes Meet
December 14 to December 20, 2025	Sunday to Saturday	Final Exam Period

Course Outline (tentative)

Unit	Number Lectures	Topic
1	8	**Introduction to convex analysis:** definitions and properties of convex sets and convex functions. Caratheodory's theorem. Norms as convex functions (both finite and infinite dimensional). Separating and supporting hyperplanes. Convex envelopes.
2	8	**Conditions for optimality:** Development of the KKT conditions for optimality in convex and non-convex problems from a geometric viewpoint. Discussion on when KKT conditions are sufficient. Includes both equality (Lagrange multipliers) and inequality constraints. Convex duality.
3	7	**Introduction to Numerical Algorithms:** Interior point methods and primal dual methods for inequality constraints. First order (i.e., gradient and stochastic gradient descent methods) versus second order (i.e., Newton's method). Convergence analysis.
4	3	Focus on Special Topics. (i) Optimal control problems/PDE constrained optimization, (ii) Obstacle problems, (iii) Optimal transport, (iv) Compressed sensing, (v) Semi-definite programing, (vi) Image

		processing.