Course Syllabus

ISYE 6669

Deterministic Optimization

Fall 2026

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Course Description

The course will teach basic concepts, models, and algorithms in linear optimization, integer optimization, and convex optimization. The first module of the course is a general overview of key concepts in optimization and associated mathematical background. The second module of the course is on linear optimization, covering modeling techniques, basic polyhedral theory, simplex method, and duality theory. The third module is on nonlinear optimization and convex conic optimization, which is a significant generalization of linear optimization. The fourth and final module is on integer optimization, which augments the previously covered optimization models with the flexibility of integer decision variables. The course blends optimization theory and computation with various applications to modern data analytics.

Prerequisite

- Linear algebra
- Multivariate Calculus
- Basic Probability
- Familiarity with programming in Python

Course Goals

Student who take this course can expect to achieve the following goals:

- Learn modeling skills for formulating various analytics problems as linear, convex nonlinear, and integer optimization problems
- Learn basic optimization theory including duality theory and convexity theory, which will give the students a deeper understanding of not only how to formulate an optimization model, but also why.

- Learn fundamental algorithmic schemes for solving linear, nonlinear, and integer optimization problems.
- Learn computational skills for implementing and solving an optimization problem using modern optimization modeling language and solvers.

Grading Policy

- There will be three faculty-graded exams: two midterm exams and one final exam. Your two highest exam scores will count toward your course grade at 42.5% each; the lowest of the three is dropped.
- There will be homework assignments most weeks of the semester. Your two lowest homework grades will be dropped, and the remaining ones will add up to 15% of the course grade. Some of the assignments will be faculty graded, and others will be peer-graded (based on the median score assigned by your peer graders). You will also need to peer-grade others' homework; you will not receive a final grade for your homework submission if you do not complete your peer assessments.
- For OMS Analytics degree students, exams will be scaled to letter grades based on their difficulty and combined with the homework to determine an overall letter grade scale at the end of the semester.
- Grade Breakdown

Homework	15%
Exams	85%
Total	100%

Homework and Exam Due Dates

All homework and exams will be due at the times in the table at the end of this syllabus. These times are subject to change so please check back often. Please convert from EST to your local time zone using a Time Zone Converter.

Timing Policy

- The Modules follow a logical sequence
- Assignments should be completed by their due dates.
- Exams must be completed during the time allotted on the schedule.
- You will have access to the course content for the scheduled duration of the course.

Exam Policy

- All three exams are cumulative: each exam may cover any material from the beginning of the course up to the modules preceding it in the schedule.
- No notes (apart from what is stated below), books, or calculator/computers are allowed in the midterm and final exams.
- For midterm and final exams, you are allowed two blank sheets of paper for scratch work (OMS Analytics degree students will be proctored; you will have to show the front and back of the blank sheet while you are being proctored). Moreover, for the first midterm you are allowed one `cheat' sheet of paper with notes, for the second midterm two cheat sheets, and for the final three cheat sheets. Each student must prepare their own notes.

Attendance Policy

- This is a fully online course.
- Login on a regular basis to complete your work, so that you do not have to spend a lot of time reviewing and refreshing yourself regarding the content.

Plagiarism Policy

- Plagiarism is considered a serious offense. You are not allowed to copy and paste or submit materials created or published by others, as if you created the materials. All materials submitted and posted must be your own.

Student Honor Code

All OMS Analytics degree students should abide by the Georgia Tech Student Honor Code

- Review the Georgia Tech Student Honor Code: www.honor.gatech.edu.
- Any OMS Analytics degree student suspected of behavior in violation of the Georgia Tech Honor Code will be referred to Georgia Tech's Office of Student Integrity.

Communication

- All learners should ask questions, and answer their fellow learners' questions, on the course discussion forums. Often, discussions with fellow learners are the sources of key pieces of learning.
- OMS Analytics degree students can also ask questions of the instructor and teaching assistants via Piazza.

Netiquette

- Netiquette refers to etiquette that is used when communicating on the Internet. When you are communicating via email, discussion forums or synchronously (real-time), please use correct spelling, punctuation and grammar consistent with the academic environment and scholarship[1].
- In Georgia Tech's MS in Analytics program, we expect all participants (learners, faculty, teaching assistants, staff) to interact respectfully. Learners who do not adhere to this guideline may be removed from the course.

[1]Conner, P. (2006–2014). Ground Rules for Online Discussions, Retrieved 8/14/2020 from https://tilt.colostate.edu/TipsAndGuides/Tip/128

Course Topics and Sample Pacing Schedule

- The table below contains a course topic outline and homework due dates.

Weeks	**Course Topics**	**Release Dates**
Week 1	Module 1: Introduction • Lesson 1: Introduction to Optimization Models • Lesson 2: Mathematical ingredients • Lesson 3: Classification of optimization problems Module 2: Illustration of the optimization process ○ Lesson 1: A portfolio optimization problem ○ Lesson 2: Formulating a portfolio optimization model ○ Lesson 3: Solving the portfolio optimization model ○ Lesson 4: Summary of the optimization process	Aug 24, 2026 at 8:00 a.m. Eastern
Week 1 Homework	Homework 1	Aug 24 at 8: 00 a.m. Eastern – Sep 3 at 11:59 p.m.

		Peer Assmt: Sep 3 at 11:59 Eastern – Sep 7 at 11:59 Eastern
Week 2	Module 3: Review of Mathematical Concepts • Lesson 1: Linear Algebra • Lesson 2: Properties of Functions • Lesson 3: Properties of Sets Module 4: Convexity • Lesson 1: Convex Functions • Lesson 2: Convex Sets • Lesson 3: Convex Optimization Problems	Aug 31, 2026 at 8:00 a.m. Eastern
Week 2 Homework	Homework 2	Aug 31 at 8: 00 a.m. Eastern – Sep 10 at 11:59 p.m. Peer Assmt: Sep 10 at 11:59 Eastern – Sep 14 at 11:59 Eastern
Week 3	Module 5: Outcomes of Optimization • Lesson 1: Possible Outcomes of Optimization • Lesson 2: Existence of Optimal Solutions • Lesson 3: Local and Global Optimal Solutions • Lesson 4: Idea of Improving Search Module 6: Optimality Certificates • Lesson 1: Optimality Certificates and Relaxations • Lesson 2: Lagrangian Relaxation and Duality	Sep 7, 2026 at 8:00 a.m. Eastern
Week 3 Homework	Homework 3	Sep 7 at 8: 00 a.m. Eastern – Sep 17 at 11:59 p.m. Peer Assmt: Sep 17 at 11:59 Eastern – Sep 21 at 11:59 Eastern

Week 4	Module 7: Unconstrained Optimization: Derivative Based • Lesson 1: Optimality Conditions • Lesson 2: Gradient Descent • Lesson 3: Newton's Method Module 8: Unconstrained Optimization: Derivative Free • Lesson 1: Methods for Univariate Functions • Lesson 2: Methods for Multivariate Function	Sep 14, 2026 at 8:00 a.m. Eastern
Week 4 Homework	Homework 4	Sep 14 at 8: 00 a.m. Eastern – Sep 24 at 11:59 p.m. Peer Assmt: Sep 24 at 11:59 Eastern – Sep 28 at 11:59 Eastern
Week 5	Module 9: Linear Optimization Modeling - Network Flow Problems • Lesson 1: Introduction to LP Modeling • Lesson 2: Optimal Transportation Problem • Lesson 3: Maximum Flow Problem • Lesson 4: Shortest Path Problem Module 10: Linear Optimization Modeling - Electricity Market • Lesson 1: How Electricity Markets Work • Lesson 2: Modeling Power plant Scheduling Using LP • Lesson 3: Market Clearing Mechanism • Lesson 4: A Real-World Example	Sep 21, 2026 at 8:00 a.m. Eastern
Week 5 Homework	Homework 5	Sep 21 at 8: 00 a.m. Eastern – Oct 1 at 11:59 p.m.

		Peer Assmt: Oct 1 at 11:59 Eastern – Oct 5 at 11:59 Eastern
Midterm 1	Midterm Exam 1	Sep 28, 2026 at 8: 00 a.m. Eastern – Oct 5, 2026 at 11:59 p.m. Eastern
Week 6	Module 11: Linear Optimization Modeling - Decision-Making Under Uncertainty • Lesson 1: the Need to Make Decisions Under Uncertainty • Lesson 2: Two-Stage Stochastic Linear Programming • Lesson 3: An Example Using Stochastic LP • Lesson 4: How to Solve Stochastic Programs Module 12: Linear Optimization Modeling - Handling Nonlinearity • Lesson 1: The Power of Piecewise Linear Functions • Lesson 2: Robust Regression Using LP • Lesson 3: Radiation Therapy • Lesson 4: LP Models for Radiation Therapy	Sep 28, 2026 at 8:00 a.m. Eastern
Week 6 Homework	Homework 6	Sep 28 at 8: 00 a.m. Eastern – Oct 8, at 11:59 p.m. Peer Assmt: Oct 8 at 11:59 Eastern – Oct 12 at 11:59 Eastern
Week 7	Module 13: Geometric Aspects of Linear Optimization • Lesson 1: Basic Geometric Objects in LP • Lesson 2: Extreme Points and Convex Hull • Lesson 3: Extreme Rays and Unbounded Polyhedron • Lesson 4: Representation of Polyhedrons	Oct 5, 2026 at 8:00 a.m. Eastern

	Module 14: Algebraic Aspects of Linear Optimization • Lesson 1: Basic Feasible Solution • Lesson 2: Polyhedron in Standard Form • Lesson 3: Basic Feasible Solution in Standard Form LP • Lesson 4: Why We Care So Much About BFS	
Week 7 Homework	Homework 7	Oct 5 at 8: 00 a.m. Eastern – Oct 15 at 11:59 p.m. Peer Assmt: Oct 15 at 11:59 Eastern – Oct 19 at 11:59 Eastern
Week 8	Module 15: Simplex Method in a Nutshell • Lesson 1: Local Search - The General Idea • Lesson 2: Local Search - Specialized to LP • Lesson 3: How to Walk on the Edge • Lesson 4: When to Stop and Declare Victory Module 16: Further Development of Simplex Method • Lesson 1: Summarize Simplex Method • Lesson 2: Handling Degeneracy • Lesson 3: Phase I/Phase II Simplex Method • Lesson 4: An Example	Oct 12, 2026 at 8:00 a.m. Eastern
Week 8 Homework	Homework 8	Oct 12 at 8: 00 a.m. Eastern – Oct 22 at 11:59 p.m. Peer Assmt: Oct 22 at 11:59 Eastern – Oct 26 at 11:59 Eastern

Week 9	Module 17: Linear Programming Duality • Lesson 1: Introduction to Duality Theory • Lesson 2: Lagrangian Relaxation and LP Duality • Lesson 3: Weak Duality and Strong Duality • Lesson 4: Table of Possibles and Impossibles • Lesson 5: Complementary Slackness Module 18: Robust Optimization • Lesson 1: Concept of Robustness • Lesson 2: Concept of Robustness in Example • Lesson 3: Robust Linear Program • Lesson 4: More Examples of Robust	Oct 19, 2026 at 8: 00 a.m. Eastern
Week 9 Homework	Homework 9	Oct 19 at 8: 00 a.m. Eastern – Oct 29 at 11:59 p.m. Peer Assmt: Oct 29 at 11:59 Eastern – Nov 2 at 11:59 Eastern
Week 10	Module 19: Large-Scale Optimization Cutting Stock Problem • Lesson 1: Cutting Stock Problem • Lesson 2: Gilmore-Gomory Formulation • Lesson 3: Column Generation • Lesson 4: Column Generation for Cutting Stock Problem Module 20: Large-Scale Optimization • Lesson 1: Example for Column Generation	Oct 26, 2026 at 8: 00 a.m. Eastern

	• Lesson 2: Primal-Dual Relationship: Constraint Generation • Lesson 3: Primal-Dual Relationship: Pricing Problem and Separation Problem	
Week 10 Homework	Homework 10	Oct 26 at 8: 00 a.m. Eastern – Nov 5 at 11:59 p.m. Peer Assmt: Nov 5 at 11:59 Eastern – Nov 9 at 11:59 Eastern
Midterm 2	Midterm Exam 2	Nov 2, 2026 at 8: 00 a.m. Eastern – Nov 9, 2026 at 11:59 p.m. Eastern
Week 11	Module 21: Large-Scale Optimization Dantzig-Wolfe Decomposition • Lesson 1: Exploiting Special Structures of Large-Scale Optimization • Lesson 2: Dantzig-Wolfe Decomposition 1 • Lesson 3: Dantzig-Wolfe Decomposition 2 • Lesson 4: Dantzig-Wolfe Decomposition 3 • Lesson 5: Example Module 22: Nonlinear Optimization Modeling - Approximation and Fitting • Lesson 1: Linear Equations, Norm, and Least Square • Lesson 2: Function Fitting • Lesson 3: Normal Equation and Singular Value Decomposition • Lesson 4: Image Compression, Constrained Least Squares, and SVD•	Nov 2, 2026 at 8: 00 a.m. Eastern
Week 11 Homework	Homework 11	Nov 2 at 8: 00 a.m. Eastern – Nov 12 at 11:59 p.m. Peer Assmt: Nov 12 at 11:59 Eastern – Nov 16 at 11:59 Eastern
Week 12	Module 23: Convex Conic Programming Introduction	Nov 9, 2026 at 8: 00 a.m. Eastern

	• Lesson 1: Convex Cones, Order, and Linear Conic Programming • Lesson 2: Second-Order Cone and SOCP • Lesson 3: PSD Cone and SDP Module 24: SOCP, SDP Examples • Lesson 1: Statistical Classification Problem • Lesson 2: Experimental Design • Lesson 3: Extremal Ellipsoid Problem	
Week 12 Homework	Homework 12	Nov 9 at 8: 00 a.m. Eastern – Nov 19 at 11:59 p.m. Peer Assmt: Nov 19 at 11:59 Eastern – Nov 23 at 11:59 Eastern
Week 13	Module 25: Discrete Optimization - Introduction • Lesson 1: Why Discrete Variables • Lesson 2: Discrete Optimization Challenges • Lesson 3: Computational Complexity Module 26: Discrete Optimization - Modeling With Binary Variables 1 • Lesson 1: Nonconvex Functions • Lesson 2: Nonconvex Sets and Logical Relations • Lesson 3: Logical Relations	Nov 16, 2026 at 8: 00 a.m. Eastern
Week 13 Homework	Homework 13	Nov 16 at 8: 00 a.m. Eastern – Nov 26 at 11:59 p.m. Peer Assmt: Nov 26 at 11:59 Eastern – Nov 30 at 11:59 Eastern

Week 14	Module 27: Discrete Optimization - Modeling With Binary Variables 2 • Lesson 1: Set Packing, Covering, Partitioning • Lesson 2: Graph and Network Problems Module 28: Discrete Optimization - Modeling Exercises • Lesson 1: Modeling Exercises - 1 • Lesson 2: Modeling Exercises - 2 • Lesson 3: Modeling Exercises - 3	Nov 23, 2026 at 8: 00 a.m. Eastern
Week 14 Homework	Homework 14	Nov 23 at 8: 00 a.m. Eastern – Dec 3 at 11:59 p.m. Peer Assmt: Dec 3 at 11:59 Eastern – Dec 7 at 11:59 Eastern
Week 15	Module 29: Discrete Optimization - Linear Programming Relaxation • Lesson 1: Linear Programming Relaxation • Lesson 2: Ideal Formulations Module 30: Discrete Optimization - Solution Methods • Lesson 1: Enumeration • Lesson 2: Cutting Plane Methods • Lesson 3: Branch-and-Bound Algorithm • Lesson 4: Heuristics	Nov 30, 2026 at 8:00 a.m. Eastern
Week 15 Homework	Homework 15	Nov 30 at 8: 00 a.m. Eastern – **Dec 8 at 11:59 p.m.** Peer Assmt: Dec 8 at 11:59 Eastern – Dec 12 at 11:59 Eastern
Final	Final Exam	Dec 10, 2026 at 8:00 a.m. Eastern – Dec 17, 2026 at 11:59 p.m. Eastern

Course Materials

- All content and course materials can be accessed online
- There is no textbook for this course
- Reference books:
  - R. Rardin. "Optimization in Operations Research", Prentice Hall, 1998.
  - S. Boyd and L. Vandenberghe, "Convex Optimization," Cambridge University Press, 2004. Online: https://web.stanford.edu/~boyd/cvxbook/
  - A. Ben-Tal and A. Nemirovski, "Lectures on Modern Convex Optimization," SIAM, 2001.

Technology/Software Requirements

- Internet connection (DSL, LAN, or cable connection desirable)
- PuLP optimization software (free download; see http://www.coin-or.org/PuLP/ -- Windows version and (for Mac users) a Linux version)
- CVX in Python: CVXOPT, CVXPY software (available at http://cvxopt.org and https://www.cvxpy.org/)
- CVX in MATLAB: CVX software (available at http://cvxr.com/cvx/)
- Python programming language (free download; see http://www.python.org). Preferably use the Anaconda distribution (http://www.anaconda.com)
- Adobe Acrobat PDF reader (free download; see https://get.adobe.com/reader/)