

Fundamentals of Mathematical Programming

ESI 6420 Section 617H

Class Periods: T | Period 7 (1:55 PM - 2:45 PM) & R | Period 7 – 8 (1:55 PM - 3:50 PM)

Location: BLK 0415

Academic Term: Fall 2023

Instructor:

Jorge A. Sefair

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Office Hours: Tuesdays, 3:00-4:30 PM, Weil 401A (Alternative office hours available by appointment)

Course Description

Introducing mathematical programming with an emphasis on classical optimization concepts, models, and solution techniques. Focus on convex analysis (convex sets, separation theorems, convex functions), optimality conditions (Fritz-John Karush-Kuhn-Tucker), Lagrangian duality and iterative solution methods gradient, conjugate gradients barrier methods.

Course Pre-Requisites / Co-Requisites

Prerequisite: Mathematical background, ability to prove mathematical statements and ability to write simple codes with MATLAB or C.

Course Objectives

At the end of the course, students will be able to (1) mathematically prove fundamental results in optimization, (2) recognize and formulate nonlinear optimization problems, (3) identify when a problem is convex, (4) understand classical results characterizing optimal solutions to these problems, (5) use these classical results in application problems and design of algorithms, and (6) use commercial software (e.g., AMPL) to implement optimization models.

Textbook (not required)

- Title: Nonlinear Programming: Theory and Algorithms
- Author: M.S. Bazaraa, H.D. Sherali, and C.M. Shetty
- Publication date and edition: 2006, 3rd edition
- ISBN number: 978-0-471-48600-8

- Instructor notes will be provided for each class.

Software

- AMPL. Unrestricted version available in Canvas (Linux, macOS 64, Windows 32 and 64). Linear and nonlinear state-of-the-art solvers (Baron, Knitro, Cplex, Gurobi).

Recommended Materials

- Title: Convex Optimization
- Author: S. Boyd and L. Vandenberghe
- Publication date and edition: 2004, 1st edition (free online)
- ISBN number: 978-0521833783

- Title: Nonlinear Programming
- Author: D. P. Bertsekas
- Publication date and edition: 2004, 2nd edition (3rd edition available)
- ISBN number: 978-1886529007

- Title: AMPL: A Modeling Language For Mathematical Programming
- Author: R. Fourer, D.M. Gay, and B.W. Kernighan
- Publication date and edition: 2002, 2nd edition (free online)
- URL: <http://ampl.com/resources/the-ampl-book/>
- ISBN number: 978-0534388096

Course Schedule (tentative)

Week 1:	Introduction to optimization, modeling, selected optimization problems.
Week 2:	Types of optimization problems, selected optimization problems in AMPL.
Week 3:	Selected topics in linear algebra: linear, conic, affine, and convex combinations; hulls.
Week 4:	Convex sets: basic definitions, types of sets, norms.
Week 5:	Convex sets: relationships with matrix properties, operations that preserve convexity, linear and affine independence, Caratheodory's theorem.
Week 6:	Convex sets: topological properties of sets, projection, separation, supporting hyperplanes.
Week 7:	Farkas' theorem and related theorems, polyhedral sets, extreme points and directions, Minkowski-Weyl (representation) theorem. (Exam 1, October 3)
Week 8:	Linear programming and duality.
Week 9:	Convex functions: basic definitions, types of functions, epigraph, subgradient.
Week 10:	Convex functions: twice-differentiable functions, positive semidefinite matrices, convex problems.
Week 11:	Convex problems: families, properties, feasible and improving directions.
Week 12:	Optimality conditions: first and second order conditions for unconstrained problems.
Week 13:	Optimality conditions: first and second order conditions for constrained problems, Fritz-John conditions, Karush-Kuhn-Tucker conditions. (Exam 2, November 14)
Week 14:	Constraint qualification, using KKT sufficient and necessary conditions.
Week 15:	Lagrangian duality.
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Attendance Policy, Class Expectations, and Make-Up Policy

Student attendance is encouraged, and active participation is expected. If you anticipate not being able to attend any class due to travel restrictions or personal health concerns, contact me at the beginning of the semester or as soon as your situation changes. If you choose to attend the class in person you must adhere to the university policies on distancing and mask use. Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://gradcatalog.ufl.edu/graduate/regulations/>

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets (3)	100 each	25%
Exam 1	100	25%
Exam 2	100	25%
Final Exam	100	25%
		100%

Grading Policy

Percent	Grade	Grade Points	Percent	Grade	Grade Points	Percent	Grade	Grade Points
93.4 - 100	A	4.00	80.0 - 83.3	B-	2.67	66.7 - 69.9	D+	1.33
90.0 - 93.3	A-	3.67	76.7 - 79.9	C+	2.33	63.4 - 66.6	D	1.00
86.7 - 89.9	B+	3.33	73.4 - 76.6	C	2.00	60.0 - 63.3	D-	0.67
83.4 - 86.6	B	3.00	70.0 - 73.3	C-	1.67	0 - 59.9	E	0.00

More information on UF grading policy may be found at: [UF Graduate Catalog](#) and [Grades and Grading Policies](#)

Students Requiring Accommodations

Accommodation will be made in situations related to religious observances/practices, officially university-sanctioned activities, and missed class due to military line-of-duty activities. Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University’s core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- HWCHE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.