Operations Research 1

ESI 3312 Section 2626
Class Periods: MWF, Period 8 (3:00 pm - 3:50 pm)
Location: FLI 0105
Academic Term: Fall 2023

Instructor:
Name: Yu Yang
Email Address: yu.yang@ise.ufl.edu.
Office Phone Number: (352) 294-7727
Extra Office Hours: By appointment (please email the TA)

Teaching Assistant:
Name: Tan Yu
Email Address: yutan@ufl.edu
Office Hours: MW 4:00 pm to 5:00 pm, Weil Hall 401

Course Description
This is a 3-credit course that serves as an introduction to Operations Research, the study of scientific approaches to decision-making, which seeks to design, improve, and operate complex systems in the best possible way under practical constraints. This course will be focused on linear programming models, algorithms, and optimization software to aid in the analysis and solution of complex, possibly large-scale decision problems.

Course Pre-Requisites / Co-Requisites
Working knowledge of linear algebra (basic matrix algebra, linear independence, solving systems of equations) and basic programming skills in Python.

Course Objectives
In this course, you will learn to solve deterministic decision problems arising from real-world applications. Upon the completion of this course, you should be able to:

1. model real-world decision problems mathematically
2. implement linear optimization models in Python and call Gurobi for solution
3. understand the simplex method theoretically and apply it to solve small-sized linear programs
4. understand and apply the linear programming duality theory
5. perform sensitivity analysis for small changes in the input data
6. understand and apply specialized algorithms to solve network models
7. understand the solution framework for integer programs and apply it to solve small-sized integer programs

These are lofty goals. To be successful in this class, you will need to invest a lot of your time and be ready to carry a lot of work. It will be rewarding because the techniques you will learn can facilitate your understanding of other classes in the IE curriculum and enhance your problem-solving skills significantly.

Materials and Supply Fees
No fees.

Relation to Program Outcomes (ABET):
The table below is an example. Please consult with your department's ABET coordinator when filling this out.

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	Medium
2. An ability to apply engineering design to produce solutions that meet specified needs with	High

consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	
3. An ability to communicate effectively with a range of audiences	
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Medium
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Medium

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

- ***Textbook:*** *Operations Research: Applications and Algorithms, by Wayne L. Winston, 4th Edition, (ISBN-13: 978-0534380588 ISBN-10: 0534380581).*

- ***Software****:* Python and Gurobi.

Recommended Materials

Introduction to Linear Optimization, by Dimitris Bertsimas and John N. Tsitsiklis, Athena Scientific 1997 (ISBN 10: 1886529191, ISBN 13: 9781886529199).

Course Schedule *(Subject to Change)*

Week	Date	Lecture Number	Topic
1	W 8/23	1	Course Introduction
	F 8/25	2	Introduction to Operations Research (Chapter 1)
2	M 8/28	3	Linear Algebra Review (Chapter 2): Concepts and Notation
	W 8/30	4	Linear Algebra Review (Chapter 2): Gauss-Jordan Method + Linear Independence
	F 9/1	5	Linear Algebra Review (Chapter 2): Inverse + Determinant
3	M 9/4		Labor Day – No Class
	W 9/6		Quiz 1
	F 9/8	6	Linear Programming (Chapter 3): Definition + Applications (HW1 Out)
4	M 9/11	7	Linear Models (Chapter 3): Diet Problem + Scheduling Problem
	W 9/13	8	Linear Models (Chapter 3): Budgeting Problem + Financial Planning Problem
	F 9/15	9	Linear Models (Chapter 3): Production Problem + Inventory Problem + Multiperiod Problem
5	M 9/18	10	Modeling Techniques: Absolute Value + Examples
	W 9/20	11	Modelling Techniques: Quiz 2 + Maximin + Minmax + Flow Balance

	F 9/22	12	Numerical Solution of Linear Programs: Graphical Solution (HW1 Due, HW2 Out)
6	M 9/25	13	Numerical Solution of Linear Programs: Graphical Solution
	W 9/27	14	Simplex Method (Chapter 4): Standard Form + BFS
	F 9/29	15	Simplex Method (Chapter 4): Overview + Principle
7	M 10/2	16	Simplex Method (Chapter 4): Quiz 3 + The Simplex Algorithm
	W 10/4	17	Simplex Method (Chapter 4): The Simplex Algorithm Continue (HW2 Due, HW3 Out) Homecoming – No class
	F 10/6		Homecoming – No class
8	M 10/9	18	Simp Simplex Method (Chapter 4): Practice examples
	W 10/11	19	Simplex Method (Chapter 4): Practice examples
	F 10/13	20	Simplex Method (Chapter 4): Degeneracy + Bland's Rule
9	M 10/16		Quiz 4 + Midterm Review
	W 10/18		Midterm
	F 10/20	21	Numerical Solution of Linear Programs: Basic Python + Gurobi Installation
10	M 10/23	22	Numerical Solution of Linear Programs: Basic Gurobi
	W 10/25	23	Numerical Solution of Linear Programs: Coding LP Models
	F 10/27	24	Numerical Solution of Linear Programs: Solving LPs by Gurobi (HW3 Due, HW4 Out)
11	M 10/30	25	Sensitivity Analysis (Chapter 5): Qualitative Analysis
	W 11/1	26	Duality (Chapter 6): Dual Interpretation + Shadow Price
	F 11/3	27	Duality (Chapter 6): Quiz 5 + Finding the Dual
12	M 11/6	28	Duality (Chapter 6): Weak + Strong Duality
	W 11/8	29	Network Models (Chapters 7): Transportation + Assignment Problem (HW4 Due, HW5 Out)
	F 11/10		Veterans Day – No Class
13	M 11/13	30	Network Models (Chapters 8): Shortest Path Problem
	W 11/15	31	Network Models (Chapters 8): Bellman Ford's + Dijkstra Algorithm
	F 11/17	32	Network Models (Chapters 8): Maximum Flow
14	M 11/20	33	Integer Programming (Chapter 9): Fixed Charges + Knapsack
	W F		Thanksgiving – No class
15	M 11/27	34	Integer Programming (Chapter 9): Quiz 6 + Set Packing/Covering/Partitioning + Assignment + TSP (HW5 Due, HW6 Out)
	W 11/29	35	Integer Programming (Chapter 9): Either Or + If Then
	F 12/1	36	Integer Programming (Chapter 9): And + Or + Xor
16	M 12/4	37	Integer Programming (Chapter 9): Branch and Bound + Examples
	W 12/6	38	Final Review (HW6 Due)
17	M 12/11		Final (10am – 12pm)

Attendance: Requirements for class attendance are consistent with university policies that can be found at: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Class Expectations: To ensure a classroom environment conducive to success for everyone, please turn off cell phones before class starts. Please make an effort to arrive at class on time. If you must enter the classroom late, be considerate and be as quiet as possible. Refrain from leaving early. If you need to do so, be as quiet as possible.

Examples of a positive contribution to the class include asking questions that clarify any confusion you might be experiencing, constructively challenging the assumptions of a model, communicating your opinion about an open problem or sharing your personal experience.

Homework: You are allowed to discuss problems with other students in the class, and you may refer to online resources, but you cannot share complete answers with each other. If you use any external resources (ideas from classmates, the internet, etc.), you must properly mention them at the start of your solution to each problem. You will **NOT** lose any points for telling the truth.

Late Assignment Policy: All homework assignments should be submitted in class before 3:50 pm on the due day. Late submissions will be deducted 10% for each additional day (submissions later than 3:50 pm on the same day will also be counted as late for one day, and there will be a 10% deduction).

Make-Up Policy: Make-up exams and quizzes will be given only in case of UF-imposed curriculum requirement, religious holiday, jury duty, or a family/medical emergency. You must communicate with me as early as possible about the problem. The quiz and homework assignments with the lowest score will be dropped. That is, the 5 highest quiz and homework scores will be included in the student's overall grade.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets (5 highest)	100 each	25%
Quizzes (5 highest)	100 each	20%
Midterm Exam	100	30%
Final Exam	100	30%
Bonus		5%
Total		110%

Grading Policy *(Subject to Change)*

Percent	Grade	Grade Points
92.0 - 100	A	4.00
90.0 - 91.9	A-	3.67
86.0 - 89.9	B+	3.33
82.0 - 85.9	B	3.00
78.0 - 81.9	B-	2.67
74.0 - 77.9	C+	2.33
71.0 - 73.9	C	2.00
68.0 - 70.9	C-	1.67
65.0 - 67.9	D+	1.33
62.0 - 64.9	D	1.00
60.0 - 61.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Students Requiring Accommodations

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
• HWCOE 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 suppor*t*, 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*.