

Operations Research 1

ESI 3312 (Section 1275)

Class Periods: MWF, Period 7 (1:55 PM - 2:45 PM)

Location: CSE E121

Academic Term: Spring 2024

Instructor:

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Office Hours: Monday 3:00-4:30 PM (by appointment)

Graders:

Name: TBD

Email Address: [TBD](#)

Office Hours: TBD

Course Description

Introduces deterministic optimization modeling, algorithms, and software to aid in the analysis and solution of decision-making problems. In this introductory course on deterministic Operations Research (OR), we will formulate mathematical models and develop solution methods for decision making. We will study how to obtain the best decisions to improve real-life problem situations, according to well-defined objectives. Although many problem classes will be studied, the course will mainly focus on problems that can be modeled as linear programming models. Formally, a linear programming model is either a minimization or maximization of a linear function of several variables constrained by linear inequalities. We will study applications in a variety of domains, including transportation, health care, and logistics. The theoretical foundation will include the Simplex algorithm, theorems of duality, sensitivity analysis, network flows, and basic integer programming.

Course Pre-Requisites / Co-Requisites

ESI 3327C with minimum grade of C. Knowledge of linear algebra (matrix algebra, linear independence, solution of systems of equations) and basic programming skills (any language).

Course Objectives

At the end of this course, students are expected to be able to: (1) identify situations where optimization can improve the decision-making process, (2) mathematically formulate optimization problems, (3) implement and solve optimization problems using commercial software, and (4) analyze, interpret, and communicate the output of an optimization problem to professionals in other disciplines.

Materials and Supply Fees

No fees.

Relation to Program Outcomes (ABET):

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 consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	High
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
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Medium

Required Textbooks and Software

- **Textbook (not required):** Optimization in Operations Research by Ronald Rardin. Pearson (ISBN#: 0134384555) (1st or 2nd edition).
- **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

- AMPL: A Modeling Language For Mathematical Programming, 2nd ed. 2002. R. Fourer, D.M. Gay, and B.W. Kernighan. Cengage Learning. URL: <http://ampl.com/resources/the-ampl-book/>
- Linear programming and network flows, 4th ed. 2010. M.S. Bazaraa, J.J. Jarvis, and H.D. Sherali. John Wiley & Sons.

Course Schedule (Subject to Change)

Week 1:	Introduction to the course, impact of OR, selected applications, in-class activity. Introduction to optimization modeling.
Week 2:	Basic definitions and classification of optimization problems. Large-scale formulations, canonical and standard forms.
Week 3:	Common modeling structures: types of constraints, objective functions, and decision variables. Modeling practice (with AMPL).
Week 4:	Graphical solution method. Basic concepts in optimization, global and local optima, improving search paradigm.
Week 5:	Linear algebra concepts (matrix/vector multiplication, inverse, determinant, systems of linear equations). Assumptions of linear programming, slack variable, binding constraint, polyhedron, extreme point, direction of a set, extreme directions, recession cone.
Week 6:	Geometry of linear programming, basis, basic solution, basic and non-basic variables, moving along extreme points.
Week 7:	Simplex method: Basic feasible initial solution, reduced costs, optimality test.
Week 8:	Simplex method: Direction of movement, minimum ratio test, pivoting.
Week 9:	Exam 1 (March 4) Simplex method in tabular form. Simplex method: Initialization.
Week 10:	Spring Break
Week 11:	Motivation, dual and primal problems, dual interpretation. Duality theorems, primal-dual relationship.
Week 12:	Sensitivity analysis, changes in right-hand-side, objective function. Change in objective function coefficients and right-hand side, adding/removing a variable, adding/removing a constraint.
Week 13:	Introduction to network optimization, notation, definitions, selected applications, minimum cost flow problem. Shortest path problems.
Week 14:	Exam 2 (April 8) . Maximum flow, transportation, and assignment problems. Applications. Specialized algorithms (Dijkstra's algorithm, Bellman-Ford algorithm).
Week 15:	Introduction to integer programming. Motivation, modeling structures, applications, modeling practice.
Week 16:	Branch-and-bound.
-----	Final Exam (May 1, 10:00 AM - 12:00 PM)

Attendance: 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. 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 and avoid using your computer during the lecture for matters that are unrelated to the class content. Please 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.

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/>.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework (x 5)	100 each	25%
Exam 1	100	25%
Exam 2	100	25%
Final Exam	100	25%
Total		100%

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>

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 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>.