Operation Research 1
ESI 3312
Class Periods: Tuesday and Thursday, Period 10 - 11 (5:10 PM - 7:05 PM)
Location: FLG 0280
Academic Term: Spring 2020

Instructor:
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Teaching Assistants:
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Office Hours: TBD

Our goal in this class is to give you the best possible learning experience about Operations Research. We want you to feel free to come consult us when you have problems with the material or concern about practical aspects of the class. However, given the large number of students in the class, it is not possible for us to allow students to stop by our offices at any time in an unstructured fashion. You can receive help in one of the following ways:

During class: The best moment to ask a question about something you do not understand is probably during the class. If you experience a problem, it is likely that other students experience the same problem too. However, if you do not feel comfortable asking questions in front of other students, you should consider one of the following three options.

Office hours: The instructor and the TA will have office hours throughout the week. You can stop by anytime during these hours.

E-mail: Very often, the questions you have are brief and do not require very long answers. If this is the case, you can send your questions by E-mail (**copy both instructor and TA**), clearly mentioning in the header that it is a question regarding ESI4312.

Appointments: If it is not possible for you to come to office hours, you can schedule an appointment with the instructor or the TA. These appointments have to be arranged by E-mail (**copy both instructor and TA**). Include in your E-mail a list of time slots throughout the week that are convenient for you. The more flexible the time slots you give, the quicker you will receive help. If you do not have a preference for who will help you, I suggest you send a single request E-mail to both instructor and TA. Please be aware that we will not make an appointment outside of regular work days/hours.

You should take advantage of these four options fully. They should give you enough flexibility to get help when you need it. Please do not stop by the instructor's or the TA's office unannounced. Also, you should not call the instructor or the TA at home. We will not answer any questions (even short) in such situation.

Finally when you come to office hours or to an appointment, you should come prepared. You should have a list of specific problems you would like the instructor or the TA to answer. Be ready to ask your questions instead of trying to locate them in the book or lecture note. You should never approach a TA with "I do not understand anything". Make sure to find out first what you do not understand before you come to see the instructor or the TA.

Course Description
Introduces optimization modeling, algorithms, and software to aid in the analysis and solution of decision-making problems.

Course Pre-Requisites / Co-Requisites
Matrix and Numerical Methods (ESI 4327C) is a prerequisite for Operations Research 1. To be successful in this class, you need to have a knowledge of basic programming techniques, linear algebra (linear independence, solving systems of equations, basic matrix algebra) and a working knowledge of differential calculus.

Professional Component (ABET):
This course contributes to ensuring that the following program educational objectives of our BSISE program are met:
Within 5 years of graduation, BSISE graduates…
Are successful professionals using industrial and systems engineering skills;
Acquire advanced knowledge through continuing education or advanced degree programs;
Are active leaders in their profession and/or community.

Relation to Program Outcomes (ABET):

Outcome	Coverage[*]
1. Identify, formulate, and solve engineering problems	High
2. Apply engineering design … consideration of public health, safety, and welfare as well as global, cultural, social, environmental, and economic factors	
3. Communicate effectively with a range of audiences	
4. Recognize ethical and professional responsibilities … impact of engineering solutions in global, economic, environmental, and societal contexts	
5. Function effectively on a team … provide leadership, create a collaborative and inclusive environment …	
6. Develop and conduct appropriate experimentation, analyze, and interpret data …	
7. Ability to acquire and apply new knowledge as needed …	

[*]Coverage is given as high, medium, or low. An empty box indicates that this outcome is not part of the course.

Course Objectives
The two Operations Research courses in ISE seek to introduce students to models commonly used in the analysis of complex decision-making problems. In OR1, we will learn how a variety of deterministic models in Operations Research can be used and applied to solve practical problems. Stochastic models are covered in OR2. Specifically, upon completion of this course (OR1), you will be able to:
1. Formulate a real-world problem as a mathematical programming model
2. Implement and solve the model in GAMS
3. Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand
4. Understand the relationship between a linear program and its dual, including strong duality and complementary slackness
5. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal

solution as the data change
6. Solve specialized linear programming problems like the transportation and assignment problems
7. Solve network models like the shortest path, and maximum flow problems
8. Understand the applications of, basic methods for, and challenges in integer programming

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 is important that you do so as the techniques you will learn here are essential to understand many other classes in the IE curriculum.

Materials and Supply Fees
No fees.

Required Textbooks and Software
Textbook: Ronald L. Rardin, Optimization in Operations Research, Second edition, Prentice-Hall 1998 (ISBN: 0023984155)

Software: GAMS is an algebraic modeling language that we will use for the class. A student demo version of GAMS can be downloaded directly from the GAMS website at http://www.gams.com/download/. Although this version handles only small-size problems, it will be sufficient for the models we study in this class.

The textbook is not considered only as a reference for what is taught in class but also as a complement for the material presented in class. In particular, topics will be taught in class that are not covered in the book and you will be asked to read sections of the book that supplement the material covered in class.

Recommended Materials
Paul A. Jensen and Jonathan F. Bard, Operations Research - Models and Methods, Wiley 2003. (ISBN: 0471428965)

Online Resources
Most of the material for this class will be available on E-learning. It is therefore crucial that you know how to efficiently use E-learning.

Using E-learning: Most of the relevant class material will be found in the Resources folder. In particular, there are 5 categories in this folder. Most of them are self-explanatory.
1. **GAMS**: Examples of GAMS codes for the models presented in class.
2. **General Info**: Contains the syllabus for this class.
3. **Homework**: Contains the statements, and solutions to the homework assignments.
4. **Exams**: Contains information relative to the quizzes, the midterms and the final. This includes the rules that will be enforced during the exams as well as the material that will be tested.

There are also three tools that you will find handy to use.
1. **Announcements**: Will contain time-sensitive important reminders or clarifications about the class.
2. **Mail**: Allows you to send e-mail to the instructor/TA and/or to other students of the class. It is very easy to use, and it is the preferred way to communicate with the instructor (please remember to always cc our regular e-mail addresses).
3. **Grades**: Contains the grades you obtained for the class so far. If you observe a discrepancy between the grade you got on paper and the grade given in E-learning, you should directly contact the TA. Also contact the TA if you have no grade on E-learning for an assignment that was returned to you.

Class communication: All communications relative to the course will be made on E-learning. When possible, these announcements will be reiterated in class. Students are therefore responsible to check E-learning regularly for possible updates.

Course Schedule

Week	Date	Topic	Deliverables
Week 1	Tuesday, Jan 7th	Class logistics, Introduction to Operation Research	Ch 1
	Thursday, Jan 9th	Introduction to Modeling with Linear Programming	
Week 2	Tuesday, Jan 14th	Graphical Solution of Linear Programming	Ch 2, Quiz 1
	Thursday, Jan 16th	Graphical Solution of Linear Programming	Ch2, HW 1
Week 3	Tuesday, Jan 21st	Mathematical Modeling	Ch 3
	Thursday, Jan 23rd	Mathematical Modeling	Ch 3
Week 4	Tuesday, Jan 28th	Mathematical Modeling	Ch 4, Quiz 2
	Thursday, Jan 30th	Mathematical Modeling	Ch 4
Week 5	Tuesday, Feb. 4th	Mathematical Modeling	Ch 4
	Thursday, Feb. 6th	Mathematical Modeling	Ch 4, HW2
Week 6	**Tuesday, Feb. 11th**	**Review Session**	
	Thursday, Feb. 13th	**Exam 1: Ch1-4**	**Cumulative**
Week 7	Tuesday, Feb. 18th	Simplex Method	Ch 5
	Thursday, Feb. 20th	Simplex Method	Ch 5, Quiz 3
Week 8	Tuesday, Feb. 25th	Simplex Method	Ch 5
	Thursday, Feb. 27th	Simplex Method	Ch 5
Week 9	Tuesday, March 3rd	No Class- Spring Break	
	Thursday, March 5th	No Class- Spring Break	
Week 10	Tuesday, March 10th	Simplex Method	Ch 5
	Thursday, March 12th	Simplex Method	Ch 5, HW3
Week 11	Tuesday, March 17th	Duality Theory and Sensitivity Analysis	Ch 6
	Thursday, March 19th	Duality Theory and Sensitivity Analysis	Ch 6
Week 12	Tuesday, March 24th	Duality Theory and Sensitivity Analysis	Ch 6, Quiz 4
	Thursday, March 26th	Duality Theory and Sensitivity Analysis	Ch 6,
Week 13	Tuesday, March 31rd	Duality Theory and Sensitivity Analysis	Ch 6, HW 4
	Thursday, April 2nd	**Review Session**	
Week 14	**Tuesday, April 7th**	**Exam 2: Ch 1-6**	**Cumulative**
	Thursday, April 9th	Introduction to Network Problem	
Week 15	Tuesday, April 14th	Introduction to Network Problem	Quiz 5
	Thursday, April 16th	Introduction to Integer Programming	
Week 16	**Tuesday, April 21st**	**Review Session**	
	Final Exam	**Cumulative**	**Cumulative**

Attendance Policy, and Class Expectations:
I will make every effort to maintain an atmosphere in the class that is conducive to learning.
<u>Noise</u>: To ensure a classroom environment conducive to success for everyone, please turn off cell phones before class starts. I will not tolerate talking during the class. Repeating offenders will be asked to leave the classroom.
<u>Disruptions</u>: Please make an effort to arrive to 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. I will not tolerate students sleeping in the class, being disruptive or working on something different from the class.

Participation: Although you will not receive credit for it, participation in class is highly recommended. It will make the learning experience better and more enjoyable for everybody. 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. Examples of a negative contribution to the class include trying to slow down the class with irrelevant questions or making other students feel "stupid".

Individuals whose behavior is detrimental to a good class atmosphere will be notified. Persistent disruptive behavior will result in grade deductions.

Make-Up Policy:

Make-up exams will only be given under two circumstances.

1. The first is if you are involved in an official school trip (needs to be documented) at the time the exam is scheduled.
2. The second is that you have another exam scheduled at this time. In both of these cases students should contact the instructor at least 2 weeks prior to the exam so that an alternate exam schedule can be found.

Make-up exams will typically take place before the regular exam is given and will be different.

Students missing exams for unpredictable family or medical reasons (provided they are valid and documented), you will need to contact the instructor to evaluate whether you should pursue the class further or receive an incomplete. If you miss an exam for any invalid reason or if you do not provide satisfactory supporting documentation for the valid reason you invoke, you will receive an E.

Excused absences are consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

Evaluation of Grades

Assignment	Percentage of Final Grade
Homework Sets (5)	20%
Quizzes (5)	10%
Exam 1	20%
Exam 2	20%
Final Exam	30%
	100%

Your performance in these five evaluation categories will primarily determine your grade in the class. Note that the only adjustments to these marks will come from possible grade deductions for disruptive behavior. I do not hand out extra projects/homework to help students that do poorly on the tests boost their grades. Such projects/homework are unfair to the rest of the class. Do not ask.

Homework:

- Five Homework will be given during the course of the semester.
- It will be assigned one week before its due date.
- You will receive solutions to all homework.
- There will be no make-ups or extended deadline for them.

- The lowest homework grade will be dropped.
- Homework will test all material covered since the homework. Questions will cover all aspects of the class: they might, for instance, ask you to show that you understand theoretical derivations given in class, that you can build simple models, that you understand solution concepts, that you can model with GAMS. The submission will consist of GAMS files, if applicable, and a Word document with your answers. You will submit your files online through Canvas unless otherwise specified.
- Any submissions after the due dates will not be accepted.

Quizzes:

- Five quizzes will be given during the course of the semester to test concepts that thought in the previous class or week (except for first and last quiz which will be about general information of the course).
- The quizzes will be online.
- Quizzes will typically be 15 minutes long.
- It will be assigned one class in advance.
- There will be **no make-up** quizzes!

Exam:

- There will be two exams and a final exam.
- The exams will be held during regular class hours.
- The exams will be confirmed one week in advance (the date were mentioned in the chart is "tentative").
- You will typically need all the time you have to complete your test so be there on time. The exam will start and finish exactly on time.
- Nobody will be allowed in the exam room to start his/her test after the first student to return his copy has left the exam room (for obvious cheating possibilities). For this reason, I require that every student stay in the exam room at least 15 minutes, even if he/she cannot answer any of the questions.
- Graded exams (answer sheets) should be returned (for review only) to you within a week of the exam date.
- Exams questions might contain GAMS questions that will verify that you know how to write codes that respect the syntax of the GAMS modeling language, modeling problems that will verify that you can convert world problems into quantitative models, solution methodologies problems that will verify that you know the theoretical class material well, and common sense/analysis problems that verify how well you can make sense of solutions you get from models. There might also be hard bonus problems that you should not try unless you are finished with the rest of the exam. The final will be cumulative, although most of the questions will be drawn from the latter part of the class.
- You are allowed to bring a one-page (US letter size) one-sided hand written formula sheet.
- You are not allowed to use your textbooks or any published material during the exam.
- You are not allowed to use notes or calculators neither.
- You are not allowed to use portable CD players, cell phones, PDAs, etc. during the exam.
- You will be asked to show your UF ID.

Grading Policy

You will receive numerical grades for your quizzes and exams. The final grade will be determined primarily by your overall score, as specified in the table below. The break between "C" and "C-" will be set at 70% of the total score. Letter grades will be monotonic in the total course scores. Your grade will be solely based

on your performance in the course and not on outside factors such as your wish to graduate this semester or the possibility of losing a scholarship.

A "C-" will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (\C" or better). Note: a "C-" average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit: https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

The following is given as an example only.

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 77.9	C+	2.33
72.0 – 74.9	**C**	**2.00**
69.0 - 71.9	**C-**	**1.67**
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

All of your papers will be graded according to a scheme that is pre-determined by the instructor. You have the right to request a re-grade of any of your papers. However, you should be aware that there is a procedure and a timeline for re-grades to be considered. For any re-grading of HWs and Quizzes, you should email TA and instructor (within one week)and explain why you claim the re-grading should be done. For exams, you should personally meet instructor in office hours (within one week) and discuss the detail of your claim.

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 feedback on the quality of instruction in this course by completing online evaluations at https://gatorevals.aa.ufl.edu/. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://gatorevals.aa.ufl.edu/.

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://www.dso.ufl.edu/sccr/process/student-conduct-honor-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.

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: http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Campus Resources:

Health and Wellness

> **U Matter, We Care:**
> If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.
>
> **Counseling and Wellness Center:** http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.
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> **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 Resource Center**, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.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://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.
>
> **On-Line Students Complaints***:* http://www.distance.ufl.edu/student-complaint-process.