Operations Research 1

ESI4312 - Section 2613

Class Periods: Tuesday and Thursday, 3-4, 9:35am - 11:30am
Location: FAB 0105
Academic Term : Spring 2018

Instructor:

Jean-Philippe P. Richard
richard@ise.ufl.edu
352-294-7713
http://www.ise.ufl.edu/richard/
Office hours: Tuesdays 4:00-5:00pm, Thursdays 4:00-5:00pm, Weil 372

Teaching Assistants:

Bijan Taslimi
(Please use E-learning e-mail)
Office hours: Wednesdays 4:00-5:00pm, Fridays 4:30-6:00pm, Weil 450

Course Description:

- *Catalog description:* Credits 4; Introduction to the use of linear decision models, particularly linear programming and related decision analysis optimization software, to aid in the analysis and solution of complex, large-scale decision problems. Consideration of related network modeling concepts.
- *Layman's description:* Operations Research (also called Management Science) is the study of scientific approaches to decision-making. Through mathematical modeling, it seeks to design, improve and operate complex systems in the best possible way. The mathematical tools used for the solution of such models are either deterministic or stochastic, depending on the nature of the system modeled. In this class, we focus on deterministic models and methods in Operations Research. Stochastic models and methods are described in ESI4313. In this class, you will learn very powerful modeling and solution techniques for decision-making problems that are used today by many successful companies to help them save/earn millions of dollars.

Course Pre-Requisites/Co-Requisites:

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, eigenvalues and eigenvectors) and a working knowledge of differential calculus. In particular, passing the class ESI 4327C "Matrix and Numerical Methods in Systems Engineering" with minimum grade of C is a formal pre-requisite for this 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, we will study nonlinear, linear, integer and network flow optimization problems, that have applications in engineering, production, design, and management. We will emphasize that models are based on assumptions that should be sometimes accepted, sometimes rejected but always carefully thought about. We will also learn how to formulate practical problems into mathematical models, and learn how to use software to solve them in a reasonable amount of time. We will learn about the fundamental mathematical principles on which solution methods are built. We will become familiar with

how to analyze the results of a model, interpret them, and present the insights obtained from their analysis.

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.

ABET:

a. Relation to Program Educational Objectives (PEOs):
This course contributes to ensuring that the following PEOs of our BSISE program are met:

- Will be successful professionals in industrial and systems engineering or other disciplines.
- Can acquire advanced knowledge through continuing education or advanced degree programs.

b. Relation to program outcomes (ABET):

	Outcome	Coverage
a.	Apply knowledge	High
b1.	Conduct experiments	
b2.	Analyze and interpret data	
c.	Design	
d.	Function on teams	
e.	Solve problems	High
f.	Professional and ethical responsibility	
g.	Communicate	
h1.	Economic impact	
h2.	Global, societal, and environmental impact	
i.	Lifelong learning	
j.	Contemporary issues	
k.	Techniques, skills, and tools for degree program	High

Materials and Supply Fees:

NA.

Required Textbooks and Software:

- *Notes:* Lecture slides are available online.
- *Textbook:* Ronald L. Rardin, *Optimization in Operations Research*, First edition, Prentice-Hall 1998 (ISBN-10: 0023984155); or Ronald L. Rardin, *Optimization in Operations Research*, Second edition, Pearson 2016 (ISBN-10:0134384555).
  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.
- *Software:* GAMS.
  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.

Recommended Materials:

- *Textbook:* Paul A. Jensen and Jonathan F. Bard, *Operations Research - Models and Methods*, Wiley 2003.

Online resources:

Virtually all of the material for this class will be available on e-learning. To access e-learning, type in your web browser the address `http://elearning.ufl.edu/`, click on the "log in to e-learning" icon, enter your UF log-in and passwords to access the site, and Select the class "ESI4312 - Operations Research I - Spring 2018". If you cannot login, please send me an email at `richard@ise.ufl.edu`. Most of the relevant class material will be found in the `Files` folder. In particular, there are the following categories in this folder: *Administrative info* (contains the syllabus for this course); *Case study* (contains statement and group compositions); *GAMS* (contains GAMS models for the problems presented in class); *Midterms & final* (contains information relative to the midterm and final exams including rules, material tested, and samples from previous years). *Problem sets* (contains sample problems and solutions); *Slides* (contains the slides that are used for every one of the classes); There are also tools that you will find handy to use: *Mail* (e-mail system for the class participants - it is very easy to use and it is the preferred way to communicate with the instructor); *Gradebook* (contains the grades you obtained for the class so far). 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:

A tentative list of topics for the class is given next.

Week 1:	Chapter 1: Introduction to OR, OR approach to decision making, OR success stories. Chapter 2: Introduction to modeling.
Week 2:	Chapter 2: Mathematical models and examples, GAMS, algebraic modeling.
Week 3:	Chapter 2: Model types, Chapter 3: Graphical approach, outcomes of models, improving search algorithm.
Week 4:	Chapter 3: Improving search algorithms, local and global optima, Phase-I models, tractability, convexity.
Week 5:	Chapter 3: Convex sets, functions, alternative definitions, convex programs and properties, Divide-and-conquer.
Week 6:	Chapter 4: NLP models, calculus review, algebra review, Optimality conditions (necessary/sufficient) for unconstrained problems.
Week 7:	Chapter 4: Feasible and improving directions, geometry and algebraic conditions, Iterative algorithms, Fundamental optimality principle.
Week 8:	Chapter 4: KKT conditions and applications.
Week 9:	Chapter 5: LP models, graphical solution, polytopes, extreme points and rays, LP standard form, basic solutions, degeneracy, geometry of simplex.
Week 10:	Chapter 5: Simplex algorithm, phase-I, matrix form, convergence.
Week 11:	Chapter 5: Primal and dual bounds, LP duality, senstivity and post-optimal analysis.
Week 12:	Chapter 6: Network models, LP formulation, unimodularity, flow decomposition.
Week 13:	Chapter 6: Shortest path, Dijkstra's algorithm, maximum flow, Ford-Fulkerson's algorithm. Max-flow/Min-Cut theorem.
Week 14:	Chapter 7: IP models, total/implicit enumeration, LP relaxations, rounding.
Week 15:	Chapter 7: Branch-and-bound.

Attendance Policy, Class Expectations, and Make-Up Policy:

On-time attendance to the class is mandatory. Sign-in sheets will be distributed during class to verify your attendance (starting the second week of the semester). You will receive attendance bonus points if your attendance exceeds 90% over the whole semester and you will receive attendance malus points if your attendance is below 70% over the whole semester. Your grade will be unaffected if your attendance is between 70% and 90%. To ensure a classroom environment conducive to success for everyone, please turn off cell phones before class starts. 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. Individuals whose behavior is detrimental to a good class atmosphere will be notified. Persistent disruptive behavior will result in grade deductions.

In the event a student is unable to attend a midterm or the final exam because of a valid reason (UF-imposed curriculum requirement or activity, religious holiday, or jury duty), a make-up exam will be organized. Students should contact the instructor ahead of 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 should notify the instructor ahead of the exam. They will receive as a grade for the midterm they missed a rank-adjusted weighted combination of the scores they obtained from the other midterm and the final. Students missing more than one test because of extreme family or medical reasons (needs to be documented) will need to contact the instructor. Incomplete grades will only be considered for students who completed a majority of the class and were in good standing ahead of the final exam. Students missing an exam without giving advance notice to the instructor, or without providing a valid (documented) reason, will receive a grade of F for this exam.

Make-up will not be given for the case study.

Evaluation of Grades:

Class grades will be based on: case study grade (10%), midterms grades (30% each), and final exam grade (30%).

- *Case study:* A case study will be performed during the course of the semester. This case study will be performed in groups of approximately 4 students. Those groups will be decided by the instructor. The result of this study will be a report containing a technical analysis supported by mathematical models. It should however be accessible to decision makers without mathematical background. It will be graded for accuracy, insights and presentation. There will also be a peer-evaluation within each group.
- *Practice problems:* Practice problems will be assigned regularly. These problems do not have to be turned in, and will not be graded. Solutions will be provided.
- *Midterms:* Students are required to take two in-class midterm exams. The first midterm will be held Tuesday February 20^{th} 2018, 9:35-11:30am in the regular classroom at the traditional class time. The second midterm will be held Thursday March 29^{th} 2018, 9:35-11:30am in the regular classroom at the traditional class time. Students will typically need all the time you have to complete your test so be there on time. Exams 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. The midterms will only cover the parts of the material covered since the last midterm. Midterm 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.
- *Final:* Students are required to take a final exam. This exam will be held at the date and time set by the registrar (Thursday May 3^{rd} 2018, 10:00am-noon) and will take place in the regular classroom. The goal is to test the general knowledge and understanding of the class material. The final is cumulative, although most of the questions will be drawn from the latter part of the class.

Your performance in these three evaluation categories will primarily determine your grade in the class. The only adjustments to these marks will come from possible grade deductions for disruptive behavior and/or attendance bonuses/deduction. 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.

Grades will only be available on the e-learning site. For reasons regarding privacy protection, grades are not communicated by phone and/or e-mail. Furthermore, grades posted on e-learning are those recorded for

you. Therefore, if you note any discrepancy between the grade of one of your papers and the grade posted on e-learning or if one of your grades is missing from e-learning, you should let the TA know. Ideally, re-grades should be requested when the reasons for such re-grades are obvious (the sums of the marks you got on every part do not add up to the total you received, etc.). Be aware that if the grader misunderstood your answer during the first grading, it is probably that it was not clear. Explaining what you meant afterwards will not earn you additional credit. You can ask for a re-grade every time you feel it is appropriate. You should submit in writing the reason you believe such re-grade is appropriate. Re-grade requests should be directed to the instructor. No re-grade will take place on the spot nor will be considered face-to-face. The instructor and TA keep the prerogative of deciding of a complete re-grade of the paper when you request the re-grade of any of its parts. Finally, be aware that tests are photocopied and kept to verify if any alteration was made between the return of a paper and the request for a re-grade. Every re-grade request should be entered within one week of the time at which the graded paper is returned to the class (if you intentionally miss three weeks of class and note later that you wanted a re-grade, it will be too late). This clause is to ensure that all grades are given when the grading scale used by the grader is still fresh in his/her mind.

If you conduct any dishonest act (*e.g.*, cheating on an exam, bringing in extra material not allowed during the exams, or copying someone else's homework), you will get an F on that assignment/exam. Further action is possible depending on the severity of cheating; see University Honesty Policy below.

Grading Policy:

You will receive numerical grades for your case study and exams. Your course grade will be determined primarily by the curve. The break between "B" and "B-" will be approximately set at the average of total scores of students with a score of 50% or more. The break between "C" and "C-" will be set at 50% 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`.

Students Requiring Accommodations:

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565), `https://www.dso.ufl.edu/drc`) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure 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://evaluations.ufl.edu/evals`. 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://evaluations.ufl.edu/results/`.

Teaching Improvement:

We are interested in being the best instructors possible. In particular, we would like to know of the problems you face during the semester as soon as they occur. It is a waste for us to learn at the end of the semester that we were not speaking sufficiently loud to be heard, that our handwriting was not readable, that nobody understood the pictures that were drawn on the board or that the software used for the class was very difficult to use. We want you to feel free to make suggestions to improve the content of the class, its exposition and our instructing skills. You can address these suggestions directly to us (in a polite manner) or anonymously by leaving comments in the instructor mailbox. We will consider carefully all these suggestions and if necessary, we will address them in class.

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.

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 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.