ESI 4312 - Operations Research 1
Syllabus

Z. Melis Teksan
Spring 2015

Course description:

Catalog description: 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.

Pre-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, "*Calculus 1-3*", "*C++ computer programming*" and "*matrix and numerical methods*" provide an adequate background for the class.

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.

Teaching staff & office hours:

Instructor:	Teaching Assistant:
Z. Melis Teksan **Office**: Weil 450 **Office Hours:** Monday - Wednesday 10:00am - 12:00pm **E-mail**: zmteksan@ufl.edu	Ioannis P. Pappas **Office**: Weil 202 **Office Hours:** Tuesday - Thursday 1:00pm - 3:00pm **E-mail**: ioannis.p.pappas@ufl.edu

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 and chaotic 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 100 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. 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. In particular, students should not come to an appointment grazing to their books in search of a question. They should not come neither with only the statement that "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.

Meeting times & location:

The class meets T-R (Tuesday & Thursday) during period(s) 4-5 (10:40am - 12:35pm) in FLG 220, except

- Tuesday March 3rd 2015 (Spring break)
- Thursday March 5th 2015 (Spring break)

Midterm exams are scheduled on

- Tuesday February 24th 2015, 8:20-10:10pm.
- Thursday March 26th 2015, 8:20-10:10pm.

The final exam is scheduled on

- Friday May 1st 2015, 12:30pm-2:30pm.

Required textbook and software:

Textbook: Ronald L. Rardin, *Optimization in Operations Research*, Prentice-Hall 1998.

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 reading:

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

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.

Accessing E-learning: Follow the instructions given below:

1. Type in your web browser the address `https://lss.at.ufl.edu/`.
2. Click on the picture "E-learning Entry System".
3. Type your UF log-in and passwords to access the site.
4. Select the class "ESI4312 - Operations Research I - Spring 2015".

If you cannot connect to E-learning: Send an E-mail to the instructor (zmteksan@ufl.edu). This E-mail should be sent from your UF E-mail account.

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. **Midterms & Final:** Contains information relative to the two midterms and the final. This includes the rules that will be enforced during the exams as well as the material that will be tested.
5. **Lectures:** Contains the slides that are used for every one of the classes. These slides will typically be available to you before the class.

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. **Gradebook:** 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 Outline:

A tentative list of topics for the class is given next. This list might be shortened or lengthened depending on the pace of the class.

Chapter 1: About OR1 and Operations Research
Class logistics (homework, midterms, grades & expectations) - Definition of OR - History of OR - OR approach to decision making.

Chapter 2: Optimization models - an introduction
Methodology for modeling real-life problems into mathematical programs - Examples and applications - Linear, Integer, Network, and Nonlinear Programs - Algebraic modeling - Algebraic modeling software - Optimization software.

Chapter 3: Optimization methods - an introduction
Outcomes of optimization problems - Graphical solution of optimization problems - The improving search paradigm - Local and global optima - Convexity - Enumeration methods - Commercial solvers.

Chapter 4: Nonlinear Programming
Review of calculus (gradient, Hessian, Taylor expansion) - Improving feasible directions - Optimality conditions (necessary and sufficient) for unconstrained and constrained problems - Finding initial feasible solutions - Iterative methods for optimization problems - Convexity.

Chapter 5: Linear Programming
Modeling strategies and assumptions for linear programs - Graphical solutions to linear programs - Polytopes - Extreme points and extreme rays - Simplex algorithm - Convergence of Simplex - Degeneracy - Primal and dual bounds for Linear Programming - Duality theory - Sensitivity analysis and post-optimal analysis.

Chapter 6: Network Programming
Introduction to networks - Modeling strategies and assumptions for network programs - Total unimodularity - Shortest path - Dijkstra's algorithm - Maximum flow modeling - Ford-Fulkerson algorithm -

Max-Flow-Min-Cut Theorem - Matching and assignment problems.

Chapter 7: Integer Programming
Modeling strategies and assumptions for Integer Programs - Difficulty of Integer Programs - Graphical solutions of IPs - Total enumeration - LP relaxations - Rounding techniques - Divide-and-Conquer schemes - Branch-and-Bound - Cutting Planes.

Attendance and class behavior expectations:

I will make every effort to maintain an atmosphere in the class that is conducive to learning.

Noise: 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.

Disruptions: 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.

Grading: methods and evaluation:

Your grade for this class will be based on four different sources of evaluation that are weighted differently:

1. Quizzes (4) and GAMS assignment: 20%
2. Midterms (2): 25% each
3. Final Exam (1): 30%

Your performance in these three 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.

1) Quizzes:

General: Four quizzes will be given during the course of the semester. They will be held on:

- Thursday January 22$^{\text{nd}}$ 2015, during class.
- Thursday February 12$^{\text{th}}$ 2015, during class.
- Tuesday March 17$^{\text{th}}$ 2015, during class.
- Tuesday April 14$^{\text{th}}$ 2015, during class.

You will receive solutions to all quizzes. There will be no make-ups for quizzes. The quiz with the lowest score will be dropped. That is, 3 highest quiz scores will be included in the student's overall grade.

Content & Structure: Quizzes will test all material covered since the previous quiz/midterm. 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, ... Quizzes will typically be 20 minutes long.

2) GAMS Assignment:

General: There will be one GAMS assignment during the course of the semester. The assignment will be due on Friday April 10^{th} 2015, online submission (11:00 pm).

Content & Structure: This assignment will test your ability to model with GAMS and to interpret the output. It will be assigned three weeks before its due date. The submission will consist of GAMS files and a Word document with your answers. You will submit your files online through Sakai. Any submissions after the due date will not be accepted.

3) Midterm & final exams:

Schedule: There will be two midterms and a final. The two midterms will be held on:

- Tuesday February 24^{th} 2015, 8:20-10:10pm.
- Thursday March 26^{th} 2015, 8:20-10:10pm.

You 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. Graded midterms should be returned to you within a week of the exam date.

Content & Structure: 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. 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.

Rules of the Game: 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, ... during the exam. You will be asked to show your UF ID.

Grading scale:

You will receive numerical grades for your quizzes and exams. The final 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`.

Make-up exam policy:

Make-up exams will only be given under two circumstances. The first is if you are involved in an official school trip (needs to be documented) at the time the exam is scheduled. The second is that you have another exam scheduled at this time. In both of these cases students should contact the instructor before Tuesday January 27^{th} 2015 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) 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. If you miss more than one test because of extreme family or medical reasons (needs to be 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 a F.

Grading & Re-grading policy:

Quizzes and tests 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.

Availability: Grades will only be available on E-learning. For reasons regarding privacy protection, grades are not communicated by phone and/or e-mail. Furthermore, note that the 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.

When to Re-grade: 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 any point as it should have been clear the first time around.

Procedure: You should submit regrade requests in writing indicating the reason you believe such re-grade is appropriate. This is to be done on a sheet of paper that is stapled to your original paper. The packet should be returned to the TA or the instructor before/after the class or during office hours. 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. This rule is to prevent frivolous complaints. Finally, be aware that samples of quizzes and 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. In the case of such event, you will receive a failing grade for the totality of your paper and the case will be handed to the Dean of Students Office for prosecution.

Time Line: Every re-grade request should be entered no later than one week following the date the graded paper was 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 were given fairly when the scales used by the grader are still fresh in his/her mind.

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.

Academic honesty and dishonesty:

All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a University of Florida student and to be honest in all work submitted and exams taken in this course. If you conduct any dishonest act (*e.g.*, cheating on an exam/quiz, bringing in extra material not allowed during the exams,), you will get a F on that quiz/exam. Further action is possible depending on the severity of cheating.

Accommodation for students with disabilities:

Students requesting classroom accommodation must first register with the Dean of Students office. That office will provide the student with the documentation that he/she must provide to the course instructor when requesting accommodation.

UF counseling services:

Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.

- Career Resource Center, Reitz Union, 392-1601, career and job search services.

Software Use:

All faculty, staff, and students of the University of Florida 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 integrity.

Feedback:

If you foresee any problem with adhering to the guidelines set in this syllabus, please discuss them with the instructor as soon as possible. The sooner problems are discussed, the more likely it is that they can be solved.