ESI 4313 - Operations Research 2
Syllabus

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Spring 2012

Course description:

Catalog description: Dynamic programming and optimization. Markov processes and queuing theory. Network analysis. Applications.

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 advanced deterministic models and methods in Operations Research as well as stochastic models. Basic deterministic models and methods are described in ESI4312. 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 and a working knowledge of calculus and probability. Further, "*ESI4312*" and "*STAT 4321*" are formal pre-requisites for the class.

Course objectives:

This is the second of a two-course sequence that introduces students to models commonly used in the analysis of complex decision-making problems. Modeling approaches and fundamental solution methodologies will be emphasized. We will learn a variety of ways in which deterministic and stochastic models in Operations Research can be used and applied to solve practical problems. Specifically, we will cover nonlinear and integer programming, with applications to production, design, and management. We will also cover dynamic programming, Markov chains and queueing theory.

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 describe methods and software to solve them in a reasonable amount of time. We will become familiar about how to analyze the results of a model, interpret them, and concisely 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:
Dr. Jean-Philippe Richard **Office**: Weil 372 **Office Hours:** *Mondays:* 8 (3:00-3:50pm) *Tuesdays:* NA *Wednesdays:* 6 (12:50-1:40pm) *Thursdays:* NA *Fridays:* 9 (4:05-4:55pm) **Phone**: 352-392-1464 (E: 2018) **E-mail**: `richard@ise.ufl.edu`	Jorge Sefair **Office**: Weil 202 **Office Hours:** *Mondays:* NA *Tuesdays:* 8 (3:00-3:50pm) *Wednesdays:* NA *Thursdays:* 10 (5:10-6:00pm) *Fridays:* NA **Phone**: - **E-mail**: `j.sefair@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 fashion:

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 60 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 ESI4313.

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.

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 office (or the TA office) unannounced. Also, you should not call the instructor or the TA at home. We will not answer any questions (even short) in such situations.

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 the only 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 MWF 3 (9:35pm to 10:25pm) in LAR0330, except

- Monday January 16^{th} (MLK day).
- Monday March 5^{th} (Spring break).
- Wednesday March 7^{th} (Spring break).
- Friday March 9^{th} (Spring break).

Midterm exams are scheduled on

- Wednesday February 15^{th} 2012, 8:00-10:00pm
- Wednesday March 21^{st} 2012, 8:00-10:00pm.

The final exam is scheduled on

- Thursday May 3^{rd} 2012, 7:30-9:30am.

Required textbook and software:

Textbook: Winston, *Operations Research*, Thompson, 4th Edition, ISBN: 9780534380588.

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.

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 "ESI4313 - Operations Research 2 (Richard) - Spring 2012"

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

Using E-learning: There are 5 categories in this E-learning page that are represented with different icons. Most of them are self-explanatory.

1. **General Info:** Contains the syllabus for this class. It also contains the office hours and location of the instructor and the TA as well as the deadlines for homework, projects, etc.
2. **Slides:** Contains the slides that are used for every one of the classes. These slides will be available to you before the class.
3. **Homework:** Contains the statements, grading grids and solutions to the homework assignments.
4. **Exams:** 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. **GAMS:** Examples of GAMS codes for different problems presented in class.

There are also three tools that you will find handy to use.

1. **Mail:** Allow you to send e-mail to the instructor and/or the other students of the class. It is very easy to use and it is the preferred way to communicate with the instructor.
2. **Chat:** Allow you to discuss with other students of the class, with the TA and the instructor.
3. **My Grades:** Contains the grades you obtained for the class so far. Note that if you note a discrepancy between the grade you see on your paper and the grade given in E-learning, you should 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 in class. When possible, these announcements will be reiterated on E-learning. Students are responsible for checking 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: Introduction:

General description of Operations Research - Review of OR1 - Introduction to GAMS.

Chapter 2: Nonlinear Programming:

Nonlinear models - Review of linear algebra and calculus - Local and global solutions - Feasible directions - Improving directions - KKT conditions - Convexity.

Chapter 3: Integer Programming:

Integer programming models - Relaxations - Branch-and-bound algorithm - Better and ideal formulations - Cutting planes.

Chapter 4: Dynamic programming:

Dynamic programming models and applications - Graphical representation - Optimality principle.

Chapter 5: Probability review:

Conditional probability - Discrete and continuous distributions - Expectation and variance - Sums of random variables - Exponential and normal distributions.

Chapter 6: Stochastic dynamic programming:

Dynamic programming models and applications - Graphical representation - Recursion.

Chapter 7: Markov chains

Stochastic processes - States, Markov Chains - Transition matrices - Types of chains - Steady-state probabilities.

Chapter 8: Queuing theory

Applications - Arrival and service process - Birth-and-death processes - M/M queues.

Attendance and class behavior expectations:

On-time attendance to the class is mandatory. Sign-in sheets will be distributed during the 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 50% over the whole semester. Your grade will be unaffected if your attendance is between 50% and 90%.

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

Noise: To ensure a classroom environment conducive to success for everyone, please turn off all pagers and 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 three different sources of evaluation that are weighted differently.

1. Homework (11): 30% average
2. Mid-Terms (2): 20% each
3. Final Exam (1): 30%

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 your attendance bonus/malus and/or 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) Homework:

General: Eleven homework assignment will be given during the course of the semester (one every week, except for those weeks in which a midterm is given). Homework will contain 6 questions. You only need to answer and turn in the first four. The last two problems are for you to gain extra practice. You will not receive extra points to turn them in. All homework will count equally towards your final grade. Furthermore, the homework with the lowest grade will be excluded when computing your

homework average. You will receive solutions to all the homework sets. Both graded homework and solutions should be available to you one week after you submitted them. Note however that not all the problems you turn in will be graded. The instructor will typically bring the graded homework from the previous week on Wednesdays.

Schedule: Homework will be assigned every Wednesday. They will be collected the following Wednesday at 9:35am. Homework returned after 9:40am will be considered late. A week is a sufficiently long time to answer homework problems. As a result, there is a strictly enforced "I do not answer questions about homework on Wednesday" rule in this class. Homework is supposed to make you think about the problems. Finding its answers is a valuable exercise for you. This exercise is completely void if it is done in a rush, ten minutes before the class, by pulling the answers out of the TA or the instructor.

Late Homework: Late homework will be accepted until Thursday 5:00pm. They will not be accepted after that. Homework received after 9:40am on Wednesday will receive a 10% deduction. Homework received after 5:00pm on Wednesday will receive a 20% deduction. In case of serious unpredictable circumstances that can be documented (such as a hospitalization, a death of a close family member, etc.), you will not be required to turn in a homework. The final grade you obtain for the homework will therefore be determined only by the other homework you turned in. If you take part in an official school trip, you need to make sure that homework are submitted on time. Remember that homework may always be turned in early.

Content: The questions will range from theoretical to practical aspects. Some will be simple applications of material seen in class, some will be challenging. Some questions will involve the use of the computer software GAMS that will be presented in class. Insightful, creative and original answers might earn you extra points.

Presentation: All submitted assignments should be neat, organized and legible. Different problems should be answered on different sheets of paper. If you need several pages to answer a single problem, these pages should be stapled. Your name should be written on every page that starts the answer of a new problem. Furthermore, an extra page should be added to the back of the last problem turned in. Your name should be written clearly on both sides of this page together with your class number and the number of the homework (this is to facilitate the sorting and distribution of papers). Assignments not meeting these requirements run the risk of being disregarded in part or even entirely.

Re-grade: See re-grading policy below.

Academic Honesty: Ideally, every student in the class should find the answers to the problems by him/herself. Operations Research is a fairly mathematical discipline. Finding solutions by yourself testifies that you do have a good understanding of the material. Understanding someone else's solution does not. Be aware that tests and exam will seek to evaluate your understanding of the material, not the ability to mimic the solution of some problems you have seen before. I am not against you working with other students on homework to stimulate interactions and improve your understanding of the material. If so, no written material should be exchanged between individuals and every student should write his/her own report. Other students with whom you interacted should be acknowledged on the homework (this will not be used in any way to adjust your grade) and collaboration should be limited to no more than five students. Failing to report cooperation on homework is considered cheating.

2) Midterms & final exams:

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

- Wednesday February 15$^{\text{th}}$ 2012, 8:00-10:00pm.
- Wednesday March 21$^{\text{st}}$ 2012, 8:00-10:00pm.

You will typically need all the time you have to complete your test so be there 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. All the midterms will have the same structure. They will be composed of modeling and solution problems. There will also typically be hard bonus problems that should not be tried unless you are finished with the rest of the exam. The final will be cumulative.

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 numeric grades for all your assignments and exams. The grading scheme I use is as follows:

- The range 85-100 roughly corresponds to an A.
- The range 75-85 roughly corresponds to a B.
- The range 65-75 roughly corresponds to a C.
- The range 55-65 roughly corresponds to a D.
- The range 0-55 roughly corresponds to a F.

Plus and minus modifiers will be assigned respectively to the upper and lower parts of these intervals. This scale applies to both homework and exams. In case of a particularly tough exam or homework, the grade of all students might be bumped up. Grades will never be bumped down.

The final grade of a student should be:

- A: if he/she demonstrates a very clear understanding of the concepts of the class and a very good knowledge of the material.
- B: if he/she demonstrates a good understanding of the major concepts of the class and a largely good knowledge of the material.
- C: if he/she demonstrates some limited deficiencies in the understanding of the class and the knowledge of the material.
- D: if he/she demonstrates significant deficiencies in the understanding of the class and the knowledge of the material.
- F: if he/she demonstrates a poor understanding of the concepts of the class and/or a poor knowledge of the material. Students that do not do their work or do them in an incomplete, hastened or unreadable fashion will also get a F.

So what grade will you get? It is entirely up to you. It will mostly depend on the time you spend on the assignments and on the time you spend studying and preparing for the class. A dedicated smart student should get at least a B. A typical grade distribution would have around 15% of As, 30-50% of Bs and the rest of lower grades. Incomplete will not be given unless a serious medical illness/injury prevented you from attending the class for a large portion of the semester (claims for such incomplete should be submitted with supporting documentation). Note that for an incomplete to be given, you should have been in good standing prior to the illness/injury. If you do not qualify for an Incomplete, do not ask.

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 Friday January 27^{th} 2012 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 the average score they obtained from the other midterm and the final. If you miss more than one test because of extreme family of 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:

Homework 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.

Grading Grids: You will be provided with the evaluation grid used to grade your homework in due time. These grids are relatively precise but cannot be completely descriptive. Therefore, there will regularly be deductions not listed on the grid since not all the mistakes possible can be envisioned when designing the grid.

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 homework. The packet should be returned to the TA or submitted with the following homework. 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 selected samples of homework and tests will be photocopied and kept for ABET reporting purposes. They can be used 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 homework and the case will be handed to the Dean of Students Office.

Time Line: Every re-grade request should be entered no later than one week following the time the homework 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 or sliding them under the door of his office. 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 UF student and to be honest in all work submitted and exams taken in this course and all others.

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 a credit of 0 on that assignment/exam. Further action is possible depending on the severity and frequency 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 documentation that he/she must provide to the course instructor when requesting accommodation.

UF counseling services:

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.