GEORGE MASON UNIVERSITY
DEPARTMENT OF SYSTEMS ENGINEERING AND OPERATIONS RESEARCH

INTEGER OPTIMIZATION
OR/MATH 642

Class time: **Tuesdays 4:30pm-7:10pm**

Classroom: **Nguyen Engineering Bldg Room 2227**
Final exam date: **Tuesday May 12th, 4:30pm-7:15pm (although will probably be a take-home exam due at 7:15pm Tuesday May 12th.**

INSTRUCTOR: **Dr. Karla Hoffman (khoffman@gmu.eduu)**
The best way to contact me is via email.
Backup email: orprofessor@gmail.com

Webpage: http://seor.vse.gmu.edu/~khoffman

Office: **Engineering Building 2207**

Office hours: **Tuesdays and Thursdays 2:00pm-3:00pm and by appointment**
With notice, I can be available after class on Tuesdays

I will not be on campus on Wednesdays.
I should be on campus most Mondays and Fridays, as well, but contact me in advance to confirm.

Office phone: **703-395-4080**

Prerequisites for the course: Linear algebra and graduate standing.

All course materials will be posted at mymason.gmu.edu. You must have a George Mason University email account to access these materials.

Textbook: *Applied Integer Programming*

Der-San Chen, Robert G. Batson, and Yu Dang Wiley 2010

Software: The course requires that you use a modeling language to complete for homework, project and the exams. You will have your choice of providing your models to GUROBI (free

academic license) via a modeling language such as MPL (Maximal Software), or JuMP (Julia for Mathematical Programming). You may also use Python to enter your models. More detailed instructions on downloading the software and getting the license set up will be provided in class. You can also use IBM's integer programming code and modeling language, but I will be less able to debug any coding problems you might have.

Part of the course will require that you use Python or JuMP since we will be looping through optimizations and MPL (without Python) does not allow looping through alternative models.

Course Description:

This course is designed to introduce discrete optimization models and to provide the mathematical foundations of integer and combinatorial optimization models along with the algorithms that can be used to solve such problems. The course will combine modeling, algorithmic developments and the use of commercial software. The problem areas discussed will include (a) planning models such as capital budgeting, facility location and portfolio selection, (b) design problems such as telecommunication and transportation network design, VLSI circuit design and the design of automated production systems, and (c) real-time applications such as routing and scheduling. Examples from statistics, economics, politics and mathematics will also be presented. Heuristic algorithms, cutting-plane methods, decompositions and tree search will be covered in detail. A tentative outline of the topics is provided below. This outline can change based on time limitations and the interests of the students.

Main Goals:

By the end course, you should be able to:

- From a problem description, formulate an appropriate model linear integer model
- Understand the basic mathematical structure of the problem
- Understand the techniques that are used by software packages to solve linear integer problems
- Understand how to covert a formulation into code and solve using a commercial software package
- Understand the limitations of "off the shelf" software and understand how to tune parameters to improve the software performance
- Learn how to decompose very large models
- If time permits, we may also present integer quadratic problems

Class Format:

- Course is taught in person; You are expected to attend all classes. If you cannot, you are to send me email and you are responsible for getting any notes or announcements from another student in the class. REMINDER: The schedule is likely to chance, so being in class or getting the notes from someone else is imperative!

Homework and Grading:

- Homework problems will be assigned at each session. Some or all of the assignments will be collected and graded.
- There will also be one project that will require the formulation and solution to an optimization problem.

Blackboard:
Lecture notes, presentations, and assignments will be found on Blackboard. The location for Blackboard is http://mymason.gmu.edu. This site is password protected, and uses the same identification as your gmu email account. I will send alerts whenever I have posted an announcement on Blackboard. You must check your gmu account even if you mostly use a different account. This is because Blackboard will only send messages to the gmu account.

Grades will be computed as follows:

- The midterm will count as 25% of grade,
- The project will count for 20% of grade,
- Homework will count 20% of grade,
- The final exam will be worth the remaining 35%.

All assignments are due BEFORE THE CLASS BEGINS. Homework will be assigned on and submitted via Blackboard. This provides me with a date stamp. Late work is penalized. Slow network is not an excuse – plan on it being slow!

CLASS RULES

- Please turn off your cell phone before class and never use it during a lecture. Feel free to walk out without distracting the class when needed.
- Attendance in class is very important. Some material, not necessarily from the book, will be covered in class and will show up on the midterm and final.
- In order to help you learn the course material, weekly homework exercises (each worth 10 points) will be assigned throughout the semester. **You will lose one point for each day late and late means after 4:30pm; but you only have until Friday to hand it in! That way, I can post solution sets before the next homework is due.**
- Of the graded assignments, I will drop the lowest grade and then average the rest of the grades. This is in acknowledgement of the fact that we all have bad days, other pressures etc. Use this wisely!
- Exams will only be given at the predetermined dates. Early or late exam taking will not be allowed, except for **very special** cases.
- Make sure you check Blackboard regularly for class announcements, grades, notes, and homework related material. I will send alerts via email when there is an important announcement on Blackboard.

Additional Notes:

The midterm exam is scheduled to be an in-class exam, but may be a take-home exam if students prefer**.** All exams will be open book and open notes. The final exam will be a take-home exam. There will be a class project. Students may work in pairs or individually on the project

Academic Integrity:

Please see notes at the end of the syllabus on the GMU Honor code and disability accommodations.

For this class, collaboration on homework is encouraged to accelerate learning, but students must turn in their own work and identify with whom they have collaborated. Depending on others for performance is dangerous! Most of your grade will be dependent on your

performance on the midterm and final, which are done individually with no collaboration.

Tentative Course Schedule:

(This schedule may change as course progresses. It is the responsibility of the student to know the schedule – posted on mymason.gmu.edu or via email announcements.)

Jan 21	**1. Introduction and Model Formulation I** (Read textbook, Chap 2 and 3)
Jan 28	**2. Model Formulation II** (Read Textbook, Chapters 5 & 6) Please bring laptops to class as we work on formulating problems using python and MPL
Feb 4	**3. Preprocessing** (Read textbook, Chap 4)
Feb 11	**4. Linear Programming Review** (Read textbook, Chap 9)
Feb 18	**Course is cancelled; Professor is traveling**;
Feb. 25	**5. Branch and Bound** (Read handout provided on Blackboard)
Mar 3	**6. Heuristics I** (Read Chapter 14 and Handout)
Mar 10	**No class - Spring Break**
Mar 17	**7. Midterm (If in class, to be determined) or Heuristics II – using optimization to obtain good solutions quickly**
Mar 24	**8. Cutting Planes**
Mar 31	**9. Column generation – Assign Project**
Apr 7	**10. Column generation**
Apr 14	**11. Decomposition I**
Apr 21	**12. Decomposition II: Stochastic Integer Programming**
Apr 28	**13. Review of Course and Project Presentations**
May 5	**Reading Period**
May 12	**FINAL EXAM** (Likely to be take-home but will be due May 13th 7:15pm)

University Policies

Honor Code:

GMU is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification.

Disability Accommodations:

If you have a learning or physical difference that may affect your academic work, you will need to furnish appropriate documentation to the Office of Disability Services. If you qualify for accommodation, the ODS staff will give you a form detailing appropriate accommodations for your instructor. In addition to providing your professors with the appropriate form, please take the initiative to discuss accommodation with them at the beginning of the semester and as needed during the term. Because of the range of learning differences, faculty members need to learn from you the most effective ways to assist you. If you have contacted the Office of Disability Services and are waiting to hear from a counselor, please tell me.

Email:

Students must use their MasonLive email account to receive important University information, including messages related to this class. See http://masonlive.gmu.edu for more information. You will need an email account to get all notices that are posted on mymason.gmu.edu (Blackboard).