University of Cincinnati

Optimization Models
BANA 7020-001
Spring 2018
Mondays 6:00PM - 8:50PM, RECCENTR 3250

Instructor Information:

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Office Hours: Tuesdays 3:00-5:00 PM EST and by appointment
Communication Policy: Students are encouraged to contact me anytime via email. A response will be given within 48-72 hours except on weekends.

Teaching Assistant:
Ben Scott – scott2bp@mail.uc.edu
Office Hours: Wednesdays 2:00-5:00 PM EST and by appointment

Pace:

This course aligns with PACE, the Lindner College of Business platform for developing the *total* business professional.

P – Professionalism: Students will acquire and refine the soft-skills necessary to effectively lead and perform in business and social situations.

A – Academics: Students will gain a breadth and depth of knowledge of business functions and general education, developing and applying strong analytical and problem-solving skills.

C – Character: Students will build a solid base of the mental and cultural competencies necessary to contribute to their organizations, professions, and the global community.

E – Engagement: Students will understand the importance of commitment to and active participation in experiences valued to their professional fields and for personal growth and development.

Course Objectives:

- Mathematically describe and model basic applications for various real-world optimization problems

- Formulate linear, integer and nonlinear models for various applications

- Solve optimization models with state-of-the-art software and interpret results for real-world applications

- Understand the basic principles of the simplex algorithm for linear programs and branch-and-bound type of algorithms for integer programs

Course Materials

Optional

- Bazaraa, Mokhtar S., John J. Jarvis, and Hanif D. Sherali. Linear programming and network flows. John Wiley & Sons, 2011.
- Ahuja, Ravindra K., Thomas L. Magnanti, and James B. Orlin. Network flows: theory, algorithms, and applications. (1993).
- Bertsimas, Dimitris, and John N. Tsitsiklis. *Introduction to linear optimization*. Vol. 6. Belmont, MA: Athena Scientific, 1997.
- Bazaraa, Mokhtar S., Hanif D. Sherali, and Chitharanjan M. Shetty. Nonlinear programming: theory and algorithms. John Wiley & Sons, 2013.

Course Description:

This course is an introduction to mathematical programming with an emphasis on modeling. Upon completion of this course, students will be able to formulate real applications as mathematical problems, understanding the underlying assumptions, and the scalability/difficulty of the proposed models. Students will also be able to solve optimization problems using state-of-the-art software and will be able to communicate the results obtained as well as perform basic sensitivity analysis.

Course and Grading Policies:

1. **Grading Policy:** Your grade will be based on assignments both written and computational, midterm and final exams.

> *Point Allocation:*
> Homework Assignments (10)   10 Points
> Course project (1)   20 Points
> Midterms (2)   50 Points

Final Exam (1)	30 Points
Total Points Available	**110 Points**

Grading Scale

93 points or above = A

90-92 points = A-	86-89 points = B+	80-85 points = B
77-79 points = B-	74-76 points = C+	70-73 points = C
67-69 points = C-	60-66 points= D	

Below 60 points = F

- *Homework Assignments:* **(10 pts.)**
  - One key to doing well in optimization modeling is to try a lot of problems. I will give 10 optional homework assignments that will be graded as submitted/not submitted and are worth 10 extra points. Trying and successfully doing these problems on a weekly basis will ensure that you understand the material and prepare you for the exams. I will provide solutions to these problems and we will discuss some of the problems in class.
- *Course project: (20 pts.)*
  - The project will require students to model and implement a computational solution for a realistic case study. The students should submit a final executive report along with the supporting code. Students can work in groups of up to 4 people.
- *Exams:* **(80 pts.)**
  - Exams will be given in class and timed. Tests will be paper-based and no electronics (phones, computers, etc.) are permitted. You can bring one page (2-sided 8.5x11) as notes for the tests.

2. **Academic Integrity:** As with all Lindner College of Business efforts, in this course you will be held to the highest ethical standards, critical to building character. Ensuring your integrity is vital and ultimately is your responsibility. To help ensure the alignments of incentives, the Lindner College of Business has implemented a "Two Strikes Policy" regarding Academic Integrity that supplements the UC Student Code of Conduct (see: UC's Student Code of Conduct)
- All academic programs at the Lindner College of Business use this "Two Strikes Policy"; Any student who has been found responsible for two cases of academic misconduct may be dismissed from the College.
- All cases of academic misconduct (e.g., copying other students assignments, failure to adequately cite or reference, cheating, plagiarism, falsification, etc.) will be formally reported by faculty; and
- Students will be afforded due process for allegations as outlined in the policy.

3. *Disability:* Students with disabilities who need academic accommodations or other specialized services while attending the University of Cincinnati will receive reasonable accommodations to meet their individual needs as well as advocacy assistance on disability-related issues. Students requiring special accommodation must register with the Disability Services Office. UC's Disability Services Office.

4. **Counseling Services, Clifton Campus:** Students have access to counseling and mental health care through the University Health Services (UHS), which can provide both psychotherapy and psychiatric services. In addition, Counseling and Psychological Services (CAPS) can provide professional counseling upon request; students may receive five free counseling sessions through CAPS without insurance. Students are encouraged to seek assistance for anxiety, depression, trauma/assault, adjustment to college life, interpersonal/relational difficulty, sexuality, family conflict, grief and loss, disordered eating and body image, alcohol and substance abuse, anger management, identity development and issues related to diversity, concerns associated with sexual orientation and spirituality concerns, as well as any other issue of concerns. After hours, students may call UHS at 513-556-2564 or CAPS Cares at 513-556-0648. For urgent physician consultation after-hours students may call 513-584-7777.

5. **Title IX:** Title IX is a federal civil rights law that prohibits discrimination on the basis of your actual or perceived sex, gender, gender identity, gender expression, or sexual orientation. Title IX also covers sexual violence, dating or domestic violence, and stalking. If you disclose a Title IX issue to me, I am required forward that information to the Title IX Office. They will follow up with you about how the University can take steps to address the impact on you and the community and make you aware of your rights and resources. Their priority is to make sure you are safe and successful here. You are not required to talk with the Title IX Office. If you would like to make a report of sex or gender-based discrimination, harassment or violence, or if you would like to know more about your rights and resources on campus, you can consult [UC's webpage for Title IX](#) or contact the office at 556-3349.

6. **LCB Weather Related Protocol**: When inclement weather threatens the safety of the University of Cincinnati community, the Senior Vice President for Administration and Finance may invoke University Rule [3361: 10-55-01](#) and declare an emergency closing.
The Lindner College of Business will observe the university emergency closing protocol <u>for all on-campus classes</u>. During a university emergency closing, all college offices will be closed.

Students should clarify with their course instructors how the closure will affect assignments and deadlines, and whether class information from the missed session(s) will be posted on Blackboard, and/or if the class will meet virtually during the closure.

In the event of inclement weather and the university is closed, the closure <u>will not</u> affect online courses. All course assignments and activities will remain as scheduled in the course syllabus.

Tentative Course Schedule:

Additional (or fewer) topics may be covered depending on time availability.

Week 1 Introduction to mathematical programing and modeling. Identifying variables, constraints, and objective function. Sets, indexes, matrices, and common notation. Standard and canonical form.

Week 2 Linear models: capacity and demand constraints, inventory constraints, ratios, soft constraints, minmax and maxmin objectives, basic goal programming.

Week 3   Network flows: assignment, shortest path, transportation, and maximum flow problems.

Week 4   Graphical solution method. Solving problems with excel.

Week 5   Optimization software: algebraic languages, optimization engines, and solving problems with Xpress-MP.

Week 6   The simplex algorithm.

Week 7   Introduction to duality and sensibility analysis.

Week 8   Review and **midterm 1**

Week 9   Integer models: disjunctions, modeling logical clauses with binary variables, facility location, and project selection.

Week 10   Scheduling and routing problems I.

Week 11   Scheduling and routing problems II.

Week 12   Branch and bound.

Week 13   Cutting-plane algorithms. Strong/weak formulations for mixed integer programs. Valid inequalities and cuts.

Week 14   Review and **midterm 2**

Week 15   Introduction to decomposition approaches: Benders' decomposition and column generation.

Week 16   Special topics: optimization under uncertainty, two-stage stochastic programs, multiobjective optimization, nonlinear programming, and basic local search algorithms.