Tentative Syllabus MATH 4420/6420 Advanced Mathematical Programming

Fall 2021, T & Th, 12:30 pm – 1:45 p.m., room Martin M-204

Instructor:	Dr. Margaret Wiecek	**Office:**	Martin Hall O-208
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Office hours:	TBA		

Class modality: TBA
Class cancellation: A class is canceled 15 minutes after the instructor fails to arrive.
Attendance: Regular attendance is recommended. You are responsible for any material covered in classes you miss.

Prerequisite: Multivariable calculus (e.g., MATH 2060), linear algebra (e.g., MATH 3110), linear programming (e.g., MATH 4400/6400) or another entry-level optimization course.

Description: Mathematical programming is part of a broader interdisciplinary field referred to as Operations Research (OR), which is the application of analytical methods to decision problems in engineering and management. OR has two fundamental parts: (1) creating mathematical models of decision problems and (2) developing methods to solve those models. One mathematical subject encompassed by OR is optimization. A first course in optimization such as MATH 4400/6400 covers models making use of linear functions and continuous variables, which are known as linear programming and network flow problems. In MATH 4420/6420, we focus on more advanced optimization models making use of integer variables, nonlinear functions (e.g., quadratic, convex) making up the objective or constraint functions, and multiple objective functions.

Topical Outline: The course covers three types of optimization problems. Each part includes modeling, theory, methodology, and applications.

Integer optimization
- Review of linear programming.
- Application-based modeling with integer and combinatorial optimization problems.
- The branch-and-bound algorithm.

Convex optimization
- Review of multivariable calculus.
- Modeling nonlinear optimization problems.
- Convexity of sets and functions.
- Unconstrained optimization.
  - Optimality conditions
  - Algorithms for optimization on a line.
  - Algorithms for optimization in higher dimensions.
- Constrained optimization.
  - Optimality conditions.
  - Algorithms.

Biobjective optimization
- Modeling biobjective optimization problems.
- Efficient solution and Pareto outcomes.
- Scalarizations.
- Conditions for efficiency.
- Problems with continuous and integer variables.
- Application in portfolio optimization.

Text: J. G. Ecker and M. Kupferschmid, *Introduction to Operations Research,* Wiley 1998, reprinted by Krieger 2004.
Supplement: R. Rardin, *Optimization in Operations Research*, Prentice Hall 1998, revised Pearson 2016

Software: The students will be expected to use software packages for solving optimization problems. The packages include

i) http://www.maximalsoftware.com/download/
ii) http://www.lindo.com/index.php/lsdownloads
iii) MATLAB available on the computers in our lab
iv) demo version of AMPL with some solvers (LPs, convex quadratic programs, smooth nonlinear programs) is available for free for download from http://ampl.com/try-ampl/download-a-demo-version/#windows
v) any other software selected by a student and approved by the instructor.

Student learning objectives: The successful student will be able to
- develop mathematical optimization models for various decision-making problems
- identify properties of the solution sets of optimization problems
- solve small-size optimization problems analytically
- solve optimization problems using software
- analyze mathematical optimization models to get additional insight into the real-life problem

Electronic equipment: Use of cell phones, laptops, and tablets is strongly discouraged during class, except for calculators and laptops used in support of classroom activities. Cell phones, laptops, and tablets are not allowed during exams.

Details on lectures, homework assignments, quizzes, project, exams, and final exam depend on whether the course will be offered online or in person. They will be given in the summer.

Grading scale: A (90-100), **B** (80-89), **C** (70-79), **F** ($\leq$ 69).

Academic Dishonesty Policy will be strictly enforced (see Student Handbook): *As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a high seminary of learning. Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form.*

Disability access: It is Clemson University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students with disabilities requesting accommodations should make an appointment with Dr. Arlene Stewart (656-6848), Director of Disability Services, to discuss specific needs within the first month of classes. Students should present a Faculty Accommodation Letter from Student Disability Services when they meet with instructors. Accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Title IX: Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This policy is located at http://www.clemson.edu/campus-life/campus-services/access/title-ix/. Mr. Jerry Knighton is the Clemson University Title IX Coordinator and the Director of Access and Equity. His office is located at 111 Holtzendorff Hall, 864-656-3181 (voice) or 864-565-0899 (TDD).