

MATH 8120

Integer Programming

Course Syllabus (Fall 2019)

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Class Time/Room: TTh 2:00–3:15pm, Martin E-4.

Office Hours: MTWTh 9:15–10:00am or by appointment.

Description: This course is an introduction to the theory and practice of discrete optimization. We will discuss integer programming applications and formulations, complexity theory, and classification of problems into “easy” and “hard” types. For “easy” problems, we will discuss efficient algorithms based on linear programming methods and on the theory of matroids. For hard problems, algorithmic approaches based on enumeration and on polyhedral description will be discussed, as well as heuristic approximation methods.

Learning Objectives Successful students will be able to formulate mathematical models of applications as discrete optimization problems; recognize complexity classes of algorithms and properties of problems that place them in one class or another; identify strategies for constructing solution methods for problems in various classes; identify structural properties of polyhedra representing solution sets of discrete optimization problems and construct systems of inequalities approximating such solution sets.

Prerequisites: Linear programming (from MATH 8100 or 4400/6400 or equivalent) plus multivariate differential calculus. Knowledge of a programming language such as FORTRAN or C, or a computational package such as MATLAB, is expected. A student whose knowledge of linear programming is limited to the material in MATH 4400/6400 will need to work a little harder to make up some deficiencies.

Textbook: Required (electronic versions are available at no cost):

- M. Conforti, G. Cornuejols, and G. Zambelli, *Integer Programming* Springer, 2014, <https://www.springer.com/us/book/9783319110073>.
- N. Pinar, *Mixed Integer Programming: Models and Methods*, 2019 https://www.researchgate.net/publication/332859832_Mixed_Integer_Programming_Models_and_Methods.

Recommended:

- *Integer Programming* by Lawrence A. Wolsey, Wiley, 1998.
- *Integer and Combinatorial Optimization* by Nemhauser and Wolsey, Wiley, 1999.

Software: AMPL and several solver libraries are available for 64-bit Windows, Mac OS X, and Linux at <https://clemons.app.box.com/folder/77948506212>.

Some other references:

- Schrijver, *Theory of Integer and Linear Programming*
- Garey and Johnson, *Computers and Intractability: A Guide to the Theory of NP-Completeness*
- Chvátal, *Linear Programming*.
- Lawler, et al., *The Traveling Salesman Problem: A Guided Tour of Combinatorial Optimization*

Some of these will be placed on reserve in Cooper Library. Additional references will be distributed as needed.

Assignments and exams Homework will be assigned each class. Although I will not collect all assignments, you are strongly encouraged to attempt to work the suggested problems. You are welcome to turn in any solutions on which you would like comments. Some assignments may be given to turn in.

Your grade will be based on a midterm (20%) and a final exam (30%), a term project (25%), and homework assignments, class participation, etc. (25%).

Final letter grades will be based on percentage scores on homework and tests. Minimum grades will be awarded according to the following schedule:

Percentage	≥ 85	≥ 70	≥ 60	< 60
Grade	A	B	C	F

Etiquette

- Course interactions should be conducted in a professional manner. If you have a computer or other electronic device in class and you are not using it to take notes or complete programming exercises, keep it closed.
- E-mail correspondence should adhere to professional standards.

Assignments and exams Homework will be assigned each class. Problems to be turned in for grades will be designated when assigned. You are strongly encouraged to attempt to work problems that are not assigned for a grade as well. You are welcome to turn in any solutions on which you would like comments. Discussion and collaboration on homework is acceptable, however you should write up and turn in your own solutions. Typeset homework (L^AT_EX preferred but not required) may be turned in one day after the due date. Extensions for one day may be granted in unusual circumstances, if arranged in advance.

Attendance Students are expected to attend class regularly and punctually. If the instructor does not arrive within 15 minutes after the designated start time, class is considered dismissed.

A note on outside sources It is in the nature of an introductory course that everything you will be asked to do for homework, exams or projects has been done before. The original papers, other textbooks that contain solutions, and computer codes may be available in the library or from other students or faculty or on the internet. In the interest of your own education and in fairness to other students, here are some ground rules for the use of outside sources.

- Before going to an outside source, you should make a good-faith effort to solve the problem on your own. This is the best way to learn the material, and to find out what you really know and don't know.
- If you do find the solution in an outside source, you should acknowledge the source. This is only fair to the original author, whether we're talking about a book, monograph or even a fellow student. Failure to disclose your sources is plagiarism.
- If you use an outside source, don't copy the result (proof, program, solution) verbatim. Rewrite it in your own words; improve the notation, construct a new example, reorganize the code, etc.. This will maximize the benefit to you of the experience of finding a solution in existing literature. Remember, not everything you read on the internet is true.
- Don't check out original sources (particularly journal articles and monographs) from the library during take-home exams. This is only fair to other students in the class who may be led to the same source.

Academic Integrity 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 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.

Sexual Harassment 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. He also is the Director of Access and Equity. His office is located at 111 Holtzendorff Hall, 864.656.3181 (voice) or 864.565.0899 (TDD).

Academic Continuity Plan for this Class Clemson has developed an academic continuity plan for academic operations. Should University administration officially determine that the physical classroom facility is not available, class will be conducted in a virtual (online) format. The University issues official disruption notifications through email/www/test notification/social media. When notified, use one of the following links to navigate for Clemson Canvas, where you will find important information about how we will conduct class

- Primary access link: <https://www.clemson.edu/canvas>
- Secondary access link, if needed: <https://clemson.instructure.com/>
- You can also use the Canvas Student App.

Our activities for teaching and learning will occur through our Canvas course. These may include assigned reading or projects, online resources, office hours by videoconference, and other activities.