IND E 599 Special Topics on Integer Programming
Syllabus for Winter 2021

Class Hours: TR 2:30–3:50pm
Instructor: Chaoyue Zhao
Office: 309 Engineering Annex
E-mail: `cyzhao@uw.edu`

Catalog Description: Methods used in the solution of optimization problems which contain integer variables. The emphasis is on general properties and the use of standard methods.

Course Objectives: Many large-scale problems arising in practice, such as supply chain optimization and communications network design, involve discrete decision variables. In recent years, the integration of theoretical and algorithmic advances in integer programming into optimization software drastically increased our ability to solve large-scale integer programs. In this course we will cover integer programming theory and algorithms, so that at the end of this course you will be able to

1. develop good models for optimization problems that involve discrete variables and combinatorial constraints,
2. apply the theory learned to design effective algorithms to solve large-scale integer programs in practice,
3. implement the algorithms designed using modeling and optimization softwares such as AMPL and CPLEX.

Texts: Conforti, Cornuéjols, and Zambelli, *Integer Programming*, Springer, 2014. (A modern take on IP)
Free PDF here: `http://link.springer.com/book/10.1007%2F978-3-319-11008-0`
Jeff Linderoth's slides: `http://homepages.cae.wisc.edu/~linderot/classes/ie418/index.html`

Other References: Wolsey, *Integer Programming*, Wiley, 1998. (Accessible)
Nemhauser and Wolsey, *Integer and Combinatorial Optimization*, Wiley, 1999. (Comprehensive)
Schrijver, *Theory of Linear and Integer Programming*, Wiley, 1998. (Highly mathematical)

Evaluation Procedure:
⋄ Homework 25%
⋄ Projects 25%
⋄ Midterm 25%
⋄ Final 25%

Class Policies:

1. *Final exam shall be held at the time listed in the official schedule.* It is your responsibility to make sure that you will be available to take the final exam at the said time. No exceptions will be made, and a make-up for the finals will be offered only under *extenuating circumstances* (such as medical reasons), and only if permitted by the university.
2. All tests will be comprehensive up to a specified topic although emphasis will be on newer material. No make-ups will given for the tests unless prior arrangements have been made with the instructor, and a written *authorized* excuse is provided. The validity of the excuse will be determined by the instructor. If a test is missed due to an emergency, inform the instructor as early as possible.

3. Homework assignments and projects are to be completed individually. You are allowed to discuss the class material pertinent to assignment questions with your class mates, but you *should not* share your solution with another person. When in doubt, avoid discussion and contact the instructor for help. Specific instructions will be provided with each assignment.

4. Late homework submissions *will not be accepted* for grading. Contact the instructor at least 2 days in advance if you are not able to meet the deadline, or within 2 days from the deadline if unforeseen circumstances forced the delay. Decision to give full/partial/no credit will be made by the instructor.

5. There will be one project to be completed individually. This will involve computer implementation of the methods described in the class. More details about the project will be provided during the quarter.

6. No disagreement on a score received on any graded material will be entertained 5 working days after the date it was returned.

7. Academic misconduct or dishonesty in any form will be dealt with severely in this course. The instructor will impose the maximum possible penalty permitted by the University system.

8. Please review the syllabus attachments for information on UW Student Academic Responsibility. Information is also available online at:
`https://depts.washington.edu/grading/pdf/AcademicResponsibility.pdf`.

Date	**Tentative topic**
Week 1	What is an IP? Formulating IPs Formulating IPs
Week 2	Formulating IPs Branch-and-bound
Week 3	Branch-and-bound Comparing alternative formulations
Week 4	Comparing alternative formulations Cutting plane method
Week 5	Ellipsoid method and “optimization=separation” Gomory Fractional Cuts
Week 6	**MIDTERM** (One page of handwritten notes) Branch-and-cut
Week 7	Convex hulls and Meyer’s Theorem Chvátal-Gomory (CG) cuts; CG rank; CG closure
Week 8	Mixed Integer Rounding (MIR) cuts & Gomory Mixed Integer (GMI) cuts Minimal descriptions; facets; dimension; aff. independence s
Week 9	Direct facet proofs Generating facets by lifting (e.g., knapsack covers)
Week 10	Perfect formulations and their characterizations Total unimodularity and total dual integrality