Syllabus

SIE 644: Integer and Combinatorial Optimization

Department of Systems & Industrial Engineering

Spring 2025

Course Description

(3 units) Modeling and solving problems where the decisions form a discrete set. Topics include model development, branch and bound methods, cutting plane methods, relaxations, computational complexity, and solving well-structured problems.

Course Prerequisites

SIE 544 – Linear Programming, or equivalent. Knowledge of linear programming.

Time and Location: TuTh 9:30AM-10:45AM, Engineering, Rm 301

Instructor: Dr. Neng Fan

Office: ENGR 312
Office Hours: TuTh 11:00AM-12:00PM or by appointment
Email: nfan@arizona.edu

Course Format and Teaching Methods

Lecture only; individual project; in-class discussion; web-delivered content.

Course Objectives

Students are expected to develop a working knowledge of integer programming in these directions: using integer variables and modeling tricks to formulate complex optimization problems in industrial engineering, management science and other areas; learning the solutions approaches for well-known combinatorial optimization problems; using various software to solve integer programming problems; being familiar in the complexity theory and polyhedral theory for integer programming; and studying basic solution approaches and developing advanced decomposition methods to solve complex/large-scale integer programming problems.

Course Communications

Course website: https://d2l.arizona.edu All class materials, including lecture notes, homework assignments, project instructions, supplemental readings, grades, announcements, etc., will be distributed through D2L. Also, if needed, the instructor will contact you through official UA email address and please check D2L and your email at least once per day.

Required Texts and Materials

Lecture notes and papers distributed through D2L.
(**Recommended book**) Laurence A. Wolsey, George L. Nemhauser, Integer and Combinatorial Optimization. 1999. ISBN-13: 978-0471359432. Wiley-Interscience.

Course Topics

1. Introduction to Integer Programming
   1.1 What is integer programming?
   1.2 Classification of integer programming problems
   1.3 Optimization modeling tricks
   1.4 Introduction to CPLEX/Gurobi
2. Combinatorial Optimization Problems
   2.1 Formulations and methods for combinatorial problems
   2.2 Relations among many well-known combinatorial problems
3. Integer Programming Theory
   3.1 Complexity theory
   3.2 Polyhedral theory and valid inequalities
4. Methods for Integer Programming
   4.1 Branch and bound methods
   4.2 Cutting plane methods
   4.3 Branch and cut methods
   4.4 Lagrangian relaxation and decomposition
   4.5 Benders decomposition and Dantzig-Wolfe decomposition

Assessments

- Two homework assignments/take-home exams: 20%*2.
- Reading and in-class discussions: 20%.
- A comprehensive project: 40% (literature review 8%, modeling 8%, algorithm design 12%, numerical experiments 8%, other 4%). More details will be posted in D2L.

Safety on Campus and in the Classroom

For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT): https://cirt.arizona.edu/case-emergency/overview

Also watch the video available at
https://arizona.sabacloud.com/Saba/Web_spf/NA7P1PRD161/common/learningeventdetail/crtfy0000000000003560

Nondiscrimination and Anti-harassment Policy

The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see: http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

University Policies

All university policies related to the syllabus are available at: https://catalog.arizona.edu/syllabus-policies.

Subject to Change Notice

Information contained in the course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.

Graduate Student Resources

A link to the University of Arizona's Basic Needs Resources page:
https://caps.arizona.edu/basic-needs