Instructor: Tamon Stephen
Meeting Time: M 2:30–4:20, W 2:30-3:20 Surrey 2740
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Office Hours: Wednesdays 3:30–4:20 (tentative) and by appointment.
Text: Integer Programming by Conforti, Cornuéjols and Zambelli.

408 Grading: 40% Individual Homework, 15% Midterm, 20% Team Homework, 25% Final
708 Grading: 30% Individual Homework, 15% Midterm, 15% Team Homework, 15% Project, 25% Final

1. **Bonus Tuesday.** Note that the class will meet once outside the usual pattern on Tuesday, October 15th, for a 2 hour class.

2. **Syllabus.** This course is an introduction to discrete optimization. The focus is on modelling problems as integer programs and polyhedral methods for solving these programs. Topics that we plan to cover include:

   Model building using integer, binary and mixed integer variables. Computer solution of integer programming models, linear programming relaxations, Lagrangian relaxations, duality, simple upper bounds using greedy algorithms. Branch and bound algorithms, implicit enumeration, LP based branch and bound.

   Valid inequalities, Gomory's fractional cut, mixed integer cuts, strong valid inequalities, simple facets for 0-1 knapsack polytope and the travelling salesman polytope, branch and cut algorithms.

   Column generation algorithm, solving the symmetric travelling salesman problem using column generation.

   Greedy and local search algorithms, construction heuristics, worst case analysis of heuristics.

3. **Individual Homework.** There will be five individual homework assignments during the term. Late homework will not be accepted.

   You are encouraged to talk with each other and the instructor about the homework, but you must write up the solutions yourself, using your own words. Solutions copied from other students, textbooks or the Internet are **not** acceptable. It is important to credit outside sources of ideas that you present on assignments. In particular, you must be thorough in documenting any use of generative AI technologies (such as ChatGPT) in the preparation of your assignment.

   Note that model solutions to homework problems will **not** be provided, even after the fact.

   Assignments, projects and exams in this class require well-written solutions.

4. **Team Homework.** In addition to the individual homework, students will work on larger-scale computational questions in teams. Teams will be assigned in the second week of classes, and the projects will proceed in stages, in roughly biweekly increments. Details will be posted to Canvas.

5. **Graduate student projects.** Graduate students will do an additional project, due at the end of the term. This will be one of an introductory lecture to the class or Operations Research Seminar on an advanced topic in Discrete Optimization, or a detailed formulation and solution (or near solution) of practical problem using methods from the course. The project will be selected in conjunction with the instructor.

6. **408 or 708?** Undergraduates who have already done well in 400-level Math courses and are considering graduate studies may in some cases consider taking the 700-level version of this course. If this applies to you, please get in touch with me after the first class.

7. **Computing.** Integer programming is a computational subject, and students are encouraged to experiment with software for integer programming. Some integer programming capability is now available even in general purpose software such as `Microsoft Excel`. There are also many specialized free and commercial packages for mathematical optimization.

   In this class, we will solve larger integer programs using the `AMPL` modelling language and environment, with popular commercial solvers such as `Cplex` and `Gurobi`. These are provided on an educational licence, and are only available for work on this course during the term. Instructions for downloading `AMPL` will be provided in class.

   The `AMPL` language comes with an on-line manual that is itself a good introduction to modelling with mathematical programs. It features examples and exercises that we will use in class, see: `https://ampl.com/learn/ampl-book/`.

8. **Exams.** Students **must** plan to take the tests in-person at their scheduled times. The midterm will tentatively take place on `Monday, October 28th`. The final exam will take place during the final exam period (December 5th to 17th). SFU will announce the exact exam timeslots in mid-October.

9. **Course Delivery Format.** This class is a fully in-person course. In particular, lectures will not be available on-line or recorded.

10. **Feeling unwell?** You are encouraged to stay home. Absences will be handled on a case-by-case basis.

11. **Books.** The main textbook for this course is *Integer Programming* by Michele Conforti, Gérard Cornuéjols and Giacomo Zambelli. This book is available at the bookstore, and also on-line through the SFU library at: `https://link-springer-com.proxy.lib.sfu.ca/book/10.1007%2F978-3-319-11008-0`. (Requires login.) There will also be readings from *The Traveling Salesman Problem: A Computational Study* by Applegate, Bixby, Chvátal and Cook. This develops the techniques in this course (and beyond) in the context of the TSP, with an interesting historical and cultural background.

    A good alternate textbook that covers similar material is Wolsey's *Integer Programming*, on reserve at the Surrey library. (Unfortunately SFU does not have electronic access.)

    For background on linear programming, you may wish to consult Vanderbei's *Linear Programming: Foundations and Extensions*. A nice overview of the development of integer programming is contained in the book *50 Years of Integer Programming 1958-2008*, edited by Jünger et al.

Have a great term!