SFU faculty of science
department of mathematics

MATH 408 Course Information

Instructor:	Tamon Stephen
Meeting Time:	MWF 9:30–10:20 Surrey 2750
E-mail:	tamon at sfu ca
Web page:	`http://www.sfu.ca/~tstephen/Teaching/1227_Math408/`
Office Hours:	Monday 10:30–11:20 (tentative) and by appointment.
Text:	Integer Programming by Conforti, Cornuéjols and Zambelli.
408 Grading:	50% Homework, 10% Midterm, 20% Computational Project, 20% Final
708 Grading:	40% Homework, 10% Midterm, 15% Computational Project, 15% Topical Project, 20% Final

1. **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.

2. **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.

   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.

3. **Computational Team Projects.** 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.

4. **Graduate student projects.** Near the end of the term, each graduate student will present a brief (25 to 30 minute) introductory lecture on a current topic in integer programming. The topic will be selected in conjunction with the instructor. Possible sources of topics are the book *Algebraic and Geometric Ideas in the Theory of Discrete Optimization* by De Loera, Hemmecke and Köppe or the surveys from *50 Years of Integer Programming 1958-2008* by Jünger. There may be an option to give these presentations in the SFU Operations Research Seminar series rather than in class.

5. **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.

6. **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/resources/the-ampl-book/chapter-downloads/`.

7. **Exams.** Students **must** plan to take the tests in-person at their scheduled times. The midterm will tentatively take place on `Monday, October 24th`. The final exam will take place during the final exam period (December 7th to 19th). SFU will announce the exact exam timeslots in mid-October.

8. **Course Delivery Format.** In recent years, some courses have been offered remotely or in a hybrid format due to the Covid-19 pandemic. This class is not of those types, it is a fully in-person course. In particular, lectures will not be available on-line or recorded.

9. **Feeling unwell?** You should certainly stay home. Absences will be handled on a case-by-case basis. I will try to post lecture notes following class for those unable to attend in person.

10. **Zoom Room and Plan B.** Of course I might feel unwell and need to isolate. There's also some possibility of more widespread closures. In that case, we may have to switch to `Zoom` for one or more classes. I do have a Zoom room available, and will send connection information to the class list by e-mail if needed.

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.)

    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. *The Traveling Salesman Problem: A Computational Study* by Applegate, Bixby, Chvátal and Cook gives a view of modern computation on this challenging problem, developing from scratch, through techniques presented in this course, right to the cutting edge (of ten years ago). It develops many of the techniques used in this course. All three of these books are available in electronic form through the SFU library.

Have a great term!