Instructor:	Tamon Stephen
Meeting Time:	MWF 9:30–10:20 in SUR 3240
Office:	2886 Podium 2
Office Phone:	778–782–7429
E-mail:	tamon at sfu ca
Web page:	`http://www.math.sfu.ca/~tamon/Teaching/1187_Math408/`
Office Hours:	Wednesday 10:30–11:20 (tentative) and by appointment.
Text:	Integer Programming by Conforti, Cornuéjols and Zambelli.
Grading:	25% Homework, 25% Midterm, 50% Final. **708**: 20% Homework, 20% Presentation, 20% Midterm, 40% 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 relations, 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.

   Lagrangian relaxation, strength of the Lagrangian dual, Lagrangian heuristics.

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

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

2. **Homework.** There will be five regular homework assignments during the term, and a short computational project for undergraduates. 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 and exams in this class require well-written solutions. You may be interested in the writing support activities available on Thursday, September 6th at 2:30 (both campuses). Details at: `https://www.lib.sfu.ca/about/branches-depts/slc/writing/writing-university`.

3. **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. Both are on reserve in the SFU Surrey library. There may be an option to give these presentations in the SFU Operations Research Seminar series rather than in class.

4. **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.

5. **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 the `Microsoft Excel` spreadsheet. 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/`.

6. **Exams.** Books, notes and calculators cannot be used on the exams. Students **must** plan to take the tests at their scheduled times.

   The tentative dates and times for the tests are:

   ```
   Midterm: Friday, October 26st, 9:30-10:20 AM  (in class)
   Final: Wednesday, December 12th, 12:00-3:00 PM, room to be announced
   ```

7. **Textbook.** 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 from off-campus.)

   Books that cover similar territory at varying levels include Wolsey's *Integer Programming*, Parker and Rardin's *Discrete Optimization* and Bertsimas and Weismantel's *Optimization over Integers*. All of these are on reserve at the SFU Surrey library.

8. **Additional Reserve Books.** Besides the textbooks and related mentioned above, there are some relevant books on reserve at the SFU Surrey library.

   Schrijver's *Combinatorial Optimization* is an excellent reference book in this area. For a refresher on linear programming, Chvatál's book is available. The books of Papadimitriou and Papadimitriou and Steiglitz provide background on computational complexity theory. Some more advanced current topics are developed in the book of De Loera, Hemmecke and Köppe.

   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. Both these books are available in electronic form through the SFU library, and I may refer to them from time to time.

Have a great term!