COURSE INFORMATION

Course title:	Optimal Decision Making II		
Course code:	BAMS 508	Credits:	1.5
Session, term, period:	2019W1, Period 2	Class location:	HA 337
Section(s):	BA1	Class times:	Tues/Thurs 2PM-4PM
Course duration:	Nov 4 – Dec 14, 2019	Pre-requisites:	BAMS 506
Division:	Operations and Logistics	Co-requisites:	N/A
Program:	MBAN		

INSTRUCTOR INFORMATION

Instructor:	Steven Shechter		
Phone:	604-822-8340	Office location:	
Email:	steven.shechter@sauder.ubc.ca	Office hours:	By appointment

COURSE DESCRIPTION

Optimization problems arise whenever one seeks to use activities in the best possible way, to maximize profits, to minimize costs, or more generally to find a "best" solution to a complex problem. Discrete Optimization models are those optimization models that involve a discrete structure, such as when activity levels are restricted to discrete values or when modeling complex logical relationships (Integer Programming), or when optimizing over a combinatorial structure, such as a graph or a network (Combinatorial Optimization). Discrete optimization applies to many functional fields of management, such as production and operations, supply chain, transportation and logistics, project planning, health care, marketing, as well as capital budgeting and investment planning involving discrete activities. It also applies to several disciplines in science, such as computer science, mathematics, physics and biology, and to many fields in engineering.

The course will present fundamental models and methods in discrete optimization. The emphasis will be placed on useful modeling methodologies and their application in some of the areas mentioned above. The course will present guidelines for choosing among alternate formulations, as well as among alternate solution approaches.

COURSE FORMAT

The course will consist of lectures, exposing the relevant material, in-class discussions, and in-class hands-on work. Learning will be enhanced by the use of optimization software in lectures and in homework assignments.

The lectures will be self-contained and no textbook is required for this course. Copies of the slides used in class will be available on the course website. You should supplement them with your own notes taken during the lectures.

Many introductory texts on Operations Research, Management Science, or Mathematical Programming contain the material covered in this course. For example, the text suggested above, Introduction to Operations Research, by Hillier and Lieberman, is a widely-used and comprehensive reference. I believe that anyone pursuing a career in Operations Research would benefit by having this on their bookshelf, but it is not required for this course.

LEARNING OBJECTIVES

Purpose/rationale for the course:

- To introduce students to the basic concepts and models of discrete optimization.
- To enable students to develop and use discrete optimization models arising in business applications

By the end of this course, students will be able to:

1. Formulate a discrete optimization model for a decision problem, solve it using appropriate tools, interpret the results, and derive managerial insights relevant to the intended application.
2. Compare alternate formulations and choose one that is most appropriate for a given situation.
3. Understand the main solution approaches used in practice, and appreciate their strengths and weaknesses in view of their practical application.
4. Solve optimization problems using Python and Gurobi, as well as Excel Solver.

ASSESSMENTS

Summary

Component	Weight
Two assignments (equally weighted)	30%
Three quizzes (10% each, drop worst of three)	20%
Final Project:	40%
20% Report	
20% Optimization Code	
Participation/Professionalism	10%
Total	100%

Details of Assessments

Homework Assignments

There will be 2 homework sets assigned during this course. Homework will be performed by teams consisting of three students each (teams of 4 will be created as necessary. Groups for the assignments will be *randomly assigned*.

Assignment deliverables will include Word documents and Jupyter notebooks. The Jupyter notebooks should contain Python and Gurobi solutions to the optimization problems you need to solve (you may want to double-check your solutions with Solver/Excel implementations and solutions, but you should not submit those). Your Jupyter notebooks should be well-documented (e.g., clear labeling of variables, markdown text, and comments clarifying steps of the code), so that someone who has not developed the model can easily understand it and replicate your results and findings.

The Word document will present and discuss your optimization modeling assumptions, formulations, and solutions. When presenting an optimization model, make sure all variables, constraints and objective(s) are clearly defined or labeled. Also include a clear, algebraic formulation of your optimization model in the Word documents before you solve it in Python/Gurobi. Use natural language when describing solutions (for example: "Produce 300 chairs", instead of "C = 300").

All assignments write-ups (as well as Project report) should reflect two perspectives: 1) a student demonstrating that you know the technical details of the course material and how it applies to the problem at hand, and 2) a consultant explaining results and insights to management. Evaluation of 1) will be based on correct model formulations, Python/Gurobi implementations, and solutions. Evaluation of 2) will be based on how clearly you explain model assumptions, setups, and solutions. Explaining solutions means going beyond just stating numerical results. Provide commentary and managerial insights. Do the results make sense? Why or why not? Are there any other data that may be needed? Do you recommend any policy changes based on the results? Not all of these questions will apply to every problem, but the idea remains the same: clearly explain how you obtained your results and what they mean.

Students not in the same group may discuss assignments at a high level, but are not to share code, solution details, or assignment write-ups with each other. The default policy is to assign the same grade to everyone within a group.

Assignments will be marked on a “CheckPlus/Check/CheckMinus” scale. These will then be converted into a number. Usually, a “Check” means an “average” solution and will receive approximately 80%. CheckPlus will receive more than this (typically 85%) and CheckMinus will receive less (typically 75%). The category assigned will depend on the quality of the solutions, where quality involves a combination of good modeling and derivation of results, as well as good presentation and discussion of the solution. The modal mark will generally be a “Check.” CheckPlus/Check/CheckMinus marks need not always map exactly to 85%/80%/75% marks. Some differences in quality may be accommodated by assigning different percentage marks. For example, while most CheckMinus solutions may receive 75%, a really bad solution may receive a much lower mark. Also, while most CheckPlus solutions may receive 85%, a really outstanding solution may receive a higher mark.

In general, a “CheckPlus” means that the solution was thorough and thoughtful, the model development was entirely (or nearly entirely) correct, and that recommendations were clearly justified. “Check” means that the solution was satisfactory but with room for improvement, due to modeling or analysis mistakes and/or due to recommendations that were not as compelling as they could be. Finally, “CheckMinus” means that the solution was unsatisfactory with significant room for improvement. For example, model development contained several errors and/or recommendations and explanations were unclear or unsupported by the evidence.

Quizzes
There will be three in-class Canvas quizzes, one in weeks 2,4,5. These quizzes will take place during the Thursday class of the week, starting promptly at 2 PM and ending promptly at 2:20 PM. They will be based on material covered in the class through (and including) the Tuesday lecture of that week. The lowest of your three quiz marks will be dropped, with 10% of the course weight given to each of the remaining two. Unlike assignments, there is no subjective component to the quiz questions, so your quiz marks will be a numerical score.

Final Project
See end of this document for details

Participation/Professionalism
This is based on both constructive class participation, as well as professionalism (which includes being on time to class, not using cell phone, etc.). Students should bring their laptops to each class for in-class

activities. Note, however, that the default policy for class will still be "lids down," and laptops should only be opened up when we are working on in-class activities.

Note on appeals of marks:
If you have received points off for part of an assignment and there is no comment as to why points were taken off, then you should absolutely feel free to ask for clarification. You have every right to understand why something is incorrect so you can learn the material better for next time. My TAs and I always intend to add comments for points taken off, but sometimes we might forget to include one.

If there is a comment indicating why something is incorrect, but you disagree with how many points were taken off, I would ask you to think very carefully before asking me to regrade it (unless there is a clear mistake in marking). Points taken off based on subjective assessments will almost never be mistakes in marking. If you still want to appeal your mark, you must send me an e-mail specifying exactly which question(s) you think are marked incorrectly or unfairly, along with a justification, within 3 days of receiving your assignment back.

LEARNING MATERIALS

Technology requirements:

- Excel Solver, the optimization tool embedded in Excel spreadsheets. For students using a Mac computer, Excel Solver will run better when accessing Excel through Windows emulation.
- Python and Gurobi

Suggested Reading Materials:

- Hillier, Frederick S. and Lieberman, Gerald J. (2014). Introduction to Operations Research, 10th Edition. McGraw Hill.
    - Relevant sections in the 10th edition are indicated in the Course Schedule below (marked with "HL" in the readings column).

COURSE-SPECIFIC POLICIES AND RESOURCES

Missed or late assignments, and regrading of assessments

Late submissions will not be accepted and will receive a grade of zero.

Academic Concessions

If extenuating circumstances arise, please contact the RHL Graduate School program office as early as reasonably possible, and submit an Academic Concession Request & Declaration Form https://webforms.sauder.ubc.ca/academic-concession-rhlee. If an academic concession is granted during the course, the student will be provided options by RHL, or by the instructor in consultation with RHL, per UBC's policy on Academic Concession.

Other Course Policies and Resources

Code Plagiarism

Code plagiarism falls under the UBC policy for Academic Misconduct. Students must correctly cite any code that has been authored by someone else or by the student themselves for other assignments. Cases of "reuse" may include, but are not limited to:

- the reproduction (copying and pasting) of code with none or minimal reformatting (e.g., changing the name of the variables)
- the translation of an algorithm or a script from a language to another

- the generation of code by automatic code-generations software

An "adequate acknowledgement" requires a detailed identification of the (parts of the) code reused and a full citation of the original source code that has been reused.
Students are responsible for ensuring that any work submitted does not constitute plagiarism. Students who are in any doubt as to what constitutes plagiarism should consult their instructor before handing in any assignments.

POLICIES APPLICABLE TO COURSES IN THE ROBERT H. LEE GRADUATE SCHOOL

Attendance

Excepting extenuating circumstances, students are expected to attend 100% of their scheduled class hours. Absent students limit their own academic potential, and that of their classmates, and cause unnecessary disruption to the learning environment. Students missing more than 20% of the total scheduled class hours for a course (including classes held during the add/drop period) without having received an academic concession will be withdrawn from that course. Withdrawals, depending on timing, could result in a "W" or an "F" standing on the transcript.

Punctuality

Students are expected to arrive for classes and activities on time and fully prepared to engage. Late arrivals may be refused entry at the discretion of the instructor or activity lead. Students arriving later than halfway through a scheduled class will be treated as absent for that class.

Electronic Devices

Devices such as laptops, tablets, and cell phones are not permitted to be used in class unless directed by the instructor for in-class activities. Students who do not follow the School's policy in this regard may be required to leave the room for the remainder of the class, so that they do not distract others. Research shows that students' use of laptops in class has negative implications for the learning environment, including reducing their own grades and the grades of those sitting around them.

Citation Style

Please use the American Psychological Association (APA) reference style to cite your sources.

Details of the above policies and other RHL Policies are available at:
http://www.calendar.ubc.ca/vancouver/index.cfm?tree=12,199,506,1625

UNIVERSITY POLICIES AND RESOURCES

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available on the UBC Senate website at https://senate.ubc.ca/policies-resources-support-student-success.

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

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All materials of this course (course handouts, lecture slides, assessments, course readings, etc.) are the intellectual property of the instructor or licensed to be used in this course by the copyright owner. Redistribution of these materials by any means without permission of the copyright holder(s) constitutes a breach of copyright and may lead to academic discipline. Audio or video recording of classes are not permitted without the prior approval of the Instructor.]

ACKNOWLEDGEMENT

UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xwməθkwəy̓əm (Musqueam) people, who for millennia have passed on their culture, history, and traditions from one generation to the next on this site.

COURSE SCHEDULE

(Subject to change with class consultation)

Week	Date	Topic	Readings or Activities	Assessments due
1	Nov 5, 7	• Introduction to discrete optimization • Network optimization: Transportation and Assignment problems	HL 9.1, 9.3	HW 1 assigned on Nov 7 (Due: Nov 17, 11:59 PM) Project Proposal due Nov 10, 11:59 PM
2	Nov 12, 14	• Network optimization: • Trees and Paths • Network Flows	HL 10.1-10.6	Quiz 1 (Nov 14, 2 PM)
3	Nov 19, 21	• Network Optimization: • Project Management • Integer programming (IP) formulations • IP "tricks" • Covering, Packing, and Partitioning	HL 10.8 HL 12.1-12.5	HW 2 assigned on Nov 18 (Due: Nov 29, 11:59 PM)

4	Nov 26, 28	• IP solution methods
		  ○ Branch-and-Bound
		  ○ Cutting planes
			HL 12.6-12.8	Quiz 2 (Nov 28, 2 PM)

5	Dec 3, 5	• Large IP Formulations • Heuristics	HL 14	Quiz 3 (Dec 5, 2 PM)
6	Dec 9-14	Final Project. To be scheduled by RHL Office		

PROJECT DETAILS

Overview

The purpose of the course project is to gain optimization modeling, analysis, and report-writing experience. Groups of 3-4 students each can choose among several optimization case studies that I will post to Canvas. You are also welcome to propose your own optimization project. You may form your own groups, or let me know if you need help finding a group. At most two groups can select the same project topic (a Google sheet will be created to sign up for projects and form groups).

Deliverables and Deadlines

Project component	Due
Proposal	Nov 10 (11:59 PM)
Final report	To be scheduled by RHL Office
Jupyter notebook(s) of optimization models	To be scheduled by RHL Office

Proposal

In at most 2 pages (single-spaced), provide a brief background of your project topic, the questions you will investigate, and your work plan for accomplishing this (include a Gantt chart).

Final report

Your report should be a very clear, well-written Word document that includes the following sections:

1. A one-page Executive Summary
2. Introduction
3. Model formulations
4. Discussion of model results
5. Conclusions (include discussion of recommendations and model limitations)

The average length of the document (before any appendices) should be approximately 15-20 pages single-spaced.

When writing up your reports, consider two perspectives: 1) a student showing me you know the technical details of what is going on, and 2) a consultant explaining to management what is going on. With regard to the latter, be sure you don't just provide numerical results, but explain things clearly and concisely. Provide insight and justify your recommendations.

Optimization models

Optimization models must be developed and solved in Python/Gurobi. Besides being logically correct and clean (i.e., if there are many ways to go about the same thing, you chose a simpler approach), your program should be well documented, through appropriate use of markdown text headings and comments within the code. If you think a separate "readme.doc" might help explain parts of the code, feel free to include that as well (may not be necessary). A good question to ask yourself is "can someone else reading my code program and report understand what it is doing and how it works, without me being there to explain it and answer any questions?"