COURSE INFORMATION

Course title:	Simulation Modelling II: Queuing and Discrete Event Simulation		
Course code:	BAMS 504	Credits:	1.5
Session, term, period:	2020W2, Period 5	Class location:	Online
Section(s):	BA1	Class times:	Tu/Th 2-4 PM
Course duration:	Apr 21 to May 21, 2020	Pre-requisites:	BAMS 503
Division:	Operations and Logistics	Co-requisites:	N/A
Program:	MBAN		

INSTRUCTOR INFORMATION

Instructor:	Steven Shechter		
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COURSE DESCRIPTION

Simulation is a widely used methodology in both industry and academia because it is a vital tool for decision making under uncertainty. A simulation model allows the user to test a variety of "what-if" scenarios on a computer and evaluate a variety of outcomes from complex processes before considering implementing any changes to the real system. Areas of application include health care, finance, risk analysis, manufacturing g, logistics, call centers, and military.

This course introduces students to discrete-event simulation for modeling complex, dynamic processes. Because queueing often plays a big role in these processes, we will begin with an introduction to queueing theory. We will then learn how to model complex processes with a widely used discrete-event simulation software package.

COURSE FORMAT

We will be using the "Collaborate Ultra" tool on Canvas to have our classes during the scheduled class times.

The course will include lectures, case discussions, in-class case activities and simulations. Please see detailed course schedule at the end.

LEARNING OBJECTIVES

Purpose / rationale for the course:

- To learn the benefits of Discrete Event Simulation (DES)
- To learn about queueing processes and when to use queueing theory vs. DES
- To develop a student's ability to make data-driven decisions using simulation models

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

- Understand when and why DES is useful
- Understand when and why queueing theory is useful
- Learn how to use a DES software (Arena)
- Know how to properly analyze DES simulation outcomes, make comparisons, and report the results to a managerial audience.

ASSESSMENTS

Project total	**60%**	
Project Report		30 %
Project Simulation Model		30 %
HW total	**30%**	
HW 1		15%
HW 2		15%
Instructor Assessment	**10%**	

ASSESSMENT DESCRIPTION

Instructor Assessment is based on class participation and professionalism (which includes being on time to class, not using cell phone, etc.). Even though you will use your laptops at times during the course, the default policy is still "lids down" until I let you know to open up your laptops. As you know, your phones should always be away and out of sight!

ASSIGNMENTS

Assignments should be done in groups of 3 or 4 people each. You may choose your own groups; if you have trouble finding a group, please let me know. Students not in the same group may discuss assignments at a high level, but are not to share code, solution details, or any part of an assignment write-up with each other.

Solutions to assignments are not purely quantitative; they also involve discussion, interpretation, insights, justification, etc. (see more below). They 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.

When working on assignments, 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. The first component involves things like correct modeling development, experimental design, and statistical analysis. Regarding the second item, be sure you don't just provide numerical results, but explain things clearly and concisely. Provide insight. 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 your results and don't just present numbers.

Also, make sure any programs you turn in are well-documented (i.e., put comments in the program where it would be helpful, make sensible labels for objects, etc.) so that someone else (like me and the course TA) can easily understand what's going on.

All students will perform peer evaluations of all members in their group, for each assignment. This will be done through iPeer (https://ipeer.elearning.ubc.ca/). Your ratings of each other will be anonymous--only the TA and I will see how you all rate each other's contributions. However, if it appears that someone in the group is not participating well, I will speak with the evaluator(s) to learn more, and then I may also speak with the student they rated. There will be three questions each of you rates each other on (as well as rating yourself on), on a scale from 1-5:

- Effort towards assignment deliverables (e.g., worked hard to contribute)
- Quality of contributions towards deliverables (e.g., produced solutions, code, write-ups, etc. that were high quality and useful for the final assignment deliverables)
- Respect towards other group members (e.g., was timely in their work, attended discussions about assignment, written and verbal communication was respectful in tone, etc.)

PROJECT DETAILS

Overview

The purpose of the course project is to gain simulation modeling, analysis, and professional writing experience. Groups of 3-4 students each can choose among several examples that have been used in past Arena/IISE[1] annual simulation competitions. Alternatively, you may propose your own independent 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 case study (these will be posted to the Canvas site, and a Google sheet will be created to sign up for projects and form groups).

As you can see from the marks breakdown, the course project makes up a significant portion of your grade (60%), so you should plan on putting a considerable amount of effort into it. My default policy is

[1] Institute of Industrial and Systems Engineers

that each person in a group gets the same project grade. If there are any issues with group dynamics, try your best to work it out among yourselves. If problems persist, then speak to me about them.

See the section on Assignments for the same approach to marking and principles for good submissions.

Deliverables and Deadlines

Project component	Due
Proposal	April 28 (midnight)
Final report	May 31 (midnight)
Simulation model(s)	May 31 (midnight)

Proposal
In at most 2 pages (single-spaced), provide a brief background of your project, 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 description
4. Discussion of data sources and assumptions
5. Discussion of validation and verification
6. Discussion and analysis of "what if" scenarios that were tested
7. Recommendations and Conclusions

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

Simulation model

Simulation models must be created using Arena. 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. This may include adding comments within your program and/or creating a separate Word document (e.g., a "README" document). A good question to ask yourself is "can someone else reading my program and related documentation understand what it is doing and how it works, without me being there to explain it and answer any questions?"

Your model should also include animation as appropriate (i.e., display things that you think a client would be interested in seeing on the screen during the actual run and/or things that might help with verification).

Submit all relevant .doe files (your baseline model, as well as alternative models for scenario analysis).

FINAL EXAM

There is no final exam for this course.

CLASS PARTICIPATION:

Please be ready and willing to actively engage in all aspects of the classroom learning experience. We all have something to contribute to the collective learning experience each day, and we all want to benefit from it.

LEARNING MATERIALS

Reading Materials:

The following are excellent references, but are not required for purchase. They will be held in library reserve for short-term loans.

- Simulation Modeling and Analysis, by Law and Kelton
- Discrete-Event System Simulation, by Banks et al.
- Simulation with Arena, by Kelton et al.

Technology Requirements:

Students need to bring their own laptop to each class. The Arena software is only compatible with Windows, so either you need a Windows-based laptop or you need to be able to install/run the software from a Windows environment on a Mac. If you have a Mac, you may obtain Windows 10 Education for free here: https://it.ubc.ca/services/desktop-print-services/software-licensing/windows-10-education. Apple has provided instructions on how to install Windows 10 here: https://support.apple.com/en-ca/HT201468. It's important to note that students must have enough space on their computers to handle both macOS and Windows 10.

The academic version of the Arena DES software is available for free. Go to https://www.arenasimulation.com/simulation-software-download and register to receive a copy of the software.

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.

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

Attendance

As per RHL Regulations on Professionalism, Attendance and Behaviour, students are expected to attend 100% of their scheduled classes. Students missing more than 20% of scheduled classes for reasons other than illness will be withdrawn from the course. Withdrawals, depending on timing, could result in a "W" or an "F" standing on a student's transcript. Students must notify their instructors at the earliest opportunity if they are expected to miss a class due to illness. A medical note from a licensed, local doctor is required if more than 20% of scheduled classes for a course are missed due to illness. Students are required to notify the Student Experience Manager if they are absent from two or more classes due to illness.

Punctuality

As per RHL Regulations on Professionalism, Attendance and Behaviour, students are expected to arrive for classes and activities on time and fully prepared. Late arrivals may be refused entry at the discretion of the instructor or activity lead. Students arriving halfway through a scheduled class, or later, will be treated as absent for that class.

Electronic Devices

As per RHL Regulations on Professionalism, Attendance and Behaviour, electronic devices (cellphones, tablets, personal technology, etc.) are not permitted in class unless required by the instructor for specific in-class activities or exercises. Cellphones and other personal electronic devices must be turned off during class and placed away from the desktop. Students who fail to abide by the RHL policy will be asked to leave the room for the remainder of the class.

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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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

Week	CLASS TOPICS	ASSIGNMENTS / DELIVERABLES
1 April 21, 23	Queueing theory Simulation of queues	April 23: HW 1 assigned
2 April 28, 30	DES modeling concepts; Model of a health care facility	May 3: HW 1 due, by midnight
3 May 5, 7	Verification and Validation Model of a call center	May 4: HW 2 assigned
4 May 12, 14	Comparing multiple scenarios	May 14: HW 2 due, by midnight
5 May 19, 21	Simulation optimization Model of manufacturing processes	
6	No class (exam week)	May 31: Project deliverables due, by midnight