OPM 3630 A01 (3 CH)
SIMULATION MODELS FOR OPERATIONS MANAGEMENT
FALL 2020
Online Teaching, TR 8:30 PM- 9:45 AM

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INSTRUCTOR

Name: Yuvraj Gajpal
Office: 622 Drake Centre
Phone: 204-4747421:
Email: Yuvsraj.Gajpal@umanitoba.ca
Office hours: M/W 2:15 -3:30 PM through Zoom or by appointment

COURSE DESCRIPTION

Simulation is a powerful tool to analyse the complex systems. Simulation is a method to mimic the behaviour of real systems. This courses introduces computer based simulation and modeling with applications to manufacturing and service system where decision making can be enhanced through the modeling and analysis of complex system. This course focuses on the construction of simulation models of real or conceptual systems using the MS Excel and the simulation software package Arena. The course assumes a previous knowledge of probability and statistics. Although some of these topics will be reviewed in the course to a limited extent, the review is intended only as a refresher and will not be comprehensive.
COURSE OBJECTIVES

This course is designed to introduce the basic concepts of system modelling and computer simulation. The process and methodology of using simulation for problem solving and decision making are emphasized. Simulation language Arena will be used as a tool for model building. Students will be required to apply the modelling techniques to a real world problem through a term project. Advances in simulation research and development will be explored through reference reading, class discussion and team presentation.

Upon completion of this course, students will be able to complete the following key tasks:

- Introduce students to simulation modeling using hand calculation and computer;
- Provide an understanding of the assumptions, strengths and weaknesses of simulation models.
- Demonstrate competence in using Arena to model simple problems;
- Apply model simulation technology for problem solving in business and industry;
- Validate a simulation model.

COURSE FORMAT

This course will be conducted “live” via videoconferencing using “Zoom” and will not involve in-person instruction. Classes will be during the scheduled class time. Students will build simulation model along with instructor through online teaching. Students are required to have either a bigger screen computer device or two computer devices. One device will be used to attend the lecture via zoom and another device is required for building simulation model.

For recording attendance and class participation, you will be expected to have your camera and microphone on during class time and exams. The instructor may tell you to leave your camera/mic on for the duration of the class or may require you to mute yourself and unmute yourself only at certain times.

COURSE MATERIALS

As classes will be delivered synchronously via videoconferencing, a device enabled with a camera and microphone is required. Further, you are expected to be in a location with a reliable Internet connection that is strong enough for streaming video. You may also want to consider using earphones/headset with a mic, unless you have a computer/tablet with good speakers/mic.

Exams, which will be administered via the Respondus Lockdown browser, you will need a device (computer or tablet; smartphone will not work) with one of the following operating systems:

- Windows 10, 8, or 7
- Mac OS 10.15 to 10.12, OS X 10.11, or OSX 10.10
- iOS: 11.0+ (iPad only)

The following website of Rockwell Corporation has additional information on the textbook and Arena software: <http://www.arenasimulation.com/>

E-book can be bought from the following link.

https://www.campusebookstore.com/integration/AccessCodes/default.aspx?bookseller_id=33&Course=OPM+3630&t=permalink

E-book can be activated from the following link.

https://connect.mheducation.com/class/y-gajpal-fall-2020

Please respect copyright laws. Photocopying textbooks or other reading material is a violation of copyright laws and is unethical, unless permission to copy has been obtained.

**ASSESSMENT OF LEARNING**

All work will be evaluated on an individual basis except in project work. In project work group members will share the same grade adjusted by peer evaluation. Your final grade will be calculated as follows:

Components and Weights

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marked Assignments</td>
<td>20%</td>
</tr>
<tr>
<td>Mid-term Examination (MT1-10%; MT2-15 %)</td>
<td>25%</td>
</tr>
<tr>
<td>Project Presentation and report preparation (group)</td>
<td>15%</td>
</tr>
<tr>
<td>Final Examination</td>
<td>40%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
ASSIGNMENT

The course assignments involve the use of simulation software Arena (Link to download the software is provided in the text book). Some of the assignments may require the ability to write simple computer programs in a language of the student’s choice, or the use of a spreadsheet.

Grade Conversion:

The following table shows the tentative grade cut-offs:

<table>
<thead>
<tr>
<th>Cumulative Marks</th>
<th>Grade</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>93 ≤ x ≤ 100</td>
<td>A+</td>
<td>Excellent</td>
</tr>
<tr>
<td>87 ≤ x &lt; 93</td>
<td>A</td>
<td>Very Good</td>
</tr>
<tr>
<td>80 ≤ x &lt; 87</td>
<td>B+</td>
<td>Good</td>
</tr>
<tr>
<td>71 ≤ x &lt; 80</td>
<td>B</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>65 ≤ x &lt; 71</td>
<td>C+</td>
<td>Marginal</td>
</tr>
<tr>
<td>60 ≤ x &lt; 65</td>
<td>C</td>
<td>Unsatisfactory</td>
</tr>
<tr>
<td>50 ≤ x &lt; 60</td>
<td>D</td>
<td>Unsatisfactory</td>
</tr>
<tr>
<td>&lt; 50</td>
<td>F</td>
<td>Unsatisfactory</td>
</tr>
</tbody>
</table>

In the event of a skewed distribution of grades, the total course marks may be curved up or down as necessary (the weighting of each component will remain unchanged).

Exams: All exams will be based on building simulation model mostly through Arena software. All exams will be submitted through Assignment Folder in UM Learn.

To protect the academic integrity of education at the Asper School, certain protocols will be observed for online exams. For instance, the online exam will set up such that each student will get a random subset of questions from a larger question bank, which means no two students will get exactly the same exam. Further, a very small number of questions will appear on a screen and you may not have the option to move back to questions you have already answered. The instructor may require your camera be on and directed at you for the entire duration of the exam.

SIMULATION PROJECT

➢ Objective
To gain experience on applying modern simulation technology for problem solving in business and industry.

Guidelines
- Students should form a team of up to three people to do a term project. All team members will be graded equally.
- It is the students' responsibility to find a real world problem for system modelling and simulation. The project should be carefully selected to demonstrate the meaningful use of simulation and to be completed in a reasonable amount of time.
- The project proposed should be submitted to and be approved by the instructor.
- The final project should be presented in class as scheduled.

Project Proposal
- The proposal report should include the project title, names of team members, the organization involved, and the brief description of the decision problem under study and the objective of the simulation. The proposal should be typed with no more than two pages. Handwriting is not acceptable.
- Proposal submission deadline is TBA

Project Presentation (6%)
The project presentation will be evaluated by both the classmates (3%) and the instructor (3%).

Project Report (9%)
The project report should include at least the following sections:
- Problem formulation. Variables and constraints. System performance measures and objective functions. The interrelationship between variables.
- Data collection and analysis. Methods of data collection. Data analysis.
- Model construction and validation. Simulation model written using Arena. Model verification and validation.
- Model experimentation and output analysis.
- Conclusion and recommendation. The interpretation of simulation results. Recommendations to solve the problem.
- Limitations and further improvement. The limitation of current study. Suggested improvement in the future.

MISSED EXAM AND LATE SUBMISSION POLICY

No make-up examinations will be given. If you miss a Mid-Term Examination for health reasons you are expected to have your doctor complete the University of Manitoba Medical Absenteeism Form and submit it to your instructor. In that case your midterm weight will be carried to the final exam.

If you miss a Mid-Term Examination for a reason other than illness, you are expected to contact your instructor at your earliest possible opportunity and explain the circumstances surrounding your absence.
Your instructor will require appropriate documentary evidence to justify your absence. Then the matter will be referred to the Department Head to ensure that all scenarios are dealt with in a uniform manner. There will be no make-up mid-term exams.

If you miss the Final Examination you will be required to consult with the Student Advisors in the Undergraduate Program Office, Room 268 Drake Centre. If you meet the criteria and qualify for a Deferred Final Examination, the Department of Supply Chain Management will schedule another opportunity for you to write your Final Examination in the course.

**ATTENDANCE POLICY**

You are expected to attend the classes. While your absences will not directly influence your grades, you are responsible for all material covered in class whether you attend classes regularly or not. Ultimately, the final grade will depend on how much you have learned and not how often you came to class (although the two are usually highly correlated since missing classes may impair your understanding of the material). If you need my help and are unable to come to my office hours, don't hesitate to schedule an appointment to see me some other time. The best way to contact me outside of office hours is by e-mail. Feel free to interrupt me (as long as you don't overdo it) during class and talk to me after class if you have questions. You are expected to be in a professional business manner in asking questions and replying to questions from both the instructor and other classmates.

**ELECTRONIC DEVICE POLICY**

This class requires the use of computer or smartphone with a camera/mic during class.

You are NOT allowed to audio/video record any lectures.

**OUT-OF-CLASS COMMUNICATION**

PowerPoint files, assignment/project guidelines, other class-related files, and grades will be posted on UM Learn. Moreover, any announcements outside of class will be sent by e-mail from UM Learn. It is your responsibility to check your UofM e-mail account frequently so that you don’t miss these emails.

There are many questions that cannot be answered succinctly over email. If you email me a question, please consider whether it can be easily and effectively answered by email. If it cannot, please talk to me before or after class. If I receive a question that is difficult to answer electronically or will require a lengthy response, I will ask you to meet with me to discuss instead.

**CLASS SCHEDULE**

**Tentative Course Schedule – Fall 2020 T/R**
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Chapter</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Week 1</td>
<td>1. What is Simulation?</td>
<td>Ch. 1: All sections, pp 1-14</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Week 2</td>
<td>A Guided tour through Arena</td>
<td>Ch. 3: Sections 3.1-3.3, pp. 53-79</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Week 3</td>
<td>A Guided tour through Arena</td>
<td>Ch. 3: Sections 3.4 – 3.9, pp. 79-110</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Week 4</td>
<td>Modeling Basic Operations and Inputs</td>
<td>Ch. 4: Sections 4.1-4.2, pp. 115-147</td>
<td>Due Date Assignment # 1</td>
</tr>
<tr>
<td>5</td>
<td>Thursday, Oct 1st, 2020</td>
<td>1st Mid-Term Exam (During the class time)</td>
<td>Material: Chapter 3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Week 5</td>
<td>Modeling Basic Operations and Inputs</td>
<td>Ch. 4: Sections 4.3-4.4, pp. 147-170</td>
<td>Due Date Assignment # 2</td>
</tr>
<tr>
<td>7</td>
<td>Week 6</td>
<td>Modeling Basic Operations and Inputs</td>
<td>Ch. 4: Sections 4.5-4.7, pp. 170-193</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Week 7</td>
<td>Modelling Detailed Operations</td>
<td>Ch. 5: Sections 5.1-5.4.2, pp. 195-215</td>
<td>Due date Assignment # 3</td>
</tr>
<tr>
<td>9</td>
<td>Week 8</td>
<td>Modelling Detailed Operations</td>
<td>Ch. 5: Sections 5.4.3-5.4.5, pp. 216-225</td>
<td>Project proposal submission deadline</td>
</tr>
<tr>
<td>10</td>
<td>Week 9</td>
<td>Modelling Detailed Operations</td>
<td>Ch. 5: Sections 5.4.6-5.4.7, pp. 225-237</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Tuesday, Nov 5th, 2020</td>
<td>2nd Mid-Term Exam (During the class time)</td>
<td>Material: Chapter 4</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Fall Term Break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Week 10</td>
<td>Modelling Detailed Operations</td>
<td>Ch. 5: Sections 5.5-5.6, pp. 237-257</td>
<td>Due date assignment # 4</td>
</tr>
</tbody>
</table>
14 | Week 11 | Statistical Analysis of Output from Terminating Simulations | Ch. 6: All sections, pp. 265-291 | Voluntary Withdrawal, TBA |
---|---|---|---|---|
15 | Week 12 | Intermediate Modeling and Study-state Analysis | Ch. 7: All sections, pp. 293-325 | |
15 | Week 13 | Project presentations | |

**IMPORTANT DATES**

- Refund deadline: Sep 22nd
- Midterm: Oct 30th
- VW deadline: Nov 23rd
- Final Exam: TBA

**INTENDED LEARNING OUTCOMES**

**AACSB Assurance of Learning Goals and Objectives**

The Asper School of Business is proudly accredited by AACSB. Accreditation requires a process of continuous improvement of the School and our students. Part of “student improvement” is ensuring that students graduate with the knowledge and skills they need to succeed in their careers. To do so, the Asper School has set the **learning goals and objectives** listed below for the Undergraduate Program. The checked goal(s) and objective(s) will be addressed in this course and done so by means of the items listed next to the checkmark.

<table>
<thead>
<tr>
<th>Goals and Objectives in the Undergraduate Program</th>
<th>Goals and Objectives Addressed in this Course</th>
<th>Course Item(s) Relevant to these Goals and Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quantitative Reasoning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A. Determine which quantitative analysis technique is appropriate for solving a specific problem.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B. Use the appropriate quantitative method in a technically correct way to solve a business problem.</td>
<td>✔</td>
</tr>
</tbody>
</table>
### 2 Written Communication

| C. Analyze quantitative output and arrive at a conclusion. | ✔ | Assignments, Quizzes, and Exams |

### 3 Ethical Thinking

| A. Use correct English grammar and mechanics in their written work. |
| B. Communicate in a coherent and logical manner |
| C. Present ideas in a clear and organized fashion. |

### 4 Core Business Knowledge

| D. Discuss the ethical implications of the decision. | ✔ | Entire course |
ACADEMIC INTEGRITY POLICY

The online format of class delivery does not lower the Asper School’s academic integrity standards. The same high levels of academic integrity are expected in online courses as they are in regular terms.

It is critical to the reputation of the Asper School of Business and of our degrees that everyone associated with our faculty behave with the highest academic integrity. As the faculty that helps create business and government leaders, we have a special obligation to ensure that our ethical standards are beyond reproach. Any dishonesty in our academic transactions violates this trust. The University of Manitoba General Calendar addresses the issue of academic dishonesty under the heading “Plagiarism and Cheating.” Specifically, acts of academic dishonesty include, but are not limited to:

- using the exact words of a published or unpublished author without quotation marks and without referencing the source of these words (includes Chat messages posted during videoconference sessions)
- duplicating a table, graph or diagram, in whole or in part, without referencing the source
- paraphrasing the conceptual framework, research design, interpretation, or any other ideas of another person, whether written or verbal (e.g., personal communications, ideas from a verbal presentation) without referencing the source
- copying the answers of another student in any test, examination, or take-home assignment
- recording exam questions using any method, regardless of whether those are shared with others
- sharing exam questions with those who are yet to take the exam, including future students
- providing answers to another student in any test, examination, or take-home assignment
- taking any unauthorized materials into an examination or term test (crib notes)
- impersonating another student or allowing another person to impersonate oneself for the purpose of attendance, earning class participation marks, submitting academic work, or writing any test or examination
- stealing or mutilating library materials
- accessing test prior to the time and date of the sitting
- changing name or answer(s) on a test after that test has been graded and returned
- submitting the same paper or portions thereof for more than one assignment, without discussions with the instructors involved
STUDENT SERVICES AND SUPPORTS

The University of Manitoba provides many different services that can enhance learning and provide support for a variety of academic and personal concerns. You are encouraged to visit the below websites to learn more about these services and supports. If you have any questions or concerns, please do not hesitate to contact your instructor or the Undergraduate Program Office.

<table>
<thead>
<tr>
<th>For Information on...</th>
<th>...follow this link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tech-related issues with UM Learn or videoconferencing</td>
<td>Information Services &amp; Technology</td>
</tr>
<tr>
<td>Admission, Registration, Tuition Fees, Important Dates, Final Exams, Graduation, and Transcripts</td>
<td>Registrar’s Office</td>
</tr>
<tr>
<td>Academic policies &amp; procedures, regulations, Faculty-specific information, degree and major requirements</td>
<td>Academic Calendar</td>
</tr>
<tr>
<td>Help with research needs such as books, journals, sources of data, how to cite, and writing</td>
<td>Library Resources</td>
</tr>
<tr>
<td>Tutors, workshops, and resources to help you improve your learning, writing, time management, and test-taking skills</td>
<td>Writing and Learning Support</td>
</tr>
<tr>
<td>Support and advocacy for students with disabilities to help them in their academic work and progress</td>
<td>Student Accessibility Services</td>
</tr>
<tr>
<td>Copyright-related questions and resources to help you avoid plagiarism or intellectual property violations</td>
<td>Copyright Office</td>
</tr>
<tr>
<td>Student discipline bylaws, policies and procedures on academic integrity and misconduct, appeal procedures</td>
<td>Academic Integrity</td>
</tr>
<tr>
<td>Policies &amp; procedures with respect to student discipline or misconduct, including academic integrity violations</td>
<td>Student Discipline</td>
</tr>
<tr>
<td>Students’ rights &amp; responsibilities, policies &amp; procedures, and support services for academic or discipline concerns</td>
<td>Student Advocacy</td>
</tr>
<tr>
<td>Your rights and responsibilities as a student, in both academic and non-academic contexts</td>
<td>Your rights and responsibilities</td>
</tr>
<tr>
<td>Full range of medical services for any physical or mental health issues</td>
<td>University Health Service</td>
</tr>
<tr>
<td>Information on health topics, including physical/mental health, alcohol/substance use harms, and sexual assault</td>
<td>Health and Wellness</td>
</tr>
<tr>
<td>Any aspect of mental health, including anxiety, stress, depression, help with relationships or other life concerns, crisis services, and counselling.</td>
<td>Student Counselling Centre</td>
</tr>
<tr>
<td>Support services available for help regarding any aspect of student and campus life, especially safety issues</td>
<td>Student Support Case Management</td>
</tr>
<tr>
<td>Resources available on campus, for environmental, mental, physical, socio-cultural, and spiritual well-being</td>
<td>Live Well @ UofM</td>
</tr>
<tr>
<td>Help with any concerns of harassment, discrimination, or sexual assault</td>
<td>Respectful Work and Learning Environment</td>
</tr>
</tbody>
</table>
Concerns involving violence or threats, protocols for reporting, and how the university addresses them

Violent or Threatening Behaviour

ABOUT THE INSTRUCTOR

Yuvraj Gajpal is an Associate Professor of Supply Chain Management at Asper School of Business, University of Manitoba Winnipeg, Canada. Yuvraj holds a PhD in Management Science from DeGroote School of Business at McMaster University Hamilton, Canada and Master in Industrial Management from Indian Institute of Technology (IIT) Madras, India. Prior to joining University of Manitoba, he worked as an assistant professor at King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia. He has worked as a postdoctoral fellow at Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT), University of Ontario Institute of Technology (UOIT) and McMaster University.

Yuvraj is a member of Institute for Operations Research and the Management Sciences (INFORMS); Canadian Operational Research Society (CORS); Administrative Sciences Association of Canada (ASAC); Society of Operations Management, India (SOM) and Soft Computing Research Society (SCRS).

Yuvraj has taught wide variety of courses in Engineering and Management. He has taught courses in Introduction to Management Science, Operations Management, Simulation, Mathematical Optimization Models, Statistics, Global Supply Chain Management, Engineering Economics, Cost accounting; and Methods engineering.