SYSD 300: Introduction to Optimization

Winter 2026 Course Outline

Course description. Suppose that the owner of a factory wants to maximize its production for the next 30 days. There is a limit on the resources available. Resources may include raw materials, labour, machine capacities, etc. This is an example of an optimization problem. We can describe the amount of production using a function. This is the function that we want to maximize, and it is called the objective function. The conditions imposed by the available resources are the constraints of the problem.

This course will discuss optimization problems where the objective function and the constraints are linear. We plan to cover the following topics, integrating these optimization principles with the foundational modelling tools of System Dynamics (SD):

1. Formulating and modelling real world problems as linear programs.
2. The simplex algorithm for solving linear programs.
3. Some theory behind the algorithm, including geometry and duality.
4. Strategies in solving integer programs.
5. Applications to a graph theory problem.

Schedule

There are 22 chapters in the textbook to be covered across 12 weeks of instruction.

Week	Date	Schedule	Quiz
1	Jan 11	**Modelling & SD Fundamentals (Ch. 1-2)**: Perspective, Policy Resistance, Case Studies.	Jan 20
2	Jan 18	**SD Modelling Tools (Ch. 3-4)**: The Modelling Process, Structure and Behaviour (Feedback & Simple Modes).	Jan 27
3	Jan 25	**SD Tools: Diagrams (Ch. 5-6)**: Causal Loop Diagrams, Stocks and Flows (Accumulation, Conservation).	Feb 3
4	Feb 1	**SD Tools: Basic Dynamics (Ch. 7-8)**: Dynamics of Stocks and Flows, Simple Structures (Linear Growth/Decay).	Feb 10

5	Feb 8	**The Simplex Method (Part 1)** (SD Ch. 9: S-Shaped Growth; Ch. 10: Path Dependence & Lock-in)	Feb 24
6	Feb 15	No new material - catch up time	n.a.
7	Feb 22	**Advanced SD Tools: Dynamics & Delays (Ch. 11-12)**: Delays, Coflows and Aging Chains.	Mar 3
8	Mar 1	**SD: Decision Making (Ch. 13-14)**: Bounded Rationality, Nonlinear Functions, Eliciting Relationships.	Mar 10
9	Mar 8	**SD: Expectations & Instability (Ch. 15-16)**: Bounded Rationality, Expectation Formation, Forecasting Errors.	Mar 17
10	Mar 15	**SD: Supply Chains & Cycles (Ch. 17-18)**: Stock Management, Supply Chain Instability, Manufacturing Chains.	Mar 24
11	Mar 22	**SD: Macro Cycles (Ch. 19-20)**: Labor Supply Chain, Commodity Cycles (Oscillation, Amplification).	Mar 31
12	Mar 29	**SD: Testing & Future (Ch. 21-22 + App.)**: Validation, Testing, Challenges for the Future.	n.a.

Course website

Go to the University of Waterloo's LEARN website learn.uwaterloo.ca to find news, assignments, solutions and information about this course. The piazza link is...

Textbook

Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World.*

Assignments

There are 10 weekly assignments. You will receive a Crowdmark link for each assignment, and you need to submit your solutions on Crowdmark. You must submit each question in the corresponding box, or it will not be graded. Late submissions will not be accepted. We will not give individual extensions for any reason.

Exams

The final exam will be comprehensive, and is scheduled by the Office of the Registrar later in the term.

Time limit.
The final exam will be held on Sunday April 18, 2021 4:00 PM. You have 2.5 hours to finish the exam. You have to finish your answers before 6:30 PM, and you have to make sure the answers is submitted via Crowdmark before 6:45 PM, i.e., within 15 minutes after the exam.

Final grade. Your final grade is:

- 5% quiz, midterm #1 15%, midterm #2 15%, midterm #3 15%, 50% final exam.

Policy on collaboration and internet usage in assignments

You may ask your instructor or the TAs for help during their office hours. You may also discuss the assignment problems in small groups. However, you must write up the solutions on your own. This means that you may not write up your solutions while you are with a group, and you should not consult any notes you have taken during your group discussions while writing up your solutions. If a classmate asks for your help, only give hints, and do not give away the entire solution. In addition, you may not use electronic resources for help with assignment problems directly. You are not allowed to use or consult solutions to assignment problems from previous offerings of related courses. Any submitted assignments that are suspected of cheating will be reported to the integrity officer of the Faculty of Mathematics.

Students with disabilities

The AccessAbility Services, located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with them at the beginning of each academic term.