

**SYDE 599**  
**Computational Simulations for Societal and Environmental Systems**  
**Syllabus for Winter Term – 2023 (subject to changes before the 1<sup>st</sup> day of classes)**

**Instructor**

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Open door policy & upon request.

**Course Description:**

This course will introduce and apply the fundamentals of computational simulation for complex systems. Data collection and analysis, conceptual modelling, computational modelling, output analysis, and communication of results to non-expert audiences will be covered extensively. Students will develop computational simulations to explore potential solutions for complex societal problems, identifying emergent scenarios, costs, and benefits with the goal of informing decision-makers. Experience with coding in Python is not required but assignments and class projects will require coding. In-class tutorials will help students develop their coding and modeling skills.

**Schedule**

Lectures and tutorials are scheduled as follows. The Friday of Week 1 will be dedicated to a tutorial on probability, statistics, and Python. Starting from Week 2, the last 30-minutes of each class will be dedicated to a tutorial going over an application of the concepts learned in that class.

Day	Time	Location	Lecture/ Tutorial
Wednesday	04:30pm – 06:20pm	<b>TBD</b>	Lecture & tutorial
Friday	03:30pm – 5:20pm	<b>TBD</b>	Lecture & tutorial

**Learning Outcome**

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

- **List, explain, and apply** the steps in the process for developing a simulation to model a socioenvironmental system or process. (1a, 1d)
- **Evaluate** the range of applicability (strengths and weaknesses) of various computational modelling approaches for a particular system or process. (2a, 2b, 12a)
- **Be confident** in their ability to use computers to solve scientific and engineering problems. (4a, 4b)
- **Think critically** about simulation results and assess the appropriate confidence level for a solution. (2c, 4c, 5c, 9a)
- **Communicate** results in a way as to convince a non-expert audience of the reliability of a solution or simulation insights. (7a, 9b)

**Course Material Posting and Distribution**

**UW-Learn** is the official site for posting material related to SYDE599, including but not limited to announcements, lecture slides, extra reading material, quizzes, project instructions...etc.  
Note: students are not authorized to post of SYDE599 materials on any other site without instructor’s consent. This does not apply to homework solutions and class project materials developed solely by the students.

**Evaluation: (subject to change)**

**Table 1: Grade Distribution**

Item	Weight [%]
<b>Homework</b>	<b>40</b>
Homework 1 (HW1)	10
Homework 2 (HW2)	10
Homework 3 (HW3)	10
Homework 4 (HW4)	10
<b>Project</b>	<b>60</b>
Milestone 1 - scope & data	10
Milestone 2 - models & simulation	10
Presentation	15
Final Report	25

Project-related deliverables will require groups of 3-4 students. Homework will be in groups of up to 2 students.

**Contingencies for Covid-19:**

Should we be required to move away from full-occupancy in-person teaching, the instructors will work with the Department to ensure that students have a fair opportunity to meet course requirements and to be notified of any changes in a timely manner.

**Fair Contingencies for Emergency Remote Teaching:**

We are facing unusual and challenging times. To provide contingency for unforeseen circumstances, the instructor reserves the right to modify course topics and/or assessments and/or weight and/or deadlines with due notice to students. In the event of further challenges, the instructor will work with the Department/Faculty to find reasonable and fair solutions that respect rights and workloads of students, staff, and faculty.



**Course Outline / Topics to be Covered in Lectures (subject to change):**  
**Table 2: Course Outline**

Week	Date	Lecture Topic	Homework	Class Project
1	Wednesday, Jan 11 Friday, Jan 13	Introduction to wicked problems and simulations	Form groups HW0 out (optional)	
2	Wednesday, Jan 18 Friday, Jan 20	Models and workflows for complex systems Models and workflows for complex systems		
3	Wednesday, Jan 25 Friday, Jan 27	Models and workflows for complex systems Models and workflows for complex systems	HW0 due, HW1 out	Project pitches due
4	Wednesday, Feb 01 Friday, Feb 03	Modelling - introduction to object-oriented programming Modelling - introduction to object-oriented programming		
5	Wednesday, Feb 08 Friday, Feb 10	Modelling - cellular automata Modelling - cellular automata	HW1 due	
6	Wednesday, Feb 15 Friday, Feb 17	Modelling - agent-based simulation Modelling - agent-based simulation	HW2 out	Milestone 1
7	Feb 18-Feb 26	Reading Week		
8	Wednesday, Mar 01 Friday, Mar 03	Modelling – discrete event simulation Modelling – discrete event simulation		
9	Wednesday, Mar 08 Friday, Mar 10	Input analysis - extracting insights from data Input analysis - extracting insights from data	HW2 due, HW3 out	
10	Wednesday, Mar 15 Friday, Mar 17	Input analysis - fitting models to data Input analysis - fitting models to data		Milestone 2
11	Wednesday, Mar 22 Friday, Mar 24	Output analysis - verification and validation Output analysis - visualization	HW3 due, HW4 out	
12	Wednesday, Mar 29 Friday, Mar 31	Output analysis - communicating results		
13	Wednesday, April 05 Friday, April 07	Project presentations <b>Good Friday - no class</b>	HW4 due	Presentations
14	Monday, April 10	Class wrap up		Final Reports

The topics listed in Table 2 are a guideline. The rate of moving from one topic to the other and the deadlines for deliverables will be adjusted prior to the beginning of the course and at the discretion of the instructor based on the class progress and the students' performance.

### Assignment deadlines

Homework assignments and project deliverables deadlines are on Fridays at 11:59 p.m.

### Assignment Submission Procedures:

Assignments will be posted on LEARN 2 weeks prior to the due date. Due dates are listed in Table 2. *Slight variations may occur and will be announced ahead of time.*

### Late Submission Rules:10

Grace period of 2 days is allowed per student, where students can submit the assignment late without penalty. The 2 days can be used for one assignment or split on 2 assignments. A fraction of the day i.e., hour(s) after deadline of submission counts as a day. Once grace days are used up, a penalty of 10% per day will be applied.

### Class project:

Class Project will be announced and discussed in class at the start of the term. Project is split into 5 deliverables: a project pitch, two milestones, a presentation, and a final report. The pitch and milestones will prepare the team to their final project application. The topic of the class project will be decided by the groups. The project pitch will allow the instructor to provide early feedback on the intended topic.

### Instructor's policy:

#### Guiding Principles for our SYDE-BME Community (faculty, staff, and students):

1) Be compassionate. 2) Be accountable. 3) Be patient. 4) Be safe and healthy.

**Compassionate and respectful communication:** Most online communication between the Department and students will be done through LEARN and/or email. Students are reminded that they should use their email account name@uwaterloo.ca. Include an academic signature with your full name, program, student- ID).

**SYDE-BME COMMENT ON ACCOMMODATION:** We respect that our SYDE-BME students are independent adult decision-makers, with many opportunities to partake in activities that might be in time conflict with academic deadlines and deliverables. Along with the right to make adult decisions comes the responsibility and accountability for those decisions and any outcomes.

The University of Waterloo's policy on accommodation for missed deliverables pertains to verifiable health matters, and highly unfortunate events (for example: family tragedies). The Department of Systems Design Engineering follows University of Waterloo's general policy: students who self-elect to forgo a deliverable receive a "0" for that deliverable. It is preferred practice so that fairness is maintained for members of the same class/course by avoiding preferential treatment, and so that instructors are not burdened with having to create extra quizzes, deliverables, etc. It also reflects professional practice, as failing to show up to work and missing deadlines can be very costly to the company and individual (for example: not submitting a contract proposal, or design review on time). **Please read the policy here:** [[Accommodation due to illness](#)]

**SYDE-BME Academic Priorities over Co-op Interviews:** students should be able to arrange co-op interviews that do not conflict with major deliverables (for example: timed course midterms, final exams). For deliverables with longer time windows (for example: 24-48 hours or more), students must manage their time for deliverables and co-op interviews accordingly. If a co-op interview conflicts with a short deliverable time window (for example: 1-3 hours), then students **MUST** follow the CECA procedure for rescheduling the interview: [[CECA rescheduling co-op interviews](#)]



**Compassionate Accommodation:** If you are facing challenges that are affecting more than one course contact the Associate Chair Undergraduate (A.C.U.G. email: [sydeunde@uwaterloo.ca](mailto:sydeunde@uwaterloo.ca)) or the Director of BME (email: [sdbmedir@uwaterloo.ca](mailto:sdbmedir@uwaterloo.ca)). They will review your case and coordinate a reasonable and fair plan in consultation with appropriate others (for example: instructors, Department Undergraduate Studies Committee, Chair, AccessAbility Services, Engineering Counselling services, Registrar's Office).

**Academic Integrity:** To maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect, and responsibility. [Check [Academic Integrity](#) on UWaterloo website for more information.]

All students are expected to work individually and submit their own original work. Under Policy 71, the instructor may have follow-up conversations with individual students to ensure that the work submitted was completed on their own.

**Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, [Student Petitions and Grievances, Section 4](#). When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

**Discipline:** A student is expected to know what constitutes [academic integrity](#) [check the UWaterloo weblink] to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to [Policy 71, Student Discipline](#). For typical penalties check [Guidelines for the Assessment of Penalties](#).

**Appeals:** A decision made, or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to [Policy 72 \(Student Appeals\)](#)

**Note for Students with Disabilities:** AccessAbility Services, located in the new addition to Needles Hall, room 1401, 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 the office at the beginning of each academic term. To schedule an appointment or to contact the virtual Front Desk, please phone 519-888-4567 ext. 45231 or ext. 47922 or e-mail [access@uwaterloo.ca](mailto:access@uwaterloo.ca).

**Wellness Support and Contact Information:** University can be a challenging environment and it is normal to need support from time-to-time. Campus Wellness services are available to students through counselling and health services. If you are struggling or need someone to talk to you, please reach out. To book an appointment or learn more about the services, call 519-888-4567 x 32655 or explore [www.uwaterloo.ca/campus-wellness](http://www.uwaterloo.ca/campus-wellness). If you're experiencing a crisis and feel unable to cope and Campus Wellness is closed, contact any of these after-hours supports: EmpowerMe (1-833-628-5589), Good2Talk (1-866-925-5454) or Here 24/7 (1-844-437-3247). They are available at any time of the day or night to help.

### CEAB Graduate Attributes:

The numbers in parentheses next to learning outcomes above refer to the CEAB (Canadian Engineering Accreditation Board) Engineering Graduate Attributes defined by the Canadian Engineering Accreditation Board that are listed below as a reference (Table 4):

**Table 4: CEAB – Graduate Attributes and Indicators**

GA#	Attribute	PI	Program-Level Indicator
1	Knowledge Base	1a	<b>Demonstrate understanding</b> of concepts in mathematics
		1b	<b>Demonstrate understanding</b> of concepts in natural science
		1c	<b>Demonstrate understanding</b> of engineering fundamentals
		1d	<b>Demonstrate understanding</b> of specialized engineering knowledge
2	Problem Analysis	2a	<b>Formulate</b> a problem statement
		2b	<b>Develop models</b> to solve engineering problems including identifying approximations, assumptions, and constraints
		2c	<b>Critically evaluate</b> solutions of engineering problems
3	Investigation	3a	<b>Design experiments</b> <sup>1</sup> to investigate complex engineering problems
		3b	<b>Gather information</b> from relevant sources <sup>2</sup> to address complex engineering problems
		3c	<b>Synthesize information</b> from multiple sources to reach valid conclusions
4	Design	4a	<b>Define</b> design requirements and specifications for complex, open-ended engineering problems <sup>3</sup>
		4b	<b>Generate and refine</b> potential solutions to complex, open-ended design problems
		4c	<b>Critically evaluate</b> and compare design choices
5	Use of Engineering Tools	5a	<b>Select</b> appropriate engineering tools <sup>4</sup> , considering their limitations
		5b	<b>Create and/or modify</b> appropriate engineering tools, identifying their limitations
		5c	<b>Use</b> <sup>5</sup> engineering tools appropriately
6	Individual and Teamwork	6a	<b>Contribute</b> as an active team member or leader to complete individual tasks
		6b	<b>Collaborate</b> with others to complete tasks effectively as a team
7	Communication skills	7a	<b>Generate</b> appropriate documentation to communicate within the profession and to society at large
		7b	<b>Orally present</b> information within the profession and to society at large
		7c	<b>Interpret</b> information, including instructions
8	Professionalism	8a	<b>Articulate</b> the roles and responsibilities of the professional engineer in society with reference to the protection of the public and its interest
		8b	<b>Describe</b> the importance of codes, standards, best practices, laws, and regulations within engineering
9	Impact of engineering	9a	<b>Identify</b> the relevance of and uncertainty associated with the different aspects (social, cultural, economic, health, safety, legal, environmental) of an engineering project
		9b	<b>Analyze</b> the social, health, safety, and environmental aspects of an engineering project, incorporating sustainability considerations in making decisions
10	Ethics and equity	10a	<b>Identify</b> ethical and unethical behaviour in professional situations
		10b	<b>Identify</b> how an engineer is accountable to multiple stakeholders in engineering practice
		10c	<b>Identify</b> equitable and inequitable situations or behaviours
11	Economics and project management	11a	<b>Apply</b> project management techniques in engineering projects, with attention to risk, and change
		11b	<b>Perform</b> economic analyses of engineering projects with attention to uncertainty and limitations
12	Lifelong learning	12a	<b>Identify</b> gaps in their knowledge, skills and abilities
		12b	<b>Obtain and evaluate</b> information or training from appropriate sources
		12c	<b>Reflect</b> on the use of information or training obtained