



# SYDE600

fall 2022

Systems Theory, Models, Research & Design

Lectures: Mondays 10:00–11:30 am and Wednesday, 10:00 to 11:30 am



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This syllabus may be slightly updated during the course of the term.

**Course Description:** The Introduction Of Systems Theory ( Graph Theoretic Methods & Formulation Of System Equations) To The Solving And Modelling Of Problems Via Design And Research Methods. Research Methods Include The Formulation Of Good Problems, Critical Analysis Of Existing Literature And Methods, The Formulation Of Ideas And Research Plans And Papers. In Addition To Problem Formulation And Definition, Design Also Includes Needs Analysis, Criteria, Generation Of Alternative Solutions, Feasibility Analysis, Optimization, Selection, And Implementation & Solution. Antireq: SYDE 361.

**Credit Hours:** 0.5 academic units

**Required Text(s):** note: (1) can be purchased at the UW book store or amazon. (2) will be provided via learn for this course only.

1. Knapp, J., Zeratsky, J., Kowitz, B. (2016). Sprint: How to solve big problems and test new ideas in just five days. Simon and Schuster.
2. Meadows, Donella H. 2008. Thinking in Systems: A Primer. Chelsea Green Publishing, Vermont. donellameadows.org

**Other Recommended Text(s):** I would recommend purchasing (1) and (2) via amazon.

1. Lidwell, W., Holden, K. Butler, J. (2010). Universal principles of design, revised and updated: 125 ways to enhance usability, influence perception, increase appeal, make better design decisions and teach through design. Rockport Publishers.

2. Hanington, B., Martin, B. (2012). Universal methods of design: 100 ways to research complex problems, develop innovative ideas, and design effective solutions. Rockport Publishers.
3. Von Oech, R. (1992). Roger Von Oech's Creative Whack Pack. US Games Systems.
4. Duggan, J. (2016). System dynamics modeling with R. Springer International Publishing.
5. Eggert, R. (2005). Engineering design. Pearson, Prentice Hall.
6. Eppinger, S., Ulrich, K. (2019). Product design and development. McGraw-Hill.
7. Gershenfeld, N.A., Gershenfeld, N. (1999). The nature of mathematical modeling. Cambridge University Press.

### Other ReferenceText(s):

- Walker, Rob (2020). The art of noticing: 131 ways to spark creativity. Knopf publishers.
- Zobel, J. (2014). Writing for computer science (Vol. 8). New York NY: Springer..3rd edition
- Thiel, D. V. (2014). Research methods for engineers. Cambridge University Press
- Ling, C.X., Yang, Q. (2012). Crafting Your Research Future: A Guide to Successful Master's and Ph.D. Degrees in Science and Engineering.
- Weinberg, G.M. (1975). An introduction to general system thinkg (Vol. 304). New York: Wiley.
- Capra, F., Luisi, P.L. (2014). The systems view of life: a unifying vision. Cambridge University Press.
- Jackson, M.C. (2007). Systems approaches to management. Springer Science and Business Media.
- Ramage, M. Shipp, K. (2009). Systems thinkers. London: Springer.
- Walker, B., Salt, D. (2012). Resilience thinking: sustaining ecosystems and people in a changing world. Island press.
- Bertalanffy, Ludwig von. (21968). General System Theory. George Braziller.
- Effective Science Communication A practical guide to surviving as a scientist Sam Illingworth Manchester Metropolitan University Grant Allen The University of Manchester
- Think Complexity, Allen B. Downey, Green Tea Press, 2012, 2nd ed

### Course Objectives:

At the completion of this course, students will be able to:

1. be comfortable with systems thinking and modelling.
2. be able to define a problem, perform literature reviews and document accordingly.
3. be comfortable with writing research papers, reports, engineering reports
4. be comfortable with system modelling and analysis
5. be able to run a design sprint and see its relation to the design process.

**Format:**

**Course website:** Available through <http://learn.uwaterloo.ca> for the purpose of distributing slides, videos, assignments and announcements. Please ensure your email settings are up to date so that you receive messages sent to the class. **Lecture slides/notes will be uploaded on Learn before each week's lectures, which will cover the material.**

**Software:** Students are required to use Python for one or two dynamic system modelling assignments and projects. Download Python and install on your computer. You can either use the BPTK-py library. [https://github.com/transentis/bptk\\_py\\_tutorial/](https://github.com/transentis/bptk_py_tutorial/) or PySD. <https://github.com/JamesPHoughton/pysd/>, which can also be accessed from <https://pysd.readthedocs.io/en/master/index.html>.

**Course Discussions:** On Learn, there is a discussion site blog to post questions for the prof. This is to be shared by the class.

**Assignments:** On Learn, Under the heading "Submit", under the heading of "Dropbox". is where you will find all assignments to be completed. Most assignments will also be uploaded here by the deadline posted.

**Project:**

The project theme will be themed around designing a solution to fighting climate change. I would like each group to choose a unique project based on the topics discussed in the recent book by Bill Gates called "How to avoid a climate disaster". You should be able to find a free copy of the book as Gates made the book freely available to college students a couple of years ago. Chapters 4 to 8 are where I want each group to choose as an area. I would like to get an even distribution of groups for each chapter. The chapters are entitled How we plug in, we make things, we grow things, we get around, we keep cool and stay warm. One choosing an area, the group will focus on a topic in this domain.

**Readings:**

by Week 4 - please read over the Meadows book.

by Week 6 - please read over the Sprint book by Knapp.

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**Outline:**

## 1. Week 1

- Introduction to Design
- References:: Eggert, Eppinger & Ulrich
- Empathy (Open Mind)

## 2. Week 2

- Design Needs
- Design Specs
- References:: Eggert, Eppinger & Ulrich

## 3. Week 3

- Design Concepts, Selection, Testing
- References:: Eggert, Eppinger & Ulrich

4. Week 4

- System Thinking
- System Models
- References:: Meadows, Duggan

5. Week 5

- Creativity
- Professionalism
- Communication
- Academic/Research Integrity
- References: various

6. Week 6

- modelling System Models
- References:: Meadows, Duggan

7. Week 7

- Group: Design Sprint - problem definition; day 1 (understand problem)
- References: Group - Knapp et al.

8. Week 8

- Group: Design Sprint - day 2 (needs)
- References: Group - Knapp et al.

9. Week 9

- Group: Design Sprint - day 3 (ideation)
- References: Group - Knapp et al

10. Week 10

- Group: Design Sprint - day 4 (prototype)
- References: Group - Knapp et al.

11. Week 11

- Group: Design Sprint - day 5 (testing)
- References: Group - Knapp et al.

12. Week 12

- Group: Project Presentations

## Grade Distribution:

- Individual
  - Openmind exercises online 5%
  - System Models, Python exercises (1). 5%.
  - Communications - executive summary, literature review 5%
  - Problem Statement 5%
  - Needs, Statements 5%
  - System Models (abstract) 5%
  - Ethics 5%
  - Design Needs 5%
  - final exam (individual) - 25%
- Group
  - design project (group)- 5 phases 10%; final report 15%; final presentation 10%;

## Important Dates:

various assignments will be posted on Learn in the dropbox  
Final Exam: tbd.

## Collaboration Rule:

Students are encouraged to discuss individual assignment exercises with each other and the course instructor. Any assistance must be limited to discussion of the problem and sketching general approaches to a solution. Each student must write their own individual solutions, including codes and text. Consulting another student's solution is prohibited and submitted solutions may not be copies from any source. In particular, submitting solutions copied in whole or in part from an assignment submission or solution key from any offering of a similar course is prohibited, even if the student is resubmitting their own work. These and any other forms of collaboration on assignments constitute cheating.

## 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 now use their email account name@uwaterloo.ca. Include an academic signature with your full name, program, student ID. We encourage you to include your preferred pronouns (he/him; she/her; they/them).

**Scheduling of Synchronous (live) online course events:** Due to the COVID-19 pandemic, all University of Waterloo courses components will be delivered online, until further notice. To

maintain build supportive teaching environments, instructors may use the time slots (EDT) scheduled ?in-class? hours to hold ?live-stream? events such as lectures, tutorial help sessions, group activities, and open office hours. To accommodate different time zones, different working/studying conditions and limitations in internet access, all critical course components, including lectures and student support must be made available in asynchronous formats. Any timed component (for example: a test or quiz) must take time zone and internet availability into account.

**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: [Link: Accommodation due to illness](#)]

**SYDE-BME Academic Priorities over Co-op Interviews:** With asynchronous schedules, 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: [[Link 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).

## **FACULTY OF ENGINEERING: MORE FINE PRINT**

Faculty of Engineering website: [[Link Academic Support and Policies](#) ].

**Academic Integrity:** In order 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 website for more information. Link Office of Academic Integrity](#)].

**Discipline:** A student is expected to know what constitutes academic integrity (see link above) to avoid committing an academic offence, and to take responsibility for their actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (for example: plagiarism, cheating) or about expectations for group work/collaboration

should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. Relevant documents include:

- University of Waterloo Policy 71 [Link Policy 71 Student Discipline].
- Academic Penalty Guidelines [Link Policy 71 Penalty Guidelines].
- Assessment of Unauthorized Collaboration: [Link Assessment of Unauthorized Collaboration].

**Grievance:** A student who believes that a decision affecting some aspect of their 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 **Associate Chair Undergraduate or Academic Advisor** who will provide further assistance. [Link Policy 70 Petitions & Grievance].

**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 they have a ground for an appeal should refer to Policy 72 (Student Appeals) [Link Policy 72 Student Appeals].

bf Note: We are facing unusual and challenging times. The instructor reserves the right to modify course topics and/or assessments with due notice. In the event of further challenges, the instructor will work with the Department to find reasonable and fair solutions. Writing and Communication Centre.

**The Writing and Communication Centre** works with students in all Faculties to help you consider your audience, clarify your ideas, develop your voice, and write in the style appropriate to your discipline. We offer one-on-one support for writing papers, delivering presentations, integrating research, and revising for clarity and coherence. Group appointments for team-based projects, presentations, and papers are also available.

**All of our services are available virtually:** booked appointments, drop-ins, resources, and writing groups. Check out our website for other ways to interact with us, such as open online forums and online ?Question and Answers?. Visit us at [www.uwaterloo.ca/wcc](http://www.uwaterloo.ca/wcc).

Please note that communication specialists guide you to see your work as readers would. We can teach you revising skills and strategies, but will not change or correct your work for you. Please bring your assignment instructions and any notes or drafts to your appointment.

[Link Writing and Communication Centre].

**AccessAbility Services:** AccessAbility Services (A.A.S.) is the University's centralized office for the provision of academic accommodations for students with a known or unknown disability, illness, or condition. Even if students are unsure of whether they qualify for A.A.S. support, an A.A.S. consultant can talk them through next steps, and refer them elsewhere if appropriate. [Link AccessAbility Services].