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Required Text: P. Fieguth, *An Introduction to Complex Systems (2nd Ed)*, Springer, 2021  
532 Home Page: SYDE 532 Learn page

Class Times: Mondays 4:00-5:30, Thursdays 8:30-10:00, E5-6006  
Tutorial scheduled for 4-5pm Fridays (will be changed)

Office Hours: Fieguth: Mondays 3-4pm at Course Zoom link  
Arnold / Brubacher: arrange via email

### Course Grading:

- 40% Five assignments, each with numerical/analytical and written components, exploring practical aspects of different parts of the course. These assignments are to be done individually. Assignments may be submitted up to 4 days late, but at -5% per day. (TurnItIn checking will be in place for assignments.)
- 10% A short in-class quiz, scheduled for Thursday, February 17th.
- 10% A modest project, essentially written in the style of the textbook examples. One or more examples (details on Learn) involving some aspect of mathematics, earth science, monitoring / inverse problems, or policy in complex systems. This project may be done individually, although preferably in groups of two, and will be due towards the end of the term.
- 40% Final exam  
(Final exams with grades below 50% may be weighted more heavily in the course grade.)

### Learning Objectives:

- Understand the assumptions and limitations behind linear dynamic / Gaussian systems
- Understand the mathematical properties of nonlinear dynamic / power-law systems
- Understand the meaning of bifurcations, hysteresis, limit cycles, heavy tails
- Be able to abstract / generalize the impacts and implications of nonlinear systems
- Be able to draw connections between macroscopic socio-environmental systems

**Course Outline:** (See home page for more detailed breakdown and additional information)

At a high level, we wish to better understand physical systems and their interactions with human society. This leads to four areas of discussion:

1. Mathematics and Modeling
2. The Science of the Physical World
3. Earth Monitoring and Inverse Systems
4. The Human World and Related Policy

In terms of content, the course will focus on Systems theory, Linear systems; Nonlinear dynamic systems; Spatial systems; Heavy-tailed or Power-law distributions; Complex systems, and Inverse problems.

Students should consult the course home page for on-line resources, a tutorial schedule, and other updates.

The course will be offered synchronously, whether in-person or on-line. The course content, expectations, and deliverables will not be affected whether the term is primarily online or in-person.

Cheating and Plagiarism: Students are expected to know what constitutes academic integrity. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71. Students are encouraged to discuss course material and concepts, however assignments and exams must be undertaken individually.

## Course and Departmental Expectations

Guiding Principles for the SYDE-BME Community:

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).

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.

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) or the Director of BME (email: 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

### **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 [www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/) for more information.

### **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, [www.adm.uwaterloo.ca/infosec/Policies/policy70.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm). 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 ([www.uwaterloo.ca/academicintegrity/](http://www.uwaterloo.ca/academicintegrity/)) 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, [www.adm.uwaterloo.ca/infosec/Policies/policy71.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm). For typical penalties check Guidelines for the Assessment of Penalties, [www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm](http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm).

### **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. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals) [www.adm.uwaterloo.ca/infosec/Policies/policy72.htm](http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm).

### **Note for Students with Disabilities:**

Accessibility Services, located in 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 OPD at the beginning of each academic term.