ENGG*3440 Process Control

01

Winter 2024
Section(s): 01

School of Engineering
Credit Weight: 0.50
Version 1.00 - January 04, 2024

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1 Course Details

1.1 Calendar Description

Students will learn about dynamic process behaviour and process control strategies relevant to biological and environmental engineering, including how to analyze, model, predict and control processes in time and frequency domains. Performance and stability parameters will be illustrated with root locus diagrams. Control by on/off and proportional (and its advanced variants) controllers will be applied to feedback control problems including regulating physical and chemical properties, and biological and chemical reactions. This course includes experimental process control laboratory work and use of controller modeling software.

Pre-Requisites:	ENGG*2400, MATH*2270
Restrictions:	This is a Priority Access Course. Enrolment may be restricted to the BIOE and ENVE specializations in the BENG and BENG:C programs. See department for more information. Non-BENG students may take a maximum of 4.00 ENGG credits.

1.2 Course Description

This course provides a background in the fundamentals of course systems applied to processes. Process control applications relevant to biological and environmental will be emphasized. Practical knowledge and understanding will be developed through a series of experiments and simulation exercises.

1.3 Timetable

Lectures: Monday, Wednesday and Friday. 3:30 pm to 4:20 pm in MCLN 107.

Lab/tutorial sections:

- Section 01: Monday, 8:30 am to 10:20 am
- Section 02: Thursday, 8:30 am to 10:20 am

Weekly tutorials will be held in THRN 1004. Lab experiments will be conducted in THRN 1116 several times during the semester. (Details of experiment times and logistics will be posted on Courselink.)

1.4 Final Exam

This course includes a final exam on Thursday April 18, 8:30 am to 10:30 am. The final exam location will be posted on WebAdvisor before the end of classes in April.

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2 Instructional Support

2.1 Instructional Support Team

Instructor:	W. David Lubitz
Email:	wlubitz@uoguelph.ca
Telephone:	+1-519-824-4120 x54387
Office:	THRN 1340
Office Hours:	Office hours will be determined during the first week of class and will be posted on Courselink.
Lab Technician:	Joanne Ryks
Email:	jryks@uoguelph.ca
Telephone:	+1-519-824-4120 x54087
Office:	THRN 1114

2.2 Teaching Assistants

Teaching Assistant (GTA):	Marziyeh Karandish
Email:	mkarandi@uoguelph.ca
Teaching Assistant (GTA):	Masoume Hekmat
Email:	mhekmat@uoguelph.ca

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3 Learning Resources

3.1 Required Resources

Process Control, Designing Processes and Control Systems for Dynamic Performance, 2nd Edition by Thomas Marlin (Textbook)

http://www.pc-education.mcmaster.ca/Book_Links.htm

The course textbook is free to download and use. A copy of the text book is posted on Courselink for viewing or download. It may also be downloaded from the accompanying

URL. It is recommended to download the entire text.

It is encouraged to print the following parts of the text for reference and note-taking during the course: Chapters 1, 3 through 9, 13, 14, 18.

MATLAB (Software)

This course includes programming in MATLAB. MATLAB is installed in all School of Engineering (SOE) computer labs. If you have access to a non-SOE computer with MATLAB, or an open-source MATLAB-like software like GNU Octave, it will need to include the Control Systems toolbox to be useful for this course, which is not part of most default MATLAB installations.

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4 Learning Outcomes

4.1 Course Learning Outcomes

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

1. apply systems theory to complex real world problems in order to obtain models that are expressed using differential equations and transfer functions.
2. predict system behaviour based on the mathematical model of that system where the model may be expressed in time or frequency domain.
3. analyze the behaviour of closed loop systems using appropriate tools.
4. design on/off and PID controllers in process control applications.
5. communicate the goals, methods and results of experiments in written reports.

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	2
1.3	Recall, describe and apply fundamental engineering principles and concepts	2
2	Problem Analysis	1, 3, 4
2.3	Construct a conceptual framework and select an appropriate solution approach	1
2.4	Execute an engineering solution	3, 4
3	Investigation	5
3.3	Analyze and interpret experimental data	5

#	Outcome	Learning Outcome
3.4	Assess validity of conclusions within limitations of data and methodologies	5
7	Communication Skills	5
7.4	Substantiate claims by building evidence-based arguments and integrating effective figures, tables, equations, and/or references	5

5 Teaching and Learning Activities

The lecture schedule listed below will change to reflect course and students needs during the semester. It is included here only as a general overview of the planned course.

5.1 Lecture

Week 1

Topics: Introduction to field of process control.

References: Textbook sections 1.1 - 1.10

Week 2

Topics: Mathematical Modeling Principles

References: 3.1 Intro, 3.2 Modeling Process, (3.3 Examples), 3.4 Linearization, 3.5 Solving ODEs

Week 3

Topics: Laplace transforms, transfer functions and block diagrams

References: 4.1, 4.2 Laplace Transform, 4.3 Transfer Functions, 4.4 Block Diagrams

Week 4

Topics: Dynamic behaviour of process systems

References: 5.1, 5.2 Basic System Elements

Week 5

Topics:	Empirical model identification
References:	6.1, 6.2 Empirical Model Procedure, 6.3 Process Reaction Curve

Week 6

Topics:	The feedback loop
References:	7.1, 7.2 Elements of Feedback Loop, 7.3 Selecting Variables, 7.4 Measuring Control Performance, 7.5

Week 7

Topics:	Winter Break - no classes, labs or tutorials this week

Week 8

Topics:	PID control
References:	Chapter 8

Week 9

Topics:	PID Tuning
References:	Chapter 9

Week 10

Topics:	Performance feedback control
References:	Chapter 13

Week 11

Topics:	Cascade control
References:	Chapter 14

Week 12

Topics: Level and inventory control

References: 18.1 - 18.9

Week 13

Topics: Measuring devices

References: Courselink notes on principles of measurements, sampling methods, linearizing and non-dimensionalizing measured data.

5.2 Lab

Topics: A total of four labs will be conducted by students in groups during this course. Groups (of 3 to 4 students) will be formed during the first tutorial sections, which will take place in Week 2 (Jan. 15-19). Groups may not include students from different sections.

Labs will take place during your scheduled lab section. Labs are tentatively planned to take place on the following dates:

- Week 3 (Jan. 22-26) Lab 1 - System Properties
- Week 5 (Feb. 5-9) Lab 2 - On/off Control
- Week 10 (Mar. 11-15) Lab 3 - PID Control 1
- Week 12 (Mar. 25-29) Lab 4 - PID Control 2

Note that the weeks when labs are conducted may be shifted due to operational considerations. Plan to be able to attend your lab/tutorial section for all weeks of the course after the first week. Students will be expected to participate in all labs and attendance will be taken. Unapproved absences or evidence of low contribution by a student in group labs may result in lab mark reductions for individual students within a group.

Labs will be conducted in-person in THRN 1116.

Tutorials will be held in THRN 1004 all weeks when labs are

not being conducted, starting the second week of class.

If public heath or university regulations do not permit in-person labs or tutorials, online versions will be conducted instead.

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6 Assessments

6.1 Marking Schemes & Distributions

Course marks for each student will be calculated using the weightings in all schemes. The highest of the calculated marks will be the student's final course mark.

Make-up or late midterm exams will not be available if students miss a midterm exam.

Name	Scheme A (%)	Scheme B (%)	Scheme C (%)
Labs	30	30	30
Midterm Exam 1	20	0	28
Midterm Exam 2	20	28	0
Final Exam	30	42	42
Total	100	100	100

6.2 Assessment Details

Midterm Exam 1 (20%)
Date: Fri, Feb 2, 12:30 PM, In class
Learning Outcome: 1, 2

Midterm Exam 2 (20%)
Date: Fri, Mar 8, 12:30 PM, In class
Learning Outcome: 1, 2, 3

Lab Reports (30%)
Learning Outcome: 3, 5
Students groups will complete four process control labs during the course. After completing each lab, student groups will have one week to prepare and submit a lab report (one submission per group). Each lab report will be 7.5% of the course mark.

Final Exam (30%)
Date: Posted before end of classes in April, location will be posted on WebAdvisor one week before the exam.

Learning Outcome: 1, 2, 3, 4

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7 School of Engineering Statements

7.1 Instructor's Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

7.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

7.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

8 University Statements

8.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

8.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration

https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

8.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

8.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

8.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

8.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

8.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

8.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars

8.9 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed

assessments or when involving a large part of a course (e.g.. final exam or major assignment).
