ENGG*3410 Systems and Control Theory

Winter 2018
Section(s): C01,C02

School of Engineering
Credit Weight: 0.50
Version 1.00 - January 05, 2018

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1 Course Details

1.1 Calendar Description

Modeling, performance analysis and control with potential application to engineering, physical and biological systems. Topics include modeling in time, Laplace and frequency domains. Performance and stability by methods of Hurwitz, Routh, Bode, and Nyquist. Control by ON/OFF and PID Controllers.

Pre-Requisite(s):   ENGG*2400, MATH*2270
Co-Requisite(s):   ENGG*2450

1.2 Course Description

This course explores the fundamentals of systems and control. The course has two primary focuses:

(1) understanding and predicting system behaviour and (2) design and analysis of closed loop control systems.

1.3 Timetable

Section 1

Lecture	Time	Location
Tuesday, Thursday	08:30AM - 09:50AM	RICH, Room 2520

Section 2

Lecture	Time	Location
Tuesday, Thursday	05:30PM - 06:50PM	ROZH, Room 103

Section 1 & Section 2

Lab	Time	Location
Monday	02:30PM - 04:20PM	RICH, Room 1504A
Monday	02:30PM - 04:20PM	RICH, Room 1504B
Tuesday	03:30PM - 05:20PM	RICH, Room 1504A
Tuesday	03:30PM - 05:20PM	RICH, Room 1504B
Wednesday	02:30PM - 04:20PM	RICH, Room 1504A
Wednesday	02:30PM - 04:20PM	RICH, Room 1504B
Thursdays	01:30PM - 03:20PM	RICH, Room 1504A
Thursdays	01:30PM - 03:20PM	RICH, Room 1504B
Friday	02:30PM - 04:20PM	RICH, Room 1504A
Friday	02:30PM - 04:20PM	RICH, Room 1504B

Section 1 & Section 2

Tutorial	Time	Location
Monday	07:00PM - 07:50PM	MCKN, Room 115
Monday	08:00PM - 08:50PM	MCKN, Room 115
Tuesday	07:00PM - 07:50PM	MCKN, Room 116
Wednesday	07:00PM - 07:50PM	MCKN, Room 121
Thursday	07:00PM - 07:50PM	MCKN, Room 115

1.4 Final Exam

April 20, 11:30AM - 01:30PM, location TBD on Webadvisor

2 Instructional Support

2.1 Instructor(s)

Hadis Karimipour
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Simon Yang
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2.2 Instructional Support Team

Lab Technician:	Hong Ma
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2.3 Teaching Assistant(s)

Teaching Assistant:	Mohammad Shallouf
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Teaching Assistant:	Adib Fatayerji
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3 Learning Resources

3.1 Required Resources(s)

Textbook (Textbook)
Richard C. Dorf, Robert H. Bishop, "Modern Control Systems", Pearson, 13th Edition.

Course material, news, announcements, and grades will be regularly posted to the ENGG*3410 [Courselink](#) site. You are responsible for checking the site regularly.

3.2 Recommended Resources(s)

Control Systems Engineering (Textbook)
Norman S. *7th edition* Wiley, 2015

3.3 Additional Resources(s)

Lab Information (Lab Manual)

The lab manuals and rubrics will be posted in the lab section of the Courselink page.

Problem sets (Notes)
Additional homework problems may be posted in the 'problem sets' section of courselink. Solutions to selected questions will be posted to the same section in Courselink by the instructor and the GTAs. **Homework problems will not be graded.**

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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, transfer functions, and state space equations
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 tools such as root locus, Routh Hurwitz, Bode, Nyquist, and Matlab
4. design controllers using classical PID methods, root locus methods, and frequency domain methods
5. devise a safe and effective method of investigating a system identification problem in the lab

6. write a report that effectively communicates the results of an experiment or design

4.2 Engineers Canada - Graduate Attributes

Successfully completing this course will contribute to the following:

#	Outcome Set Name	Course Learning Outcome
1	Knowledge base	1, 2, 3, 4, 5
1.1	Recall, describe and apply fundamental mathematical principles and concepts	1, 2, 3, 4, 5
1.2	Recall, describe and apply fundamental concepts and principles in natural sciences	1, 2, 3, 4, 5
1.3	Comprehend and apply fundamental engineering concepts	1, 2, 3, 4, 5
1.4	Comprehend and apply program-specific engineering concepts	1, 2, 3, 4, 5
2	Problem analysis	1, 2, 3, 4, 5
2.1	Formulate a problem statement in engineering and nonengineering terminology	1, 2, 3, 4, 5
2.2	Construct a conceptual framework	1, 2, 3, 4, 5
2.3	Identify, organize and justify appropriate information	1, 2, 3, 4, 5

#	Outcome Set Name	Course Learning Outcome
2.4	Execute an engineering solution	1, 2, 3, 4, 5
2.5	Critique and appraise results	1, 2, 3, 4, 5
3	Investigation	5
3.1	Propose and test working hypotheses	5
3.2	Design and apply an investigation plan	5
3.3	Analyze and interpret experimental data	5
3.4	Assess validity of conclusions within limitations of data and methodologies	5
4	Design	4
4.1	Describe the design process	4
4.2	Construct design-specific problem statements	4
4.3	Create engineering design solutions	4
4.4	Develop engineering design solutions	4
4.5	Assess engineering design solutions	4
4.6	Implement engineering design solutions	4
5	Use of engineering tools	3, 4
5.1	Select appropriate engineering tools from various alternatives	3, 4
5.2	Apply selected engineering tools	3, 4
5.3	Recognize limitations of selected engineering tools	3, 4
7	Communication skills	6
7.1	Develop and deliver clear, key concepts using methods appropriate for the intended audience	6
7.2	Critically evaluate received information	6
7.3	Demonstrate active listening and follow instructions	6
11	Economics and project management	5
11.1	Apply project management techniques and manage resources within identified constraints	5
11.2	Estimate the life cycle engineering benefits and costs associated with engineering design	5

4.3 Relationships with other Courses & Labs

Previous Courses:

ENGG*2400: System fundamentals, linear equations, responses, solving differential equations
MATH*2270: Linear differential equations, responses, solving differential equations, Laplace transform
ENGG*2450: Foundations of systems analysis, frequency response, RLC circuit analysis, ideal operational amplifiers

Follow-on Courses:
ENGG*3490: Foundations of systems and control, system responses, stability, PID ENGG*4280: Everything
ENGG*4430: Foundations of systems and control, closed loop control

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5 Teaching and Learning Activities

5.1 Lecture

Topic(s):   Tentative Schedule
Lecture   Topic

Lecture	Topic
1-2	Topic 1 – Introduction to systems, Math review (Laplace, partial fractions, etc.)
3-4	Topic 1,2 – Transfer functions: FVT
5-9	Topic 3 – Modeling in time domain: linearization, state-space
10-11	Topic 4 – Time response (transient chracteristics)
12-14	Topic 5 – Stability, steady-state errors
15-16	Topic 6 – Introduction to Control: closed loop systems, block diagrams
17-20	Topic 7 – Root locus, PID control
20-23	Topic 8 – Frequency design: Bode, Nyquist
24	Topic 9 – More control design: lead-lag

5.2 Lab

Topic(s):   Lab Scheule

- All of the lab sections are all full. This means that you will not be allowed to attend a lab section that you are not scheduled for. Please go to the laboratory time and date that corresponds to the section that you selected in webadvisor.
- Lab reports are due at 4:30pm on the week indicated below on the day of the week corresponding to your lab section (i.e., if your lab is on a Monday, then your submission

is due on a Monday at 4:30pm in the week indicated below). You must submit your lab using Courselink. The final writup for lab 5 must be submitted in softcopy on courselink **and** in hardcopy in the SOE submission boxes (box number 18).

Week	Lab	Due Date
1		
2	Lab 1: On/Off Lab, Safety Lab	
3	Lab 2: MATLAB	Lab 1 Due
4		Lab 2 Due
5	Lab 3: Modeling	
6		Lab 3 Due
7	Reading Week	
8	Lab 4:PID Investigation	
9		Lab 4 Due
10	Lab 5 (day 1): PID Design	
11	Lab 5 (day 2): PID Design	
12		Lab 5 Due

5.3 Note: Week 1 is the week of January 8.

5.4 Other Important Dates

Monday, January 8, 2018: First day of class

Monday, February 19 - Friday, February 24, 2018: Winter Break

Friday, March 9, 2018: drop date - 40th class

Friday, April 6, 2018: last day of class

5.5 Lab Schedule

All of the lab sections are all full. This means that you will not be allowed to attend a lab section that you are not scheduled for. Please go to the laboratory time and date that corresponds to the section   that you selected in webadvisor.

6 Assessments

6.1 Assessment Details

Labs (25.00%)
All of the lab sections are all full. This means that you will not be allowed to attend a lab section that you are not scheduled for. Please go to the laboratory time and date that corresponds to the section that you selected in webadvisor.

Midterm (35.00%)
Date: Sat, Mar 3, 9:30 AM - , 11:30 AM, ROZH 101

Final Exam (35.00%)
  Date: Fri, Apr 20, 11:30 AM - , 1:30 PM, location TBD on Webadvisor

4 quizzes (5.00%)
  Date: In class
  Quiz 1- Jan 23

  Quiz 2- Feb 6

  Quiz 3- March 15

  Quiz 4- April 5

6.2 Prelabs weights

Prelab 2 is 1%, Prelab 3 is 2%, Prelab 5 is 2%, (for a total of 5%).

Labs are not equally weighted: Lab 1 is 2%, Lab 2 is 3%, Lab 3 is 4%, Lab 4 is 5% and lab 5 is 6% (for a total of 20%).

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7 Course Statements

7.1 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psycholog- ical, or compassionate reasons, please email both course instructors. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email both course instructors within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of Religious Obligations: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Missed midterms: If you miss the midterm due to grounds for granting academic consideration or religious accommodation, the weight of any missed test will be added to the final exam weight. There will be no makeup tests. No extra time will be given to students who arrive late.

Midterm and Final exams: For both exams you are allowed to *bring your own* only one aid sheet A4   size (you can write on both sides) that can only have formulas (No solved problems, no deriva- tions, no description, no explanation, no figures, no diagrams, no graphs, no curves, no tables, etc.) Any deviations from this will result in 40% deduction of your exam mark.

Lab Work: You must attend and complete all laboratories. If you miss a laboratory due to grounds   for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup lab.

Attendance will be taken in the lab. All students are required to demo their lab during their lab session; this demo is graded. If you are not present for your lab and your demo, you will not be

allowed to submit a lab report and you will get a zero on that lab. If you miss more than 25% of a lab period due to lateness or by leaving before you have finished the lab, you will be considered absent. Some labs are scheduled to take place over two weeks; if you complete your lab in the first week, you do not need to attend the second week.

Pre-lab: Some labs have a *mandatory* prelab. Prelabs will be posted on the Courselink. Your group must submit your prelab 24 hours prior to arriving to your scheduled lab section. Your prelab will be graded by the TA before you enter the lab. You should arrive at the lab already having looked at the feedback from your prelab. You will not be allowed to enter the lab if your prelab is incomplete or missing. Since all lab sections are full, we can not allow you to attend a later lab if your miss your scheduled time due to a missing prelab; therefore, if your prelab is incomplete, then you will get an automatic zero on that lab.

Late Lab Reports: Late submissions of lab reports will be penalized at a rate of 10% per hour.

All labs and prelabs are submitted via courselink. It is your responsibility to ensure that your lab has been properly submitted, not your lab partner's. Double check that the correct file has been uploaded to the drop box. If you upload the incorrect file or fail to upload properly and do not fix the problem before the due date, you will be penalized according to the late submission rules: there will be NO exceptions. If you are having trouble submitting to courselink, email a copy of your report to the TA or submit a hard-copy before the deadline to provide proof that you completed the lab on time. A date stamp on a soft copy file DOES NOT constitute proof of timely completion.

8 School of Engineering Statements

8.1 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.

8.2 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.

8.3 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.

9 University Statements

9.1 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.

9.2 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 regulations and procedures for [Academic Consideration](#) are detailed in the Undergraduate Calendar.

9.3 Drop Date

Courses that are one semester long must be dropped by the end of the fortieth class day; two-semester courses must be dropped by the last day of the add period in the second semester. The regulations and procedures for [Dropping Courses](#) are available in the Undergraduate Calendar.

9.4 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.

9.5 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 book their exams at least 7 days in advance, and not later than the 40th Class Day.

More information: www.uoguelph.ca/sas

9.6 Academic Misconduct

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 discourages misconduct. 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.

The [Academic Misconduct Policy](#) is detailed in the Undergraduate Calendar.

9.7 Recording of Materials

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

9.8 Resources

The [Academic Calendars](#) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.