ELEC ENG 3CL4
Introduction to Control Systems
Winter 2018
Course Outline

CALENDAR/COURSE DESCRIPTION

Modelling of control systems in the continuous-time domain; state space representations; model linearization; performance of control systems in time and frequency; stability; control design.

PRE-REQUISITES

Registration in any Computer Engineering or Electrical Engineering Program,
One of ELECENG 3TP3 or 3TP4

SCHEDULE

Lectures: HSC 1A1, Monday, Wednesday, Thursday 1:30 pm – 2:20 pm
Tutorial: TSH 120, Wednesday 9:30 am – 10:20 am; starts 11 January 2018
Labs: Every Other Week: L01 Monday 2:30 pm – 5:20 pm; L02 Monday 2:30 pm – 5:20 pm; L03 Tuesday 2:30 pm – 5:20 pm; L04 Tuesday 2:30 pm – 5:20 pm; L05 Wednesday 2:30 pm – 5:20 pm; L06 Wednesday 2:30 pm – 5:20 pm; L07 Thursday 2:30 pm – 5:20 pm; L08 Thursday 2:30 pm – 5:20 pm; L09 Friday 2:30 pm – 5:20 pm; L10 Friday 2:30 pm – 5:20 pm

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Tim Davidson
ITB-A111/A
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ext. 27352

Office Hours:
See course web site

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

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Office hours and updated contact information will be posted on the course web site

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

http://www.ece.mcmaster.ca/~davidson/EE3CL4

COURSE OBJECTIVES

To engage students in the art of classical control system design for linear systems, with an emphasis on the design of lead and lag controllers using root locus and Nyquist diagram techniques, and on the development of insight into the trade-offs in control system design.

ASSUMED KNOWLEDGE

- Basic understanding of dynamic systems (Phys 1D03)
- Basic understanding of electromagnetics (Phys 1E03)
- Understanding of electric circuit analysis (Elec Eng 2CI5, Elec Eng 2CJ4)
- Understanding of first and second order linear differential equations with constant coefficients (Math 2Z03, Elec Eng 2CI5)
- Understanding of the Laplace Transform (Math 2Z03, Elec Eng 2CJ4)
- Transfer functions (Elec Eng 2CJ4, Elec Eng 3TP3)
- Understanding of Bode diagrams (Elec Eng 2CJ4)

COURSE MATERIALS

Required Text:
Dorf and Bishop, *Modern Control Systems*, 13th edition, Prentice Hall, 2017.
The 11th and 12th editions of the above text will be sufficient as a textbook this year. However, I may drop support of these editions in future years, and this may affect their local re-sale value.

Calculator:
Only the McMaster Standard Calculator will be permitted in tests and examinations. Please note that as of September 2017, the McMaster Standard Calculator is the Casio fx-991 MS or Casio fx-991 MS Plus. The Casio fx-991 is available with various letter configurations, however only the MS or MS Plus models are acceptable when the McMaster Standard Calculator has been designated for use. (See https://registrar.mcmaster.ca/exams/requirements/ for more information.)

Other Materials:
The slides from lectures will be posted on the course web site, as will references to a number of additional resources.

COURSE OVERVIEW

Date/Week	Topic	Readings (Sect's in text)
Week 1	Introduction	1.1,1.3, 1.5, 1.8, 1.9, 1.10
Week 2	Mathematical modelling of dynamic systems	2.5, 2.10, 2.6
Weeks 3,4	Characteristics of feedback	4.2-4.4, 4.6, 4.7, 5.2, 5.3, 5.5, 5.6
Week 5	Stability and Routh Hurwitz analysis	6.3, 6.3, 6.7, 6.5
Weeks 6-8	Root locus analysis and design	7.2, 7.3, 7.4, 7.7, 10.3, 10.5, 10.7
Week 9	PID and Digital Control	7.6, 13.2, 13.3
Week 10	Frequency response	8.1-8.3, 10.3
Weeks 11-13	Nyquist diagram analysis and frequency-domain design	9.2-9.5, 10.4, 10.8

A more detailed time line is available on the course web site.

LABORATORY OVERVIEW

Date/Week	Topic
Weeks 2,3	Introduction
Weeks 4,5	System Identification
Weeks 6,7	Proportional control
Weeks 9,10	Lead control
Weeks 11,12	Lag control

LABORATORY OPERATION

- The laboratories will be held in ITB-154.
- The laboratories will be performed in groups of two students.
- Each lab will involve a significant amount of pre-lab work. You may submit one pre-lab report per group, or you can submit your own pre-lab, should you so wish.
- The pre-lab work will be assessed at the beginning of the lab. The penalties for late pre-lab work are as follows. Pre-lab received by TAs before 2:45pm: No penalty. Pre-lab received by TAs between 2:45pm and 3:00pm: A penalty of 50% of the awarded mark will be applied. Pre-lab not submitted before 3:00pm: No marks will be awarded for the pre-lab component, but you will be allowed to attempt the experiments
- The TAs and the instructor reserve the right to interview students to assess their understanding of the pre-lab material. Such interviews will be held at random and we reserve the right to adjust the pre-lab mark based on the outcome of the interview.
- Your performance of the experiments described in the lab will be assessed through an interview process with a TA, and a report prepared during the lab time. During the interview process students will demonstrate

the outcome of the experiment. The TAs will ask questions that probe your understanding of the experiment and the outcome, and they will assess your work based on your responses.

- The laboratories will end at 5:30pm. If you are unable to complete an experiment by that time, you will not receive the marks for that component of the laboratory.
- The laboratories constitute an important component of the course, and, as such, the content of the labs is examinable in the midterm test and the final exam.

ASSESSMENT

Component	Weight
Laboratory reports	20%
Mid-term test	25%
Final Exam	55%
Total	100%

Grading Policies:

- In order to be eligible for a final grade, each student must personally complete all laboratories and write a satisfactory laboratory report
- Percentages will be converted to letter grades using the Registrar's recommended procedure.
- Statistical adjustments (such as "bell curving") will not normally be used.
- A request for remarking of a mid-term test can me made using the form provided on the course web site. Mid-term tests written in pencil will not be remarked. Neither will test booklets with missing pages.
- When a test or examination is formally deferred, the instructor reserves the right to conduct that test or examination orally.

ACCREDITATION LEARNING OUTCOMES

Note: The *Learning Outcomes* defined in this section are measured throughout the course and form part of the Department's continuous improvement process. They are a key component of the accreditation process for the program and will not be taken into consideration in determining a student's actual grade in the course. For more information on accreditation, please ask your instructor or visit: http://www.engineerscanada.ca .

Outcomes	Indicators	Measurement Methods(s)
Problem analysis	Demonstrates an ability to identify a range of suitable engineering fundamentals (including mathematical techniques) that would be potentially useful for analyzing a technical problem	Midterm and final exam questions
Design	Recognizes and follows an engineering design process (This means an iterative activity that might include recognizing the goal, specifying the constraints and desired outcomes, proposing solutions, evaluating alternatives, deciding on a solution, and implementing.)	Labs, final exam questions
Communication skills	Constructs effective oral or written arguments as appropriate to the circumstances	Labs, final exam questions
Professionalism	Demonstrates an understanding of the role of the engineer in society, especially in protection of the public and public interest	In-class examples and surveys
Impact of Engineering on Society and the Environment	Identifies and quantifies the full range of short-term, long-term, local and global impacts of their engineering projects on society, including: economic aspects; social, cultural, and human health aspects, and; ecosystem integrity aspects.	In-class examples, surveys, essays
Ethics and equity	Applies the engineering code of ethics, understanding of the stakeholders: the individual, the employer, and the public.	In-class examples, surveys, group discussions

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

ACADEMIC ACCOMMODATIONS

Students who require academic accommodation must contact Student accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contact by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca. For further information, consult McMaster University's Policy for Academic Accommodation of Students with Disabilities.

NOTIFICATION OF STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work": http://www.mcmaster.ca/msaf/

NOTICE REGARDING POSSIBLE COURSE MODIFICATION

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

Electrical and Computer Engineering Lab Safety

Information for Laboratory Safety and Important Contacts

This document is for users of ECE instructional laboratories in the Information Technology Building.

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory.

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe condition.
6. The location and correct use of all available safety equipment should be known.
7. Potential hazards and appropriate safety precautions should be determined, and sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.

Location of Safety Equipment

Fire Extinguisher

On walls in halls outside of labs

First Aid Kit

ITB A111, or dial “88” after 4:30 p.m.

Telephone Pulls

On the wall of every lab near the door

Fire Alarm

Near all building exit doors on all floors

Who to Contact

Emergency Medical / Security: On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.
Non-Emergency Accident or Incident: Immediately inform the TA on duty or Course Instructor.
University Security (Enquiries / Non-Emergency): Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.
See TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs
Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.
ECE Specific Instructional Laboratory Concerns: For non-emergency questions specific to the

In Case of a Fire (Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents.

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In Power Lab, press wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol for Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you're not sure, ask!

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

Defined Roles

TA	The first point of contact for lab supervision	
ECE Lab Supervisor	Steve Spencer- ITB 147	steve@mail.ece.mcmaster.ca
ECE Chair	Tim Davidson- ITB A111	davidson@mcmaster.ca
ECE Administrator	Kerri Hastings- ITB A111	hastings@mcmaster.ca
ECE Course Instructor	Please contact your specific course instructor directly	