



# ECE 360 Control Systems I

Fall 2019 - September 03 to December 06

Class time: Tuesday, Thursday 12:30-13:50      Location: GSB 211

---

## Instructor:

Mahdi Tavakoli, PhD, PENG

780-492-8935

mtavakol@ualberta.ca

13-360 Donadeo Innovation Centre for Engineering

Office Hours: 60 minutes before each class; you are welcome to drop by at other times or (preferably) send me an email to arrange an appointment.

## Course Description:

\*3.8 (fi 8) (either term, 3-0-3/2) Linear system models. Time response and stability. Block diagrams and signal flow graphs. Feedback control system characteristics. Dynamic compensation. Root locus analysis and design. Frequency response analysis and design.

**Prerequisites:** ECE 203 or E E 250, and ECE 240 or E E 238. Credit may be obtained in only one of ECE 360, ECE 362, E E 357, E E 462 or E E 469.

## TA Information:

LI: Marzieh Kooshkbaghi (kooshkba@ualberta.ca)

TA: Junyi Yang (junyi7@ualberta.ca)

Marker: Melika Vahdat (vahdat@ualberta.ca)

The TAs will mark your lab reports. The Marker will mark the assignments.

## Lab Sections:

Section	Day	Time	Location
LAB D41	Thursday	14:00 - 16:50	ETLE5-006

## Course Objectives & General Content:

The overall objective of this course is to introduce the students to the study of control systems. As future engineers, the students will study the tools needed to evaluate the performance of a given system, and to design a feedback controller to achieve a set of desired performance goals. To this end, the course will introduce:

- The basic concepts of dynamic systems and how to describe them via mathematical models.
- Analysis of the fundamental characteristics of feedback control systems.
- The classical control techniques for designing feedback controllers.

The course and its lab will repeatedly use the knowledge of and skills in mathematics, signals and systems theory, and Matlab programming.

Slide decks of lectures will be available in this notebook made in Microsoft OneNote:

[https://1drv.ms/u/s!Aqm8-4tBBfOA7IYB\\_m4-Y64TBxYk](https://1drv.ms/u/s!Aqm8-4tBBfOA7IYB_m4-Y64TBxYk) (viewable in any browser). The slide decks are intentionally incomplete and will be completed in class. You will have online access to the completed (i.e., annotated) slides through the same URL at any time, and are able to convert them to PDF documents for offline access. If you learn better when you actively take notes in the class, I recommend that you print and bring your copy of the incomplete (i.e., unannotated) notes to the class, and add your notes on them as I am writing on the slides.

### Marking Scheme:

Activity	Due/Scheduled	Weight
Assignments	Varies	10%
Laboratories & their reports	1 week after you perform the lab	15%
Midterm exam	Oct 31, 2019	25%
Final exam	See Bear Tracks	50%

The Faculty recommended grade point average for a 300 level course is 3.0. Instructors have the leeway to deviate from this average and can assign grades based on their own scheme. All grades are approved by the department chair (or delegate). The office of the Dean has final oversight on all grades.

### Term Work

All term work solutions will be posted no later than the last day of classes. All term work will be returned to students by the final day of classes, with the exception of major term work due in the last week of classes. The latter will be returned by the day of the final examination or the last day of the examination period if there is no final examination in the course as per university policy; instructors will make accommodations to return these term work. It is the responsibility of the student to pick up all their term work at the specified time and place. Any unreturned term work, shall be retained and then shredded six months after the deadline for reappraisal and grade appeals. Final examinations will be kept for one year as required by university guidelines and the Government of Alberta's Freedom of Information and Protection of Privacy Act.

### Additional Notes

MATLAB/Simulink is extensively used throughout the course. We will be using Simulink, the Control Systems Toolbox and the Symbolic Math Toolbox.

You should already be familiar with MATLAB basics. Basic reviews of MATLAB/Simulink are contained in Appendices of Nise. You can become more familiar with MATLAB by running the control demonstrations (In Matlab prompt, type demo and follow Toolboxes >> Control Systems).

A lab report is due by 4:00 pm, one week after you perform the lab. Lab reports submitted after 4:00 pm on the due date and before they are picked up from the drop box will receive a 25% penalty. No late reports will be accepted once the box is emptied. Lab reports should be clear, clean and stapled.

There are six sets of assignments to be posted on the course website. Assignments should be put into the course assignment box by 4:00 pm on the due date. The solution to each assignment will also be posted on the website after its due date. Correction: Assignments are to be submitted electronically via eClass.

In the midterm exam, you can bring one formula sheet (letter-size, two-sided), but no books, notes, or other materials.

In the final exam, you can bring two formula sheets (letter-size, two-sided), but no books, notes, or other materials.

### **Calculator Policy**

Only approved non-programmable calculators are permitted in examinations. Any calculator taken into an examination must have a sticker identifying it as an acceptable non-programmable calculator (gold sticker). Students can purchase calculators at the University Bookstore with the stickers already affixed. Calculators purchased elsewhere can be brought to the Dean's Office where the appropriate sticker will be affixed to the calculator.

### **Text and References (Recommended):**

HIGHLY RECOMMENDED MAIN TEXT:

Norman S. Nise. Control Systems Engineering (any of the recent editions)

Other references for your interest:

- Karl J. Åström and Richard M. Murray. Feedback Systems: An Introduction for Scientists and Engineers, Princeton University Press. This book is available online for free:  
<http://www.cds.caltech.edu/~murray/amwiki>.
- Richard C. Dorf and Robert H Bishop. Modern Control Systems, 11th edition, 2008, Prentice Hall.
- Gene F. Franklin, J. David Powell, and Abbas Emami-Naeini. Feedback Control of Dynamic Systems. Prentice-Hall.

### **Website:**

eClass

### **Previous Examples of Evaluative Materials:**

Sample problems from previous midterms and final exams will be provided on eClass.

### **University Policies:**

Policy about course outlines can be found in Course Requirements, Evaluation Procedures and Grading of the University Calendar.

The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behaviour (online at [www.governance.ualberta.ca](http://www.governance.ualberta.ca)) and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

Audio or video recording, digital or otherwise, of lectures, labs, seminars or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan. Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study, and is not to be used or distributed for any other purpose without prior written consent from the content author(s).

Only those items specifically authorized by the instructor may be brought into the exam facility. The use of unauthorized personal listening, communication, recording, photographic and/or computational devices is strictly prohibited. Students should refrain from bringing any unauthorized electronic device into an examination room, including cell phones, high tech watches, high tech glasses or other such devices.

**Faculty of Engineering Statement on Safety During Learning Activities:**

In all Faculty of Engineering courses, labs, seminars or other learning activities, safety is of paramount importance. In some cases, laboratory work in a program requires high standards for risk management to keep potential hazards safely under control. Anyone found to be unable to function safely, due to intoxication, behavior, or other reasons, in the class, lab, seminar or other learning activity may be asked to leave or be removed for their and the safety of other participants and instructors. As members, or prospective members, of the engineering profession, it is your responsibility to identify and inform the proper authorities of an unsafe work/learning environment.

**Learning Outcomes:**

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

1. Develop mathematical models from relatively simple physical systems.
2. Apply the Laplace transform to systems modeled by linear differential equations and derive the corresponding transfer functions.
3. Simplify and find closed-loop transfer functions of complex systems using block diagram reduction and Mason's formula in signal flow graphs.
4. Relate step response specifications in the standard second-order system to the system parameters and regions of pole locations.
5. Describe bounded input, bounded output stability of a linear system and relate it to pole locations of the transfer function.
6. Use the Routh Hurwitz stability criterion to evaluate closed-loop stability of given control systems.
7. Appreciate and identify the main advantages of using feedback in control systems.
8. Use the root locus method to analyze control systems and design controller gain by sketching the root locus.
9. Generate Bode plots of control systems and estimate the gain margin and phase margin graphically.
10. Sketch Nyquist plots of control systems and use the Nyquist stability criterion to analyze closed-loop stability.
11. Identify advantages and disadvantages of lead and lag compensators, and use Bode plots to design such compensators.

**Lab Information:**

Lab Topic	Date
Lab 1: Lab 1	2019-09-26
Lab 2: Lab 2	2019-10-10

Lab 3: Lab 3	2019-10-24
Lab 4: Lab 4	2019-11-07
Lab 5: Lab 5	2019-11-21

*Did you know that the University of Alberta has various low-to-no-cost services to help students succeed? Visit <http://www.deanofstudents.ualberta.ca/> for information about the academic, wellness, and various other support services available to U of A students. It's never too early or too late to seek help!*



**Students PLEASE READ.** It is **your responsibility** to be aware of and understand the implications of contravening the University of Alberta's Code of Student Behaviour.

All suspected infractions identified by Faculty, TAs, Markers and Exam Invigilators will be:

- 1) Investigated by the responsible Faculty member delivering the course including an interview with the student.
  - a) A second Faculty member will be present at the time of the interview.
  - b) The student is entitled to an advisor sourced from the Office of the Student Ombuds during such an interview.
- 2) If the outcome of (1) warrants, then it will be referred to the Office of the Dean for investigation and possible disciplinary sanction.
  - a) The student will be invited to meet with the Associate Dean, Dr. Joseph for an interview.
  - b) The student is entitled to an advisor sourced from the Office of the Student Ombuds during such an interview.
  - c) The Associate Dean will decide on a sanction weighing the evidence "**on the balance of probabilities**".
- 3) The student has the right to appeal any sanction imposed through the University Appeals Board.

The following is selected content from the Code of Student Behaviour that students should be particularly aware of, ref: "**CODE OF STUDENT BEHAVIOUR**", updated July 1, 2018

### "30.3.2 Inappropriate Academic Behaviour

#### 30.3.2(1) Plagiarism

No Student shall submit the words, ideas, images or data of another person as the Student's own **in any academic writing, essay, thesis, project, assignment, presentation** or poster in a course or program of study."

#### *Dispelling some of the myths that lead to plagiarism*

- a) It is **not OK** to use someone else's words or work without appropriate citation and referencing but claim that you are 'honouring them' by using their words.
- b) It is **not OK** to put references at the end of a piece of work but not cite the reference at the end of the specific section of paraphrased text or vice-versa.
- c) It is **not OK** to use a figure, table or graph from someone else's work without appropriate citation.
- d) It is **not OK** to put a verbatim quote in quotation marks or italics and not to cite the reference at the end of the quote, or vice-versa.
- e) It **is OK** for you to work with a person or group on an assignment, lab report or project as long as your solution or submission for grading was worked and written **independently** of the person or group.
- f) **No** assignment, lab report or project submission from one student should show strong similarity in written style or calculation layout to another student.
- g) It is **not OK** to work with someone else on an assignment or lab report or paper **and** submit an identical or highly similar document for grading.
- h) A momentary lapse in judgment **is not** an excuse.

### "30.3.2 Inappropriate Academic Behaviour

#### 30.3.2(2) Cheating

30.3.2(2)a No Student shall in the course of an examination or other similar activity, obtain **or attempt to obtain** information from another Student or other unauthorized source, give or attempt to give information to another Student, or use, attempt to use or possess for the purposes of use any unauthorized material.

30.3.2(2)b No Student shall represent or attempt to represent themselves as another or have or attempt to have themselves represented by another in the taking of an examination, preparation of a paper or other similar activity. See also misrepresentation in 30.3.6(4).

30.3.2(2)c No Student shall represent another's substantial editorial or compositional assistance on an assignment as the Student's own work.

30.3.2(2)d No Student shall submit in any course or program of study, without the written approval of the course Instructor, all or a substantial portion of any academic writing, essay, thesis, research report, project, assignment, presentation or poster for which credit has previously been obtained by the Student or which has been or is being submitted by the Student in another course or program of study in the University or elsewhere.

30.3.2(2)e No Student shall submit in any course or program of study any academic writing, essay, thesis, report, project, assignment, presentation or poster containing a statement of fact known by the Student to be false or a reference to a source the Student knows to contain fabricated claims (unless acknowledged by the Student), or a fabricated reference to a source."

#### *Plagiarism can also be cheating (two counts in one)*

*Plagiarizing within the context of assignments, papers, lab reports, tests and examinations is also an attempt to take academic advantage over others in the same class; such that a better grade may be achieved, and hence may also be subject to a charge of cheating.*

### "30.3.6(5) Participation in an Offence

No Student shall counsel or encourage or knowingly aid or assist, directly or indirectly, another person in the commission of any offence under this Code."

### "30.3.4 Inappropriate Behaviour towards Individuals or Groups

#### 30.3.4(1) Disruption

30.3.4(1)a No Student shall disrupt a Class in such a way that interferes with the normal process of the session or the learning of other Students." **Comment: This includes use of laptops, phones and working on assignments distracting others**

#### "30.3.4(6) Violations of Safety or Dignity

30.3.4(6)a No Student shall have sexual or physical contact with another person without that person's consent.

30.3.4(6)b No Student shall physically abuse another person, threaten any other person with physical abuse or cause any other person to fear physical abuse.

30.3.4(6)c No Student shall create a condition which endangers or potentially endangers or threatens the health, safety or wellbeing of other persons.

30.3.4(6)d No Student shall harass another person. Harassment is defined in the Discrimination, Harassment and Duty to Accommodate Policy in UAPPOL, and includes Harassment, Bullying, Sexual Harassment and Racial Harassment.

30.3.4(6)e No Student shall use words which threaten violence or physical abuse to any group or individual whether or not the group or individual thus threatened knows of such threatening words and whether or not the words are employed with a demonstration, rally or picketing."

### “30.3.6 Other Offences

#### “30.3.6(4) Misrepresentation of Facts

No Student shall misrepresent pertinent facts to any member of the University community for the purpose of obtaining academic or other advantage..." **Comment: This includes falsely claiming ill health to defer examinations or gain extensions**

### “30.3.3 Inappropriate Behaviour in Professional Programs

30.3.3(1) A Student enrolled in Professional Programs is bound by and shall comply with the Professional Code of Ethics governing that profession and the practice of its discipline.

30.3.3(2) It shall be the responsibility of each student in a Professional Program to obtain, and be familiar with, the Professional Code of Ethics relevant to the discipline and all amendments thereto as may be made from time to time."

### Association of Professional Engineers & Geoscientists of Alberta - APEGA CODE OF ETHICS

1. Professional engineers and geoscientists shall, in their areas of practice, hold paramount the health, safety and welfare of the public and have regard for the environment.
2. Professional engineers and geoscientists shall undertake only work that they are competent to perform by virtue of their training and experience.
3. Professional engineers and geoscientists shall conduct themselves with **integrity, honesty**, fairness and objectivity in their professional activities.
4. Professional engineers and geoscientists shall comply with applicable statutes, regulations and bylaws in their professional practices.
5. Professional engineers and geoscientists shall **uphold and enhance the honour, dignity and reputation of their professions** and thus the ability of the professions to serve the public interest.

### Unauthorized use of devices & resources

On-line resources such as “**Course-Hero**” are considered inappropriate resources that **students should avoid accessing**. Such resources are the subject of concern by the Office of the Dean and University Legal Counsel, as content has previously been identified as unauthorized use of Faculty of Engineering Professors’ intellectual property, including notes & solutions. To use such resources is both **Cheating** and **Plagiarism**.

Students identified to have used **unauthorized devices**; such as **smart phones, watches and glasses**; to access E-class or communicate with others via email or social media during an **examination** have received **Cheating** sanctions which can include the loss of the full exam grade value as a minimum, up to a suspension or expulsion from University recommendation.

In many instances, cheating in examinations occurred when students were using washrooms, although some students access resources in exams in front of invigilators. Students need to be aware that the Office of the Dean uses all available technology and services to **monitor use of unauthorized devices and resources**, including IP logs specific to device traffic during examination periods. Instructors are encouraged to monitor E-class logs and ‘electronic material sharing’ sites during exam periods.

### Faculty of Engineering rules related to unauthorized electronic devices in examinations

1. Section 23.5.1(1) Permitted References and Aids, of the University Calendar states: "Only those items specifically authorized by the instructor may be brought into the exam facility. The use of unauthorized personal listening, communication, recording, photographic and/or computational devices is strictly prohibited". Any violation of this is a violation of the Code of Student Behaviour.
2. On entering an examination, students must turn off all unauthorized electronic devices including but not limited to cell phones, laptops, tablets, watches with internet/storage capability, or other audio-visual devices. Invigilators should remind students to do this before the examination is started.
3. Such devices should be placed in a carrying bag or backpack, and placed behind or underneath the student's chair; or if the room is deemed capable, invigilators may ask all bags and backpacks be placed in a designated area and only retrieved once the examination is completed.
4. Any student in possession of an unauthorized electronic device, regardless of perceived action, will be reported by the invigilator and/or instructor for investigation under the Code of Student Behaviour. All such reports will be referred to the Office of the Dean.
5. Students requiring a washroom break must present their ONEcard to the invigilator prior to leaving the examination room. Invigilators will be responsible for noting such students' names and exact time of departure and return.
6. Calculators with storage capability other than approved programmable calculators are prohibited in examinations.

### General rule for unauthorized devices in examinations

**Students should refrain from bringing any unauthorized electronic device into an examination room.** At the very least **no unauthorized device should be on your person** during an examination, but should be secured in your backpack or bag out of reach for the duration of the examination.

### Study and assignment tips for students

1. Study in groups, but only to discuss concepts and principles, **NOT** to complete assignments.
2. Perform assignment calculations and written solutions on your own – you are only competing with yourself.
3. Take advantage of using the TA scheduled office time to ask additional questions – if in doubt ask.
4. If colleagues are getting higher grades in assignments, labs, exams, remember you are not competing with other students only with yourself.
5. If you are tempted to take a shortcut think about this: What is the value of the assignment or lab or test that I am tempted to cheat or plagiarize to get credit?