



Carleton
UNIVERSITY

Department of
**Systems and
Computer Engineering**

SYSC 4505

Automatic Control Systems I

Calendar description

Review of Laplace transform techniques. Effects of feedback: frequency response, pole-zero positions. Compensation: root locus, Bode plots. State variables: formulation, solution of linear systems, examples of simple second-order non-linear systems. Discrete time systems: z-transforms. Signal reconstruction.

Includes: Experiential Learning Activity.

Lectures three hours a week, laboratory three hours alternate weeks.

<http://calendar.carleton.ca/undergrad/courses/SYSC/>

Prerequisites

MATH 2004 and (SYSC 3500 or SYSC 3600 or SYSC 3610).

Precludes additional credit for MAAE 3500, MAAE 4500 (no longer offered).

Prior knowledge

Students should:

- Have prior exposure to elementary transforms and differential equations.

Course objectives

The objective of the course is to teach the student the fundamental concepts of control system design and analysis. The course reviews linear systems theory and presents how linear systems theory is used to both specify performance requirements and how to design the control system. A number of electromechanical examples are used to illustrate control system analysis and design. The course focuses on the engineering design process to achieve required specifications.

List of topics

- Review of Laplace transforms, transfer functions, dynamics of linear systems and frequency response.
- Review of modeling of dynamic systems.
- Review of block diagram reduction and Op-Amp circuits.
- Steady state errors, system types, stability and Routh-Hurwitz criteria.
- The effect of feedback on system dynamics. Construction of root loci.
- Real axis segments, asymptotic angles, centroids of asymptotes.

- Root locus design examples.
- Time domain controller design. The PD and PID controllers.
- Frequency response analysis.
- Nyquist polar plots, the Nichols chart, gain margin and phase margin.
- Compensation design.
- Phase lead compensation in time domain and frequency domain.
- Phase lag compensator design in the time and frequency domain.
- Design of lead-lag compensation.
- State space techniques, matrix formulation.

Learning outcomes

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

- Understand control system diagrams, feedback loops and identify the processing of signals through block processors (such as amplifiers, integrators, differentiators etc.).
- Model control systems and create simulation experiments for analyzing their performance.
- Propose alternate designs and/or fine tune system parameters to achieve design goals.
- Design suitable control blocks (compensators) to be used in feedback loops and/or feedforward configurations to achieve required performance characteristics.
- Compare and assess the performance of control systems and propose design procedures for optimizing their response.
- Be trained to use various simulation software (MATLAB, simuling, Analog Devices PLL modelling and analysis software etc.) to assess and design practical control systems (e.g. Phase Locked Loops).

Graduate Attributes (GAs)

The Canadian Engineering Accreditation Board requires graduates of engineering programs to possess 12 attributes at the time of graduation. Activities related to the learning outcomes listed above are measured throughout the course and are part of the department's continual improvement process. Graduate attribute measurements will not be taken into consideration in determining a student's grade in the course. For more information, please visit: <https://engineerscanada.ca/>.

Graduate Attribute	Learning outcome(s)
1.8.S – Knowledge base: Developed - Discipline-specific concept SCE-5: Software Engineering	
3.2 – Investigation: Developed - Design of experiment	

3.3 - Investigation: Developed - Experimental procedure	
4.4 - Design: Introduced - Design solution(s)	
4.5 - Design: Introduced - Design implementation / task(s) definition	
5.3 - Use of engineering tools: Developed - Tools for design, experimentation, simulation, visualization, and analysis	

Special Information for Pandemic Measures

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are [a number of actions you can take](#) to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

Feeling sick? Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's [symptom reporting protocols](#).

Masks: Carleton has paused the [COVID-19 Mask Policy](#), **but continues to strongly recommend masking when indoors**, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

Vaccines: Further, while proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in [cuScreen](#) as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the [University's COVID-19 website](#) and review the [Frequently Asked Questions \(FAQs\)](#). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.

Self-Declaration Process in Effect for Fall 2022 Term

Since the beginning of the COVID-19 pandemic, Carleton has temporarily suspended the need for doctor's notes or medical certificates for academic accommodation requests related to COVID-19. This decision was made in recognition of the fact that alternate course delivery and assessment methods present unique challenges and that it continues to be more difficult than usual for students to see a doctor and obtain documentation.

As we all continue to navigate ongoing disruptions caused by the public health crisis, we are **extending this process for the Fall 2022 Term**.

In place of a doctor's note or medical certificate, students will be advised to complete the [self-declaration form](#) available on the Registrar's Office website to request academic accommodation for missed course work including exams and assignments. Students will also be encouraged to connect directly with their instructors to discuss required accommodations arising from the COVID-19 situation.

Instructor and TA contact

Specific to course offering (tbd)

Textbook (or other resources)

Specific to course offering (tbd)

Evaluation and grading scheme

Specific to course offering (tbd)

Breakdown of course requirements

Specific to course offering (tbd)

Tentative week-by-week breakdown

Specific to course offering (tbd)

Important Information

Specific to course offering (tbd).

General regulations

Attendance: Students are expected to attend all lectures and lab periods. The University requires students to have a conflict-free timetable. For more information, see the current *Undergraduate Calendar, Academic Regulations of the University, Section 2.1.3, Course Selection and Registration and Section 2.1.7, Deregistration*.

Health and Safety: Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: <http://sce.carleton.ca/courses/health-and-safety.pdf>

Deferred Term Work: Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases, this must occur no later than three

(3.0) working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule.

Instructors may, at their discretion, require students to provide medical documentation to support requests for accommodation for missed course work including exams and assignments. As per the Provost's message of August 27, 2021, for the Fall 2021 term, students have been instructed to complete the [Medical Self-Declaration](#) form available on the Registrar's Office website rather than seeking to obtain a doctor's note or medical certificate. Instructions for the Winter 2022 term will be communicated by the Provost's office.

For more information, see the current *Undergraduate Calendar, Academic Regulations of the University, Section 4.4, Deferred Term Work*.

Appeal of Grades: The processes for dealing with questions or concerns regarding grades assigned during the term and final grades is described in the *Undergraduate Calendar, Academic Regulations of the University, Section 3.3.4, Informal Appeal of Grade and Section 3.3.5 Formal Appeal of Grade*.

Academic Integrity: Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: <https://carleton.ca/registrar/academic-integrity/>. This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

Plagiarism: The University Academic Integrity Policy defines plagiarism as “*presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own.*” This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source. Examples of sources from which the ideas, expressions of ideas or works of others may be drawn from include but are not limited to: books, articles, papers, literary compositions and phrases, performance compositions, chemical compounds, artworks, laboratory reports, research results, calculations and the results of calculations, diagrams, constructions, computer reports, computer code/software, material on the internet and/or conversations.

Examples of plagiarism include, but are not limited to:

- any submission prepared in whole or in part, by someone else;
- using ideas or direct, verbatim quotations, paraphrased material, algorithms, formulae, scientific or mathematical concepts, or ideas without appropriate acknowledgment in any academic assignment;
- using another's data or research findings without appropriate acknowledgement;
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own; and
- failing to acknowledge sources through the use of proper citations when using another's work and/or failing to use quotations marks.

Academic Accommodations

Carleton University is committed to providing access to the educational experience in order to promote academic accessibility for all individuals.

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University.

Requests for Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows:

- **Addressing Human Rights Concerns:** The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the [Department of Equity and Inclusive Communities](#) at equity@carleton.ca.
- **Pregnancy Obligation:** Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF, 2.1 MB\)](#)
- **Religious Obligation:** Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the [Student Guide to Academic Accommodation \(PDF, 2.1 MB\)](#)
- **Academic Accommodations for Students with Disabilities:** If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to send your instructor your **Letter of Accommodation** at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). **Requests made within two weeks will be reviewed on a case-by-case basis.** After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the [Paul Menton Centre website](#).

- **Survivors of Sexual Violence:** As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit the [Equity and Inclusive Communities website](#).
- **Accommodation for Student Activities:** Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the [Senate Policy on Accommodation for Student Activities \(PDF, 25KB\)](#).

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