

EGEN5307: Control Systems and Robotics

Course Description and Requirements

This course covers the fundamental aspects of modelling and control of robot manipulators as devices integrating electronics and mechanics. Topics include kinematics and dynamics, electronic actuators, and automation. The course also introduces principles of proximity, tactile, and force sensing, along with programming platforms/languages and automation strategies.

Prerequisite(s): enrolment in the M.Eng.- Engineering Practice program

Lectures: 3 hours per week, in-person.

Includes: graduate-level lectures, project-based learning

Instructor

Professor: Helia Mazdarani

Email: heliamazdarani@cunet.carleton.ca

Course Webpage: on Brightspace

Textbook:

Some lecture notes will be provided but are unlikely to provide a comprehensive resource unless you attend class and reinforce or fill in concepts. There are plenty of online resources available for this material; however, quality will vary widely. Use at your own risk! Suggested references may not map directly onto course material but can provide useful background.

Suggested textbooks:

1. Dorf, R.C. and Bishop, R.H. Modern Control Systems, 14th ed., Pearson Prentice Hall.
2. Spong, M.W. and Vidyasagar, M. Robot Dynamics and Control, 2nd ed., John Wiley & Sons.

Cost:

- Students are not required to purchase textbooks or other learning materials for this course.

Lecture Outline

Lectures: In person, Tuesdays 18:05 – 20:55, Nideyinàn (former UC) 378

The following topics will be covered during the course lectures with an approximate schedule:

- Week 1:** Introduction to Robotics and Control Systems
- Week 2:** Feedback Control Fundamentals; System Modelling and Transfer Functions
- Week 3:** Time-Domain and Frequency-Domain Analysis and Control Design
- Week 4:** Sensors, Actuators, and Robotic System Components

- Week 5:** Spatial Descriptions, Coordinate Frames, and Homogeneous Transformations
- Week 6:** Review; **Midterm exam**
- Week 7:** Manipulator Kinematics: Forward and Inverse Kinematics, and Jacobians
- Week 8:** Manipulator Dynamics; Control of Robot Manipulators
- Week 9:** Force Control; Hybrid Position/Force Control; Impedance and Admittance Control
- Week 10:** Teleoperation and Haptics
- Week 11:** Robotic Applications and Case Studies
- Week 12:** Industrial Robotics and Automation; Robot Programming and Platforms

Evaluation and Grading Scheme

The cumulative course grade will be determined as follows:

	Due Date	%
Assignments	Due dates and rubrics will be announced in Brightspace	15
Project	Tentative (November 24) – Final due date and rubrics will be announced in Brightspace	15
Mid-term test	October 20 th - In class	30
Final exam	TBD – scheduled by Examination Services (Dec. 12–23, 2026)	40
Total		100
Pop quizzes	Bonus mark; During lecture	5 (extra)

Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Analyze and design feedback control systems using time-domain and frequency-domain techniques.
2. Explain the functions and integration of sensors, actuators, and other components in robotic systems.
3. Model and analyze robot manipulators using spatial transformations, kinematics, and dynamic models.
4. Apply control strategies for robotic systems, including motion, force, impedance, and teleoperation control.
5. Evaluate robotic applications in industrial automation, programming, and emerging areas.

Course Communication

All course materials and announcements will be posted on the Brightspace web page. The Brightspace page for the course should be the first place you look for information about the course. The use of email for communication with the instructors is encouraged. You must send email from Brightspace or from your Carleton Email address. **Email sent from an email address other than your Carleton address may not be read. Please put "EGEN5307" in the subject line.**

Course Policies

Self-Declaration form and Deferred Term work

Consult with the instructor no later than 3 days after any missed coursework or midterm examination.

Missed Midterm:

Students who miss the midterm for documented and approved reasons will have the weight transferred to the final exam. No make-up midterm will be offered.

Final Examination:

Final exams are for evaluation purposes and will not be returned to students.

Deferred Final Examinations:

Students who are unable to write the final examination because of a serious illness/emergency or other circumstances beyond their control may apply for accommodation by contacting the Registrar's office. Consult Section 4.3 of the University Calendar

(<https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/examinations/>)

Academic Integrity and Plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: <https://carleton.ca/engineering-design/current-students/fed-academic-integrity>.

Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. 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 violations of the policy include, but are not limited to:

- Any submission prepared in whole or in part, by someone else;
- Using another's data or research findings without appropriate acknowledgment;
- Submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own;
- Failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotation marks; and
- Unless explicitly permitted by the instructor in a specific course, the use of generative AI and similar tools to produce assessed content (such as text, code, equations, images, summaries, videos, etc.).

Generative Artificial Intelligence (AI):

Students may use AI tools for ideas, clarifying challenging concepts, or getting started on projects. However, any work submitted in project reports **cannot** contain any portion created by AI tools.

As our understanding of the uses of AI and its relationship to student work and academic integrity continues to evolve, students are required to discuss their use of AI in any circumstance not described here with the course instructor to ensure it supports the learning goals for the course.

Academic Accommodations

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes, including information about the Academic Consideration Policy for Students in Medical and Other Extenuating Circumstances, are outlined on the Academic Accommodations website (students.carleton.ca/course-outline).

Pregnancy obligation: Contact us 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 accommodation regarding a formally scheduled final exam, you must complete the Pregnancy Accommodation Form ([click here](#)).

Religious obligation: Contact us 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, [click here](#).

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send us your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, contact us, if needed, to ensure that accommodation arrangements are made.

You should request your academic accommodations in the [Ventus Student Portal](#), for each course at the beginning of every term. For in-term tests or midterms, please request accommodations at least two (2) weeks before the first test or midterm.

Please consult the [PMC website](#) for the deadline to request accommodations for formally-scheduled exams (if applicable).

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: <https://carleton.ca/equity/sexual-assault-support-services>

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 will be provided to students who compete or perform at the national or international level. Contact us 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: <https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>

Course Copyright

Student or professor materials created for this course (including presentations and posted notes, case studies, projects, and exams) remain the intellectual property of the author(s). They are intended for personal use and may not be reproduced or redistributed without prior written consent of the author(s).