CS 128: Robot Program and Control Theory
Spring 2025

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Collier-Scripps Room#335

Logistics: The lectures and most course content will be hosted at `https://drake.blackboard.com`. Coursework for will include attending weekly lecture sessions, completing individual and collaborative activities, completing programming assignments, and finishing quizzes/exams. The goal is to help students practice implementing the concepts we see in class.

Office hours: The instructor will hold weekly office hours, either in person or online via Zoom. Please see Blackboard for up-to-date times and URLs. If you cannot make office hours, contact the instructor to make a separate appointment.

- Office hour#1: Tuesday: 12:00 pm - 2:30 pm
- Office hour#2: Thursday 12:00 pm - 2:30 pm
- Location: Collier-Scripps#323

Course overview: This is an introductory course for robotics. I will give a broad overview of the field. The emphasis will be on algorithms, mathematical models, and techniques. Topics will include (tentatively and not necessarily in this order):

- *Robot kinematics:* Rigid body motion, kinematic chains
- *Mobile robot control:* how to control robots, trajectory generation
- *Motion planning:* Discrete planning, graph search, shortest path, A* methods, configuration space
- *Localization:* Motion model, sensor model, Bayes filter, particle filter, Kalman filter
- *Mapping:* Occupancy map, reflection map
- *Simultaneous Localization and Mapping:* SLAM, Graph SLAM, RGB-D SLAM
- *Robot visual perception:* Single view geometry, feature detection and matching, 3D reconstruction, object recognition, object detection, iterative closest point (ICP) algorithm
- *Robot learning:* Markov decision process (MDP), reinforcement learning, imitation learning

Prerequisites: No background in robotics is required; however, familiarity with some topics in Artificial Intelligence would be helpful. You will need to be proficient in a general-purpose programming language; as a quick rule-of-thumb, you should be able to easily implement basic matrix operations using basic data structures of the language (e.g., matrix multiplication using arrays). I recommend either Python or Matlab. Robotics draws from many other fields, including linear algebra, basic calculus, machine learning, graph theory, probability theory, control theory, and statistics. Exposure to these topics is helpful but not required, although you may need to do some background reading.

Textbooks and materials: Readings will come from papers and several textbooks, primarily:

- Mordechai Ben-Ari and Francesco Mondada, *Elements of Robotics*
- Robot Operating System (ROS). `http://wiki.ros.org/ROS/Tutorials`.
- S. Russell and P. Norvig, *Artificial Intelligence, Prentice Hall, 1995.*
- R. Sutton and A. G. Barto, *Introduction to Reinforcement Learning. MIT Press, 1998.*

Schedule, readings, and resources will be available via Blackboard, `https://drake.blackboard.com`.

Grading and requirements:

- *Assignments (40%):* Take home assignments (submit on Blackboard).
- *In-class activities (25%):* Simple coding activities or paper-based tasks (submit on Blackboard).
- *Quizzes (30%):* 3 quizzes, 10% each.
- *Participation (05%):* physical presence, participation in polls (not based on correctness).

Grading scale: The tentative grading scale for this course would be as follows (subject to change upon Instructor's discretion):

A (93%-100%)	A- (90%-92.9%)	B+ (87%-89.9%)
B (84%-86.9%)	B- (80%-83.9%)	C+ (77%-79.9%)
C (74%-76.9%)	C- (70%-73.9%)	D (60%-69.9%)
F (0%-59.9%)		

Assignments (40%) Throughout this course, students will engage in the application of robotics concepts utilizing the Python programming language. Regular submission of code will be required to demonstrate proficiency with the tools introduced. In addition to coding assignments, students will complete written assignments that involve computational tasks or the application of robotic algorithms. Over the duration of the course, students can expect to submit **5-6 assignments** throughout the course.

In-class Activities (25%) You'll also regularly submit your paper-based activities and/or small coding activities. These should be easier since they follow the lecture and are usually done during or right after class. Expect to submit about **6-7 in-class activities** throughout the course.

Quizzes (30%) There will be **3 quizzes** that will be administered via Blackboard. They will not be timed, and you will have a few days to complete them. Quizzes should be completed individually. There is no time limit on these quizzes. As in the real world, you will be allowed to use external resources like the class notes and the internet. You will be required to cite any sources that you used while completing these quizzes other than the class notes.

Attendance/Participation (05%): This class is highly interactive, meaning that active participation is both expected and the norm. You will receive credit for your participation, and it will be counted towards your final grade. I will keep track of your involvement using a signature sheet. Throughout the course, I will pose questions using polling software and conduct in-class Q&A sessions to better understand how the class is grasping the content. These responses will not be evaluated for correctness but rather for completion. ***More than five absences may result in being withdrawn from the course***. If you miss an assessment because of illness, you must provide documentation before you can take an assessment. All other absences from assessments must receive prior approval.

I respect your privacy. If you encounter challenges (physical health, mental health, or life in general) that interfere with your ability to participate in the course or complete your work, I will not require any kind of documentation. You also do not need to explain; you can simply inform me that you are experiencing problems and we will work together to figure out a plan that will enable you to complete the course if you want to. For example, if for some reason, you are unable to make the in-person class session, please email me and I will provide you with the Zoom link for the day so you can attend class virtually. If you are unable to participate in the course for a prolonged period, we will discuss whether an incomplete is the best option.

Academic Integrity Policy: *We take academic integrity very seriously.* You are required to abide by the Drake University policy on academic integrity, as described in the Statement on Academic Dishonesty: Cheating and Plagiarism (`https://www.drake.edu/studentlife/handbook-resources/handbook/academic/`). It is your responsibility to understand these policies. Students agree that by taking this course, papers and source code submitted to us may be subject to textual similarity review, for example, by Turnitin.com. These submissions may be included as source documents in reference databases solely for the purpose of detecting plagiarism of such papers or codes.

Accommodation for students with disabilities: Drake University is committed to providing equitable access to learning opportunities for all students. The Disability Services office (107 Old Main) collaborates with students who have disabilities to provide and/or arrange reasonable accommodations. If you have, or think you may have, a disability (e.g., mental health, attentional, learning, autism spectrum disorders, chronic health, traumatic brain injury and concussions, vision, hearing, mobility, or speech impairments), please contact:

- Michelle Laughlin, Student Disability Services Coordinator (x1835)
- michelle.laughlin@drake.edu

to arrange a confidential discussion regarding equitable access and reasonable accommodations.

Holiday Observance: If you miss class because of a holiday or observance, you can fill out the form to automatically notify me (faculty). You can find the form on the `https://www.drake.edu/diversity/initiatives` for Initiatives and Programs, or click here to directly access the `https://drake.qualtrics.com/jfe/form/SV_d5qfVUKtuTQdg7b`.