

COSC 81/281: Principles of Robot Design and Programming

Semester: Fall 2026 | Instructor: Brian Plancher

Meeting time: 2A: TuTh 2:25–4:15pm, X-hour Wed 5:30–6:20pm | Room: ECSC 009

Prerequisites: COSC 70 or COSC 70.01 (formerly COSC 11), or COSC 1 and MATH 22/24. COSC 10 and COSC 50 are recommended. Comfort with programming, basic calculus, linear algebra, and probability matters more than any specific course; contact the instructor if you have equivalent prior experience but not the prerequisites.

Enrollment capped at 50 students. COSC 281 is the graduate section of this course; 281 students complete the additional starred question(s) on each assignment and exam (see Grading).

Description:

Robots are cyber-physical systems, leveraging computational intelligence to sense and act in a real world far too large to fully enumerate. This introductory course teaches robotics as an algorithmic discipline built around that challenge and explore concepts across the full robotics stack with examples from navigation, manipulation, and locomotion. The first third of the course covers the many ways to plan real-world motions, ranging from search to sampling to optimization to learning. The second third builds on this foundation, covering state estimation, computer vision, and modern robot learning, each reusing algorithmic machinery from our study of planning. Throughout, you will complete programming and written assignments that dive into the theory and practice of these algorithms, and will be assessed via written, in class, closed-book exams. The final third of the course culminates in a team-based project deploying a full robotics software stack on real hardware, where you will see firsthand how compute budgets and changing real-world conditions reshape your algorithms. *Finally, we note that robotics is a much larger field than any one course can cover. This course surveys the key ideas across the full robotics stack, going deeper where fundamental concepts reach beyond any single algorithm or application.*

Learning Outcomes:

By the end of the semester, you will be able to:

- Understand and implement the core algorithms of a mobile robot, from perception, to estimation, to planning, to control
- Be able to compare and contrast robotics algorithms and understand their tradeoffs and their failure modes
- Collaborate with a team to integrate and deploy a simulation-tested autonomy stack on a physical robot

Grading:

- 15% Homework (graded pass/fail on completion)
- 20% Midterm (written, in class, closed-book)
- 40% Exam (written, in class, closed-book)
- 25% Project (write-up, demo day, and milestones)

Homework is where most of the learning in this course happens. It is also take-home in the age of generative AI, and we will be honest about what that means. You may use AI tools on homework however you like, and we will not attempt to police how (see AI policy below). As such, all homework is graded pass/fail on good-faith completion, so there is nothing to gain by competing with your peers or with the tools. There is also nothing to gain by letting the tools do your thinking for you. The midterm and exam are completed on paper, in class, without AI, and they test exactly the skills the homework builds. If AI does the homework and you do not, the exam will make that gap obvious. So do all of it, wrestle with it honestly, and do not panic over it. It is the best possible practice for the assessments where you prove your learning.

COSC 281 students: each homework, the midterm, and the exam carry starred (★) question(s) that are required for you and part of your grade. For COSC 81 students the starred questions are worth zero points either way: try them for fun if you finish early to see how you would do in the graduate section. Separately, assessments may carry *bonus* questions open to everyone for a small amount of extra credit, and problem sets may include extra ungraded practice questions for those who want more.

We will be using **Gradescope** (<https://www.gradescope.com/courses/1372528>) for homework submission and autograding. All coding assignments with autograders can be submitted an infinite amount of times until the deadline. Homework is graded pass/fail on completion (the autograder and a completion checklist define “complete”), so regrades on homework will only be allowed in extenuating circumstances. The midterm, the exam, and the project report are manually graded following submission. All re-grade requests must be submitted as a private message on Slack and will only be accepted for one week following the return of a grade. Do note that grades could go up or down following a re-grade.

Homework is due by 11:59pm ET on the due date, and there are **no late days**: homework is pass/fail on completion, solutions release shortly after the deadline, and late submissions are not accepted once solutions are out. This is deliberate as the homework exists for learning, not for points, so the winning move is to do it on time, use whatever help you need, and bank the practice for the midterm and exam.

If there is a situation that you feel should be exempt from this policy and deserves an extension, you must reach out over email at least 2 weeks prior to the due date. Note that this also applies to rescheduling exams, presentations, etc. For missed deadlines without prior notification, extension, and approval due to illness or other emergencies, please reach out ASAP and include a doctor’s note or other official documentation to verify and validate the emergency. Finally, events that are known in advance do not constitute legitimate reasons for extensions (e.g., conferences, sporting events, other exams, family celebrations); please make sure to plan ahead accordingly.

Email and Slack Policy:

I request that as much as possible you use Slack (instead of email) for all course-related questions. Please post liberally as if you have a question, another student likely has a similar question. There is also an anonymous bot if you would like to submit anonymously. I will try to respond to all Slack posts as soon as possible during working hours and at least within 1 business day. Click this link (https://canvas.dartmouth.edu/courses/81663/external_tools/12469) to sign up for our course Slack. I will try to respond to emails within 2 business days sent to: plancher+courses@dartmouth.edu.

Student drop-ins (Office Hours)

See brianplancher.com/office_hours for the most up-to-date schedule!

- These are scheduled time-slots for us to chat and I will also be available by appointment in case the scheduled slot doesn't work for you!
- I strongly encourage you to come to at least one student drop-in slot per semester.
- This is your time, so you can use it however you want! Stop by for a quick chat, ask questions about the course (or give feedback), ask questions about research, ask questions about getting jobs in finance/consulting/tech, tell me about a new hit TV show, any reason is a good reason!

Readings and Materials:

There are no required textbooks and nothing to purchase. Some possibly useful reference texts include the following (all uploaded to Canvas or linked here): Russell and Norvig's *Artificial Intelligence: A Modern Approach*, Thrun, Burgard, and Fox's *Probabilistic Robotics*, LaValle's *Planning Algorithms*, Sutton and Barto's *Reinforcement Learning: An Introduction*, Boyd and Vandenberghe's *Convex Optimization*, Richard Szeliski's *Computer Vision: Algorithms and Applications* and Tedrake's *Underactuated Robotics*. All coding runs in the course's Python simulator on your own machine (or Colab); the hardware weeks use course-provided vehicles.

Use of AI Content Generators:

My view in one line: these tools should be **a tool, not a crutch**; used that way, they are genuinely helpful, and this course is built so that using them well helps you learn.

I view AI tools as a powerful resource that you will likely leverage in the future. As such, the use of AI-based content generation tools, such as ChatGPT, is permitted in this course. However, you will be required to disclose any use of AI tools for each assignment.

The goal of this policy is to help you develop your resilience to automation, as these tools will become increasingly prevalent in the future, and also to learn about their weaknesses. By incorporating these tools into your work process, you will be able to focus on skills that will remain relevant despite the rise of automation. However, it is important to note that AI tools are susceptible to errors (e.g., most citations are incorrect). As a student, it is your responsibility to ensure the quality and appropriateness of the work you submit in this course. As such please make sure to read carefully (and likely heavily edit) the output from such tools. Also, please be mindful of the data you provide to these systems, as your work may contain private information, not just your own but also that of others. For example, you should never enter the names of study participants into ChatGPT. Furthermore, there is a risk of inadvertently plagiarizing when using these tools as they often draw content without proper citation. Standard plagiarism policies will apply to all assignment submissions, and "AI did it!" is not a sufficient excuse. To prevent this, you can consider using more responsible tools that are designed to cite their data sources, and in either case you should make sure to add citations where appropriate yourself. Lastly, be aware of the dangers of becoming overly dependent on these tools. While they can be incredibly useful, relying on them too much can diminish your own critical thinking and writing skills.

If you do not wish to use these tools, that is a valid decision. The use of AI tools in education can be messy and unpredictable due to the risks mentioned earlier. You may have moral confusion

or concerns about the uncertainty associated with using AI tools in their coursework. This policy aims to mitigate any potential harms associated with AI tool usage, rather than promote their use.

For every assignment submission, you are required to include an “AI Tool Disclosure” paragraph which states to what extent you used AI tools. We will not mark you down for the use or non-use of AI tools. The course staff simply wants to understand the prevalence of AI tool use and methods of use to better adapt course policies and teaching practices for the future.

Academic Integrity:

Dartmouth’s [Academic Honor Principle](#) states: “Academic integrity is foundational to a Dartmouth education. All members of the Dartmouth community—faculty, staff, and students—are responsible for maintaining a culture of integrity, honesty, and respect in teaching, learning, scholarship, and creative work. By upholding this principle, we foster an atmosphere of intellectual growth and personal development both within and beyond Dartmouth.”

As this course likely draws in a diverse cohort of students I would also like to draw your attention to the various specific honor codes for your school:

- MD students follow the Geisel School of Medicine’s [Student Honor Code](#).
- MBA students follow the Tuck School of Business’ Academic Honor Principle found in their [Student Handbook \(Sharepoint\)](#).
- PhD, MS, MA, MALS, MFA, and [graduate special students](#) in the Guarini School of Graduate and Advanced Studies and MHCDS, MHS, and MPH students follow the [Academic Honor Policy for Graduate and Professional Students](#).
- BE, MEng, MS, MEM, and PhD students in the Thayer School of Engineering follow [Thayer’s Academic Honor Policy](#).
- AB undergraduates and special non-degree seeking students follow the [Academic Honor Policy for Undergraduate Students in the Arts and Sciences](#).

This course’s specific policy on academic integrity builds on these honor codes and is best stated as “be reasonable.” We recognize that interactions with classmates and others can facilitate mastery of the course’s material. As this course revolves mostly around team projects we expect students to collaborate heavily and work together on those assignments. Even on individual assignments students should feel encouraged to ask classmates and others for conceptual help. However, there remains a line between asking for help and submitting someone else’s work. Especially on individual assignments, make sure this collaboration does not reduce to your classmate doing your work for you (e.g., writing your response, copy-pasting code, or making your slides). If in doubt as to whether some act is reasonable, ask first! The course staff would much rather have a conversation about extensions than about academic integrity! We hope you are reading these policies (or at least skimming them), so if you are, please send the course instructor an email with a (robotics) pun/joke/meme with the subject “academic integrity easter egg” and if you come by office hours I’ll give you a prize (exact prize subject to availability)! Acts considered not reasonable will be reported, and the course reserves the right to impose local sanctions on top of that outcome. If you commit some act that is not reasonable but bring it to the attention of the course staff within 48 hours, the course may impose local sanctions, but the course will not refer the matter further except in cases of repeated acts.

Diversity, Inclusion, Accessibility, and Accommodations:

In an ideal world, science would be objective. However, much of science is subjective and is historically built on a small subset of privileged voices. We acknowledge that it is possible that there may be both overt and covert biases in the material due to the lens with which it was written, even though the material is primarily of a scientific nature. Since integrating a diverse set of experiences is important for a more comprehensive understanding of science please contact the course staff (in person or electronically) or submit anonymous feedback if you have any suggestions to improve the quality of the course materials. We would also like to create a learning environment that supports diversity of thoughts, perspectives, and experiences, and honors your identities. If you have a name and/or set of pronouns that differ from those that appear in your official records, please let us know!

We also note that our community is composed of students from a variety of financial backgrounds. Socioeconomic diversity can be invisible, and you may be experiencing financial difficulties related to the cost of textbooks, materials, or other necessities for our class of which we are not aware. If you encounter financial challenges related to this class, there may be sources of support for you. If you feel comfortable sharing your experience with us, you may. You may also consider meeting with a financial aid officer to discuss options, reaching out to the First-Generation Office if you are a first-generation student, browsing the [Funding Resources page](#), or, applying for the [Dartmouth 4E Fund](#) which provides supplemental funds for essentials, enrichment, experiences, and emergencies.

We also note that the academic environment is challenging, our terms are intensive, and classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including: the [Counseling Center](#) which allows you to book triage appointments online, the [Student Wellness Center](#) which offers wellness check-ins, and your [undergraduate dean](#). The student-led [Dartmouth Student Mental Health Union and their peer support program](#) may be helpful if you would like to speak to a trained fellow student support listener. If you need immediate assistance, please contact the counselor on-call at (603) 646-9442 at any time.

Dartmouth also has a deep commitment to support students' religious observances and diverse faith practices. Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with me as soon as possible—before the end of the second week of the term at the latest—to discuss appropriate course adjustments.

Student Accessibility and Accommodations

Students requesting disability-related accommodations and services for this course are required to register with Student Accessibility Services (SAS; [Apply for Services webpage](#); student.accessibility.services@dartmouth.edu; (603) 646-9900) and to request that an accommodation email be sent to me in advance of the need for an accommodation. Then, students should schedule a follow-up meeting with me to determine relevant details such as what role SAS or its [Testing Center](#) may play in accommodation implementation. This process works best for everyone when completed as early in the quarter as possible. If students have questions about whether they are eligible for accommodations or have concerns about the implementation of their accommodations, they should contact the SAS office. All inquiries and discussions will remain confidential.

Title IX:

At Dartmouth, we value integrity, responsibility, and respect for the rights and interests of others, all central to our Principles of Community. We are dedicated to establishing and maintaining a safe and inclusive campus where all community members have equal access to Dartmouth's educational and employment opportunities. We strive to promote an environment of sexual respect, safety, and well-being. Through the Sexual and Gender-Based Misconduct Policy (SMP), Dartmouth demonstrates that sex and gender-based discrimination, sex and gender-based harassment, sexual assault, dating violence, domestic violence, stalking, etc., are not tolerated in our community. For more information regarding Title IX and to access helpful resources, visit [Title IX's website \(sexual-respect.dartmouth.edu\)](https://sexual-respect.dartmouth.edu). As a faculty member, I am required to share disclosures of sexual or gender-based misconduct with the Title IX office. If you have any questions or want to explore support and assistance, please contact the Title IX office at 603-646-0922 or TitleIX@dartmouth.edu. Speaking to Title IX does not automatically initiate a college resolution. Instead, much of their work is around providing supportive measures to ensure you can continue to engage in Dartmouth's programs and activities.

Consent to Recording:

I'll be recording all of our class meetings, so that those who cannot be there due to unforeseen circumstances can watch later. Dartmouth has asked that I include the following language describing some bounds on how recording should be used. You do not need to send me any sort of agreement, it just makes clear that you shouldn't record or distribute any recordings without my consent.

Consent to recording of course and group office hours

- I affirm my understanding that this course and any associated group meetings involving students and the instructor, including but not limited to scheduled and ad hoc office hours and other consultations, may be recorded within any digital platform used to offer remote instruction for this course;
- I further affirm that the instructor owns the copyright to their instructional materials, of which these recordings constitute a part, and distribution of any of these recordings in whole or in part without prior written consent of the instructor may be subject to discipline by Dartmouth up to and including expulsion;
- I authorize Dartmouth and anyone acting on behalf of Dartmouth to record my participation and appearance in any medium, and to use my name, likeness, and voice in connection with such recording; and
- I authorize Dartmouth and anyone acting on behalf of Dartmouth to use, reproduce, or distribute such recording without restrictions or limitation for any educational purpose deemed appropriate by Dartmouth and anyone acting on behalf of Dartmouth.

Requirement of consent to one-on-one recordings.

- By enrolling, I hereby affirm that I will not under any circumstance make a recording in any medium of any one-on-one meeting with the instructor without obtaining the prior written consent of all those participating, and I understand that if I violate this prohibition, I will be subject to discipline by Dartmouth up to and including expulsion, as well as any other civil or criminal penalties under applicable law.

Course Schedule (F26):

Tu/Th are full lectures; W rows are X-hours. Note that one X-hour is required.

Wk	Day	Date	Topic	Assignments
1	T	Sep 15	L0: Course Overview & Planning 101	PS0 Out
1	Th	Sep 17	L1: (Un)Informed and Random Search	
2	T	Sep 22	L2: (Optimal) Random Search & MDPs	PS0 Due; PS1 Out
2	Th	Sep 24	L3: Solving MDPs and Reinforcement Learning	
3	T	Sep 29	L4: Optimization for Robotics	PS1 Due; PS2 Out
3	Th	Oct 1	L5: Transformations and Kinematics	
4	T	Oct 6	L6: Planning and Control Review	PS2 Due
4	W	Oct 7	X: Midterm (written, in class, closed-book)	
4	Th	Oct 8	L7: Localization and Filtering	
5	T	Oct 13	L8: Mapping and SLAM	PS3 Out
5	Th	Oct 15	L9: Perception and Vision	
6	T	Oct 20	L10: Deep Computer Vision	PS3 Due; PS4 Out
6	Th	Oct 22	L11: Modern Robot Learning	
7	T	Oct 27	L12: Course Review	PS4 Due
7	Th	Oct 29	Exam (written, in class, closed-book)	Project Instructions Out
8	T	Nov 3	Project Kickoff and Hardware Bring-Up	Project Design Doc Due
8	Th	Nov 5	Project Design Feedback and Lab Time	
9	T	Nov 10	Project Lab Time	
9	Th	Nov 12	Project Lab Time	
10	T	Nov 17	Project Demo Day	Project Report Due Wed Nov 18

Where to go next:

If this course leaves you wanting to push the computational and optimization topics further, check out **COSC 69.23/169.23, Parallel Optimization for Robotics** (winter term)! Dartmouth's machine learning and computer vision offerings deepen the learning and perception threads!