THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Introduction to Robotics

COMP 581 Fall 2024

The University of North Carolina at Chapel Hill

Course Information

Credit Hours: 3

Pre or Co-Requisites: COMP 301 and 311; or COMP 401, 410, and 411; a grade of C or better is required in all prerequisite courses.

Target Audience: The course is geared towards undergraduate or Masters students who desire to learn about robots, particularly regarding their computational and algorithmic aspects.

Meeting Pattern: Tuesdays, Thursdays 11:00am-12:15pm

Instructional Format: in-person

Classroom or Location: Fred Brooks Building (FB) 009

Instructor Information

Instructor Name: Professor Ron Alterovitz

Email Address: ron@cs.unc.edu

Office Location: FB 254

Office Hours: Thursdays 12:15pm-1:15pm or by appointment

TA Information

Instructor Name: Elad Ohana

Email Address: eohana@cs.unc.edu

Office Location: Sitterson Hall (SN) 304

Office Hours: Tuesdays 3:00pm-4:00pm and Fridays 9:30am-11:00am

Course Content

Course Description

Robots are having a significant impact on our daily lives and beyond, from autonomous cars driving on our highways to robotic surgery in our hospitals to robotic vacuum cleaners in our homes. The objective of this course is to learn about robots by both introducing algorithms that enable robot to operate autonomously and implementing these algorithms

on real mobile robots. The course will focus on algorithms that enable robots to effectively make use of sensory information from the environment and purposefully act upon it. Topics to be covered include the anatomy of a robot, robot kinematics, actuation, sensing, configuration spaces, control, motion planning, and the intersection of artificial intelligence (AI) and robotics. The course will also discuss applications to personal assistance, autonomous vehicles, medical surgery, manufacturing, games, and other areas. The course will feature a combination of lectures, discussions, exams, assignments, and hands-on labs that will involve building and programming a mobile robot to autonomously race to a destination.

Course Texts & Materials

Required textbook: Gregory Dudek and Michael Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, 3rd edition, 2024. Edition ISBN: 9781108736381
Canvas: Additional materials will be made available through the course site on Canvas at http://canvas.unc.edu.
Piazza: The course will use Piazza as an online discussion facilitator among students. When you have a technical question, please use Piazza as your first venue to try to resolve your question. Piazza is an excellent forum for sharing questions and solutions, and it is likely that other people have a similar question. Please post on Piazza and wait an appropriate amount of time for a response before sending an email to either the instructor or the TA.

Class Expectations

As part of this course, you (possibly as part of a team of students) may receive a robot kit for use in labs during this course. It is expected that you take the robot kit with you to work on the labs outside of class time and that you periodically bring the kit to Fred Brooks Building or Sitterson Hall for testing and evaluation. The kit comes in a container approximately 15 in x 11 in x 6 in. Before the end of the semester, you will be required to return your kit with all parts undamaged. If you have any concerns about these expectations, please reach out the instructor regarding accommodations

Course Goals & Student Learning Outcomes (SLOs)

Upon completion of the course, you should be able to list and understand the key components of robots, be able to analyze and implement certain algorithms for robot motion planning and control, and be aware of the current challenges in creating robots.

Course Assignments & Assessments

Assignments

Students will complete approximately 2 assignments, which may include readings and mathematical topics and will be submitted in written form. The dates of assignment due dates will be announced in class or on Canvas at least one week in advance. Each assignment will contain submission instructions; assignments must be submitted in accordance with the instructions by the date and time specified. Late assignments will subject to the Late Work policy specified below. Except when explicitly noted otherwise, no collaboration is permitted on assignments. Please do not accept anyone's assistance (other than the instructor's or the TA's). All submitted work must be your own.

Labs

Students will complete approximately 4 hands-on labs. As part of the labs, each student will gain hands-on experience creating a working mobile robot using a robot kit (e.g., the LEGO Mindstorms EV3 kit with MicroPython). Students will implement and evaluate algorithms enabling the robot to autonomously perform specified tasks. Students may be required to complete the labs as part of a team, which will be explicitly approved by the instructor. Students are required to return robot kits (including all components, each of which must be undamaged) by the last day of classes in this semester. Failure to do so may result in a grade of Incomplete and disciplinary actions.

Each lab will contain submission instructions; labs must be submitted in accordance with the instructions by the date and time specified. Labs will require attending class to demonstrate results to the instructor, and you will receive a score of 0 for a lab if you miss class and have not made a prior arrangement with mutual agreement with the instructor and lab team. Except when explicitly noted otherwise, no collaboration is permitted on labs with anyone except a member of your team. Please do not accept anyone else's assistance (other than the instructor's or the TA's). All submitted work must be your own or by your team member.

Midterm Exam

A midterm exam will be administered in class. The date of the midterm exam will be announced in class at least one week in advance of the exam, and the exam will take place approximately in the middle of the semester. The exam will test students' knowledge of the material being covered in the lectures. Unless otherwise explicitly noted, all exams will be closed-book and closed-notes and you cannot have computing or communication devices within reach.

Participation

This class will be far more enjoyable for everyone if everyone comes to class ready and willing to discuss the material being covered. Students are expected to attend lectures and participate in class discussions (see the Class Attendance Policy later in this syllabus). To participate, you should (1) attend class and contribute to class discussions, and (2) answer questions on Piazza. A key part of participation is to routinely contribute to class discussions (i.e., answer questions or ask good questions in class). Attendance is important: if a student often misses class, then the student will be unable to sufficiently participate in class, which is a course requirement. Attendance will be recorded on at least 3 unannounced random dates during the semester, and missing class will result in a reduction in the participation grade. Attendance may be recorded, for example, via in-class quizzes that count as participation and receive full credit if submitted in class. Please communicate with the instructor early about potential absences. Absences will be excused based on university policy or by clearing the reason with the instructor. A student can participate on Piazza by being a contributor (i.e., post responses to questions or endorse answers).

Final Exam

The course final exam will be comprehensive, covering topics from the entire course. The final exam will be scheduled in accordance with the university's final exam calendar.

Grading Scale & Schema

Late Work

Each student is allotted 4 free "late passes" for the entire semester that can be used for assignments (not labs or any exams). A late pass gives you an extension of 24 hours. This 24-hour extension period includes weekends and university breaks. You can turn in an assignment late for whatever reason and still receive full credit if you have sufficient late passes. Late passes cannot be used after the last day that classes are held. Unused late passes have no value. Assignments turned in late for which you have insufficient late passes will not be accepted and you will receive a 0 for that assignment. You may use multiple late passes on one assignment to accumulate a longer extension. Other than using late passes, no other extensions for assignments will be given except in very exceptional circumstances such as long-term medical conditions. If late passes are used for an assignment, the student should write "X late passes" on the first page of the assignment, where X is the number of late passes used. Please note that there will be no extensions on labs or exams, and you will receive a zero on these items if they are not completed by the deadline. Note that labs may sometimes be referred to as "Assignments" (e.g., on Canvas), but any task related to the robot kits are considered labs for purposes of this policy.

Grade Components

Students will be evaluated using the following criteria:

- Assignments: 20% of course grade
- Labs: 35% of course grade
- Midterm exam: 15% of course grade
- Participation: 10% of course grade
- Final exam: 20% of course grade

Grading Scale

Grades will be assigned based on the following table, which is subject to change.

Numeric Grade (%)	Letter Grade
92.5 and above	A
90.0 – 92.4	A-
87.5 – 89.9	B+
82.5 – 87.4	B
80.0 – 82.4	B-
77.5 – 79.9	C+
72.5 – 77.4	C
70.0 – 72.4	C-
67.5 – 69.9	D+
60.0 – 67.4	D
59.9 and below	F

Table a: Grading Scale Table

Course Schedule

The course will cover the following topics:

- Brief history of robotics
- Anatomy of a robot
- Kinematics
- Actuation
- Sensing
- Control
- Configuration space
- AI for robots: motion planning for point robots and for complex robots, robot perception
- Applications of robotics

Policy Statements

Academic Policies

University Class Attendance Policy

University Policy: As stated in the University's Class Attendance Policy, no right or privilege exists that permits a student to be absent from any class meetings, except for these University Approved Absences:

1. Authorized University activities: University Approved Absence Office (UAAO) website provides information and FAQs for students and FAQs for faculty related to University Approved Absences
2. Disability/religious observance/pregnancy, as required by law and approved by the Equal Opportunity and Compliance Office (EOC)
3. Significant health condition and/or personal/family emergency as approved by the Office of the Dean of Students, Gender Violence Service Coordinators, and/or the Equal Opportunity and Compliance Office (EOC).

Collaboration Policy

I encourage you to discuss the material covered in this course with other people to deepen your understanding of the concepts. But all academic work in this course that you submit for grading, including assignments, labs, and exams, is to be your own work (or by a team member when a lab is supposed to be completed by an instructor-approved team). No collaboration is permitted when preparing or writing your written answers for assignments. All submitted work must be your own. All code for your labs must be your own. No code obtained from other sources may be used for projects without the explicit (in writing) permission of the instructor or TA. Receiving help or code from undocumented sources constitutes an honor code violation. Please speak to the instructor or TA if you have any questions. It is your responsibility if you have any doubt to confirm whether a form of collaboration is permitted.

Code of Conduct

All students are expected to adhere to University policy and follow the guidelines of the UNC Code of Conduct. Additional information can be found at https://studentconduct.unc.edu/.

Artificial Intelligence (AI) Use Policy

Use of generative AI tools of any kind is not permitted in this course. Any use of these tools will be considered an instance of academic dishonesty and will be referred to the Honor System.

Syllabus Changes

The instructor reserves the right to make changes to the syllabus including project due dates and test dates. These changes will be announced as early as possible.

Acceptable Use Policy

By attending the University of North Carolina at Chapel Hill, you agree to abide by the University of North Carolina at Chapel Hill policies related to the acceptable use of IT systems and services. The Acceptable Use Policy (AUP) sets the expectation that you will use the University's technology resources responsibly, consistent with the University's mission. In the context of a class, it's quite likely you will participate in online activities that could include personal information about you or your peers, and the AUP addresses your obligations to protect the privacy of class participants. In addition, the AUP addresses matters of others' intellectual property, including copyright. These are only a couple of typical examples, so you should consult the full Information Technology Acceptable Use Policy, which covers topics related to using digital resources, such as privacy, confidentiality and intellectual property. Additionally, consult the Safe Computing at UNC website for information about data security policies, updates, and tips on keeping your identity, information, and devices safe.

Data Security & Privacy

UNC-Chapel Hill is committed to fulfilling its responsibilities of transparency as a state-sponsored institution of higher learning, protecting certain types of information, and using information Carolina collects only for appropriate purposes. Consult the UNC-Chapel Hill Privacy Statement for additional information.

Grade Appeal Process

If you have any concerns with grading or believe you have been awarded an incorrect grade, you must let the TA or me know in writing within 7 days of the grade being reported. Then we will set a time to discuss it.

Classroom Etiquette

You are expected to maintain proper etiquette in class. This includes the following.

- Do not make a habit of arriving late or leaving during class. If you must be late once or twice, take an aisle seat quietly, and likewise if you must leave early.
- Keep mobile phones and other ringing devices in silent mode or off during class.
- We encourage discussion in class, but during class-wide discussions and lectures only talk if you are speaking with the instructor or the entire class. Private discussion between students, even whispers, carry surprisingly well and are a real distraction to those seated near you and to the instructor. If you have questions about the material or what was said in lecture or during a class-wide discussion, please raise your hand, especially since other students may have a similar question or might gain from your insights.

- Do not use your laptop or other computing device to play games or pursue other activities unassociated with the class. This means no e-mail, no Facebook, no X/Twitter, no ESPN, and so on.

We will try to be courteous to you and we ask that you be courteous to others as well.

Services & Student Support Policies

Equal Opportunity and Compliance - Accommodations

Equal Opportunity and Compliance Accommodations Team (Accommodations - UNC Equal Opportunity and Compliance) receives requests for accommodations for disability, pregnancy and related conditions, and sincerely held religious beliefs and practices through the University's Policy on Accommodations. EOC Accommodations team determines eligibility and reasonable accommodations consistent with state and federal laws.

Counseling & Psychological Services (CAPS)

UNC-Chapel Hill is strongly committed to addressing the mental health needs of a diverse student body. The Heels Care Network website is a place to access the many mental health resources at Carolina. CAPS is the primary mental health provider for students, offering timely access to consultation and connection to clinically appropriate services. Go to the CAPS website or visit their facilities on the third floor of the Campus Health building for an initial evaluation to learn more. Students can also call CAPS 24/7 at 919-966-3658 for immediate assistance.

Title IX Resources

Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Reports can be made online to the EOC or by contacting the University's Title IX Coordinator, Elizabeth Hall, or the Report and Response Coordinators in the Equal Opportunity and Compliance Office. Please note that I am designated as a Responsible Employee, which means I must report to the EOC any information I receive about the forms of misconduct listed in this paragraph. If you'd like to speak with a confidential resource, those include Counseling and Psychological Services and the Gender Violence Services Coordinators. Additional resources are available at safe.unc.edu.

Policy on Non-Discrimination

The University is committed to providing an inclusive and welcoming environment for all members of our community and to ensuring that educational and employment decisions are based on individuals' abilities and qualifications. Consistent with this principle and applicable laws, the University's Policy Statement on Non-Discrimination offers access to its educational programs and activities as well as employment terms and conditions without respect to race, color, gender, national origin, age, religion, genetic information, disability, veteran's status, sexual orientation, gender identity or gender expression. Such a policy ensures that only relevant factors are considered, and that equitable and consistent standards of conduct and performance are applied.

If you are experiencing harassment or discrimination, you can seek assistance and file a report through the Report and Response Coordinators (email reportandresponse@unc.edu or see additional contact info at safe.unc.edu) or the Equal Opportunity and Compliance Office. Please note that I am designated as a Responsible Employee, which means that I must report to the EOC any information I receive about harassment or discrimination. If you'd like to speak with a confidential resource, those include Counseling and Psychological Services and the University's Ombuds Office.

Diversity Statement

I value the perspectives of individuals from all backgrounds reflecting the diversity of our students. I broadly define diversity to include race, gender identity, national origin, ethnicity, religion, social class, age, sexual orientation, political background, and physical and learning ability. I strive to make this classroom an inclusive space for all students. Please let me know if there is anything I can do to improve. I appreciate any suggestions.

Undergraduate Testing Center

The College of Arts and Sciences provides a secure, proctored environment in which exams can be taken. The Undergraduate Testing Center works with instructors to proctor exams for their undergraduate students who are not registered with ARS and who do not need testing accommodations as provided by ARS. In other words, the Center provides a proctored testing environment for students who are unable to take an exam at the normally scheduled time (with pre-arrangement by your instructor).

Learning Center

Want to get the most out of this course or others this semester? Visit UNC's Learning Center to make an appointment or register for an event. Their free, popular programs will help you optimize your academic performance. Try academic coaching, peer tutoring, STEM support, ADHD/LD services, workshops and study camps, or review tips and tools available on the website.