College of Engineering
Electrical and Computer Engineering

Syllabus

Course Number	EECE 4560/5560
Course Title	Fundamentals of Robotics
Credits	3
Semester/Class	Spring 2021 Semester Tues/Thur 5:00-6:15PM <Zoom link on Blackboard>
Faculty Name	Prof Robinette
Preferred Pronouns	he, him, his
Office Hours	Tues/Thur 2:30PM-4:00PM and by appointment <Zoom link on Blackboard>
Office Location	Ball 311 (office hours may be in DAN 407)
Phone/Email	paul_robinette@uml.edu (preferred contact) 978-934-3347

I. Course Description

The purpose of this course is to introduce you to the basics of robotics. The material in this course is a combination of essential topics, techniques, algorithms, and tools that will be used in future robotics courses. Fundamental topics relevant to robots (linear algebra, numerical methods, programming) will be reinforced throughout the course using introductions to other robotics topics that are each worthy of a full semester of study (dynamics, kinematics, controls, planning, sensing).

A majority of the content in this course will be presented in the form of lectures and demonstrations. Students will complete homework, labs and a semester-long project (graduate section only) to reinforce their learning. There is no assigned textbook for this course, but lecture notes will be provided online.

II. Course Objectives

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

- Describe and explain the methods a robot can use to accomplish tasks
- Develop ROS packages
- Understand and explain complex robotic systems
- Describe and explain the mathematics underlying robotic algorithms
- Understand and apply basics of linear algebra in robotics problems
- Understand and apply coordinate transformation in 2D and 3D
- Understand and apply basic robotics perception algorithms
- Understand and apply best coding practices for robotics

III. Textbook/Readings

There is no required text. Course notes will be provided by the instructor. Students will be expected to purchase their own robot kit. Links to purchase the kit and to reading material for the course will be provided in lectures or on Blackboard.

IV. Required Equipment

Ideally, all students will have their own laptop capable of running ROS in Linux. This could take many forms, including a laptop that dual-boots into Linux as well as Windows or MacOS, a laptop running a Linux Virtual Machine or a laptop using Docker or similar containers for ROS. **If this is not possible, please contact the instructor as soon as possible.**

Students will be expected to purchase a Duckiebot for the class. Kits can be purchased on the Duckietown website. A discount code will be given in class so that it is approximately the price of a textbook. More details will be given in lecture.

V. General Information

This course is designed to be accessible to junior/sophomore undergraduate students and graduate students of all levels. We strongly encourage first-year graduate students to take this course as early as possible.

No prerequisites are needed for the graduate section of this course. It is recommended that all students have some programming experience (MATLAB is okay, but Python/C/C++ is preferred) and are familiar with linear algebra.

A. Teaching Methods

The best way to learn robotics is to build and program a robot to accomplish tasks in a lab environment. Lectures and other formal material in this class are generally designed to take a portion but not all of the class time. The remainder of the class is for the student to work on the robots with the instructor on hand to answer questions and guide learning.

B. Attendance

Attendance is highly recommended but not required. Attendance will not be taken in class. Some assignments require an in-person demonstration which can occur in class or in a time scheduled with the instructor or teaching assistant. Attendance and interaction in class will count towards the participation grade.

Students are expected to attend class regularly, as regular attendance is one of the most important contributors to student success. However, students may occasionally need to miss class due to illness, emergency, or caring for a sick family member. In such cases, you are responsible for notifying me of your absences and working with me to arrange to make up any missed work. I will be very accommodating to students who are experiencing pandemic-related challenges, but you must communicate your requests with me regularly and with as much advance-notice as possible. Likewise, if I should become ill or need to miss class, I will communicate with you via email as soon as possible with clear instructions.

A note on Zoom Participation: Because I believe that the class will be more engaging if we can see one another, I strongly recommend that students keep their cameras on during class unless you have a valid

reason not to, which you should discuss with me ahead of time.

C. Assessment and Evaluation Methods

Your final grade will be assessed through the use of labs, homework, and participation. Five labs will be completed throughout the course in lieu of tests. For the graduate students, a final group project will show that mastery of the subject. Participation in course lectures/debug sessions will also count towards the grade

Graduate Section Grade Breakdown:
Homework (10): 20% (2% each)
Labs (5): 50% (10% each)
Final Project: 20%
Participation: 10%

Undergraduate Section Grade Breakdown:
Homework (10): 25% (2.5% each)
Labs (5): 62.5% (12.5% each)
Participation: 12.5%

D. Grading Scale

Final grades will be rounded to the nearest percentage point and distributed as follows:

Graduate Section		Undergraduate Section	
A+	97-100%	A	93-100%
A	93-96%	A-	90-92%
A-	90-92%	B+	87-89%
B+	87-89%	B	83-86%
B	83-86%	B-	80-82%
B-	80-82%	C+	77-79%
C+	77-79%	C	73-76%
C	70-76%	C-	70-72%
F	<70%	D+	67-69%
		D	60-66%
		F	<60%

E. The Centers for Learning and Academic Support Services (CLASS)

provide tutoring services, including an online searchable tutoring schedules are available that include resources on all campuses. A tutoring request form is also available if there are no tutors listed for the class for which you need help.

F. Student Mental Health and Wellbeing

We are a campus that cares about the mental health and well-being of all individuals in our campus community, particularly during this uncertain time. If you or someone you know are experiencing mental health challenges at UMass Lowell, please contact Counseling Services, who are offering remote counseling via telehealth for all enrolled, eligible UMass Lowell students who are currently residing in Massachusetts or New Hampshire. I am available to talk with you about stresses related to your work in my class.

G. Disability Services

If you have a documented disability that will require classroom accommodations, please notify me as soon as possible, so that we might make appropriate arrangements. Please speak to me during office hours or send me an email, as I respect, and want to protect, your privacy. Visit the Student Disability Services webpage for further information. Additionally, Student Disability Services supports software for ALL students. Read&Write Gold is literacy software that allows you to read on-screen text aloud, research and check written work, and create study guides. You can download the software from the IT Software webpage on the UML website: IT Software page

H. Diversity, Inclusion, and Classroom Community Standards

UMass Lowell—and your professor—value human diversity in all its forms, whether expressed through race and ethnicity, culture, political and social views, religious and spiritual beliefs, language and geographic characteristics, gender, gender identities and sexual orientations, learning and physical abilities, age, and social or economic classes. Enrich yourself by practicing respect in your interactions, and enrich one another by expressing your point of view, knowing that diversity and individual differences are respected, appreciated, and recognized as a source of strength.

I. Student Feedback (Course Evaluations)

Student feedback on teaching is a highly valued and helpful mechanism for monitoring and improving the quality of College of Engineering programs and instructional effectiveness. To that end, course evaluations are administered during the last few weeks of classes. Students are encouraged to participate actively in this process.

J. Academic Integrity Policy

For homework and labs, you are expected to do your own work. You are encouraged to discuss in groups but the submission you turn in must represent only your work. Turning in code or other homework that is substantially the same as another student's work in plagiarism. Doing the work yourself is an important part of learning the material and is the only way you will be able to master it in order to move on to later classes or career positions in robotics.

Examples and solutions from the internet and other sources may be useful to you in learning this material but you cannot turn in something downloaded from the internet and claim it as your own. That would be plagiarism. If you use something from another source as a reference in one of your submissions, cite it clearly.

Cheating and plagiarism will not be tolerated. A first offense will result in a failing grade for the assignment/exam in question and a formal filing with the Office of Provost according to the Academic Integrity Policy. A second offense could lead to a failing grade in the course, suspension or expulsion, as detailed in the policy. All students are advised that there is a University policy regarding academic integrity. It is the students' responsibility to familiarize themselves with these policies: graduate academic integrity policy.

K. Classroom Conduct

Students are expected to exhibit professional and respectful behavior that is conducive to a mutually beneficial learning environment in the classroom. Examples of inappropriate behavior include: text

messaging, listening to music, cell phone use (other than the campus alert system), late arrivals, early departures, use of laptops for other than class purposes, disrespectful comments or behavior, intentional disruptions, failure to follow faculty directives, etc. Students in violation of these standards may be asked to leave class and/or be referred to the Dean of Students for disciplinary action.

L. Credit Hour Policy

Federal definition of a credit hour requires that for every course credit awarded, a course must offer 15 hours of instructor-led course activities and 30 hours of out-of-class student work. This means that a standard 3 credit hour course requires 45 hours of instructor-led course activities and 90 hours of out-of-class student work.

M. Athletic Academic Policy

Student-athletes must adhere to the Athletic Academic Policy.

N. University Privacy Statement

UMass Lowell recognizes the importance of mutual trust between students and faculty. Neither faculty nor students may record video or audio of a course or private conversation without all parties' consent. Massachusetts is a two-party consent state, which means it is illegal to record someone without their permission. Recordings of classroom lectures are the intellectual property of the instructor. Instructors have the right to prohibit audio and video recording of their lectures, unless the requesting student is registered with Disabilities Services and recording of class sessions is an approved accommodation. In addition, sharing of or selling recordings of classroom activity, discussions or lectures with any other person or medium without permission of the instructor is prohibited.

VI. Course Requirements

Homework will be assigned frequently throughout the class to reinforce understanding of the basic mathematical and algorithmic concepts covered in those lectures. Homework may take the form of problem sets or programming assignments. *Late submissions will have a 10% penalty for each calendar day they are late. After FIVE calendar days, late submissions will not be accepted.*

Labs while homework is intended to test a particular concept, labs ensure that the concept fits into the bigger picture. Each lab will cover several lectures worth of content. Some steps of each lab will overlap with some homework assignments, but the final grade in the assignment will be based on an in-class demonstration using a duckiebot (or simulation), code submission, and a brief report. *Late submissions will have a 10% penalty for each calendar day they are late. After FIVE calendar days, late submissions will not be accepted.*

Final Project (graduate section only) Students will form groups (4-5 people) to complete a project of their choosing. Project topics must be approved by instructor. Groups will be graded on a demonstration, their report, and a presentation of their work.

Participation will be assessed based on several factors. Students are encouraged to use the class slack to ask questions and help each other, which will count towards participation. Interaction in class (even just

turning on your camera) will also count towards participation. Barring disruptive behavior, if you attend most classes and are active on slack you will likely receive full points for participation.

VII. Course Outline & Class Schedule:

The purpose of this class is to ensure that all beginning graduate students have a baseline level of understanding of the fundamentals of robotics, so the schedule is subject to change throughout the semester depending on the progress of the class.

#	Date	Topic	Assigned	Due
1	Jan 26	Introduction to Robotics	Robot Ordering	
2	Jan 28	Tools: ROS, Docker, Python, Linux	HW1	
3	Feb 2	ROS Programming		
4	Feb 4	Debugging Robots	HW2	HW1
5	Feb 9	Introduction to Duckietown		ORDER YOUR ROBOT!
6	Feb 11	Setting Up and Calibrating	HW3, Lab1	HW2
X	Feb 16	**NO CLASS Monday Schedule**		
7	Feb 18	Programming Duckiebots	HW4	HW3
8	Feb 23	Introduction to Autonomy		
9	Feb 25	Dynamic Systems	Lab2	Lab1
10	Mar 2	Coordinate Systems	FP	
11	Mar 4	ROS TF	HW5	HW4
12	Mar 9	Numerical Methods		
13	Mar 11	Robot Odometry	HW6, Lab3	HW5, Lab2
14	Mar 16	Human-Robot Interaction		
15	Mar 18	Robot Perception	HW7	HW6
16	Mar 23	Introduction to Computer Vision		
17	Mar 25	Color Filtering	HW8, Lab4	HW7, Lab3
18	Mar 30	Edge and Line Detection		
19	Apr 1	Ethics and Robotics		HW8
20	Apr 6	Path Planning		
21	Apr 8	ROS Services and Actions	HW9	Lab4
22	Apr 13	Introduction to Controls		
23	Apr 15	PID Controllers	HW10, Lab5	HW9
24	Apr 20	Guest Lecture		
25	Apr 22	Advanced Planning		HW10
26	Apr 27	Guest Lecture		
27	Apr 29	Trends in Robotics		Lab5
	FINAL	Final Project Presentation (Grad Section)		FP