

Sample Syllabus

ME 456 – Introduction to Robotics

Fall 2024

Instructor

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Office hours:
Monday 4:00-5:00 pm
Wednesday 4:00-5:00 pm
Or by appointment

TA

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Office hours:
Monday 1:00-2:00 pm
Friday 1:00-2:00 pm

Class Time and Location

Class time: Monday, Wednesday, & Friday, 10:10AM - 11:00AM
Class location: Thomas Bldg 201

Prerequisites

Required: EMCH 212 and ME 360/ME367
Strongly recommended: MATH 220

Course Material Tools

- MATLAB: students can obtain a free copy from Software at Penn State.
- Corke Robotics Toolbox: A MATLAB toolbox with robotic-specific functions. Download the toolbox for free from <http://petercorke.com/wordpress/toolboxes/robotics-toolbox>

Recommended Textbook

- *Robotics, Vision and Control* by Peter Corke, Springer, 2017, 2 ed. (free ebook option at <https://catalog.libraries.psu.edu/catalog/7523223>)
- *Modern Robotics: Mechanics, Planning, and Control*, by Kevin Lynch and Frank Park, Cambridge University Press, 2017. (Free Preprint ebook: <http://hades.mech.northwestern.edu/images/7/7f/MR.pdf>)

Course Description and Objectives

This course is a technical elective where students learn about the present and future status of robot applications, and are required to apply fundamental knowledge of physics, mechanics, and mathematics to develop software to analyze and control robots. This course utilizes a significant amount of trigonometry and linear algebra, particularly matrix multiplication. This course also uses concepts covered in earlier engineering mechanics courses such as kinematics and dynamics. In addition, MATLAB software will be used extensively. The course deals with mechanics and control of mobile robots and robot manipulators. We will cover descriptions of position and orientation of a rigid body, including rotation matrix, roll-pitch-yaw angles and Euler angles. We will also cover the description and control of mobile robots and robotic manipulators. In addition, we will provide a brief introduction to motion planning, computer vision, Robot Operating System (ROS2) and robot simulation platforms.

By the completion of the course, students will be able to

- Represent the position and orientation of robots using standard methods,
- Perform kinematics and control of wheeled mobile robots
- Derive 3-D kinematics, statics, dynamics and control of robot manipulators

- Familiarize with software and platforms used in robotics
- Apply the foundational knowledge to perform control and analysis of a robot manipulator

Grading

- Homework 20%
- Exam 1 20%
- Exam 2 20%
- Project 20%
- Final Exam 20%

Homework

Homework should be submitted on time to Canvas. If an assignment is 30 minutes to 24 hours late, there is a 20% deduction of the particular homework grade, and if an assignment is beyond 24 hours late, a zero grade will be given. If you need an extension, you must ask at least 24 hours before the due date with an approved absence notice. One homework (out of five) with the lowest grade (including late homework or not turned in homework) will be dropped from the overall homework grade.

Project

A group project will be assigned with 5-6 students working on a robotic manipulator. The task involves programming the robot through kinematic and dynamic control to perform reaching, grasping, and transporting objects. The assignment includes a written report (15 points) (written report template will be uploaded to Canvas) and an in-class demo (the demo (5 points) will be peer graded).

Course Outline

Weeks	Topics	Notes
	Section 1: Fundamentals	
1	Introduction MATLAB and Simulink Overview	
2	Representations: Position and Orientation	Monday: Labor Day
	Section 1.1: Mobile Robot	
3	Kinematics	
4	Localization and Mapping Trajectory Generation	HW 1 due Sun. midnight
	Section 1.2: Robotic Manipulator	
5	Manipulator Kinematics	
6	Manipulator Jacobian	HW 2 due Sun. midnight
7	Manipulator Dynamics	Mon: SFN meeting Exam 1: Wed. in-class (Weeks 1-6 materials)
	Section 2: Robotic Control	
8	Motion Planning	HW 3 due Sun. midnight Wed: NIH meeting
9	Computer Vision	
10	Motion Control	Project Assignment HW 4 due Sun. midnight
11	Grasping	Exam 2: Wed. in-class

		(Weeks 7-10 materials)
12	Feedback Control	HW 5 due Sun. midnight
	Section 3: Robotic System Applications	
13	Robot Operating System (ROS2)	Project midway update
14	Holiday	Thanksgiving Week
15	Robot Simulation Platforms Robotic System Applications	
16	Project Demos	
17	Final Exam: TBD	Project Report Due TBD

Note: The instructor reserves the right to make changes to the outline schedule, including assignment due dates and exam dates (excluding the officially scheduled final examination), when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules accordingly.

Academic Integrity Statement

Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts. Academic integrity includes a commitment by all members of the University community not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.

According to Penn State policy [G-9: Academic Integrity \(https://undergrad.psu.edu/aappm/G-9-academic-integrity.html\)](https://undergrad.psu.edu/aappm/G-9-academic-integrity.html), an academic integrity violation is "an intentional, unintentional, or attempted violation of course or assessment policies to gain an academic advantage or to advantage or disadvantage another student academically." Unless your instructor tells you otherwise, you must complete all course work entirely on your own, using only sources that have been permitted by your instructor, and you may not assist other students with papers, quizzes, exams, or other assessments. If your instructor allows you to use ideas, images, or word phrases created by another person (e.g., from Course Hero or Chegg) or by generative technology, such as ChatGPT, you must identify their source. You may not submit false or fabricated information, use the same academic work for credit in multiple courses, or share instructional content. Students with questions about academic integrity should ask their instructor before submitting work.

Students facing allegations of academic misconduct may not drop/withdraw from the affected course unless they are cleared of wrongdoing (see G-9: Academic Integrity). Attempted drops will be prevented or reversed, and students will be expected to complete course work and meet course deadlines. Students who are found responsible for academic integrity violations face academic outcomes, which can be severe, and put themselves at jeopardy for other outcomes which may include ineligibility for Dean's List, pass/fail elections, and grade forgiveness. Students may also face consequences from their home/major program and/or The Schreyer Honors College.

Disability Accommodation Statement

Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. Student Disability Resources (SDR) website provides contact information for every Penn State campus (<http://equity.psu.edu/sdr/disability-coordinator>). For further information, please visit Student Disability Resources website (<http://equity.psu.edu/sdr/>). In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: See documentation guidelines (<http://equity.psu.edu/sdr/guidelines>). If the documentation supports your request for reasonable accommodations, your campus disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early as possible. You must follow this process for every semester that you request accommodations.

Educational Equity or Report Bias Statement

Consistent with University Policy AD29, students who believe they have experienced or observed a hate crime, an act of intolerance, discrimination, or harassment that occurs at Penn State are urged to report these incidents as outlined on the [University's Report Bias webpage](http://equity.psu.edu/reportbias/) (<http://equity.psu.edu/reportbias/>).

Counseling & Psychological Services Statement

Many students at Penn State face personal challenges or have psychological needs that may interfere with their academic progress, social development, or emotional wellbeing. The university offers a variety of confidential services to help you through difficult times, including individual and group counseling, crisis intervention, consultations, online chats, and mental health screenings. These services are provided by staff who welcome all students and embrace a philosophy respectful of clients' cultural and religious backgrounds, and sensitive to differences in race, ability, gender identity and sexual orientation.

Counseling and Psychological Services at University Park (CAPS): 814-863-0395

(<https://studentaffairs.psu.edu/counseling>)

Counseling and Psychological Services at Commonwealth Campuses

(<https://senate.psu.edu/faculty/counseling-services-at-commonwealth-campuses/>)

Penn State Crisis Line (24 hours/7 days/week): 877-229-6400

Crisis Text Line (24 hours/7 days/week): Text LIONS to 741741