

Penn State Abington College
EDSGN 410
Robotics Design and Applications
Syllabus v1
Fall 2025 (Great Valley)
TR 2:45 – 5:15pm

Instructor: Robert Avanzato, Associate Professor of Engineering, Room 202 Rydal Bldg. Abington campus, E-mail address: RLA5@psu.edu, Office hours (R 10:30am – 12:30pm; W 1pm – 4pm) in Zoom by appointment. Students may email instructor at any time with questions or comments. Zoom office hour link: <https://psu.zoom.us/my/ravanzato>

Course Objectives:

The objective of this course is to apply the basic concepts of electrical, mechanical, and software technologies to analyze, design and test a robotics system. This course will draw from skills in prior coursework in electricity and electronics, statics and dynamics, and software design. The course includes a discussion of present applications and future directions of robotics in such areas as manufacturing, science, transportation, military, healthcare, and entertainment. Students will be introduced to mechanical systems analysis, sensors, software development, electrical systems, control algorithms, testing, prototyping, design, modeling, and simulation of robot systems. Students will work in teams to design and prototype a robot to perform a task and to satisfy a set of design requirements. Professional communication and documentation will be included in the course experience. This course is a multi-disciplinary, project-based course and will have a substantial laboratory component supporting team-based design, integration and testing of a robot system.

Note: This is an in-person course. The class will meet at Great Valley from 2:45pm to 5:15pm on Tuesdays and Thursdays. Typically, the first 30 to 60 minutes will be a lecture/discussion and the remainder of the class will be instructor-guided, hands-on projects. Each student is expected to attend class at the scheduled time and day each week. In the event we need to switch to remote delivery, then meetings will be held on Zoom.

Prerequisites:

EE 316 and (CMPSC 200 or CMPSC 201 or CMPSC 121 or CMPSC 131) and EE 310 and EMCH 212

Required Textbook: No required textbook

Required Materials/Software

- 1) OSOYOO Arduino mobile robot (with LiPo batteries). Amazon ~\$65 to \$70 (purchase from Amazon.com). This robot is required by end of 1st week or start of 2nd week of classes. [amazon link to OSOYOO robot](#) (OSOYOO Robot Starter kit v2.1 with LiPo batteries). Just make sure you order a robot kit with the rechargeable (LiPo) batteries included. Do not use lab equipment for this requirement – this is personal purchase.
- 2) Optical wheel encoders for mobile robots (Quantity = 2) ~\$10 total. Purchase from Amazon.com. There are alternatives to this model below if out of stock (see lecture notes) This sensor is required by 3rd week of classes. NOTE: 1 package contains 2 sensors. We need a total of 2 sensors per robot.
https://www.amazon.com/gp/product/B00EERJDY4/ref=ppx_yo_dt_b_asin_title_o05_s00?ie=UTF8&psc=1

- 3) Student Edition of MATLAB software toolboxes (free for PSU students)
<https://www.it.psu.edu/software/> (requires PSU authentication for license)
MATLAB should be downloaded and installed by 3rd week of semester.

References:

- Roland Siegwart, Illah Nourbakhsh, *Autonomous Mobile Robots*, MIT Press, 2011.
- Peter Corke, *Robotics, Vision and Control*, Springer, 2013.
- *Introduction to Robotics*, John J. Craig, Addison-Wesley Publishing, Inc., 1989.
- *Modern Robotics: Mechanics, Planning, and Control*, Kevin Lynch and Frank Park, Cambridge University Press, 2017.
- *ROS Robotics By Example – Second Edition: Learning to control wheeled, limbed, and flying robots using ROS Kinetic Kame*, Carol Fairchild, Thomas L. Harman, 2017.
- *Programming Robots with ROS: A Practical Introduction to the Robot Operating System*, Morgan Quigley, Brian Gerkey, 2015.
- ROS Website: <http://www.ros.org/>

Grading Policy:

Quizzes/Exams (2-3) – 30% (C average or better required)
Homework – 10%
Laboratory Assignments/Design Projects – 45%
Final Team Design Project – 15%

A	93.0 – 100	C+	75 – 79.9
A-	90.0 – 92.9	C	70 – 74.9
B+	87.0 – 89.9	D	60 – 69.9
B	83 – 86.9	F	< 60
B-	80 – 82.9		

Course Outcomes:

1. Communicate the present and future role of robotics in a variety of application areas in industry and for society in general.
2. Evaluate, test, and interface sensors to a robot system.
3. Develop a 2D kinematic analysis of a subsystem of the robot system mechanics (example: kinematics of a wheeled mobile robot).
4. Calculate the power requirements and create a circuit diagram for the power and control system of a robot system.
5. Create a CAD model and simulation of a subsystem of a robotics system.
6. Design, program, and test software for a robot system
7. Design, prototype, test, document a complete robotics system to meet a set of design requirements.
8. Work collaboratively in a team to achieve engineering design goals.

Policies:

- **Homeworks are due on Canvas prior to the posted deadline.** If you need to ask for an extension, you must do so before the posted deadline.
- **Homeworks and labs are to be completed on an individual basis unless otherwise indicated.**
- **Late homework/projects will be penalized (20%, starting at original deadline).** No late homework will be accepted after one week beyond the deadline (the HW assignment drop box will be closed).

Late homework will receive no credit once solutions have been discussed in class, posted, dropbox closed, or graded homework posted.

- **Honorlock exam proctoring service will be used in this course for select exam/quizzes.** This would require students to use Chrome web browser on a laptop with a web camera.
- **Missed exams or quizzes without prior instructor notification/approval will result in a zero grade.**
- **An average exam/quiz grade must be greater than 70 to achieve a final course grade greater than C regardless of other course module grades.**
- **HW and Lab solutions must utilize functions and concepts covered in the course.** Use of Generative AI solutions and other external resources are for supplemental and supportive role only.

Course Schedule (tentative):

Week 1-5	<p>Overview of course, introduction to robot systems design, applications and impact of robotics on society, industry, medicine, manufacturing, search and rescue, entertainment, space exploration and rehabilitation.</p> <p>Demonstration of robots: Stormbot, Dobot robot arm, Arduino mobile robot, BlueROV2 underwater robot, Husky outdoor mobile robot.</p> <p><u>Module #1: Mobile Robotics Design and 2D Kinematics</u></p> <ul style="list-style-type: none">- Construct and Test Arduino Mobile robot (each student must have a mobile robot)- Arduino Robot Labs with wheel encoders- Design and Test Line following robot with PID control and obstacle avoidance- Firefighting Robot Maze Contest- Quiz: Arduino Interfacing and Mobile Robotics
Week 6-9	<p><u>Module #2: Introduction to ROS/MATLAB software with Turtlebots</u> (Gazebo simulation software and physical Turtlebot3 robots)</p> <p>Lab Modules: 1) Intro to MATLAB and ROS, 2) Robot navigation with sensors, 3) SLAM with ROS, 4) 3D simulation with Gazebo, 5) Turtlebot3 labs, 6) Intro to computer vision</p> <p>- Quiz: ROS and MATLAB Mobile Robotics</p>
Week 10-13	<p><u>Module #3: Robot Manipulators (Robot Arm with MATLAB/ROS/Python)</u></p> <ol style="list-style-type: none">1) Robot arms/manipulators in industry and manufacturing2) Introduction to forward kinematics, inverse kinematics (and dynamics)3) MATLAB and Simulink simulation of robot arm4) Intro. to Python programming5) Intro. to Programmable Logic Controllers (PLCs) and Ladder Logic6) Lab: Control of Dobot Arm using Python7) Lab: Ladder Logic with PLCs8) Quiz: Robot Arm Programming and PLCs
Week 14-15	<p><u>Team Design Project:</u> (team design of a robot system or subsystem)</p> <p>Include objectives, requirements, system diagram/overview, results, conclusions, team roles, demo, PPT, software.</p> <ul style="list-style-type: none">- Project must be pre-approved by instructor (2 to 3 students per team)- Team Presentations and Demonstrations.

Academic Integrity

All students are expected to act with civility, personal integrity; respect for other students' dignity, rights and property; and help create and maintain an environment in which all can succeed through the fruits of their own efforts. An environment of academic integrity is requisite to respect for self and others and a civil community.

Academic integrity includes a commitment to not engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty include cheating or copying, plagiarizing, submitting another person's work as one's own, submitting work previously used without informing the instructor, using Internet sources without citation, fabricating field data or citations, "ghosting" (taking or having another student take an exam), stealing examinations, tampering with the academic work of another student, fabricating other students' acts of academic dishonesty, etc.

Academic dishonesty violates ethical principles of the University community and compromises the worth of work completed by others. A student should avoid academic dishonesty when preparing for any class. If charged with academic dishonesty, students will receive written or oral notice of the charge by the instructor. Students who contest the charge should first seek resolution through discussion with the faculty member or the campus Director of Academic Affairs. If the matter is not resolved, the student may request a hearing with the Commonwealth College Committee on Academic Integrity at the campus.

Academic dishonesty will not be tolerated in this course. Academic dishonesty on an assignment leads to, at a minimum, a failing grade of F (a score of zero points) for that assignment or activity. Sanctions for breaches of academic integrity may range (depending on the severity of the offense) from F for the assignment to F for the course. In severe cases of academic dishonesty, including, but not limited to, stealing exams or "ghosting" an exam, students may receive a grade of XF, a formal University disciplinary sanction that indicates on the student's transcript that failure in the course was due to a serious act of academic dishonesty. The University's statement on academic Integrity from which the above was drawn is available at: <http://www.psu.edu/dept/oue/aappm/G-9.html>

It is appropriate and necessary for students to collaborate with each other in the completion of the team project and presentation.

Students with Disabilities

Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. At Penn State Abington, services for students with documented disabilities are provided through the Coordinator of Disability Services, Tiffany Ostrowski, located in 223 Sutherland (215) 881-7962, tmo5227@psu.edu. 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: <http://equity.psu.edu/sdr/guidelines>. If the documentation supports your request for reasonable accommodations, your campus's 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 in your courses as possible. You must follow this process for every semester that you request accommodations.

Center for Student Achievement

The Center for Student Achievement, located in 315 Sutherland, offers free tutoring and writing consultations to all students. For assistance, please email achieve-ab@psu.edu. Tutoring will be conducted in 315 Sutherland and The Library; writing consultations will be conducted remotely through Zoom. Tutoring appointments and writing consultations can be scheduled through Starfish. We can also provide you with same-day assistance by visiting 315 Sutherland or through our Zoom walk-in room: <https://psu.zoom.us/j/99255021745>. Online Tutoring is also available through Brain Fuse and can be

accessed by visiting abington.psu.edu/achievement. The CSA offers workshops that strengthen students' abilities to study, write, manage time, make decisions and achieve goals. The Center for Student Achievement office is open 8:00 am to 5:00 pm, Monday through Thursday, and 8:00 am to 3:00 pm Fridays

Information on available Counseling & Psychological Services (CAPS)

Many students at Penn State face personal challenges or have psychological needs that may interfere with their academic progress, social development, or emotional wellbeing. If you encounter personal problems of any kind on or off campus, please reach out for help. 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. On campus counseling and psychological services are available on the first floor of the Cloverly Building. Please send an email to abingtoncaps@psu.edu which is the main contact for students to reach CAPS. Or, stop by the Wellness Center in 103 Lares any time.