

IE 482/582: Special Topics in Robotics

Course Syllabus – Fall 2020

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(please include “IE 482:” or “IE 582:”, as applicable, in the subject)
Office: Virtual (off campus)
Office hours: Wednesdays 1-2pm, or by appointment
Teaching Assistant: N/A

Course Meeting Days, Times, and Locations

The course is officially scheduled as follows:

MWF, 11:30am - 12:20pm, remote

However, since this course will be taught fully remote, we will follow a modified meeting schedule. Specifically:

- We won’t plan to meet on Mondays. I’ll post videos, links to articles, and homework assignments for you to do on your own.
- On Wednesdays at 11:30am, we will have a “live” lecture via WebEx. These lectures will be recorded. In these meetings I will present you with new information (like what we’d do if we were in class together).
- On Fridays at 11:30am, we will have “live” question-and-answer sessions via WebEx. Unlike a “lecture”, in these sessions we’ll just have open discussions about the material covered earlier in the week. This will allow us time to do some examples and discuss how the week’s topics are related to other material covered thus far. These sessions will also be recorded.

If you can’t attend one of the “live” lectures, please email your questions to me so I can answer them in the recording.

I will email the WebEx link to you separately.

Course Description

This course introduces Industrial Engineering students to robots and robotic systems, including the design of robot controllers, coordination of multiple robots, simulation of robotic systems, and optimization of robot task scheduling.

Prerequisite(s): None (However, this course is computer programming intensive. Students should ideally have programming experience; a willingness to work outside of class to become proficient with the Python programming language is sufficient otherwise.)

Corequisite(s): None

Textbook and/or Other Required Materials

- Programming Robots with ROS, by Quigley, Gerkey, and Smart
<http://www.amazon.com/Programming-Robots-ROS-Practical-Introduction/dp/1449323898>
- Each student must have a laptop that meets UB's requirements:
<https://www.buffalo.edu/ubit/service-guides/hardware/getting-started-with-hardware/purchasing-or-using-an-existing-computer.html>

Course Websites

- UBlearns will be used for all course grades;
- GitHub will be used for disseminating course materials (e.g., code)
<https://github.com/IE-482-582/fall2020>

Course Learning Outcomes

The following table lists learning outcomes for this course. The statements generally complete the sentence, "Upon completing this course, students will be able to..."

	Course Learning Outcome	Program Outcomes*	Assessment Methods
1	Understand the basics of the Robot Operating System (ROS).	7	Quiz 1, Homework
2	Apply concepts of Systems Engineering to simulated robotic systems.	1	Course Project
3	Understand, interpret, and modify Python code for the purposes of controlling robotic systems.	1, 7	Homework, Course Project
4	Demonstrate and improve upon project management skills. Students will be developing a complex system with numerous deadlines. To be successful, each student team must establish (and hit) their milestones.	5	Course Project
5	Appreciate the importance of developing thorough documentation of a system. Students will be responsible for writing README files that document important elements of the system, including instructions for running the code, citations for reference materials, opportunities for future enhancement, and known issues.	3	Homework, Course Project
6	Acquire and apply new knowledge related to computer programming. To successfully complete the course project in particular, students will need to learn how to find solutions to challenges. This will involve looking for code examples online and reading journal articles.	7	Homework, Course Project

* The Student Outcomes from the Engineering Accreditation Commission of ABET have been adopted, see <http://www.abet.org/>

Program Outcome Support

0: No Coverage

1: Introduced

2: Practiced/Reinforced

3: Mastered

1	2	3	4	5	6	7
1	0	3	0	2	0	2

- (1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;
- (3) an ability to communicate effectively with a range of audiences;
- (5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;
- (7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Course Requirements

Requirement	Quantity	Material Covered	Approx. Date
Quizzes	~2	(1) ROS Basics (2) ROS/Python coding	(1) Week 3; (2) ~Week 6;
Homework/Coding Assignments	~4	Variable; related to material covered within lecture, see schedule	Typically one assignment per module.
Project Proposal	1	Topic selected by student(s) in consultation with instructor	Week 10
Project Status Report	1	See below	Week 13
Project Documentation	1	See below	Week 15
Project Demonstration	1	See below	Week 15
Attendance			See below

Grading Policy

Students will be evaluated on:

Quizzes [20%]: As you progress through the textbook, you will be asked to demonstrate your knowledge of a particular topic. This may come in the form of a quiz, or as a software demonstration. You will be notified at least one class period in advance (i.e., there will be no “pop” quizzes. The first quiz will cover the material in Module 2 (Intro to ROS), and should occur towards the end of Week 3. You should expect one other quiz/demonstration around the end of Week 6.

Homework/Coding Assignments [30%]: You should expect to have one coding assignment for each module. Some of these assignments will be individually assigned, some will be group assignments. Details and requirements will be provided for each assignment. The purpose of

these assignments is to help students gain a deeper understanding of the material covered in each topic. Homework/coding assignments will be concentrated in the first 10 weeks of the semester.

Course Project [50%]: The last 1/3 (approximate) of the semester students will primarily focus on activities related to the course project. Students will work in teams of no more than two (2) students. The exact topic of the project will be up to each team to decide (with approval from the instructor). The project should involve expanding the students' basic ROS knowledge (as obtained during the first 2/3 of the semester) to develop a simulated robotic system. Examples and suggestions will be provided during the first 10 weeks of the semester.

There are four key project deliverables:

- 1) A project proposal [~15%] – This will be in the form of a 1-page written document, due at the beginning of Week 10 (unless directed otherwise). Each project team will give a brief (~5-minute) oral presentation to the class.
- 2) A project status report [~10%] – On the Monday before Thanksgiving break each team will be required to submit a written document outlining the status of the project. This document should clearly list all milestones, and should identify those activities that have been completed, those that are in progress, and those that are in danger of being missed. In the latter case, a plan to address these potential misses should be provided. Each team will present their status reports orally in class.
- 3) Project documentation [~50%] – By the last week of class, each team must submit detailed documentation of the project. This should include instructions for running the code, example outputs, and citations to reference materials. The documentation should also identify potential areas for future improvement. Each team must have their documentation reviewed by at least one other team (and must also review the documentation of at least one other team). Grades will also be based on how well a team evaluates another team.
- 4) Project demonstration [~25%] – During the last week of class, each team will present their projects in class.

Final course grades will be determined based on the following scale:

Final Avg $\geq 94.0\%$	A
Final Avg $\geq 90.0\%$	A-
Final Avg $\geq 87.0\%$	B+
Final Avg $\geq 83.0\%$	B
Final Avg $\geq 80.0\%$	B-
Final Avg $\geq 77.0\%$	C+
Final Avg $\geq 73.0\%$	C
Final Avg $\geq 70.0\%$	C-
Final Avg $\geq 67.0\%$	D+
Final Avg $\geq 60.0\%$	D
Final Avg $< 60.0\%$	F

Do not expect your grade to be “rounded up.”

Incomplete Grades

A grade of incomplete (“I”) indicates that additional course work is required to fulfill the requirements of a given course. Students may only be given an “I” grade if they have a passing average in coursework that has been completed and have well-defined parameters to complete the course requirements that could result in a grade better than the default grade. An “I” grade may not be assigned to a student who did not attend the course.

Prior to the end of the semester, students must initiate the request for an “I” grade and receive the instructor’s approval. Assignment of an “I” grade is at the discretion of the instructor.

Grade Disputes

If you disagree with the manner in which an assignment was graded, you may request a re-evaluation of your assignment within two (2) weeks of the due date of that assignment. A re-evaluation request should consist of two (2) components:

- Page 1: A photocopy of the graded assignment.
- Page 2: A detailed explanation, not exceeding one-half page in length, describing why you believe your answer was correct.

The instructor will consider each case at the end of the term, but only if it appears that it may change your final grade. Obvious arithmetic errors will be corrected immediately.

Professionalism

UB SEAS aims to enhance the education of the students in various aspects of professionalism, and to elevate the standards of behavior that are expected from students. The goals are two-fold: (1) to improve the working and learning environment within SEAS, and (2) to best equip students for employment after graduation.

- Students are expected to use professional style in all communications, including email, with course faculty and teaching assistants. This includes the use of salutations and closings (including clear identification of the author) and correct grammar.
- Students are expected to log in prior to the start of class, and to remain for the duration of the class.
- Students are expected to use proper etiquette while on WebEx calls. This includes remaining muted while not speaking to the class.

Accessibility Resources

If you have a disability and may require some type of instructional and/or examination accommodation, please inform me early in the semester so that we can coordinate the accommodations you may need. If you have not already done so, please contact the Office of Accessibility Resources; 60 Capen Hall; email: stu-accessibility@buffalo.edu Phone: 716-645-2608 (voice); 716-645-2616 (TTY); and on the web at <https://www.buffalo.edu/studentlife/who-we-are/departments/accessibility.html>. All information and documentation is confidential.

Academic Integrity

This course will operate with a zero-tolerance policy regarding cheating and other forms of academic dishonesty. Any act of academic dishonesty will subject the student to penalty, including the high probability of failure of the course (i.e., assignment of a grade of 'F'). It is expected that you will behave in an honorable and respectful way as you learn and share ideas. Therefore, *recycled papers, work submitted to other courses, and major assistance in preparation of assignments without identifying and acknowledging such assistance* are not acceptable. All work for this course must be original for this course. Please be familiar with the University at Buffalo Academic Integrity Policy and Procedure outlined at <https://catalog.buffalo.edu/policies/integrity.html>.

Tentative Course Schedule

Week	Topic	Reading/Assignment
Week 1	Introduction	Review syllabus, order textbook, install virtual machine.
Weeks 2 and 3	Intro to ROS	Study Chapters 1-5, complete the ROS tutorials, prepare for quiz at end of Week 3.
Week 4	Chapter 7 - Wander-bot	Read Chapters 6 and 7.
Weeks 5 and 6	Working with Sensor Data	Visualizing sensor data.
Week 7	Chapter 8 - Teleop-bot	A homework assignment will be given.
Weeks 8 and 9	Chapter 12 - Follow-bot	One or two homework assignments will be given.
Week 10	Class Project Proposals	Written reports will be due and oral presentations given.
Week 11	Building a Robot	
Week 12	openCV	A homework assignment will be given.
Week 13	Class Project status reports	Each project team must report on their progress
Week 14	Documenting Projects	Finalize the README document for your class project.
Week 15	Class project demonstrations	Documentation due. Demonstrations.