EECE 5554 Robotics: Sensing and Navigation

Syllabus: Section 01 (CRN 16695), Section 02 (CRN 18252)

This course examines the mathematical techniques and practical methods for robotic sensing and navigation with a focus on sensors such as inertial measurement units (IMUs), Global Positioning Systems (GPS) and cameras. These are used in association with navigation techniques and algorithms for dead reckoning and visual inertial odometry. Course topics include basic properties of sensors, inertial sensors, GPS systems, error analysis, computer vision as applied to robot navigation, SLAM (simultaneous localization and mapping) and systems aspects of robotics. A large component of the class involves programming in ROS (Robot Operating System) to obtain real-world data sets using GPS, RTK GPS and IMUs for later analysis and incorporation into a navigation system. The course culminates with a team-based final project focused on analysis of robot sensor data and/or implementation of a SLAM navigation system.

Prerequisite(s): MATH 3081 with a minimum grade of D- or EECE 3468 with a minimum grade of D- ; and EECE 2160 with a minimum grade of D- or EECE 2210 with a minimum grade of D- ; or graduate program admission.

Meeting Times:

Section 01: Mondays and Wednesdays, 02:50 PM – 04:30 PM

Section 02: Mondays and Thursdays, 11:45 AM – 01:25 PM

Classroom/Lab

Section 01: Shillman Hall, Room 220

Section 02: Dodge Hall, Room 173

Instructor: Dr. Thomas R. Consi

Teaching Professor, Dept. of Electrical and Computer Engineering

Office: Dana 405

Email: t.consi@northeastern.edu

Office Hours: TBD

Or by appointment

Teaching Assistants:

Aditya Bondada, bondada.a@northeastern.edu

Office Hours: TBD

Online Tools

Piazza: We will use Piazza as our primary means of communication and dissemination of information (lecture notes, lab handouts, assignments, etc.).

Section 01: https://piazza.com/northeastern/fall2023/eece5554sec01

Section 02: https://piazza.com/northeastern/fall2023/eece5554sec02

GitHub: GitHub will be used for handing-in assignments and for code development. We will instruct you creating and using a GitHub account in the first lecture.

Canvas: The EECE5554 Canvas page will be used primarily for grading and for handing-in reports. https://canvas.northeastern.edu/

ROS wiki: The main source of information about ROS, the Robot Operating System. Includes a good beginners tutorial to get you up and running with ROS.
http://wiki.ros.org/Documentation

Course Deliverables

Labs: You will work individually for Lab 0. You will work in groups of 4 for Labs 1 – 5. For Labs 1 – 5 you will gather your data together and use the same data for your reports. However, each student within the group must perform their own analysis and write their own lab report. These will be graded individually.

Journal Club: It is important for you to learn how to read research papers in robotics in the relevant journals. Each group of 4 students will select a journal article of their choice and present it to the class.

Final Project: The final project will be a substantial piece of work involving sensing and navigation. Students will work in groups of four. The project proposal, presentation, and written report will be group grades.

Grade Breakdown:

Lab 0: 5%

Labs 1 – 3 and 5: 10% each, 40% total

Lab 4: 15%

Journal Club: 10%, group grade

Final Project: 30% total, group grade

Project Proposal: 5%

Presentation: 10%

Report: 15%

Late Policy: It is important that you submit your work before or on the due dates. Late assignments will be penalized according to the following Python formula:

finalScore = onTimeScore * (1 – hrsLate // 24 / 10)

Grading Scheme: Every deliverable will be graded out of 100. The percentages will be adjusted in Canvas. Numerical grades with fractions will be rounded up to the nearest integer grade.

A	≥ to 93%
A-	90% to 92%
B+	87% to 89%
B	83% to 86%
B-	80% to 82%
C+	77% to 79%
C	73% to 76%
C-	70% to 72%
D+	67% to 69%
D	63% to 66%
D-	60% to 62%
F	≤ 59%

Course Policies

Missing Class:

It is important that you attend all the lecture/lab sessions in this course. If you are feeling unwell and do not plan to attend, please inform Dr. Consi via email. Arrangements will be made to hand in late assignments due to illness.

If you know in advance that you will miss a class meeting, you are expected to submit any relevant assignment on time through GitHub.

We will be taking attendance at each class. This is to allow us to monitor your participation and lets us know if you are having problems with the class.

COVID Policy:

Please read the latest Northeastern COVID-19 policy,
http://news.northeastern.edu/coronavirus/

Masking is optional for attending classes, it is up to you to determine your own comfort level.

If you come down COVID and/ or are isolating, then we will make sure that you can continue your course work remotely and/or make-up for lost time.

Academic Integrity:

A commitment to the principles of academic integrity is essential to the mission of Northeastern University. The promotion of independent and original scholarship ensures that students derive the most from their educational experience and their pursuit of knowledge. Academic dishonesty violates the most fundamental values of an intellectual community and undermines the achievements of the entire University.

Northeastern University (and the instructional staff of this course) expect students to complete all examinations, tests, papers, creative projects, and assignments of any kind according to the highest ethical standards, as set forth either explicitly or implicitly in this Code or by the direction of instructors. https://osccr.sites.northeastern.edu/academic-integrity-policy/

Please read this about cheating: http://www1.coe.neu.edu/~jaisaacs/honesty.html

Academic Accommodations:

Northeastern University and the Disability Resource Center (DRC) are committed to providing disability services that enable students who qualify under Section 504 of the Rehabilitation Act and the Americans with Disabilities Act Amendments Act (ADAAA) to participate fully in the activities of the university.

We strive to make the class as accessible as possible. If you have documentation on file with the DRC and you believe those accommodations apply to this course, please email to set up a short meeting. We can discuss course policies and assignments and make sure that your accommodations are being met.

If you feel you need academic accommodations but do not have appropriate documentation on file with the DRC, please check out this resource: https://drc.sites.northeastern.edu/

Title IX:

Title IX of the Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender-identity, in educational programs and activities that receive federal financial assistance. Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence and stalking. The Title IX Policy applies to the entire community, including male, female, transgender students, faculty and staff. In case of an emergency, please call 911. Please visit https://www.northeastern.edu/ouec/title-ix-policy-2/ for a complete list of reporting options and resources both on-and off-campus

We will seek to keep information shared with me as private as possible, but we are obligated to report any situations relating to sexual misconduct or harassment that I become aware of to the Title IX office, which may result in the office contacting you to provide you with resources and ask for further information.

EECE 5554 Spring 2023 Class Schedule – Subject to Change

Section 01

Date	Day	Lecture	Lab	Due Dates
6-Sep	Wed.	Course Intro., Intro. To Robotics	Lab 0 - Linux, GitHub, ROS	
11-Sep	Mon.	Operating Systems, Intro to ROS	Lab 1 GPS	
13-Sep	Wed.	Maps, Intro. to Journal Club	Lab1 GPS	
15-Sep	Fri.			Lab 0
18-Sep	Mon.	GPS, Project Proposal	Lab 1 GPS	
20-Sep	Wed.	Acoustic Navigation, Intro. To Project	Lab 1 GPS	
22-Sep	Fri.			Lab 1
25-Sep	Mon.	Measurement of Time	Lab 2 RTK GPS	
27-Sep	Wed.	RTK GPS, Journal Club	Lab 2 RTK GPS	
2-Oct	Mon	Sensors: General Principles	Lab 2 RTK GPS	
4-Oct	Wed.	IMU: Inertial Measurement Unit, Journal Club	Lab 2 RTK GPS	
				Lab 2
9-Oct	Mon.	Indigenous Peoples' Day Holiday		
11-Oct	Wed.	IMU: Lecture 2, Journal Club	Lab 3 IMU	
16-Oct	Mon.	Dead Reckoning	Lab 3 IMU	
18-Oct	Wed.	SLAM	Lab 3 IMU	
23-Oct	Mon.	SLAM	Lab 4 Navigation	
25-Oct	Wed.	Power	Lab 4 Navigation	
				Lab 3
30-Oct	Mon.	Robot System Architecture	Lab 4 Navigation	
1-Nov	Wed.	Project Proposal Presentations	Lab 4 Navigation	
6-Nov	Mon.	Computer Vision I	Lab 4 Navigation	
8-Nov	Wed.	Computer Vision II	Lab 4 Navigation	
13-Nov	Mon.	Catch Up Lecture or Final Project	Lab 4, Navigation	
15-Nov	Wed.	Catch Up Lecture or Final Project	Lab 5, Navigation	
17-Nov	Fri.			Lab 4
20-Nov	Mon.	Final Project	Lab 5, Visual Mosaicing	
22-Nov	Wed.	Thanksgiving Holiday		
27-Nov	Mon.	Final Project	Lab 5, Visual Mosaicing	
29-Nov	Wed.	Final Project	Lab 5, Visual Mosaicing	
1-Dec	Fri.			Lab 5
4-Dec	Mon.	Final Project		
6-Dec	Wed.	Final Project		
11-Dec	Mon.	Final Project Presentations		
13-Dec	Wed.	Final Project Presentations		
15-Dec	Fri.	Final Project Written Report Due		

Section 02

Date	Day	Lecture	Lab	Due Dates
6-Sep	Thurs.	Course Intro., Intro. To Robotics	Lab 0 - Linux, GitHub, ROS	
11-Sep	Mon.	Operating Systems, Intro to ROS	Lab 1 GPS	
14-Sep	Thurs.	Maps, Intro. to Journal Club	Lab1 GPS	
15-Sep	Fri.			Lab 0
18-Sep	Mon.	GPS, Project Proposal	Lab 1 GPS	
21-Sep	Thurs.	Acoustic Navigation, Intro. To Project	Lab 1 GPS	
22-Sep	Fri.			Lab 1
25-Sep	Mon.	Measurement of Time	Lab 2 RTK GPS	
28-Sep	Thurs.	RTK GPS, Journal Club	Lab 2 RTK GPS	
2-Oct	Mon	Sensors: General Principles	Lab 2 RTK GPS	
5-Oct	Thurs	IMU: Inertial Measurement Unit, Journal Club	Lab 2 RTK GPS	
				Lab 2
9-Oct	Mon.	Indigenous Peoples' Day Holiday		
12-Oct	Thurs.	IMU: Lecture 2, Journal Club	Lab 3 IMU	
16-Oct	Mon.	Dead Reckoning, SLAM	Lab 3 IMU	
19-Oct	Thurs.	SLAM	Lab 3 IMU	
23-Oct	Mon.	SLAM, Power	Lab 4 Navigation	
26-Oct	Thurs	Robot System Architecture, Proj. Proposals	Lab 4 Navigation	
				Lab 3
30-Oct	Mon.	Project Proposal Presentations	Lab 4 Navigation	
2-Nov	Thurs		Lab 4 Navigation	
6-Nov	Mon.	Computer Vision I	Lab 4 Navigation	
9-Nov	Thurs	Computer Vision II	Lab 4 Navigation	
13-Nov	Mon.	Catch Up Lecture or Final Project	Lab 4, Navigation	
16-Nov	Thurs	Catch Up Lecture or Final Project	Lab 5, Navigation	
17-Nov	Fri.			Lab 4
20-Nov	Mon.	Final Project	Lab 5, Visual Mosaicing	
23-Nov	Thurs.	Thanksgiving Holiday		
27-Nov	Mon.	Final Project	Lab 5, Visual Mosaicing	
30-Nov	Thurs.	Final Project	Lab 5, Visual Mosaicing	
1-Dec	Fri.			Lab 5
4-Dec	Mon.	Final Project		
7-Dec	Thurs.	Final Project		
11-Dec	Mon.	Final Project Presentations		
14-Dec	Thurs.	Final Project Presentations		
15-Dec	Fri.	Final Project Written Report Due		