AE 8803 Syllabus

Advanced Mobile Robotics, 3 Credits

Fall 2026

Instructor Information

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General Course Information

Description

Mobile robots, ranging from ground vehicles and aerial drones to deep-sea explorers, play a critical role in modern autonomous systems and are increasingly prevalent across diverse application domains. This course aims to provide students with a comprehensive introduction to the mathematical foundations of robot mobility, emphasizing modeling, optimization, estimation, and control. Designed to support both theoretical understanding and practical skill development, the course offers extensive hands-on experience with a variety of mobile robots in simulation and on physical hardware.

Pre- &/or Co-Requisites

- Linear Algebra
- Multivariate Calculus
- Probability Theory

Course Learning Outcomes

Upon successful completion of this course, you should be able to:

- Derive kinematic and dynamic models of common mobile robots
- Interpret mathematical models of range, vision, and inertial sensors
- Design estimation/SLAM algorithms for various sensor modalities
- Implement real-time navigation algorithms for different mobile robots
- Apply and extend these methods in your own research

Course Materials

Textbook

- Thrun, S., 2002. Probabilistic robotics. Communications of the ACM, 45(3), pp.52-57.
- SLAM Handbook: https://github.com/SLAM-Handbook-contributors/slam-handbook-public-release
- Introduction to Robotics and Perception: https://www.roboticsbook.org/intro.html

Course notes

Course notes and slides will be shared on canvas.

Topics Overview

- Coordinate Transformations
- EKF Basics, Sensor Models: IMU, Range Sensors
- Filtering Foundations: Bayes Filter, Kalman Filter (KF), Extended KF (EKF)
- Invariant Extended Kalman Filter (IEKF)
- Forward and inverse kinematics
- Floating-base Dynamics
- Introduction to Factor Graphs & Non-linear Least Squares Optimization
- IMU Preintegration: Theory and Factor Formulation
- Factor Graphs for State Estimation and Control
- Differential Drive Kinematics & Odometry
- Camera Geometry: Pinhole Model, Calibration, Image Rectification
- Homography
- 2D Scan Matching, 3D Point Cloud Registration
- Pose Graph SLAM Formulation
- Frontier-Based Exploration Algorithms
- Data Association Challenges in SLAM (Loop Closures, Multi-Robot)
- Multi-Robot Systems: Architectures & Basic Coordination Planning
- Integrating IMU Preintegration Factors into Pose SLAM
- Continuous-Time SLAM Concepts

Grading Policy

This course will be graded as

20%	In-class participation
20%	Quizzes
40%	Individual projects
20%	Team project

Description of Graded Components

In-class participation: We will have in-class activities designed to help you practice the concepts learned in class and build a foundation for your projects.

Quizzes: There will be 4–5 quizzes throughout the semester. Each quiz will count for 4–5% of your grade.

Individual projects: There will be 4 individual projects in which each student will independently contribute to the deliverable code. Each project will count for 10% of your grade.

Team project: The course will conclude with a final team project in which you will propose and prototype a new idea that applies what you have learned in class.

Grading Scale

Your final grade will be assigned as a letter grade according to the following scale:

A	90-100%
B	80-89.5%
C	70-79.5%
D	60-69.5%
F	0-59.5%

Course Policies

Attendance and/or Participation

Attendance and in-class participation is mandatory and will count for a large part of your grade, 20%. Besides institute-excused absences, any absences in the class have to be documented through the Dean of Students, if valid. To allow for the occasional happenstance we will allow one undocumented absence per section in the class - no questions asked.

Extensions and Late Assignments

Extensions may be granted when extenuating circumstances prevent a student from reasonably completing an assignment on time. Examples include illness, emergencies, family situations, and Institute-excused absences. Students may request an extension by contacting the instructor directly. For more private or sensitive matters, students should work with the Office of the Vice President and Dean of Students, which can assist students with documented emergencies by contacting instructors on their behalf. Students are expected to notify the instructor at least one day before the deadline if they require an extension.

Projects and quizzes submitted after the published due date and time on Canvas will be penalized 10% per 24 hours late.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct.

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Collaboration, Group Work, and Use of Generative AI

Students are highly encouraged to discuss problems with each other but should write up solutions on their own. The use of generative AI to code up an entire assignment with minimal involvement from your part (e.g., pasting the entire assignment in to an AI, or using "Agentic" AI to take care of the whole project) defeats the point of the class. Hence,

this falls under the academic dishonesty policy. The purpose of the assignment is to build intuition and skill in robotics, which cannot be outsourced. Hence, students are expected to personally embark on each TODO in the coding assignments, being fully engaged. If abuse is of this nature is detected, the penalty will be an automatic zero on the assignment, and an F in the class on a second offense.

The assignments will frequently be accompanied with reflection questions designed to help assess whether you have fully grokked the methods/algorithms/techniques the assignments are designed to help you learn. Again, students are expected to be the author of the answers, not the prompter.

Core IMPACTS

Not applicable

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faulty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.