ECE 4560: Introduction to Automation and Robotics (4-3-3)

Course Information

- **Instructor:** Maegan Tucker (mtucker@gatech.edu)
- **Course Prefix and Number:** ECE 4560 A/AL
- **Term:** Fall 2026
- **Prerequisite:** ECE 3085/3084 or ECE 3550

Course Description

Fundamental disciplines of modern robotics: mechanics, control, and computing. Analysis, design, and control of mobile robots and manipulators. Course may contain team projects and hands-on labs.

Course Learning Outcomes

The goal of this course is to provide students with the knowledge to analyze and understand robotic manipulators, covering elements of theoretical and applied kinematics and the mathematical analysis and synthesis of mechanical manipulators. By the end of this course, students should be able to:

- Analyze and mathematically describe a given manipulator.
- Understand a manipulator's operational limits.
- Create design proposals for a manipulator given its specifications.
- Confidently read the kinematics and robotics literature.
- Understand programmatic issues related to serial manipulators.
- Pursue and demonstrate mastery in an area of robotics of their choosing.

Topic Outline

The course is broken into the following segments:

1. **Mathematics and Modeling**
    - Coordinate representation of manipulators
    - Homogeneous coordinates and representation of orientation
    - Lie groups and Lie algebras, exp and ln

- Body versus spatial reference frames

2. **Kinematics**
    - Forward kinematics
    - Workspace analysis
    - Inverse kinematics
    - Manipulator velocities and Jacobian
    - Task planning
3. **Dynamics**
    - A primer on Euler-Lagrange equations and Lagrangian mechanics
    - Position and torque control

The weekly schedule will be posted on Canvas along with course notes.

Required Course Materials

No textbooks are required. The following optional references are recommended (purchase not required):

- Craig, J.J. *Introduction to Robotics: Mechanics and Control*, 3rd Ed.
- Murray, Li, and Sastry. *A Mathematical Introduction to Robotic Manipulation*.
- Lynch and Park. *Modern Robotics: Mechanics, Planning, and Control*.
- Spong, Hutchinson, and Vidyasagar. *Robot Modeling and Control*, 3rd Ed.

Grading Policy

Grading Breakdown The course grade is calculated from the following components, where each category is weighted by total points earned within it:

Component	Percentage of Final Grade
Homework	40%
Lab Project	20%
Midterm Exam	20%
Final Exam	20%

Lab Projects The lab project is group-based, with each group consisting of 2–4 students, and will culminate in a final presentation. Each group will choose one of the following robotic platforms:

1. Piktul planar manipulator project
2. Turtlebot mobile robot project
3. Bipedal robot project
4. SO-101 manipulator project

Groups will be formed and must select a lab project track within the first three weeks of the course.

Throughout the semester, 50% of the project grade (10% of the overall grade) is based on weekly homework submissions documenting project progress. Even though the project is group-based, each student must submit their own writeup. Late written submissions are subject to the homework late policy below.

The remaining 50% of the project grade (10% of the overall grade) is based on the final presentation.

Homework Homework is assigned approximately weekly to reinforce topics covered in class. Assignments are due on Fridays at 11:59 PM and must be submitted via Gradescope through Canvas.

Extension policy: All students are automatically granted three extension days per semester, which may be split across assignments in any combination (e.g., three assignments submitted one day late each, or one assignment submitted three days late). Once extension days are exhausted, late work is accepted up to 72 hours past the deadline with a 20% penalty per 24-hour period. After 72 hours, solutions will be posted and late submissions will not be accepted. For circumstances beyond these provisions, contact the instructor before solutions are posted.

While collaboration on homework material is encouraged, all submitted work must be individually completed. Students are expected to abide by the Georgia Tech Honor Code.

Programming The course requires implementing the learned mathematics in MATLAB and/or Python. Documentation and primers for both are widely available online. Platform-specific requirements are as follows:

- **Piktul manipulator:** MATLAB only.
- **Bipedal robot:** MATLAB plus additional libraries (compatible with Windows, macOS, and Linux).
- **Turtlebot mobile robot:** Robot Operating System (ROS) and Python on Linux.
- **SO-101 manipulator:** Python.

Attendance Policy

Regular attendance at lecture is expected. If you need to miss class, please notify the instructor in advance when possible.

Academic and Research Honesty/Integrity Statement

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 the Student Code of Conduct and the Academic Honor Code.

Any student suspected of cheating or plagiarizing 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.

Core IMPACTS

None

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services 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-Faculty Expectations

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 articulates 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.