ENGR122 - ENGINEERING DESIGN II

Design of Systems

Stevens Institute of Technology

2025 Spring Semester

COURSE DESCRIPTION

ENGR122 is an engineering design course that focuses on students understanding systematic engineering design processes and engineering principles. Students work in teams to develop, build, and test systems through an iterative design process. Specifically, teams of 3-4 people design, build, and test a mobile robotic boat that can autonomously navigate a track in a water tank. The project involves the design and development of mechanical, electrical, and software systems. In the design lab, each team is provided with a robot kit, robot fabrication tools including 3D printers, and an environment to test the robot system they built. Through an iterative design process, students develop systems and improve and optimize system performance. They also develop problem-solving and critical thinking skills as they encounter and solve real-world engineering problems and develop and practice leadership and effective communication skills through teamwork.

Typically, teams will mostly be comprised of 3 students but, at the instructor's discretion, one or more teams may consist of 3 or 4 students. Maximum enrollment for any section is 24. Classes will meet for 2 hours and 50 minutes, once per week, for a total of 14 weeks.

CLASS SESSION SUMMARY

Section	Day	Time	Instructor	Room	South/North
A	Monday	8:00 am ~ 10:50 am	Prof. Joo	EAS011	South
B	Monday	11:00 am ~ 1:50 pm	Prof. Russo	EAS011	North
C	Monday	11:00 am ~ 1:50 pm	Prof. Joo	EAS011	South
D	Monday	2:00 pm ~ 4:50 pm	Prof. Joo	EAS011	South
E	Monday	2:00 pm ~ 4:50 pm	Prof. Russo	EAS011	North
F	Monday	6:30 pm ~ 9:20 pm	Prof. Castellanos	EAS011	South
G	Tuesday	8:00 am ~ 10:50 am	Prof. Shupenko	EAS011	South
H	Tuesday	8:00 am ~ 10:50 am	Prof. Russo	EAS011	North

I	Tuesday	11:00 am ~ 1:50 pm	Prof. Shupenko	EAS011	South
J	Tuesday	11:00 am ~ 1:50 pm	Prof. Russo	EAS011	North
K	Tuesday	2:00 pm ~ 4:50 pm	Prof. Shupenko	EAS011	South
L	Tuesday	2:00 pm ~ 4:50 pm	Prof. Russo	EAS011	North
M	Tuesday	6:30 pm ~ 9:20 pm	Prof. Castellanos	EAS011	South
N	Wednesday	8:00 am ~ 10:50 am	Prof. Shupenko	EAS011	South
P	Wednesday	11:00 am ~ 1:50 pm	Prof. Joo	EAS011	North
Q	Wednesday	11:00 am ~ 1:50 pm	Prof. Shupenko	EAS011	South
R	Thursday	8:00 am ~ 10:50 am	Prof. Russo	EAS011	North
S	Thursday	8:00 am ~ 10:50 am	Prof. Shupenko	EAS011	South
T	Thursday	11:00 am ~ 1:50 pm	Prof. Joo	EAS011	North
U	Thursday	11:00 am ~ 1:50 pm	Prof. Shupenko	EAS011	South
V	Thursday	2:00 pm ~ 4:50 pm	Prof. Russo	EAS011	North
W	Thursday	2:00 pm ~ 4:50 pm	Prof. Joo	EAS011	South
X	Wednesday	6:30 pm ~ 9:20 pm	Prof. Troudt	EAS011	South

Teaching Assistants:

Guoqing Zhang (gzhang21@stevens.edu)
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Joel Martsinovsky (jmartsin@stevens.edu)

WEEKLY SCHEDULE

Week	Class Topic(s)	Class Activities
1	Introduction Course Overview Gallois Competition & Stevens Innovation Expo (5/9/25)	Course Overview - Course Objectives Introduction to Gallois Competition & Final Project (DEMO video) Class Preparation - Software Installation (SolidWorks, Arduino IDE, Office 365, Flashprint) Lab safety quiz (Individual) 3D printing Quiz (Individual) Teaming - Team Building Survey (Google Survey)
2	Project Kickoff Mid-term project: Seize the target zone! Challenge Final project: Speed Boat Race Challenge Problem Definition Identifying Design Objectives & Requirements Conceptual Design Generating Design Alternatives	Boat Hull Design Activity (Problem Definition & Conceptual Design) Teaming - Team bonding & warm up activity (icebreakers) Assignment - Create Team Asset Map - Technical Report Submission I
3	Preliminary Design - Model and analyze chosen design Modeling - SolidWorks Review (Loft) Design Analysis - SolidWorks CoM & CoB Analysis	Create a Hull design using the Loft feature Find CoM and CoB before 3D printing, and analyze the stability of the system Assignment - Technical Report Submission II

4	Analysis of the functions and means of the system Bill of Material DC motor/motor controller board Current limiter for DC motor circuit Understanding the system test environment I Introduction to Smart Pool - Pool & Pump How to operate the Smart Pool(Especially the Emergency button.) Preliminary Design	Hull Design Activity (Group Activity) Robot Programming Quiz (Individual)
5 & 6	Preliminary Design - Test and evaluate chosen designAnalysis of the functions and means of the system Inertial Measurement Unit & PID controller Required Libraries & Built-in functionsSystem Integration current limiter	Assessment - Float Test - (Week5) Static (maximum load) - (Week6) Dynamic `
7	Analysis of the functions and means of the system Camera Sensor, IoT network - location feedback OLED (Z axis & PID Control output values) Understanding the system test environment II Introduction to Smart Pool - Camera & UI (User Interface) How to operate the Smart Pool system Mid-Term Project Introduction to Seize the target zone! Activity	Integrate the system including all the circuit components Output location and orientation information using an OLED display Seize the target zone! activity*- Target Reading and Stop - Kickoff (*A boat must reach the given target & Remain within a 10 cm radius of the target for 1 minute.) Assignment - Technical Report Submission III (MQTT network & OLED display)
8	Introduction to Final Project Competition Rules Project Management GANTT Chart Design Communication Flowchart	Robot Capability Assessment Seize the target zone! Activity*- Target Reaching and Stop (*A boat must reach the given target & Remain within a 10 cm radius of the target for 1 minute.) Assignment - Create a GANTT chart - Team Check-in Assessment - Target Reaching and Stop (1st opportunity)
9	Project Work	Project Work: Algorithm Development & Test Refine and optimize chosen design Assessment - Target Reaching and Stop (2nd opportunity -5% penalty)
10	Design Communication Documentation - final report guideline	Project Work: Algorithm Development & Test Refine and optimize chosen design Assessment - Target Reaching and Stop (3rd opportunity -10% penalty)
11	Project Work	Project Work: Algorithm Development & Test
12	Project Work	Project work: Performance Testing & Optimization
13	Final System Demonstration In-class Competition (Speed Race Challenge)	Project work: Finalize Report and Presentation Assessment - In-class competition

14	Design Communication Final Reports to Client -Group Presentation / Poster Presentation -Final Report Submission	Assessment - Final Report Submission & Oral Presentation Final Document Submission
Innovation Expo Day 5/9/2024	Gallois Competition* *Note: The Gallois competition is scheduled after the semester.	Qualifying for the Galois competition does not affect final grade.

LEARNING OBJECTIVES

After successful completion of this course, students will be able to...

1. Design, test and operate sensor-integrated system for autonomous navigation
2. Establish test procedures to calibrate, validate, and refine the system design for optimal performance
3. Program a microcontroller to periodically poll sensors, control motors, and process data
4. Control and calibrate motors using PWM (Pulse Width Modulation) signaling
5. Display system variables (e.g., system's position & orientation, sensor readings) on OLED display panel using the I^2C communication protocol
6. Implement data networking and communication using MQTT protocol
7. Utilize Solidworks to design a robot body in 3D
8. Develop and program autonomous navigation logic to move toward a desired location
9. Collaborate professionally and efficiently with teammates and contributing actively to the team's success
10. Enhance oral and written communication skills in technical and team-based settings

FORMAT AND STRUCTURE

This course is a design lab class consisting of in-class individual/group activities with a final group project. Most of the tasks will be completed collaboratively during class sessions.

COURSE MATERIALS

Textbook:

Engineering Design: A Project-Based Introduction,
By: Clive L. Dym, Patrick Little, Elizabeth Orwin, 4th Edition, Wiley (2014)
Print ISBN: 9781118324585, 1118324587
eText ISBN: 9781118806999, 1118806999
Affordability Note: $16-$17 to rent the e-book for the semester

Documents:

All required information is located on CANVAS

Software used:
SolidWorks 2023,
FlashPrint 5 (Slicer software for 3D printing),
Arduino IDE (Integrated Development Environment),
Microsoft Office (Excel, Word, and PowerPoint).

Note: All software is available on **Stevens AppSpace.(hosted by Apporto). Software is also available for download (software.stevens.edu. Windows OS required for SolidWorks installation*

ENGR122 Hardware (per team)

1 x MH ET Live MiniKit for ESP32
1 x OLED display panel
1 x Micro USB Cable Type-B
1 x Breadboard
1 x Plastic Storage Container w/lid
1 x Battery with charging cable
1 x MPU6050 IMU sensor
1 set x Jumper Wires
1 x Feetech 4 Channel Servo Motor Controller board
2 x 8520 Coress Brushed Motor with CW/CCW Propeller
1 x Polyethylene Craft Foam Noodle (2 inch Diameter)

ENGR122 Equipment (Available in the Design Lab - EAS 011)

3D Printers (Flashforge Adventurer 3)
Soldering Stations (Solder Fume Extractor, Soldering Iron, Soldering Mat)
Miscellaneous Tools and Hardware (ex. measuring tools and mechanical fasteners)
Autonomous Robotic Boat Test Pool (Camera sensor installed SMART Pool)

MakerSpace Equipment*

3D Printers (Bambu)
*ENGR122 students can use the 3D printers at the MakerSpace.

ENGR122 CLASSROOM CONFIGURATION

All ENGR122 section classes are held in the Design Lab. In the Design Lab, two classes of different sections may run simultaneously (North and South sides), each section taught by a different instructor.

COURSE REQUIREMENTS

Attendance

Students will be working in a team throughout the semester. Attendance is mandatory for all labs unless excused absence. Absences will be excused only with proper documentation, e.g. doctor's note. The final 10% of the grade will be based upon individual attendance and team participation (i.e., the student contributed to his team's efforts). Each unexcused absence will reduce this element of the grade by 1/4 – ***4 unexcused absences will result in a zero***.

Class Participation

Students are expected to actively engage with the professor and their peers during class discussion and activities. For group assignments, all team members are required to contribute fairly and equitably. Peer assessments will be conducted at the end of the semester, allowing students to evaluate both their team members' contributions and performance on group projects and class activities. These evaluations will be incorporated into the final grade.

Progress Submissions

During lab sessions, all quizzes & reports must be submitted via CANVAS.

Design & Analysis Report

At the end of each module, a design & analysis report must be submitted via CANVAS.

Project

In the autonomous robotic boat project, each team will design and build a system that can autonomously navigate e a Smart Pool using position and direction information measured from a camera sensor and two motors, IMU sensor in the robot. Each team will go through a repetitive process of designing, testing, and optimizing their system (to satisfy performance conditions and achieve the best performance). The SolidWorks files and Arduino program created for the design must be submitted along with the project report at the end of the project.

GRADING PROCEDURES

Grades will be dependent upon both individual work (40%), and team activities (60%). Weekly quizzes and exercise will account for approximately 45% of the grade and the course project approximately 45% of the final grade.

The following table provides a summary of the grading elements and their contribution to the final grade.

Week	Assignment	% of Grade	Individual	Group

1	Lab Safety Quiz	5	x	
1	3D printing Exercise Quiz	5	x	
2	Team Asset Map	4		x
2	Technical Report I	3		x
3	Technical Report II	3		x
4	Robot (Arduino) Programming Quiz	10	x	
5, 6	Float Test - Static & Dynamic	5		x
7	Technical Report III (MQTT Network & OLED display)	3		x
8~10	Mid-term Project: Seize the target zone activity	10		x
8	Project Management (Gantt Chart)	3		x
13	Final Project Demonstration: Speed boat race challenge	10		x
14	Final Report Submission	17		x
14	Oral Presentation	10	x	
1~14	Attendance & Participation	10	x	
1~14	Robot Kit Management	2		x
	Total	100	40	60

Important Notes!

Most group assignments are graded as a group, and all group members will receive the same grade. However, unless an absence is excused, students who fail to participate in class activities or contribute to final report due to absence may receive a zero grade.

HOW ARE GRADES COMPUTED?

Evaluations of 93% or more will result in an A grade. For B+ and below, grades will depend upon how the whole class and team perform with respect to the other teams, since the grades are assigned for individuals, team, and group.

LATE ASSIGNMENT SUBMISSION POLICY*

Each assignment should be submitted by the due date, as posted on Canvas. Check the due date announced on CANVAS. The date marked "until" does not imply deadline, but simply indicates the end date of the semester. *Unless the deadline for the assignment has been separately announced on CANVAS, all assignments must be submitted within the lab hours on the same day the assignment is given*. Late assignments will be subject to a late penalty of -3% per day, up to a maximum of -30% (10 days late). Note that additional points may be deducted based on the accuracy and/or performance of your submission. (For example, if you submit an assignment out of 100 points late, 3 points will be deducted every day, up to a maximum of 30 points. In addition to deductions for late submission, there may be deductions based on assignment evaluation.) *Any unsubmitted assignments that have passed the deadline for more than two weeks cannot be submitted and will receive 0 points.*

Extensions may be granted for students who cannot complete the assignment on time due to circumstances beyond their control. Proper documentation (e.g. doctor's note) should be submitted for extension requests.

ASSIGNMENT RESUBMISSION POLICY*

Assignment resubmission is not allowed.

*Exception: If the student cannot complete the assignment due to circumstances beyond their control, the assignment submission/re-submission date may be adjusted at the instructor's discretion. Proof material must be submitted in case of exception. (ex. Doctor's note).

ACADEMIC INTEGRITY

Undergraduate Honor System

Enrollment into the undergraduate class of Stevens Institute of Technology signifies a student's commitment to the Honor System. Accordingly, the provisions of the Stevens Honor System apply to all undergraduate students in coursework and Honor Board proceedings. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the **Honor System Constitution**.

More information about the Honor System including the constitution, bylaws, investigative procedures, and the penalty matrix can be found online at **http://web.stevens.edu/honor/**.

The following pledge shall be written in full and signed by every student on all submitted work (including, but not limited to, homework, projects, lab reports, code, quizzes, and exams) that is assigned

by the course instructor. No work shall be graded unless the pledge is written in full and signed.

"I pledge my honor that I have abided by the Stevens Honor System."

Reporting Honor System Violations

Students who believe a violation of the Honor System has been committed should report it within ten business days of the suspected violation. Students have the option to remain anonymous and can report violations online at www.stevens.edu/honor.

LEARNING ACCOMMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other such disabilities in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

DISABILITY SERVICES CONFIDENTIALITY POLICY

Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

For more information about Disability Services and the process to receive accommodations, visit https://www.stevens.edu/office-disability-services. If you have any questions, please contact Phillip Gehman, the Director of Disability Services Coordinator at Stevens Institute of Technology at pgehman@stevens.edu or by phone (201) 216-3748.

INCLUSIVITY

Name and Pronoun Usage

As this course includes group work and in-class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your name and/or pronouns, please inform the instructor of the necessary changes.

INCLUSION STATEMENT

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester. Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements. You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

TYPICAL TECHNICAL REPORT TEMPLATE

1. Requirements provided for the design
2. Design Process

In the design process (2), Describe the solution and how it meets the requirements stated in (1). For mechanical components show (and include) CAD files, detailed drawings with dimensions and any calculations done to establish the dimensions. For software components, show the logic (flowchart or pseudo code) and how the software design addresses requirements. Show the tests performed to verify that the design indeed satisfies the requirements. Describe and document the design in as much detail as possible (so someone else can take and manufacture/reproduce it).

Everyone is expected to write the report sections and help edit. When submitting the group reports, list the individuals in the group and their contributions

e.g.

Adam Antman --- performed the mechanical design, collected data from all the tests.
Sandy Superstorm --- performed coding, flashed firmware and tested operations
Ivan Ironfist --- **Absent.**