Spring 2021 EE400D Senior Design Project Options

For Spring 2021 You may choose to follow one of two (2) Options defined in this document. ***Both paths will teach you the Engineering Methods and require Research, Breadboarding, and rapid prototyping***.

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Option 1: Regional or National Design Competition

Participate in a regional or national design competition, like the IEEE Green Energy and Smart Systems Conference (IGESSC) conference.

Reasons you may want to select this option.

- Companies, like Tesla and SpaceX, make their hiring decisions primarily based on the student's leadership and success in national design competitions, with secondary attention placed on the student's academic record.
- **No Cost** 👉 Instructionally Related Activities (IRA) Funds can be provided to you and your team, to participate in the design competition and give you a competitive advantage.

Potential Project Areas

You are encouraged to research any design competition that is in your area of interest. For illustrative purposes, here are the topics for this year's IEEE Green Energy and Smart Systems Conference (IGESSC) conference. Follow this link for more details and a more complete list of topics.

- Smart Systems: DSP, IoT, CubeSat, EV and charging.
- Green Energy and Power: Micro-grids, G2V, V2G, solar power, and wildfire detection.

What your team will be working on.

What you will be working on over the semester will be based on the submittal requirements of the selected design competition. Again for illustrative purposes, for the IEEE Conference, you would be writing a paper (4-6 pages) for submission to the IGESSC proceedings of the IEEE and an accompanying poster presentation. The deadline, for submissions of both, would by necessity be the end of the semester.

Paper Submittal with Poster Presentation: Section 01/02 on Monday, May 10 10:15 am-12:15 pm and Section 02/03 Tuesday, May 11 12:30 pm-2:30 pm.

Option 2: In-Class Maze Competition

Traditional (Pre-Pandemic) Mission/Project

In the past students have started the class by defining a mission and a robot (the project) to complete that mission on the day of the final exam. The number of robot possibilities are almost limitless. While choosing a robot is easy, defining a mission for the robot to accomplish is difficult. Here are four example missions you can read and some past videos you can watch.

Both the mission and project facilitate the teaching of the Engineering Method and the design and fabrication of an electrical circuit implemented using SMT devices fabricated on a small PCB, known as a shield. Put another way, the focus of the semester is more on electrical engineering, with the robots and missions as supporting actors.

- Missions: https://www.arxterra.com/news-and-events/project-missions/
- Robot Project: https://www.arxterra.com/news-and-events/members/3dot-robots/ *Rolling over Class Projects from the main menu bar provides access to additional projects.*
- Videos: https://www.arxterra.com/news-and-events/project-videos/

To give you a sense of how all this works here are the projects from the Spring 2020 EE400D classes which started out as a traditional class/lab and then transitioned to our current remote learning model.

1. Sojourner

Mission - Mars Mission (Electronic slip differential, rocker bogie suspension, solar panel charging)
Robot Project - 6-wheel micro-replica of the JPL Sojourner Mars rover
Electronics - Sensorless RPM Shield.

2. MicroFobo

Mission - Mars Mission
Robot Project - BiPed walking robot
Electronics - 6v Buck (UBEC) 3DoT Servo Shield.

3. ModWheels

Mission - Obstacle course including Loop
Robot Project - Four-wheel car with servo steering mechanism.
Electronics - Turbo Boost 3DoT Shield. This shield will allow metal gear motors to operate at 5v and for short bursts (i.e., to clear the loop) 12 volts. The shield will include a current limited boost converter charging a supercapacitor.

4. Softform “Fuzzy” Bear Bot

Mission - Toy for hospitalized children
Robot Project - OpenCat Robot+Kitty
Electronics - Servo and Peltier heater

5. Proposal Bot

Mission - Write a message to display while music is being played (IE proposal). May open a container once it is done.

Robot Project - Four-wheel drive platform.

Electronics - Shaft encoder plus audio and speaker

6.IloMilo

Mission - Two robots will navigate through a maze in order to meet each other. Will be articulating throughout

Robot Project - Two wheel with caster

Electronics - Inductance-to-Digital Converter (LDC) Sensor Shield, other electronics.

7. Mini Rosco

Mission - Locate and follow user with additional GPS data

Robot Project - Track vehicle with scan and tilt platform.

Shield - GPS, other electronics

8.Build a block

Mission - Robot can pick up and stack blocks while being controlled (Goliath as base)

Robot Project - Existing Goliath tank chassis with laser-cut robot arm

Shield - Servo/motor extension

Closed Campus Plan

The current situation, due to the pandemic, makes it hard to structure the class as we have in the past. For the senior design course, there are two primary goals for the student to experience.

1. To work with other students in an environment that simulates what you will see in the industry (i.e., The Engineering Method). This should still be possible with Zoom. This semester will organize the class into one of the following three models, based on the make-up of the class and projects selected.
   - Functional (Small Company)
   - Project
   - Matrix (Big Company)

2. To gain practical experience by building a real project. While meeting this objective was relatively easy to achieve when teams could meet in person as they would only need to…
   1. Build one robot/project and pass the parts around as needed.
   2. In addition, teams had access to University resources including the Librarie's Innovation Space for laser cutting and/or the 3D printing of their projects.
   3. And most importantly, students could work in the Electrical Engineering Senior Design lab, with easy access to electrical and mechanical parts, plus the use of soldering and testing equipment.

With the current situation, it could be unsafe (sending parts to other teammates) or relatively expensive (all members buy the parts needed). At the minimum, we are planning to have students design and fabricate a printed circuit board (PCB). To solve this problem each student who selects Option 2 will purchase a "Maze Kit" from Humans for Robots. By standardizing on this kit we solve most of the problems posed by the Pandemic.

- Class works on a common Mission Objective.
- Each class member has access to the project hardware.
- Each team gets real-world electrical engineering experience by building a small low-cost custom SMD PCB. Within the Arduino community this PCB is known as a "Shield.".

3DoT PaperBot Maze Kit

You can learn and purchase the Maze Kit at Humans For Robots here.

- 3DoT PaperBot Chassis Kit
    - 3DoT Board v10.1
    - Wood Chassis
    - Drivetrain (motors, wheels, caster)
- IR Sensor Shield (soldered)
- Wheel Encoder Shield
- Maze (Back and White or Color?)
- Not Included
    - PaperBot Template (Free Download)
    - Playing Cards (Free Download)
    - Bluetooth LE module
    - Breadboard Shield(s)
    - USB-B cable

Mission Objective

- Maze Game(s) with Competition.
    - Here you can find cards and four games designed for the Maze included with your Humans For Robots Maze Kit.
    - We could also implement the open-source robot game RoboRally, including the RoboRuckus variant.

Projects

- Most projects are designed to meet the Mission Objective. Final name of the project will ultimately be defined by characteristics of the robot and student's creativity.

Shield(s)

Electronics / Shield	**Robot Type**	**Project**	**Mission**
IMU Shield	2-Wheel w/o Caster [1]	PaperBot +	Maze
Unknown (DoF, IR)	2-Wheel w/o Caster [1]	PaperBot +	Maze
Compass w/ IR Shield	2-Wheel w/ Caster	PaperBot +	Smart Maze [2]
Mechanism	2-Wheel w/ Caster +	PaperBot Hopper	Maze w/ Blocks [3]
Camera [4]	2-Wheel w/ Caster	PaperBot +	Maze
Three Mid-Range IR [5]	2-Wheel w/ Caster	PaperBot +	Maze
Turbo-Boost	4-wheel w/ servo steering	DeLorean	Custom Track [6]
EMF Shield [7]	2-Wheel w/ Caster	PaperBot +	Maze
Commutator Shield [8]	2-Wheel w/ Caster	PaperBot +	Maze
OLED / Speaker [9]	2-Wheel w/ Caster	PaperBot +	Maze
OLED Multimeter [10]	2-Wheel w/ Caster	PaperBot +	Maze
LDC Sensor Shield	2-Wheel w/ Caster	PaperBot +	Smart Maze [11]
RFID	2-Wheel w/ Caster	PaperBot +	Smart Maze [12]
QR-code	2-Wheel w/ Caster	PaperBot +	Smart Maze [13]
Alexa / Speech Shield [14]	2-Wheel w/ Caster	PaperBot +	Maze
Ultrasonic	2-Wheel w/ Caster	PaperBot +	Enclosed Maze [15]
ToF	2-Wheel w/ Caster	PaperBot +	Enclosed Maze [16]
LiDar	2-Wheel w/ Caster	PaperBot +	Enclosed Maze [17]
Rotary Encoder	Track Vehicle	Goliath Tank [18]	Maze

E Ink +	2-Wheel w/ Caster	PaperBot +	Maze
Molybdenum magnet	2-Wheel w/ Caster		E Ink Smart Maze
Animatronic Shield [19]	2-Wheel w/ Caster	PaperBot +	Maze
Your Shield Here	*Your Robot Here...*	*Your Project Here*	*Your Mission Here*

Notes

1. Caster removed resulting in a self-balancing robot
2. Maze room includes code for detection of walls (hit wall, left paw, right paw) by the inside IR sensors of the IR Sensor shield.
3. Some type of mechanical system allowing the robot to hop. Hopper Project with Google Doodle or modified included Maze as Mission.
4. Camera shield for path following and wall detections
5. Three (3) midrange sensors shield, detect walls and intersections
6. Robot can jump chasms and do loop-de-loops with 15v Super-capacitor
7. Speed measured using back EMF of the motor
8. High precision shaft encoder made by measuring motor commutator noise
9. OLED / Speaker Maze visualizer
10. OLED Multimeter Shield provides real-time data on Robot systems.
11. Inductance to Digital Shield with maze modified by addition of conductive ink or copper tape.
12. Maze rooms include RFID labels.
13. Maze rooms include QR codes for detection of walls (hit wall, left paw, right paw) by the inside IR sensors of the IR Sensor shield.
14. Your Robot gains a competitive advantage by human guiding it through the maze.
15. Ultrasonic sensor(s) (multiple or rotating) use triangulation to navigate the maze.
16. ToF sensor(s) (multiple or rotating) use triangulation to navigate the maze.
17. Lidar sensor(s) (multiple or rotating) use triangulation to navigate the maze.
18. Goliath tank rotary encoder using idler wheel
19. Based on Next Generation PaperBot