ENES 100 – Introduction to Engineering Design

Terps Young Scholars Program, July 12-30, 2021

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This is a draft syllabus that is subject to change before the course date.

Meeting time / place

Online only. Zoom links: TBD
Monday through Friday, 9 am to 1 pm

Course Description:

This intensive 3-week course introduces students to the concepts and processes involved in engineering design. Students complete a design project on search-and-rescue robots in the setting of a damaged building. The course is offered in a virtual setting in 2021. Each student will be provided with a set of parts and materials to construct a single robot. There are a number of different tasks that a real robot would need to do; in this class, each student will be primarily responsible for one of these tasks, and will be provided with the appropriate materials. Students will work on teams, analogous to a team of subcontractors working together on a single large project. On their teams, the students will help each other get their individual tasks performed correctly, but also help with experimental design, collection and summary of data, and thinking conceptually about how these individual robots could be integrated to form a single robot that could complete all of the tasks.

The course teaches fundamentals of project planning, design practices, teamwork, innovation, and systems integration. The course also includes instruction on specific engineering disciplines, such as electric circuits, mechanics, and computer programming. Some electrical components will be mailed to students for direct experimentation, but students will also learn some circuit simulation tools. Students will also learn basics of computer-aided design and 3-D printing. We will print selected models that students develop in our lab and show them over the video link; students with personal access to a 3-D printer can print their own designs there as well.

Student Preparation:

This 3-week course is the equivalent of the 15-week freshman course offered at the university. The credit you receive for this class can be used at the University of Maryland. In this compressed form, each day is equivalent to a week during the regular semester. Thus, readings and homework need to be completed nearly every day. Students do not need any prior experience in electric circuits or computer programming; everything necessary to build the robots will be taught in the class.

Textbook

The course does not have a specific textbook. The fall and spring semester versions of the course have a standard textbook, which contains some information that would be useful for students in the TYS version of the course. However, the 3-week timeframe of the TYS course causes it to be significantly different from the other versions, and as a result, the applicability of the textbook is limited and does not justify its cost. All written materials and other resources necessary for the course will be provided by the instructors.

Project

The project for this course is the exploration of a simulated scenario after a multi-hazard accident, such as an earthquake, explosion caused by a gas leak, or other natural or man-made events. Deployment of a robot to scout the environment in such a situation is common, because the environment may not be safe or accessible by first responders. We will assume that the floor plan is known, and the four types of relevant hazards might include (a) fire, (b) compromised building envelope, in the form of wind, (c) exposed electrical hazard, and (d) significant water leakage.

You will learn to teach the robot to navigate through the “accident site.” You will learn to program in Arduino C. Students are expected to have access to a computer (either desktop or laptop, PC or Mac), on which they can install the free Arduino IDE. The software can be downloaded at https://www.arduino.cc/en/software. Previous programming background is not required, and every student is expected to learn enough to program the robot. Do not relegate this part of the course to other students on your team. Quiz questions will include programming. You will learn to sense the environment, by using the available sensors.

Equipment

Each student will receive a box in the mail prior to the beginning of the course. This box will contain parts and materials for the robot, plus parts and materials for some experiments that are part of the course content. Students should be able to construct the various assemblies with common household tools, including flat and Phillips screwdrivers and small pliers.

Policies

1. Attendance is mandatory. Late arrivals will be penalized.
2. Class participation is also extremely important. Students are expected to contribute appropriately to their teams. Student cameras must be on during the entirety of every course period.
3. Homework and exams are individual work and duplication of other students’ work or group work is not permitted.
4. Students must wear closed toed shoes when working with tools at home to avoid injury, and must otherwise dress appropriately for an engineering design / fabrication environment.
5. Grading is based both on individual assessments (homework problems, quizzes, class participation) as well as team assessments (the final oral and written reports generated by each student team).

The breakdown of your course grade is

Homework	30%
Quiz 1	10%
Quiz 2	10%
Quiz 3	10%
Oral presentation	10%
Written report	20%
Class participation	10%

Teaching Assistants:
TBD

Schedule

	Lecture	Lab	Demo	Homework
M 7/12	*Introduction, team formation* *Introduction of class project* *Arduino introduction*	*Lab safety* *Brainstorming design ideas*	*LEDs in different forms* *Controlling LEDs by using Arduino*	*Project ideas*
T 7/13	*Electricity, current, voltage, resistance Ohm's Law, Diode* *Arduino C*	*Circuit simulation software* *LEDs*	*LED does not follow Ohm's Law*	*Ohm's law, diodes, etc.* *C/C++ programming* *Controlled flow and variable scope*
W 7/14	*Kirchhoff's laws* *voltage divider* *PWM*	*LCD display* *micro controllers* *Distance sensors*	*LCD display* *Voltage divider*	*Series and parallel circuits.* *C/C++ programming* *Functions and objects*
Th 7/15	*AutoDesk Inventor, Infrared LEDs and phototransistors, Anemometer*	*optical encoder* *Robot driving--Straight, 90° turn* *Engineering drawings*	*Simple turn control* *Anemometer*	*C/C++ programming logic* *Inventor*
F 7/16	*Binary, hexadecimal, and decimal conversion* *Inventor* *3D printing*	*Robot driving – wall following* *Binary LED timer* *Binary, hex, dec conversion* *Flame sensor*	Wall-following robot *Flame sensor*	*binary, hex, decimal* *Inventor*

M	7/19	*Voltage regulators*	*Navigate course* *Parts/ Assemblies* *3D part printing*	*Navigate course* *Laser cutter*	*LEDs* *circuits* *3D print*
T	7/20	*Servo motors*	*Control of servo motor*	*Servo robot arm*	*Servo* *motor drive circuits*
W	7/21	*Project implementation*	*Optical measurements* *Precise robot positioning*	*Optical encoder*	*Optical encoder*
Th	7/22	*Project implementation*	*Voltage detection* *Water detection*	*TA's robot demo*	*Robot control*
F	7/23	*Project implementation*		*TA's robot demo*	*Robot control*
M	7/26	*Requirements of oral and written reports*	*Project implementation*	-	*Outline of reports*
T	7/27	*Project implementation*	*Project implementation*	-	*Outline of oral presentation*
W	7/28	*Project implementation*	*Project implementation*	-	-
Th	7/29	*Oral presentation of final project*	*project demonstration*	-	*Final report*
F	7/30	*Troubleshooting and fine-tuning* *Written report*	*Final demonstrations*	-	-