Designing Solutions to Global Challenges

ENGR001, First Year Design Experience, 3 Credit Hours

Spring Semester, Essex High School, A-Days, Block 5/6

Instructor: Jonathan Stapleton, jstapleton@ewsd.org, Office Hours: Normal A-Days 8:00-9:20, Normal B-Days 9:25-10:45

Course Description

Engineering is the application of science to problem solving. Design is the creative expression of knowledge. Engineering Design is an open-discovery art form where the principles of iterative exploration enable us to find solutions to global challenges. Join other Vermont students in this collaboration between the University of Vermont and area high schools. Successful students will earn 1 credit at their own school and may also earn 3 UVM credits through the College of Engineering and Mathematical Sciences. This course is an invitation to all students that believe we can find ways to improve the quality of life for people around the world.

Course Learning Objectives

Designing Solutions is based on proficiencies within the Science and Engineering Practices described in the Next Generation Science Standards. These proficiencies include…

- Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints (e.g. cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts).
- Use a computer simulation (when applicable) to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Students will develop skills in the following areas…

- Adherence to an iterative design cycle
- Constructing prototypes/solutions using a variety of tools, media, and methods.
- Use of rapid prototyping equipment
- Computer Assisted Design
- Computer Programming / Micro-computer Control

Grading Criteria/Policies:

The A, B, C, and D grading ranges for this class have standard lower cutoffs of 90%, 80%, 70%, and 60%, respectively.

Assessments (Graded Work):

- Quarter Grading: This is a project-based class. Students are responsible for keeping an Engineering Notebook in the form of a Google Doc, with sub-pages for individual projects throughout the year. While there may be some skill and knowledge tests relating to the design process, methods, and tools, the bulk of the grade for this class will be determined by documentation of the engineering process.

- Mid-year/final assessments: Both the mid-year and final assessments for this class will be project based. The midterm assessment will center around a formal plan for your 2nd capstone project. The final assessment will be a presentation of your completed capstone project.

- Non-Graded Feedback and Contests: The grading emphasis for this class will be on process, rather than product. However, most projects will have contest components that will allow students to gauge their product's success relative to the rest of the class. By succeeding in these contests, students may win nominal prizes or possibly a small amount of extra credit. Students may also receive ungraded, subjective teacher feedback on their performance in the class. Additionally, the student(s) with the highest cumulative score in all of our contests will win the *Designing Solutions Cup*, the precise nature of which is TBD.

Course Evaluation:

All students are expected to complete an evaluation of the course at its conclusion. Evaluations will be anonymous and confidential, and the information gained, including constructive criticisms, will be used to improve the course.

Accommodations:

Accommodations will be provided to eligible students with disabilities. Please obtain an accommodation letter from the ACCESS office and see one of the instructors early in the course to discuss what accommodations will be necessary. If you are unfamiliar with ACCESS, visit their website at http://www.uvm.edu/access to learn more about the services they provide. ACESS: A-170 Living Learning Center, University of Vermont, Burlington, VT 05405. PH: 802-656-7753, TTY: call 711 (relay), Fax: 802-656-0739, Email: access@uvm.edu, Instant Messenger: UVMaccess. General office hours: 8:30am – 4:30pm Monday through Friday. Call to make an appointment.

Religious Holidays:

Students have the right to practice the religion of their choice. If you need to miss class to observe a religious holiday, please submit the dates of your absence to me in writing by the end

of the second full week of classes. You will be permitted to make up work within a mutually agreed-upon time. https://www.uvm.edu/registrar/religious-holidays

Academic Integrity:

Students are expected to adhere to the UVM code of academic integrity regarding plagiarism, fabrication, collusion, and cheating. https://www.uvm.edu/policies/student/acadintegrity.pdf

FERPA Rights Disclosure:

The purpose of this policy is to communicate the rights of students regarding access to, and privacy of their student educational records as provided for in the Family Educational Rights and Privacy Act (FERPA) of 1974.
http://catalogue.uvm.edu/undergraduate/academicinfo/ferparightsdisclosure/

Instructional Sequence:

Unit	Time	Topics/Activities
1	3 Weeks	Introduction to the iterative design cycle. Design, build, test, and refine rubber band cars to achieve a maximum velocity. Compete in a class-wide competition.
2	1 Week	Introduction to Long Term ("Capstone") Projects. Students begin planning their capstone projects. Students will continue developing their long-term projects at the same time that they are working on their other class units. We will have regular check-ins on project status, including formal presentations at midterm and at the end of the school year.
3	6 weeks	Introduction to CAD and 3-D printing. Through a variety of tutorials and hands-on activities, students will learn to design for 3-D printing, prepare 3-D print files, and operate a 3-D printer. This unit will culminate in a project requiring students to design, print, assemble, test, and refine a fan-powered car. The car's powertrain will comprise a 10F supercapacitor and a mini quadcopter motor. Allowed materials are bamboo skewers, hot glue, and 3-D printed plastic. Compete in a class-wide speed and aesthetics competition.

4	6 weeks	Introduction to laser cutting. Through tutorials and hands-on activities, students will learn to use CAD design for laser-cutting. They will be trained to safely operate the school Fab Lab laser cutter. At the end of the unit, students will Design, laser cut, assemble, test, and refine a complex wooden mobile, using CAD analysis tools to achieve proper balance. In a class-wide competition, mobiles will be judged on ease of operation and aesthetic quality (by a panel of teachers).
5	5 weeks	Introduction to Arduino. Design, build, program, test, and refine a Bluetooth-controlled car (powered by continuous servos) that can be raced through a complex course in a minimum time. Students may design laser-cut and 3-D printed components. This is a team competition.
6	1 week	Capstone Project Status Presentation. By this time, students will be expected to have clearly defined their Capstone projects. They will present their goals and plans to the class.
7	4 weeks	Introduction to Design with 3-D Scanning. Design, build, test, and refine a “wearable” device – something that fits on a complex object, such as a human. Compete in a class-wide speed and aesthetics competition.
8	14 weeks	Long-term individual projects. Students will spend much of the 2nd semester focusing on their Capstone Projects.