University Of California, Berkeley
Department of Mechanical Engineering

ME 150A: Solar-Powered Vehicles: Analysis, Design and Fabrication (3 units)

Undergraduate Elective

Syllabus

CATALOG DESCRIPTION

This course addresses all aspects of design, analysis, construction and economics of solar-powered vehicles. It begins with an examination of the fundamentals of photovoltaic solar power generation, and the capabilities and limitations that exist when using this form of renewable energy. The efficiency of energy conversion and storage will be evaluated across an entire system, from the solar energy that is available to the mechanical power that is ultimately produced. The structural and dynamic stability, as well as the aerodynamics, of vehicles will be studied. Safety and economic concerns will also be considered. Students will work in teams to design, build and test a functioning single-person vehicle capable of street use.

COURSE PREREQUISITES

Math 54, Physics 7A; Upper division status in engineering.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

Text: Solar Technologies for the 21st Century, Anco Blazev, Fairmont Press, 2013, ISBN-13: 978-1466582910.

Text: H-Point: The Fundamentals of Car Design & Packaging, Stuart Macey and Geoff Wardle, Design Studio Press, 2009, ISBN-13: 978-1933492377.

COURSE OBJECTIVES

This course provides a structured environment within which students can participate in a substantial engineering project from start to finish. It provides the opportunity for students to engage deeply in the analysis, design and construction of a functioning vehicle powered by a renewable source. Through participation in this course, students should strengthen their understanding of how their engineering education can be used to address the multidisciplinary problems with creativity, imagination, confidence and responsibility. Students will recognize the importance of effective communication in effectively addressing such problems.

DESIRED COURSE OUTCOMES

This course will strengthen students' abilities: to apply knowledge of mathematics, science, and engineering to real projects; to design a component or process that is part of a larger system; to function on multi-disciplinary teams; to identify, formulate, and solve engineering problems; to communicate effectively; to understand the impact of engineering solutions in a context beyond the classroom; to appreciate the importance of engaging in life-long learning and understanding contemporary issues; and to recognize and use the techniques, skills, and modern engineering tools necessary for successful project completion.

TOPICS COVERED

This course will address a broad range of topics from mechanical engineering, electrical engineering, and materials science and engineering. Listed below are areas to be covered during the semester:

- Introduction to photovoltaic power.
- Solar cell design, cost and performance.
- Energy conversion involving solar, electrical, chemical and mechanical systems.
- Thermal and electrical control in photovoltaic systems.
- Power distribution systems.
- Mechanical concerns in photovoltaic systems.
- Motor design and performance.
- Motor control and controllers.
- Efficiency of components.
- Data collection and utilization to maintain optimal performance.
- Efficiency of systems.
- Structural stability of vehicles.
- Design of vehicle control systems.
- Design and analysis of structural elements.
- Material considerations involving strength, stiffness and weight.
- Introduction to fiber-reinforced composite materials.
- Manufacturing considerations.
- Component and system weight concerns and optimization.
- Aerodynamics.
- Safety concerns.
- Economic concerns.

CLASS/LABORATORY SCHEDULE

Two hours of lecture and three hours of laboratory per week.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

Students in this interdisciplinary course apply their math, science and engineering knowledge to analyze, design, build and test a solar powered vehicle. Through this hands-on experience, students gain an appreciation of the complexity involved in creating a functioning machine, and learn how their knowledge of engineering science can be used to analyze real mechanical, structural and electrical components. Students use a variety of hardware and software. Students will use state-of-the-art computer aided design (CAD), computational fluid dynamics (CFD) and finite element analysis (FEA) packages in analyzing and optimizing their designs. They will have the opportunity to engage in a range of different fabrication techniques, from welding to composite lay-up to solar cell encapsulation. Students will work in teams on a particular aspect of the overall problem, but will analyze and evaluate the work of other teams through regular presentations. Each group will present their work at least twice during the semester, providing students the opportunity to strengthen their oral communication skills. Students prepare a technical report on their work, providing the opportunity for them to strengthen their written communication skills.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

(a) an ability to apply knowledge of mathematics, science, and engineering
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

Homework (20%)
Midterm projects (40%)
Final project and report (40%)

PERSON(S) WHO PREPARED THIS DESCRIPTION

Professor George Johnson
October 1, 2013

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): SOLAR PWR VEHICLES
TIE CODE: LECS
GRADING: Letter
SEMESTER OFFERED: Fall and/or Spring
COURSES THAT WILL RESTRICT CREDIT: NONE
INSTRUCTORS: JOHNSON, STAFF
DURATION OF COURSE: 14 WEEKS
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 9
IS COURSE REPEATABLE FOR CREDIT? NO
CROSSLIST: None