University Of California, Berkeley
Department of Mechanical Engineering

ME 146: Conversion Principles (3 units)

Undergraduate Elective Course

Syllabus

CATALOG DESCRIPTION

This course covers the fundamental principles of energy conservation processes, followed by development of theoretical and computational tools that can be used to analyze energy conversion processes. The course also introduces the use of modern computational methods to model energy conversion performance characteristics of devices and systems. Performance features, sources of inefficiencies, and optimal design strategies are explored for a variety of applications, which may include conventional combustion based and Rankine power systems, energy systems for space applications, solar, wind, wave, thermoelectric, and geothermal energy systems.`

COURSE PREREQUISITES

ENG 7 (or equivalent), ME 40, ME 106 and ME 109. ME 106 and 109 may be taken concurrently.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

Text: Energy Conversion, D.Y. Goswami and F. Kreith, CRC Press, Boca Raton, FL, 2007, ISBN-13: 978-142004431-7.

COURSE OBJECTIVES

This class provides students with an understanding of the thermophysical principles that govern energy conservation processes of different types, and will introduce them to modern computational methods of modeling the performance of energy conversion processes, devices and systems. This course is the capstone experience for ME students, synthesizing thermodynamics, fluid dynamics, heat transfer, and computational analysis tools to facilitate engineering design analysis. This course will provide a foundation for design analysis of energy conversion and systems encountered in a variety of applications.

DESIRED COURSE OUTCOMES

Students will gain an understanding of the thermodynamics, heat transfer and fluid dynamics principles that affect performance of a wide variety of energy conversion devices and systems. Students will learn how to construct multidisciplinary computational performance models of a variety of energy conversion systems. Students will gain an understanding of how the advantages and limitations of a variety of energy conversion systems are dictated by the physical mechanisms of such systems.

TOPICS COVERED

- Energy resources; review of thermodynamics of energy conversion in closed and open systems; reversibility, exergy and the Second Law; heat engines; thermodynamic limitations on energy conversion efficiency; determination of system heat rejection.

- Rankine cycles, gas turbine cycles; computational tools for energy conversion analysis; guidelines for algorithm and program development; modeling hierarchy; treatment of properties; numerical differentiation; finding roots of equations; solution of linear equations.
- Parametric analysis for component design; steady state performance of components; heat exchanger design and impact on efficiency; operating characteristics of compressors, pumps, solar collectors, and other energy system components.
- Modeling energy transport and conversion processes in components; solution of governing differential equations; application to heat exchangers, solar collectors and energy storage systems.
- Component interactions; synthesis of component models into a system simulation; categories of system simulation models; computational methods for system simulations.
- Energy conversion in solar thermal and solar photovoltaic systems; computational simulation of solar energy system performance.
- Thermodynamics of isothermal energy conversion; performance analysis of fuel cells and batteries; biochemical energy conversion.
- The final third of the course will examine the physics and develop analysis tools and de sign strategies for efficient energy conversion in example systems selected from the following applications areas:
- combustion based engines and power systems
- power and propulsion systems for automotive or aerospace applications
- energy storage and retrieval systems
- hydrogen energy systems
- alternate hydrocarbon fuels (ethanol, biodiesel) thermoelectric power generation
- renewable power systems: wind, solar (photovoltaic) and hydroelectric geothermal power generation
- energy conversion in environmental control of human habitats
- energy conversion from (fuel) source to end application and sustainability
- energy distribution systems (electric power, hydrocarbon fuels) and implications for alternative fuel systems.
- Special topics

CLASS/LABORATORY SCHEDULE

Three hours of lecture and one hour of discussion per week (variable).

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

The course gives students experience in component versus system-level thinking. The course provides breadth and depth of experience with application of analysis tools to design evaluation of components and systems that produce or use energy.

The course addresses the professional component of engineering through experience in teamwork, communication skills and the importance of energy technologies in the context of societal needs.

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

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

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 assignments	(15%)
5 Quizzes	(15%)
3 Midterm projects	(40%)
Final examination	(30%)

PERSON(S) WHO PREPARED THIS DESCRIPTION:

Professor V. P. Carey, October 2009
Change in format (discussion), approved by Prof. Carey in May 2016