Department of Chemical Engineering University of Rochester

ChE 150 Green Engineering for a Sustainable Environment, Spring 2009

COURSE OVERVIEW AND OBJECTIVES

Current course description

Sustainable technology is emerging as a critical contemporary issue in advanced industrial societies. By sustainable technology we mean the development of environmentally benign processes that have minimal adverse impact on the earth's ecosystem. This freshman-oriented course will provide an introduction to many important ideas and familiarize students with some of the central tenets of the field.

The lectures will focus on a range of technical, economic and political issues. The material will be presented in the style of a survey course, team-taught by several faculty from the chemical engineering department. We will discuss the current regulatory context for this topic, amid increasing debate about the greenhouse effect, climate change, and global warming. Alternative energy technologies like fuel-cell and solar power systems, which are being developed for low-emission power generation purposes, will also be discussed.

Current syllabus topics

1) Concepts Related to Energy Transitions-two weeks (Prof. Ben Ebenhack)

The Magnitude of Consumption and the Challenge for Alternative Resources and Technologies

- The urgency of energy transitions is discussed in terms of both the impending depletion of petroleum and the negative environmental impacts of our petroleum consumption: especially in terms of Global Climate Change. This portion of the course will focus most intensively on the resource constraints. The background of petroleum occurrence and realistic limits on its production will be discussed. The magnitude of petroleum-based energy consumption will be introduced and set a background for assessing the needs for the coming transition to alternative energy technologies.

2) Global Warming, Climate Change and Carbon Dioxide Emissions-two weeks (Prof. Yates)

- The Role of Carbon Dioxide in Climate Change
- Engineering Tools to Reduce Carbon Dioxide Emissions
- Long-Term Storage of Carbon Dioxide

3) Economics of Energy, Pollution, and the Environment (Prof. Anthamatten)

This unit will introduce students to the fundamentals of pollution economics and green decision making. Students will learn how to classify pollution and its effect on mankind. Incentives to economic development, pollution, and recycling will be discussed through an in-class simulation of tradable discharge permits (TDP). The concepts of a life cycle analysis and risk analysis will be introduced as decision making tools for the engineer.

- Introduction, Economics of Pollution
- Tradable Permits Simulation
- Risk Analysis and Evaluating Exposure to Chemicals
- Life Cycle Analysis

4) Fuel-Cell Technology-two weeks (Prof's. Jorne and Olsen)

- Heat versus Work, Defining Energy Efficiency
- The Hydrogen Fuel-Cell, the Hydrogen Economy
- Efficiency of Fuel-Cells, Current-Voltage Characteristics
- Proton Exchange Membrane and Solid Oxide Fuel Cells

5) Solar Energy-two weeks (Prof. C. Tang)

- Introduction to solar energy conversion – economics and technologies
- Basics of solar cells – semiconductor materials and device structures, p-n junction, efficiency
- Current technologies for solar electricity generation - crystalline and thin-film solar cells, concentrated solar power
- Exercise – Buying solar panels for residential homes

6) Introductory design problems using the MATHEMATICA programming language -4 weeks (Prof. Chimowitz)

- Three **MATHEMATICA tutorials** oriented towards learning some of the basic commands and features of the program will be assigned. Coursework will require working on three projects meant to exercise the material learned in class.
- A simple chemical kinetic model for ozone formation in the atmosphere
- Sizing a 100 kW wind turbine system for electrical power production.

Course goals, learning outcome objectives

- To introduce students to the importance of energy usage, sustainability and their global environmental consequences.

- Develop and exercise analytical and **computational skills** useful for solving engineering design problems in a team setting.

- Outcomes are assessed by the evaluation of homework assignments in each section of the course.

Required/Elective: Elective

Pre-requisites: None

Catalogue Description: This course will study the issue of green engineering ideas in pursuit of "sustainable technology" which is emerging as a critical one in advanced industrial societies. By sustainable technology we mean the development of environmentally benign processes that have minimal adverse impact on the surrounding earth's ecosystem. This new course will provide an introduction to these issues, focusing upon renewable clean energy technologies, like electrochemically based fuel cell driven power systems that use hydrogen gas as the input fuel, and the prospects for solar power in the future. We will also discuss the current regulatory context and growing interest in this topic amid the world-wide debate about the greenhouse effect, climate change and the potential for global warming.

Textbook: No specific book however, a list of general reading materials will be put on the course website

Class schedule: as per bulletin

Course Role in meeting Curriculum/ABET Program Outcome Objectives

(a)	An ability to apply knowledge of mathematics, science and engineering	
(b)	An ability to design, conduct experiments, analyze and interpret data	
©	An ability to design a system, component or process to meet desired needs	
(d)	An ability to function on multi-disciplinary teams	
(e)	An ability to identify, formulate and solve engineering problems	
(f)	An understanding of professional, ethical responsibility	X
(g)	An ability to communicate effectively	
(h)	education necessary to understand global/societal impact of engineering solutions	A
(i)	a recognition of the need for and ability to engage in life-long learning	A
(j)	a knowledge of contemporary issues	A
(k)	an ability to use techniques, skills and tools useful in engineering practice	X

ASSESSING SPECIFIC COURSE OUTCOMES (ChE 150)

The overall course grades are assessed by the evaluation of homework assignments. Each unit of the course will have required assignments, one of which, at least, to be determined by the instructor, will be used as part of the course grade. The overall course grade will be a weighted average of each of these individual unit grades.

UNIFORM ASSIGNMENT HAND-IN PROCEDURES

Homework assignments will be given for each section of the course. Students will be given two weeks from the end of a particular section to hand in the assignments- by placing them in the ChE 150 course file kept in Gavett 201. The TA's will login the assignments at the end of this 2-week time frame and give them to the instructor for evaluation.