Physics 130/Environmental Studies 130
The Science of Renewable Energy
Spring 2009

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MWF 1:10 – 2:10 OLRI 100
Lab: T 9:30-11:30 OLRI 154

Introduction

Welcome to the Science of Renewable Energy! This is a course on the current status of the most promising alternative and renewable energy methods from a primarily scientific and technological perspective. The course will begin with a consideration of the nature of energy and the physics and chemistry of energy generation. Current methods of electricity generation and transportation energy sources will be briefly reviewed, including discussion of their limitations and environmental consequences. The focus of the course will be on understanding the scientific basis of alternative and renewable energy sources, and their promise and technological challenges for wide scale implementation. Wind, concentrated solar power, hydrogen, biofuels, photovoltaics, fusion, and geothermal will be considered in depth.

The course can also be considered as a introduction to physics and chemistry in the context of renewable energy. In our study we will cover topics from many diverse fields including mechanics, chemistry, thermodynamics, electromagnetics, electrochemistry, and even some excursions into biology and geology! As you can see, the technology associated with renewable energy requires a very multi-disciplinary approach.

The laboratory part of the course has two closely related goals. First, the laboratory exercises provide some concrete hands-on experience with the scientific principles and renewable energy technologies that reinforce the more conceptual discussion given in class. Some of the exercises will deal with very fundamental principles such as energy conservation and electric circuit principles; others will explore actual technologies such as photovoltaics, wind turbine design, and fuel cells. The second goal of the laboratory will provide experience with the scientific method used by scientists and engineers, which is important in order to understand how these technologies are actually developed.

Although the current interest in renewable energy sources is motivated by environmental, geopolitical, and economic concerns, the focus of this course is the scientific and engineering aspects of renewable energy. Some technological aspects are inseparable from the issue of cost and this will also be discussed where appropriate. In addition, we will motivate our study with a brief discussion of global warming at the beginning of the course. However, broader matters of policy and economics will not be discussed except perhaps in passing. In addition, the history of renewable energy will not be discussed to any great length, except insofar that it informs the current state of the technology. The very fact that such a course is being offered implies some level of advocacy for renewable energy! However, particular advocacy strategies for influencing policy decisions will not be covered. Rather, the goal of the course is to provide a *scientific and technological foundation* for policy and broader economic issues in renewable energy.

Prerequisites and Level

There are no college level prerequisites for this course. Basic pre-calculus mathematics will be used throughout the course. Review of the needed mathematics will be given when needed. Excel will be used throughout the course for various analyses. The first laboratory exercise will be devoted to the mathematical and Excel skills needed for the course.

Materials

There is no textbook for the course. Supplementary readings will be posted on the course Moodle site. You should purchase a three-ring binder (at least 2") for the class handouts and the laboratory handouts. You should also purchase an inexpensive spiral bound notebook to serve as a lab notebook.

Laboratory

You are required to enroll in the laboratory section of the course. *Material covered in the laboratory is an essential part of the course and will be covered on the exams.* More details on the laboratory part of the course will be discussed at the first lab meeting.

Assignments and Evaluations

Short Exercises will be assigned most class periods. These should take only ~ 20 minutes to complete, and are intended to help you keep up with the class on a ~daily basis. Longer more involved problem sets will be assigned approximately every 1 to 1.5 weeks. You are encouraged to work together on the problem sets. However, each student must submit their own copy for grading. Lab reports will be submitted for each lab. These reports will be brief and informal, and will for the most part be completed during the lab period and submitted electronically. There will be two in class hour exams and a comprehensive final. The weighting in your final grade is as follows:

Homework: Your homework will constitute 15 % of your grade.
Lab: Your labs will constitute 15% of your grade
Exams: Each hour exam will count 20%, and the final will count 30%

Attendance

From the syllabus below you will see that we will cover *a lot* ground in this course. Every class and lab will cover several essential topics in our development. Since there is no textbook, the principal course content will be the material presented and discussed in class and in the laboratory exercises. The readings and other handouts are supportive for this material. *Therefore, although class attendance will not be recorded, class attendance is mandatory.* If you miss a class you it is *your responsibility* to get class notes from another student in the class (which are almost never as good as your own notes), and to find out what, if any, handouts were missed, and to get those from the instructor.

Lab attendance *is absolutely mandatory* and *attendance will be taken.* Lab material is an essential part of the course and will typically supplement (as well as reinforce) the conceptual material discusses in class. Missed labs cannot be made up unless there are very extenuating circumstances. In such cases confirmation (doctor's note, etc.) will be required. **You are also expected to arrive at lab on time (9:30) please**! There is often explanatory material given at the beginning of lab that you will need to understand what you are doing.

Consultation

You are *strongly encouraged* to see me if you have difficulties with assigned problems or any other aspect of the course. My office hours are posted on my office door, and you may also make an appointment (e-mail please so I can write it into my office calendar). You may also "drop in" if I am in my office and not busy with another person or on the telephone.

The laboratories and the homework problems are primarily for your own learning and practice, rather than for evaluation purposes. You should therefore seek out help when you get really stuck. However, although you are allowed to collaborate on the homework, *it is very important that you do your best to solve the problems or answer the questions on your own before comparing results with others*. Obviously you will not be able to collaborate on the exams, and it is not possible to develop good quantitative problem solving skills without struggling with the problems themselves – "passive" reading of someone else's answer makes little impact.

Date	Day	Subject	Laboratory (Tuesday)

1/26	M	Introduction; Energy Basics	Intro to Excel
1/28	W	KE and PE	
1/30	F	Thermal Energy	
2/2	M	Chemical Energy	Chemical Energy I
2/4	W	Chemical Energy	
2/6	F	Laws of Thermodynamics	
2/9	M	Laws of Thermodynamics	Chemical Energy II
2/11	W	Engines and Biofuels	Ethanol production
2/13	F	Biofuels	
2/16	M	Biofuels	Ethanol field trip
2/18	W	Biofuels	8:30 – 12:30
2/20	F	Electrical Energy	
2/23	M	Electrical Energy	Electric Circuits
2/25	W	Magnetism and Faraday's Law	
2/27	F	**Exam 1**	
3/2	M	Electricity Generation	Faraday's Law and
3/4	W	Electrochemistry	Generators
3/6	F	Batteries and Electric Cars	
3/9	M	Fuel cells and Hydrogen	Electrochemistry and
3/11	W	Fuel cells and Hydrogen	Fuel Cells
3/13	F	Fuel cells and Hydrogen	
3/16	M	**Spring Break**	**No Lab**
3/18	W	**Spring Break**	
3/20	F	**Spring Break**	
3/23	M	Nuclear Physics: Fission	Wind I
3/25	W	Fusion	
3/27	F	Fusion	
3/30	M	Wind	Wind II
4/1	W	Wind	
4/3	F	Wind	
4/6	M	Wind	PV I
4/8	W	Solar (PV)	
4/10	F	Exam II	
4/13	M	Solar (PV)	Solar Ovens
4/15	W	**No Class**	
4/17	F	**No Class**	
4/20	M	Solar (PV)	PV II: Dye-sensitized
4/22	W	Solar (PV)	Solar cell
4/24	F	Solar (PV)	
4/27	M	Solar (PV)	CSP
4/29	W	Solar (CSP)	
5/1	F	Geothermal	
5/4	M	Geothermal	
5/5	T		**No Lab**

Last Day of Class

Final Exam time