UNIVERSITY OF CALIFORNIA at MERCED

SCHOOL of ENGINEERING

MSE 161: Sustainable Energy: Powering the World with Minimal Materials

<Semester> <Year> <Room>; <Days and Times>

Instructor: <Instructor; currently Sarah Kurtz>

Office Hours: <Room>; <Days and Times>

1. COURSE GOALS

Renewable energy will power the world for generations to come and California is leading! Materials have played and will play a key role in advancing these technologies. Explore how these work, the progress that has been made, and what is still needed. Class will include both individual and team activities.

2. LEARNING OUTCOMES

You will

- Review understanding of power vs energy and the importance of energy to our world
- Understand how each of the major sources of renewable electricity/energy works and understand the role of materials in making optimal use of each of these;
- Understand the societal impact and value of *renewable* energy;
- Sort the myth from the reality: renewable energy has grown and can be the low cost option in many circumstances;
- Identify the anticipated growth of renewable energy in at least one part of the world;
- Apply your understanding, knowledge and insights to the selection of (i) strategy for

achieving low-cost implementation of renewable energy, and (ii) materials-related research that may facilitate the growth of renewable energy.

The knowledge will be demonstrated through homework, discussion exercises, and in the midterm and final examinations. The course learning outcomes contribute to the attainment of the following program learning outcomes (marked with an asterisk):

(a) An ability to apply knowledge of mathematics, science, and engineering*

(b) An ability to design and conduct experiments, as well as to analyze and interpret data

(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 multidisciplinary 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

3. OUTLINE OF TOPICS

Lecture Topics

Part 1. Overview of concepts and problem definition

1. What is power vs energy? What is electricity? – In class exercise to estimate electricity consumption. Homework to document electricity use at home.
2. Why is energy/electricity important? What forms of energy are used in what amounts by the world? – In class exercise to compare electricity use found at home.
3. What are the types of renewable energy? What are the attributes that are important? (to be discussed in later parts of the course) including: What are the different ways these are used (electricity vs heat vs chemical; instantaneous vs stored)? How much of each resource is available to the world and to local economies? Cost, energy payback, efficiency, variability, dispatchability; land use; environmental issues.

Part 2. Deep dive into the various forms of renewable energy, covering topics just listed, as appropriate.

4. Hydro – how does it work?
5. Wind – how does it work? Midterm 1.
6. Solar – how does it work?
7. Geothermal – how does it work?
8. Marine – how does it work?
9. Biomass – how does it work? Midterm 2

Part 3. Putting the big picture together

10. Materials use in renewable energy.
11. Historical growth of renewable energies. Cost reduction. Experience curves; what drives experience curves?
12. Role of resource availability vs. policy in growth of renewable energy
13. Projected growth of renewable energies.
14. Materials research that could enable cost reduction and growth of renewable energy.
15. Addressing the variability issue to get 100%.

4. PRE-REQUISITES

Upper division standing. Introductory calculus, physics, and chemistry.

5. TEXT

The scope of this class is not covered by any textbook. Your class notes will be your primary source of reference material. In addition, readings from current research and professional literature will be assigned.

6. DISCUSSION SECTIONS

Discussions will be included in the lectures.

7. HOMEWORK

Homework is a critical component of this course and is designed to help you learn, understand and practice the material. It will be expected that you complete the assigned homework before each class. You are encouraged to work with your peers when doing homework.

Based on the reading and homework assignment for each class, a short quiz will be given at each class. Some of the quizzes will be closed book; some will be open book. To account for illness and other emergencies, the lowest quiz score will be dropped.

A project will be assigned with individuals choosing from a wide range of interdisciplinary topics. The projects will be shared with other class members in order to broaden the interdisciplinary nature of the class.

8. EXAMS

There will be two in-class midterm exams as indicated on the accompanying schedule. There will also be a comprehensive final exam. There will be no make-up exams. If you are sick during a regularly scheduled exam, please bring a note from the university clinic or your own doctor verifying your illness. Your course grade will then be determined by the rest of your work.

Crib sheets will not be allowed during any of the exams. However, calculators will be allowed when necessary, provided that they are not used to store data or formulae pertaining to the course.

9. GRADE DETERMINATION

Your final grade will be based on the following components:

- In-class quizzes (20%)
- Project (10%)
- first midterm (20%)
- second midterm (20%)
- final exam (30%)

10. DROPPING THE COURSE

Please see the UC Merced General Catalog and the Registrar's / Student First website for details.

11. CatCourses

CatCourses will be used for periodic course announcements, and for the distribution of class notes, discussion exercises, homework sets, and solutions. You can also check the scores that you have received on your homework assignments and exams.

Warning: pay no attention to any letter grade that is reported on CatCourses, *except* for the midterm and final grades. Handouts for a given week will normally be posted during the preceding weekend, and can be annotated electronically or printed. Full copies of lecture slides will normally be posted during the weekend following the lecture. To

encourage you to take effective notes, and to think about the material, the lecture slides are “read only”.

CatCourses may also be used to distribute audio podcasts (.mp3 files) of the lectures. These can be used best in conjunction with the slides.

12. SPECIAL ACCOMMODATIONS

The University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. If you qualify for accommodations because of a disability, please submit a letter from the Disability Services Center to me in a timely manner (during the first three weeks of the semester, except for unusual circumstances) so that your needs may be addressed. Student Affairs determines accommodations based on documented disabilities.

I will make every effort to accommodate all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please speak with me during the first week of class regarding any potential academic adjustments or accommodations that may arise due to religious beliefs.

13. ACADEMIC HONESTY AND CONDUCT

Students are expected to complete their own work and to abide by the UC Merced academic honesty policy, which can be found on the Student Life website http://studentlife.ucmerced.edu/ under the “Student Judicial Affairs” link. Any work submitted by a student in this course for academic credit will be the student's own work.

You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, (for example) in the form of an email, an email attachment file, an online file in a shared folder, a diskette, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied

will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action.

You must do your own work during examinations. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.

Note that most of the handouts provided in this course are protected by copyright, and are flagged accordingly on CatCourses. They are for your *personal* use only. Re-posting the files or their contents on sites such as (for example) "Course Hero" is an explicit violation of this copyright.

Students and instructors are expected to honor UC Merced's Founding Principles of Community: http://www.ucmerced.edu/about_ucmerced/values.asp.

14. FINAL THOUGHTS

If you are in trouble (behind in homework, doing worse in the course than you would like, etc.) for whatever reason, please let me know. I will try to help.

Because this is a 4-unit course, you should plan to do *at least* 12 hours of work on it, per week. Here is one suggestion for how to spend this time effectively:

- reading assigned material ahead of the lectures: 4 hours/week
- attending lectures / discussion: 4 hours/week
- homework / attending office hours / consolidation: 4 hours/week

It is a good idea to explicitly block out time for all these activities in your schedule. The same is true for your other courses too!