MAE 6291: Nanotechnology in Energy Applications
Spring 2014 Syllabus

Department of Mechanical & Aerospace Engineering
The George Washington University

Instructor

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Course Description

An investigation of the role nanotechnology plays in evolving energy applications such as thermoelectrics, photovoltaics, and batteries. Students will investigate relevant questions: What are the fundamental energy physics? Why is the nanoscale significant in energy applications? How does nanoengineering affect energy system performance? How do interdisciplinary factors, including technical, economic, and policy considerations, affect the impact of nanotechnology in the energy field?

Credit & Prerequisites

3 credit hours. Thermodynamics is a required prerequisite. Heat transfer and solid state physics are recommended. Familiarity with programming in Matlab is recommended.

Objectives & Key Questions

1. **Assess the performance of energy technologies.** What are the fundamental energy physics? What are the relevant metrics for different energy technologies? How do the energy technologies work? What are the advantages, drawbacks, and limitations?

2. **Demonstrate the relevance of nanoscale physics.** What are the applicable physics terms, principles, and relationships? Why is the nanoscale significant in energy applications? How does nanoengineering affect energy system performance?

3. **Analyze real world energy applications.** How do we apply knowledge of energy physics, energy system performance, and nanotechnology to real world energy technologies? What are the relevant technical, economic, and policy factors? What critical analyses investigate and assess these interdisciplinary factors?

4. **Communicate clearly, effectively, and professionally.** How do you effectively communicate your learning, questions, and mastery of the course topics? In what ways do you critique your methodologies/work and continuously improve? Where and how do you solicit feedback? How are you developing professionally?

Textbooks & References

Required:
M. F. Ashby, P. J. Ferreira, and D. L. Schodek, *Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects*, Butterworth-Heinemann, 2009.

J. Baxter *et al.*, "Nanoscale design to enable the revolution in renewable energy," *Energy & Environmental Science*, 2009.

Recommended:
A. da Rosa, *Fundamentals of Renewable Energy Processes*, 3rd ed., 2012.
(available in electronic format)

G. Chen, "Nano-to-Macro Transport Processes," Course #2.57, MIT Opencourseware, ocw.mit.edu/courses.

G. Chen, *Nanoscale Energy Transport and Conversion: A Parallel Treatment of Electrons, Molecules, Phonons, and Photons*, Oxford Press, 2005.

World Energy Outlook, International Energy Agency, 2011.

Time& Location

Course: Tuesdays 3:30-6:00pm; Monroe Hall, Room 252
Office Hours: Mondays 4:00-6:00pm; Phillips Hall, Room 721
Web site: Blackboard

Expectations & Policies

I expect all class participants, students and instructor, to be committed, ethical, and respectful. You and I will comply with the university Code of Academic Integrity and Code of Student Conduct (http://studentconduct.gwu.edu/). Notification of disabilities, appropriate supporting documentation, and required arrangements/accommodations must be provided to me, the instructor, no later than the second week of the course.

Grading

Homework: 20% **Exam (1): 20%** **Projects (2): 50%** **Participation: 10%**

Participation: Your peers and I will evaluate your participation. We will complete an evaluation about the participation of every class participant at the end of the course, so it behooves you to interact positively, productively, and professionally both in and outside the classroom.

Schedule

Topic	Session	Date	Assignments
Introduction Course overview Nanotechnology & Energy Student surveys *Precourse assessment*	1	1/14	Ch. 1 J. Baxter *et al*., Introduction, pgs. 559-562
Material structure Energy carriers	2	1/21	Ch. 4.1, 4.2 Ch. 12 (choose two sections)
Energy states Doping	3	1/28	Ch. 4.4, 4.5, 6
Transport: heat, charge, mass Nanomaterials	4	2/4	Ch. 7.2, 7.3 Ch. 10 (choose two sections)
Thermoelectrics: applications, fundamentals, metrics, materials	5	2/11	***HW 1 due*** J. Baxter *et al*., Solar thermal: thermoelectric conversion, pgs. 567-568, 577-579
Photovoltaics: solar resource, p-n junctions	6	2/18	Ch. 7.5 J. Baxter *et al*., Solar photovoltaics, pgs. 563-565
Photovoltaics: fundamentals, metrics, materials	7	2/25	***HW 2 due 2/27***
Exam	8	3/4	
		3/11 (Spring Break)	*Midterm check-in*
Broader context: technical, economic, policy Group project: introduction, technology overview	9	3/18	
Group project: technology overview	10	3/25	
Project 1 presentations	11	4/1	
Group project: nanotechnology, broader context	12	4/8	
Project 2 presentations	13	4/15	
Project 2 presentations	14	4/22	
Project report due		4/29	