

## MSE/ER C226 Photovoltaic Materials

### Overview

This graduate course focuses on the science, engineering, and economic fundamentals of photovoltaic energy. Incorporating ideas from a variety of disciplines, the course aims to equip students with the concepts and analytical skills necessary to assess the utility and viability of various modern photovoltaic materials and technologies in the context of a growing global renewable energy market. Traditional materials science and device physics are integrated with the practical issues of connectivity, cost and market analysis, and policy considerations to provide a complete picture of the engineering and development of modern photovoltaic systems.

*This class fulfills one of the requirements for the Management of Technology program as well as the Designated Emphasis in Energy Science and Technology.*

### Class Meeting (see course schedule for location on specific dates)

Lecture: Tuesday/Thursday 9:30 -11:00am and Friday 3:30-5:00pm  
348 Hearst Memorial Mining Building (Part I only)  
123 Wheeler Hall (Parts I-III)

### Course Website

<http://socs.berkeley.edu/~kammen/C226/index.html>

### Contacts

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#### **Professor Eugene Haller**

Materials Science and Engineering

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**Office Hours:** Tue/Thurs 11am-12pm

#### **Cyrus Wadia**

Energy and Resources Group

D83 Hildebrand Hall

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**Office Hour:** Wed 3-4pm in D83

#### **Professor Daniel M. Kammen**

Energy and Resources Group & Goldman School  
of Public Policy

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**Office Hours:** Wed am (call 642-1640 for appt)

#### **Becca Jones**

Materials Science and Engineering

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**Office Hour:** Thurs 1-2pm in 350 HMMB

### Grading

- 55% Final Project
- 35% Midterm/Quiz
- 10% Class Participation

### Course Texts (other assigned readings are posted on the course website)

1. MSE 223 Course Reader (available from Copy Central, Euclid & Hearst Avenues)
2. Green, Martin. *Solar Cells: Operating Principles, Technology and System Applications*. Prentice Hall, Inc, 1982.
3. Optional - Bube, R H. *Photovoltaic Materials*. Imperial College Press: London, 1998.

**Part I: Principles of Semiconductor Materials and Photovoltaics****\* Held in conjunction with MSE 223**

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*Aug 29	Introduction and intrinsic semiconductors (Kammen, Haller) <i>Reading: MSE 223 Course Reader, Green Chapter 2</i>	348 HMMB
*Aug 31	Optical properties of intrinsic semiconductors (Haller) <i>Reading: MSE 223 Course Reader, Green Chapter 3</i>	348 HMMB
Sept 1	In-depth course outline and background assessment	348 HMMB
-----	<b>WEEK 2</b>	
*Sept 5	Direct and indirect band gaps; effective mass (Haller) <i>Reading: MSE 223 Course Reader, Green Chapter 3.3</i>	348 HMMB
*Sept 7	Phonons (Haller) <i>Reading: MSE 223 Course Reader</i>	348 HMMB
-----	<b>WEEK 3</b>	
*Sept 12	Extrinsic semiconductors (Haller) <i>Reading: MSE 223 Course Reader, Green Chapter 2</i>	348 HMMB
*Sept 14	Extrinsic semiconductors (Haller) <i>Reading: MSE 223 Course Reader, Green Chapter 2</i>	348 HMMB
Sept 15	p-n junctions (Haller) <i>Reading: Green Chapter 4</i>	348 HMMB
-----	<b>WEEK 4</b>	
Sept 19	QUIZ and Class Project Introduction	123 Wheeler
Sept 21	Discussion and Selection of Class Projects <i>Reading: Class Project List</i>	123 Wheeler
Sept 22	Photovoltaic devices (Kammen) <i>Reading: Green Chapter 5</i>	123 Wheeler
-----	<b>WEEK 5</b>	
Sept 26	Class Project Team Formation	123 Wheeler
Sept 28	Silicon solar cell production (K.V. Ravi, Intel) <i>Reading: Green Chapter 6.2 - 6.4</i>	123 Wheeler
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Oct 3	Solar cell video and class logistics	123 Wheeler
Oct 5	Guest Lecture (Brian Stone, VP Marketing, and Jack Peurach, VP Technology, PowerLight Corporation)	123 Wheeler

**Part II: Economics and Public Policy**

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Oct 10	Energy future and renewable energy sources (Kammen) <i>Reading: Renewables 2005 Global Status Report (skim)</i>	123 Wheeler
Oct 12	Introduction to Solar Energy (Jones, Wadia)	123 Wheeler
Oct 13	The role of PV in the global energy market (Kammen) <i>Reading: Articles on the course website by Hoffert, M. I. et al., Kammen, and Pacala, S., and Socolow, R. (2004)</i>	348 HMMB

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Oct 16	<b>Special Guest Lecture: The potential of photovoltaics</b> (Martin Green, Executive Research Director, ARC Photovoltaics Centre of Excellence, University of New South Wales)	<b>*290 HMMB*</b>
Oct 17	Guest Lecture (Dave Eaglesham, VP Technology, First Solar) <i>Solar Power 2005 Conference</i>	123 Wheeler (San Jose, CA)
Oct 19	Solar energy financing (Claire Broido, President, Sun Edison) <i>Solar Power 2005 Conference</i>	123 Wheeler (San Jose, CA)
-----	<b>WEEK 9</b>	
Oct 24	PV markets: public policy (Professor Margaret Taylor, GSPP)	123 Wheeler
Oct 26	PV markets: economics and market dynamics (Kammen) <i>Reading: G.F. Nemet, Beyond the learning curve: factors influencing cost reductions in photovoltaics</i>	123 Wheeler
-----	<b>WEEK 10</b>	
Oct 31	MIDTERM	123 Wheeler
Nov 2	The PV Industry: An Insider Perspective (Charlie Gay, VP General Manager, Solar Business Group, Applied Materials)	123 Wheeler
Nov 3	Project Status Report	348 HMMB
-----	<b>WEEK 11</b>	
Nov 7	Engineering of photovoltaic systems (Kammen) <i>Reading: Green Ch.6.5 – 6.6 and T. Su et al. (on website).</i> PV Market Framework (Wadia)	123 Wheeler
<b><u>Part III: PV Technologies (Guest Lecture Series)</u></b>		
Nov 9	Concentrator Systems (Suvi Sharma, Solaria)	123 Wheeler
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Nov 14	Concentrating Systems at SolFocus (Steve Horne, Founder and Chief Scientist, SolFocus)	123 Wheeler
Nov 16	Organic solar cells (Professor Peter Peumans, Stanford Univ.)	123 Wheeler
Nov 17	Project Check-in	348 HMMB
-----	<b>WEEK 13</b>	
Nov 21	The Graetzel cell (Matt Law, National Renewable Energy Lab)	123 Wheeler
Nov 23	NO CLASS - Thanksgiving	
-----	<b>WEEK 14</b>	
Nov 28	The Kenya Story (Kammen)	123 Wheeler
Nov 30	PV Market Framework (Wadia) Nanoparticle and CIGS Solar Cells (Gur)	123 Wheeler
-----	<b>WEEK 15</b>	
Dec 5	Multijunction and multiband solar cells (Jones)	123 Wheeler
Dec 7	<b>Project Papers Due</b>	123 Wheeler
<b><u>Part IV: Group Project Presentations</u></b>		
Dec 12	Symposium	126 Barrows, 1-4pm