Green Chemical and Energy Technologies (52:237); SPRING 2009[1]

Syllabus Version 1 (January 19, 2009)

1. Time and Place of Course
   Lecture: 11:30-12:45 Tues, Thur, in Room 3220 Seamans Center (SC)

2. Instructor
   Charles O. Stanier
   Office: 4122 Seamans Center
   Phone: 335-1399
   Email: cstanier@engineering.uiowa.edu
   Office Hours: by appointment

3. Teaching Assistant
   none

4. Textbook
   no required textbook. A required coursepack is available at Zephyr on Washington St.

   Recommended and reference texts, many of which have sections in the coursepack and/or are on reserve in the engineering library.

   Texts that span multiple parts of the class.

   DO NOT BUY THESE for the course.
   Recommended just means that Dr. Stanier thinks that it is (in general) a useful text.

   Recommended

   Allen and Shonnard. Green Engineering: Environmentally Conscious Design of Chemical Processes. Prentice Hall 2002.

   Raldoph, and Masters. Energy for Sustainability: Technology, Planning, Policy. Island Press. 2008.

   Other

   Abraham, editor. Sustainability Science and Engineering: Defining Principles. Elselvier 2006.

   Anastas, Heine, and Williamson, editors. Green Engineering (ACS Symposium). ACS 2000.

   Anastas, Heine, and Williamson, editors. Green Chemical Syntheses and Processes (ACS Symposium). ACS 2000.

   Beloff, Lines, Tanzil, eds. Transforming Sustainability Strategy into Action: The Chemical Industry. Wiley 2005.

   Sikdar, Glavic, and Jain, editors. Technological Choices for Sustainability. Springer, 2004.

   Texts for part 1, Introduction to environmental issues, science, energy, and regulations

   Recommended

   Masters and Ela. Intro to Environmental Engineering and Science, 3rd Ed. Prentice Hall, 2008.

[1] cross listed at University of Kansas as C&PE 715 Topics in Chemical and Petroleum Engineering: Environmental Assessment of Chemical Processing

Drapcho, Nhuan, and Walker. Biofuels Engineering Process Technology. McGraw Hill 2008.

Other

Nathanson. Basic Environmental Technology, 4th Ed. Prentice Hall, 2003

Smil, Vaclav. Energy in Nature and Society. MIT Press 2008.

Cassedy and Grossman. Introduction to Energy, 2nd Ed. Cambridge Univ Press, 1998

Rubin and Davidson. Introduction to Engineering and the Environment. McGraw Hill, 2001.

Texts for part 2, Tools for environmental and energy assessment

Recommended

Ahluwalia, Kidwai. New Trends in Green Chemistry. Kluwar, 2004.

Boethling and Mackay. Handbook of Property Estimation Methods for Chemicals: Environmental and Health Sciences. 2000, CRC Press (Lewis Publishers).

McCabe, Smith, and Harriott. Unit Operations of Chemical Engineering, 7th Ed. McGraw Hill 2005.

Walas. Chemical Process Equipment – Selection and Design.

Other

Doble and Kruthiventi. Green Chemistry and Engineering. Elselvier, 2007. McGraw Hill 2001.

Lancaster. Green Chemistry: An Introductory Text. Royal Society of Chemistry, 2002.

Poling, Prausnitz, and O'Connell. The Properties of Gases and Liquids, 5th Ed. McGraw Hill 2001.

Sanghi, and Srivastava. Green Chemistry. Alpha Science 2003.

Tundo, Perosa, Zecchini, editors. Methods and Reagents for Green Chemistry. Wiley 2007.

Wulfinghoff. Energy Efficiency Manual. Energy Institute Press, 1999

Texts for part 3, Case studies, application of the tools, and process integration

Recommended

Turton, Bailie, Whiting, Shaeiwitz. Analysis, Synthesis, and Design of Chemical Processes, 3rd Ed. Wiley 2009.

Other

El-Halwigi. Pollution Prevention Through Process Integration: Systematic Design Tools. Academic Press 1997.

Sikdar and El-Halwigi. Process Design Tools for the Environment. Taylor and Francis, 2001.

5. Website

http://icon.uiowa.edu contact instructor if you have trouble logging in

6. Overview of course

PART 1. Introduction to environmental issues, science, energy, and regulations -- hopefully review for most students. We do a lot of reading here, there are some problem sets. We cover air pollution and water pollution basics, energy and combustion basics, biofuel basics, and key environmental regulations. PART 1 includes a group project.

PART 2. Tools for environmental and energy assessment. Here we touch on exposure, risk assessment, dose-response relationships, environmental fate and transport, and toxicology databases. We then cover toxicology and property estimation methods, green chemistry principles, pollution prevention, industrial ecology, and tier 1 – tier 3 environmental assessments. This culminates in our coverage of Life Cycle Assessment.

PART 3. Case studies, application of the tools, and process integration. In this section, we examine case studies that involve the tools from Part 2, and look more in depth at improving energy efficiency and reducing waste in continuous chemical processes. Process heat integration and pinch technology are discussed.

PART 4. Contemporary issues. As if that was not enough ... throughout the course we will be discussing (as time allows) contemporary environmental issues such as biofuels, fuel cells, hybrid vehicles, nanotechnology, green buildings, and climate science disputes. For many students, this is their favorite part.

Class-by-class outline (as of Jan 19)

Week	Class Period	Date	Topic	Format of class	Reading (do before class)	Notes
1	1	Tue, Jan 20	Ice-breaker, objectives, syllabus			
		Thu, Jan 22	No class. Stanier travel.			
	PART 1 -- INTRODUCTION AND BACKGROUND MATERIALS					
2	2	Tue, Jan 27	Lecture and discussion - where are we going with all of this? A preview to part II - Sustainability, principles of Green Design	Lecture & Discussion Hybrid	Nat. Academy of Sci.	
	3	Thu, Jan 29	Training by Jean Florman, Center for Teaching, on Leading a Discussion (45 min) + Lecture by Stanier on Regional air pollution		Active listening. Air pollution	
3	4	Tue, Feb 03	Lecture and discussion of Cornucopian vs. Limitist Philosophies	Lecture & Discussion Hybrid	Julian Simon (science) + Enviro philosphy reading	
	5	Thu, Feb 05	Lecture & discussion - CFCs - atmospheric chemistry and the policy response	Lecture/Slideshow (Stanier) + Class Discussion	Unep O3 Q&A + Skeptics vs. Ozone Hole	
4	6	Tue, Feb 10	Energy class 1. Introduction to Energ + Conventional fossil technologies for electricity production	Lecture with limited A/CL	Randolp & Masters Ch 1, 2 (parts), 9	Example problem collection 1 passed out (air pollution and CFCs)
	7	Thu, Feb 12	Energy class 2. Alternative / renewable technologies for electricity production.	Lecture & Discussion Hybrid	Randoph and Masters 10, 11, 12	
5	8	Tue, Feb 17	Energy class 3. Transportion - conventional liquid fuels - gas, diesel + hybrids, electric	Lecture & Discussion Hybrid	Randolp & Masters 13	
	9	Thu, Feb 19	Energy class 4. Alternative liquid fuels. Ethanol, biodiesel.	Lecture & Discussion Hybrid	Ethanol, chapters of Draphco, + biodiesel review article (turkish authors) + regents renewable	
6	10	Tue, Feb 24	Climate system 1.	Lecture with limited A/CL	SP4 / Phaeton	
	11	Thu, Feb 26	Climate system and energy policy	Lecture & Discussion Hybrid	Randolph & Masters Ch 3 Ch 16	Group project on CO2 due
7	12	Tue, Mar 03	Remaining environmental issues -- water, wastewater, surface water, groundwater, coastal and wetlands, brownfields, toxic substances, hazardous waste	Lecture only. Perhaps one question to solve in class?	Rubin and Davidson handouts + unit ops	
	PART 2 -- GREEN DESIGN AND ASSESSMENT TOOLS					
	13	Thu, Mar 05	Risk Concepts (e.g. Allen & Shonnard Ch 2) and Into to Environmental Fate and Transport Concepts	Lecture & Discussion Hybrid	masters and Ela ch. 4. Nanofear article. Fluoronated + RBCA	notebooks will be collected and graded during this week
8	14	Tue, Mar 10	Estimation of Environmentally Important Properties of Chemicals (e.g. Allen & Shonnard Ch. 5)	Lecture with limited A/CL	A&S Chap 5 (parts) + Chap 1 of Prop Est Methods + GWP + ODP	Example problem collection 2 (energy calcs) distributed
	15	Thu, Mar 12	Green Chemistry	Lecture & Discussion Hybrid	A&S Chap 7 + TOC	
		WEEK OF MARCH 16	spring break			
9	16	Tue, Mar 24	LCA & Industrial Ecology	Lecture & Discussion Hybrid	A&S Chap 13 + Sima Pro + examples	
	17	Thu, Mar 26	LCA & Industrial Ecology	Lecture & Discussion Hybrid		take home exam (energy calcs) given
10	18	Tue, Mar 31	Tier 1 / Tier 2 Assessments	Lecture and in-class problem	A&S Chap 8	take home due
	19	Thu, Apr 02	Tier 1 / Tier 2 Assessments	Lecture and group discussion of pre-handed out case studies		
	PART 3 -- SYNTHESIS					
11	20	Tue, Apr 07	Review - Distillation	stanier lead - no discussion	MSH Chap 13	
	21	Thu, Apr 09	Review - Process Heating and Cooling	lecture / discussion / in class probs	Energy Effic Manu	Example problem collection 3 (Part 2 of course) distributed
12	22	Tue, Apr 14	Synthesis 1 - Heat Exchanger Networks	stanier lead - no discussion	Turton	
	23	Thu, Apr 16	Synthesis 2 - Heat Exchanger Networks	stanier lead - no discussion		
13	24	Tue, Apr 21	Synthesis 3 - Mass Exchange Networks	stanier lead - no discussion		Oral/notebook exams
	25	Thu, Apr 23	Synthesis 4 - Mass Exchange Networks	stanier lead - no discussion		
14	26	Tue, Apr 28	Review - More Energy Hog Unit Ops - Drying , Cooling Towers, Motors	lecture / discussion / in class probs		
	27	Thu, Apr 30	Discussion - flowsheet optimization paper	No lecture - discussion only		
15	28	Tue, May 05	Guest lecture - Craig Just			Example problem collection 4 (HEN/MEN) distributed
	29	Thu, May 07	Final presentations - Kansas			

7. Grading

Grades will be assigned using the following weights. These are subject to change!

- 20% Class participation and performance as "discussion leader"
- 20% Notebook (may be accompanied by oral exam)
- 15% Group project
- 20% Take home exam
- 25% Final individual project

Grading is based on the meeting of the following criteria. The course is not curved. Grading is based on the criteria below.

- Participation, and performance as "discussion leader"
  - A =
    - participates in discussion in nearly every class;
    - demonstrates that readings have been done.
    - Shows efforts to synthesize existing knowledge and experience with class materials
    - Adds non-required research (e.g. reading, web searches, etc.).
    - Shows enthusiasm, leadership, and good teamwork in group projects.
    - As discussion leader, well prepared, discussion stays on track, discussion is covers a broad range of topics and has wide participation
    - As discussion leader, only minor problems and in only one or two areas: (preparation, keeping discussion on track, eliciting broad participation, discussion covers multiple facets of the topic, active listening).
    -
  - B =
    - participates in discussion most classes.
    - demonstrates that readings are usually done prior to class.
    - Good teamwork in group projects.
    - As discussion leader, between the B and C criteria
  - C =
    - occasional participation in classes.
    - As discussion leader, major problems in two or more areas: (preparation, keeping discussion on track, eliciting broad participation, discussion covers multiple facets of the topic, active listening).
  - D
    - showing little to no comprehension of material
    - several readings not completed

- Exam (take home exam on energy calculations)
  - A = neat and easy to follow. Shows complete understanding of concepts, checking of answers for physical plausibility, good use of units, proper use of significant figures, and reasonable care to avoid calculation error. Problems set up properly.
  - B = somewhere between A and C. A few minor errors, or difficulty with one concept.
  - C = More than 25% incomplete OR shows lack of understanding of more than one major concept OR many minor errors combined (e.g. non-physical answers, bad units, & messy)
  - D = showing little to no comprehension of material. or lower work will be returned to the student for redoing.

- Projects - specific guidelines will be given for projects

- Notebook

All students are required to keep a notebook that includes notes that are taken as readings are done, as research is done for projects, and for in class notes. This notebook will be examined twice during the class. Once in the first half of the class – with no grade, just suggestions. Then during the second half of the class. The second examination may be accompanied by an oral exam.

Although the notebook will be graded on quality (not quantity) of notes, at least one page of notes is expected for each 20 pages of assigned reading.

- A = Notebook neat, complete, and makes a valuable addition to the reading – assuming the notebook was used as a reading companion by a senior in chemical engineering. Notebook shows evidence of a good understanding of concepts and context, and appropriate organization of course concepts.
- B = somewhere between A and C.
- C = Notebook failing in two or more areas (neatness; completeness; organization of class concepts; value as a reading companion).