Green Chemical and Energy Technologies (52:237); SPRING 2009
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**

   **Other**

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

   **Recommended**

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

**Other**


Texts for part 2, Tools for environmental and energy assessment

**Recommended**


**Other**


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

**Recommended**


**Other**


5. Website

[http://icon.uiowa.edu](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)

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