The Nature and Future of Water
CEE 73
Summer 2013
Location: Y2E2 111; Time: Monday/Wednesday 11:00 – 12:50 PM

Instructors:

Sandy Robertson       Derek Fong       Allison Pieja
Office Hours: TBA     Office Hours: TBA     Office Hours: TBA
sandrob@stanford.edu  dfong@stanford.edu  apieja@stanford.edu

Teaching Assistant:

Austin Hay
Office: Coupa Café / Blue Atrium
Office Hours: Monday/Wednesday 1:00 – 2:00 PM
AustinHa@Stanford.edu

Course Description:
Pure water is colorless, tasteless and odorless. Water is the only substance that occurs at ordinary temperatures in all three states of matter: solid, gas and liquid. Water is essential in determining the quality of all living organism. It covers more than 70% of the earth, however only 1% of the Earth water is available for drinking. This team-taught class will provide a multidisciplinary introduction to water, our planet’s precious and vital resource. This course will explore water from molecular to global cycle scales; identify key science and engineering concepts in relation to sustainability, management and socioeconomic issues, and the impact on populations and the environment.

Course Objectives:
At the completion of the course, students should:
(1) Understand the hydrological cycle and its interaction with human societies.
(2) Be able to do basic science and engineering calculations related to water quantity, quality, and flow.
(3) Understand the principles of aquatic ecology, water quality, and water treatment.
(4) Be knowledgeable about important water issues in U.S. and around the world.

Course Units and Grading:
This lecture course is being offered for 3 units, for letter grade or credit/no credit. Your grade in this class will reflect your knowledge of the lecture material through 3 homework problem sets and a final project.

Your grade will be calculated as follows:
Homework (50%)
Final Project (40%)
Class Participation (10%)  

**Textbook:** None—readings from several texts will be assigned/suggested. All readings should be available electronically through Stanford Libraries  

**Course Schedule:** The class meets on Monday and Wednesday, 11:00am – 12:50pm

<table>
<thead>
<tr>
<th>Week</th>
<th>Date and Topic</th>
<th>Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>June 24: Introduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>June 26: Water Properties/Chemistry</td>
<td></td>
</tr>
<tr>
<td>Week 2</td>
<td>July 1: Chemistry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 3: Chemistry/Hydrology</td>
<td></td>
</tr>
<tr>
<td>Week 3</td>
<td>July 8: California water and hydrologic cycle</td>
<td>PS #1 due</td>
</tr>
<tr>
<td></td>
<td>July 10: Physical transport of water: conservation laws and applications</td>
<td></td>
</tr>
<tr>
<td>Week 4</td>
<td>July 15: Physical transport of water: prediction and design</td>
<td>Deadline to speak with instructor(s) on Final Project topic</td>
</tr>
<tr>
<td></td>
<td>July 17: Transport and motions in the ocean</td>
<td></td>
</tr>
<tr>
<td>Week 5</td>
<td>July 22: Ecology</td>
<td>PS #2 due; Final Project topic due</td>
</tr>
<tr>
<td></td>
<td>July 24: Water Quality &amp; Pollution</td>
<td></td>
</tr>
<tr>
<td>Week 6</td>
<td>July 29: Water Treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>July 31: Water Technologies &amp; Case Studies</td>
<td></td>
</tr>
<tr>
<td>Week 7</td>
<td>August 5: TBA</td>
<td>PS #3 due</td>
</tr>
<tr>
<td></td>
<td>August 7 Final Project Work (no class)</td>
<td></td>
</tr>
<tr>
<td>Week 8</td>
<td>August 12: Final Project Presentations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>August 14: Final Project Presentations</td>
<td>Final Project due</td>
</tr>
</tbody>
</table>
**Readings**

**Introduction**
http://www.crcnetbase.com/isbn/9781420055450

Ch 2—All about Water

**Water Properties/Aquatic Chemistry**

*Environmental Chemistry.* Manahan, Stanley E. 2000
http://www.crcnetbase.com/isbn/9781439832769

Ch3—Fundamentals of Aquatic Chemistry

*Key Concepts in Environmental Chemistry.* Hanrahan, Grady, 2012

Ch3—Aqueous Chemistry

http://www.crcnetbase.com/isbn/9781420055450

Ch 4—Water Chemistry

NOTE: Ch28 in Manahan provides background material that may be useful for those with limited chemistry background or those who would like a refresher

**Physical transport processes of water**


Ch 2: Hydrologic Cycle and the Water Budget

http://www.crcnetbase.com/isbn/9781420055450

Ch3 – Hydraulics


Ch 5 – The oceanic heat budget
Ch 7 – Equations of Motion (Stewart)
Ch10 – Geostrophic Currents

**Biology of Water** *(selections will be assigned prior to class)*


- Ch 5 – Water Biology  
- Ch 6 – Water Ecology


- Ch 1 – Basic Considerations in Hydrobiology  
- Ch 4 – Basic Aquatic Ecosystems  
- Ch 5 – Microorganisms and Pollution Control  
- Ch 6 – Water Pollution  
- Ch 10 – Water Treatment and Distribution  
- Ch 12 – Pathogens and Their Removal  
- Ch 14 – Introduction to Wastewater Treatment
Course Outline:

Week 1 (June 24): Introduction, Water Chemistry
  • Water Properties,  
  • Reactions  
  • Equilibria

Week 2 (July 1): Chemistry
  • Types of reactions and equilibria  
    o Phase transfer  
    o Acid/base  
    o Redox  
  • Carbonate system

Week 3 (July 8): Physical Transport processes
  • California water systems: natural and manmade  
  • Hydrologic cycle  
  • Fundamental Conservation laws  
  • Bernoulli’s equation and continuity

Week 4 (July 15): Physical transport processes
  • Applications  
    o Flow in rivers, streams and canals  
    o Flow in pipe systems  
  • Physical Oceanography  
    o Additional physical processes  
    o Scaling

Week 5 (July 22): Biology of Water
  • Ecology  
  • Microbes to Macrobes  
  • Food Chains and Food Webs  
  • Water Quality & Water Pollution

Week 6 (July 29): Biology of Water: Putting Science in Context
  • Water and Wastewater Treatment  
  • Case Studies of Natural & Engineered Ecosystems

Week 7 (August 5): Water Resources Management (Tie into NSF ERC)
  • Surface Water Catchments  
  • Underground Water Storage  
  • Energy Production – Hydroelectric, Geothermal, Tidal, Nuclear

Week 8 (Aug 12): Final Project Presentations
Final Project:

Description of Assignment:

You are a science journalist for the New York Times, and your editor has assigned you the topic of “water” for your next column. You will research a recent issue, discovery, or scientific advancement in the field of water. Your editor has requested two things:

1. A short (10 min) presentation on your topic to be given as a local university seminar

Important deadlines:

- **July 17th**: Discuss your topic with one or more of the instructors.
- **July 24th**: Submit a brief (<½ page) write-up of your topic.
- **August 12th or 14th**: Final presentations.
- **August 14th**: Final op-ed/review piece due.

Op-ed:

In this assignment, you will be writing a two page (length is approximate; use 1.5 spacing and 11 pt font) opinion editorial (“op-ed”) for the NY Times on a current local or global water issue, discovery, or scientific advancement. Op-eds are an opinion writing piece, that are written to educate the general public about a specific issue beyond what is normally found in public media. In writing this article, you should clearly state your hypothesis or opinion on the topic (e.g. “This dam is beneficial because...”). The two-page limit does not include references and graphics.

In writing your op-ed piece, you need to use scientific findings contained in the peer-reviewed literature to support your position. In some instances, you will be able to find data and graphs that specifically support your position. In other cases, you may find it useful to focus on the uncertainty of a scientist’s findings to support your position.

The definition of peer-reviewed literature for this assignment is literature that has been published in scientific journals and has been peer-reviewed by other scientists. This means that graphics and data you find on the internet or on an advocate’s website are not information you should use in writing your op-ed piece (although if you can find the source of these data/graphs in the peer-reviewed literature they are certainly fair game). For the op-ed, you will need to reference at least two peer-reviewed papers. In addition, you must include at least one graph or table that you have taken from a peer-reviewed paper. You should use these graphs/tables to support your arguments. Be sure to effectively communicate an interpretation of the graphs so that the readers will be able to understand why you have included them. Remember that your audience may not be able to easily interpret complicated graphs. Feel free to re-make graphs using data you find in the peer-reviewed literature if you feel you could make them easier to interpret.
Presentation:

For this part of the assignment, you will be sharing your research on the topic with the rest of your class, an audience that is scientifically literate but may not know much about your topic. In your presentation, you must state and support the opinion or hypothesis that you wrote on in your op-ed. Your presentation should also include at least one figure with data from the literature. Although there are no strict guidelines for the presentation, you may want to consider addressing the following questions:

- **What** is your topic?
- **Why** is this a problem/issue/important advancement or discovery?
- **Who** is affected by this?
- **Where** is this an issue, geographically?
- **When** did or will this become an issue?
- **How** should the issue be addressed?
- **What** are the other arguments in favor of or against the issue?