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Physical Principles of Environmental Science
Spring 2012

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Office Hours: Monday 11:30-12:15 Food Science Cafe
Wednesday 12:00-1:00 pm Cook Campus Center Cafe

Class Schedule: Monday and Thursday 12:35-1:55 pm
Bartlett Hall Rm 123

Grading: 25% problem sets (including project); 35% quizzes; 40% final

Course Description:

This course is an introduction to environmental systems. Mass, energy and momentum balances will be used to quantitatively describe environmental systems and provide information needed to mitigate human impacts on these systems. The course will provide an appreciation of the role of energy in the environment, and an understanding of how the fundamental forces of nature affect contaminant and radiative transport. Perhaps most importantly, this class will provide guidance on how to simplify extremely complex systems so that solutions can be obtained.

Learning Objectives:

After this class, students will be able to:

- Apply knowledge of mathematics, science and engineering (mass, energy and momentum transport principles) to solve environmental problems
- Function on multidisciplinary teams
- Provide quantitative answers to highly complex problems by making assumptions and communicating the knowledge gained and limitations imposed by those assumptions.
- Communicate scientific calculations clearly in writing

Students will have a basic understanding of 1) climate change, 2) the relationship between the residence time (or lifetime) of a compound in a reservoir and its concentration (or loading) in that reservoir, 3) the equations of motion governing mass, energy and momentum transport, and 4) the associated commonly used terminology.

Course Materials and Problem Sets:

There is no required text book for this class. You might choose to purchase Mihelcic (listed below). Important course materials including readings, web references, problem sets, and solutions will be posted on Sakai (<https://sakai.rutgers.edu>).

References on Reserve at Chang Library:

Mihelcic, James R. "Fundamentals of Environmental Engineering," John Wiley and Sons, New York, 1999.

Masters, Gilbert "Introduction to Environmental Science and Engineering, Prentice Hall, Upper Saddle River, New Jersey.

Environmental Systems and Processes by Walter J. Weber, Jr. Wiley Interscience, New York (2001)

Bird, R. Byron, Stewart, Warren E., and Lightfoot, Edwin N. "Transport Phenomena," John Wiley and Sons, New York.

Policy on Problem Sets:

The primary purpose of weekly problem sets is to facilitate learning. Do not expect to pass this class without doing these problem sets by the specified dates. By doing the problems and comparing your answers to the posted solutions you will understand how to apply the lecture material and you will be prepared for quizzes. Even more importantly you will be more likely to retain the knowledge from this class and be able to apply it in your upper level courses and in your profession.

Problem sets will be posted at <http://sakai.rutgers.edu>. Solutions will be posted after class on the day the problems are due. Problems are due at the beginning of class. Problem sets will not be accepted after solutions are posted. One problem each week will be graded and problem sets will be returned within one week of collection. **Students are expected to compare their solutions for all problems with the posted solution set right away. This will help ensure success in exams and in learning the material.**

You are encouraged to teach each other, but the work that you turn in must be your own. You are welcome to use computer programs or spreadsheets prepared by yourself. You may handwrite your work, if desired. You must document your work

completely. *Copying from other classmates will not be tolerated, and all students involved will receive no credit for that assignment.*

Required Problem Set Format:

Problem sets give the student practice in problem solving and communication of results to others. Many of the problems could be solved multiple ways, and it is up to you to decide what assumptions to make in solving the problem. Therefore, communication of what you did in the problem is critical. For this reason, the following format **must** be used:

1. Briefly restate the objective of the problem to make sure it is understood (for example “find:___”).
2. Identify the physical setting of the problem. State information provided and assumptions made (for example “given:___”; “assuming:___”). Whenever possible draw a sketch of the system.
3. Solve the problem showing all assumptions and the basis for those assumptions. Do not skip steps.
4. Any facts that you use that were not provided in the problem should include a reference to indicate where the information was obtained. This includes equations unless you derive them in the problem or they are common knowledge like $F=ma$ or $PV=nRT$. No reference is required for conversion factors.
5. When using an equation, write out the equation first before entering values. Always include units. Making sure your units cancel is a very good quality control check! Also ask, “does my answer make sense?”
6. As needed, include a brief running commentary to explain your thought process. Circle answers and call attention to important intermediate results.
7. Discuss the significance of the results whenever possible.

Class Participation: Class attendance and active participation is expected.

Warning: This course starts with basics and ends with sophisticated concepts. Last year some students thought, based on the early material that they did not need to attend class. They discovered their error when they started failing quizzes. Since most material builds on previous material, attending class and doing the weekly work are essential.

Quizzes

There will be 4-5 quizzes over the course of the term. Please let me know in advance (in class) if there is a school or religious event that would constitute an excused absence.

Group Project

Multidisciplinary teams of three students (selected by me) will formulate and solve a quantitative question of their choice pertaining to a topic of environmental interest using a mass, energy, or momentum balance (i.e., tools learned in this class). This project will demonstrate environmental problem solving skills. Many examples of environmental problem solving will be provided in class lectures. Two weeks will be devoted to the projects including some in-class time and time outside of class for information gathering and to finalize the deliverable. Use of project management software such as *Teamness* (on our Sakai site) or *Google Docs* to help your team interact with each other remotely is encouraged. Teams will be assigned early in the term to enable the brainstorming of ideas in advance. The group project will count as 2 problem sets. Grading will take into consideration problem/solution communication, technical accuracy, and level of difficulty.

The delivered report (4-8 pages) should include 1) title and contributors names, 2) background explaining the motivation for the problem (why it is important; including references, typed), 3) the question you will answer, 4) your defined control volume and assumptions needed to make the problem solvable with tools you learned in this class (mass, energy and or momentum balances), 5) data that you used and what it is based on (with references as appropriate), 6) a drawing of the system, 7) a written mass, energy and/or momentum balance equation, 8) a step-by-step solution of the problem, 9) an answer to the question you posed, 10) a written evaluation of how good the assumptions are, the limitations they pose on the answer, and under what circumstances your solution is valid. Please indicate, when appropriate, if your solution is an upper or lower bound.

Every fact stated requires a reference, provided as “(author, date)” immediately after the stated fact in the text. Any equations that you did not derive from first principles also require a reference. A reference list at the end of the report should contain complete citations. You are encouraged to use peer reviewed journal articles (www.libraries.rutgers.edu), books and web sites. Please critically evaluate the quality/reliability of the available resources. **The reference librarian at Chan Library is there to help you. You are encouraged to discuss your idea with the professor.**

General Project Topic Ideas:

Global cycling of DDT, Exposure of children to lead, Cycling of mercury to Hudson River Estuary, Air-water-sediment-fish partitioning, Methane on Titan – Saturn’s moon, Stratospheric ozone, Sources, sinks and concentrations of CFCs, Lawn application of pesticides and drinking water, An aspect of climate change on a planet, Wastewater treatment of BOD, Mercury removal in the air pollution control system of a power plant, Fate of ingested PBDEs in nursing mothers