ENV 6002: PHYSICAL AND CHEMICAL PRINCIPLES IN ENVIRONMENTAL ENGINEERING
University of South Florida
Cunningham **Fall 2008**

Course Description (from catalog)

Investigates how chemical properties, physical processes, and environmental characteristics all influence the fate and transport of chemicals in natural and engineered systems. Includes theory, practical examples, and laboratory experiments.

About this Class

This course is modeled after a class that has been taught at Stanford University for many years. The course at Stanford was developed by Professors Perry McCarty and Paul Roberts; more recently it has been modified and taught by Professor Richard Luthy. All three are members of the National Academy of Engineering; Professors McCarty and Roberts are also recipients of the Founders' Award from the Association of Environmental Engineering and Science Professors (AEESP). The material presented in this course at USF will borrow heavily from the materials developed by Professor Roberts.

Course Objectives

1. To understand the factors governing the behavior of chemicals in the environment, especially hazardous chemicals: transport; distribution among air, water, and soil; transformations; environmental and health effects.
2. To comprehend equilibrium and rate principles and their interplay.
3. To appreciate how a chemical's properties affect its environmental fate.

Learning Outcomes

Upon completing the class, students should be able to:

1. Identify the key provisions of central pieces of U.S. environmental legislation;
2. Estimate quantitatively the distribution of chemicals between environmental phases or compartments;
3. Identify the most important chemical properties and environmental characteristics that govern how a chemical behaves in the environment; and
4. Assess qualitatively how chemicals in environmental systems will respond to a state of chemical non-equilibrium.

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Lectures: Tuesdays and Thursdays, 12:30–1:45 PM

Instructor: Prof. Jeffrey A. Cunningham — ENC (Engineering Bldg III), room 3215
cunning@eng.usf.edu — 974-9540

Office Hours: To be announced as soon as possible; probably held on Mon. and Wed., maybe Fri.

Credit: 3 units, letter grade

Grading:

Homework*:	25%	Laboratory‡:	10%
Midterm exam#:	25%	Final exam†:	40%

* Approximately 9–11 homework sets, to be completed individually.

‡ A laboratory experiment will be performed by students under guidance of the instructor. Students will be evaluated on the quality of their lab report(s) primarily, and on the quality of their data secondarily.

Written midterm exam, to be taken in class.

† Written final exam, to be taken at the time set by the registrar (tentatively set by the registrar for Thursday, Dec 11, 10 AM)

Prerequisites:

Required (ENV 6002):	B.S. in engineering, *OR* consent of instructor (CI).
Required (PHC 6312):	CHM 2046, PHY 2054, & MAC 2312, *OR* CI.
Recommended:	math through differential equations; one year of chemistry

E-Mail: Outside of class, I will use e-mail to disseminate information. This will probably be done through the Blackboard software program.

Web site: Course documents -- including assignments -- will be posted on the web. Postings will be made on Blackboard and at the following site, which I will maintain:
http://www.eng.usf.edu/~cunning/ENV6002/PhysChem.htm

Course Notes: Compiled by instructor; purchase from Pro-Copy (Fowler Avenue, 813-988-5900).

Texts: I will put some text books on reserve in the library. These may aid you to understand the material if you find that the course notes are not sufficient. Referring to multiple sources is almost always beneficial to students when learning material for the first time (as long as all of the sources are reliable).

Guidance for Reading Assignments:

Course Notes: An assemblage of sections comprised in part of the instructor's notes and in part of articles, etc., from other sources. Peruse the assigned sections before class, and bring the notes to class. The lectures will follow the notes for the most part, so read ahead before class. If you don't follow the assignments in the Course Notes conscientiously, you may get lost. *Highest Priority!*

Other Texts: You may find other text books that cover some of the same subjects that we will cover in this class. Some of these may be put on course reserve in the library. Examples include: *Water Quality* by Tchobanoglous and Schroeder; *Environmental Organic Chemistry* by Schwarzenbach, Gschwend, and Imboden; *Environmental Science and Engineering* by Henry and Heinke; *Introduction to Environmental Engineering and Science* by Masters; *Principles of Environmental Engineering and Science* by Davis and Masten. You are encouraged to explore other text books -- there may be one that works better for you than those recommended above, and that is fine. However, see the caution immediately below:

Beware: The recommended textbooks differ from the Course Notes in some places, often importantly (i.e., nomenclature, methods, viewpoints). When in doubt, follow the Course Notes for the purposes of this course (e.g., homework or exams), but prepare yourself for differing opinions and approaches in the "real world."

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Course Topics:
Students taking this class will be required to invest their time, attention, and imagination. In return they will receive 3 units of credit, receive a letter grade, and (hopefully) gain new insights into the behavior of chemicals in the environment, particularly the aquatic environment. Topics to be covered will proceed in approximately the following order (subject to minor changes, pending how the course progresses):

I. Foundation Material
Introduction
Physical properties of water; Environmental chemodynamics perspective
Basic chemistry review
Concentration; Electroneutrality; Stoichiometry
Regulatory background
Water Quality Criteria and Standards; Legislation; Health risks
Hazardous chemical introduction
Origin and pathways of synthetic chemicals

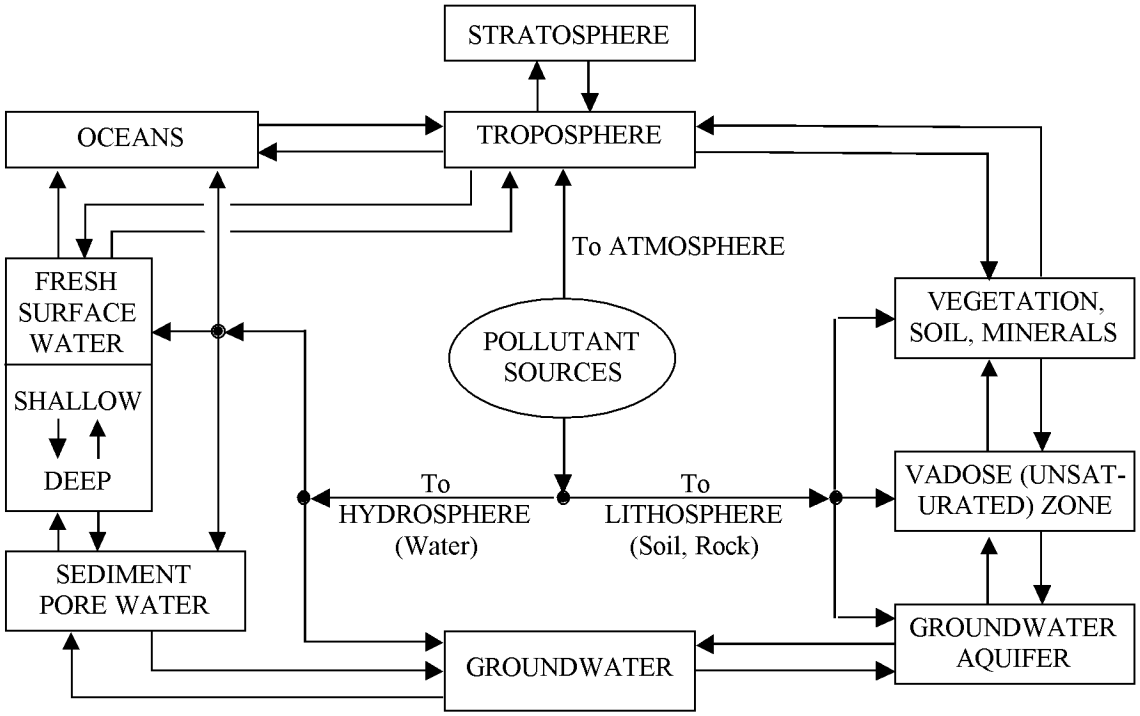
II. Concepts (the "heart" of the course)
Phase equilibrium and partitioning
Free energy concepts; Phase equilibrium -- air/water, solid/water
Mass transfer principles
Interphase transfer; Mass transfer coefficients
Transformations
Reactions, degradation, and persistence; Rate equations; Oxygen demand
Reactor theory
Reactor types; Residence time distribution; Extent of reaction

III. Applications
Oxygen depletion in streams
Oxygen consumption and reaeration, Streeter-Phelps equation for oxygen sag
Chemical fate in wastewater treatment
Activated sludge process; Disappearance mechanisms, Computation of fate
Partial mixing and dispersion
Causes of dispersion; Advection-dispersion equation; Transport and reaction
Groundwater
Hydrogeology review; Advection, dispersion, and retardation

IV. Catch-up, Review, and Course Closure

Course Thesis
The central thesis of this course is that fate and transport of organic chemicals in the environment depend upon *chemical properties*, *physical processes*, and *environmental characteristics*.

Course Framework [*from Professor P. Roberts*]
We will follow an approach termed *chemodynamics*, which we understand as the applied science underlying the movement and fate of chemical substances within the three major compartments of the environment: air, water, and earthen solids. We will concentrate on what happens in water, and how that compartment interacts with air and solids.



Another important compartment:
The BIOTA is the sum total of living beings. The BIOSPHERE is the domain occupied by the biota, mainly comprised of near-surface portions of the hydrosphere, atmosphere, and lithosphere. From the viewpoint of chemodynamics, the biota is considered a separate compartment, whereas the biosphere overlaps compartment boundaries (hydro-, litho-, atmo-).

Class Policies: 1., Homework Policy

- There will be about 9–11 homework sets to be performed throughout the semester, approximately one per week.
- It is the instructor's goal that all homework assignments be graded. However, it is possible that, on occasion, a particular homework assignment might not be graded.
- It is in your best interests to invest the time in doing the homework well. If you do a good job on the homework assignments, you are likely to perform well on the examinations. If you don't spend the time on the homework, then you are likely to have difficulty on the examinations.
- The instructor will be available at least one hour each week, and probably more, to assist with homework problems.
- Students may discuss the assignments among themselves, *but each student must conduct the actual computations and write up his/her work without referring to others' solutions*. Copying the work of others (including text, computations, figures, tables, sections of computer programs, or sections of lab reports) will be considered cheating. For assignments in which computer spreadsheets are used, each student should run the spreadsheet individually.
- This year's assignments are likely to be similar to previous years' assignments. Therefore, you *may not refer* to previous years' solution sets when completing your homework. Using solution sets from previous years will be considered cheating -- it is the same as copying work completed by a fellow student.
- Assignments will usually be distributed at least one week before the due date.
- Assignments are due *in class* on their due date unless otherwise noted. Occasionally, assignments will be due on a non-class day. In those cases, completed assignments can be sent electronically to the instructor, or can be delivered to the CEE departmental office, where they can be time-stamped by the office staff.
- Homework solutions will be provided to students, usually after the next class following the due date.
- Homework submitted in class on the due date will be considered on time and thus eligible for full credit. Thereafter, a 20% *late penalty* will be subtracted up until the homework solutions are distributed. After the solutions are distributed, late homework will not be accepted.
- Homework should be neat and legible, on standard 8.5-by-11 or A4 paper, stapled.
- Report your numerical answers to a reasonable number of significant digits. You may be graded down for reporting an excessive number of significant digits.
- Your homework solutions must include at least enough detail that the grader can follow your reasoning and calculations. An answer provided without this level of detail will be considered insufficient.
- Helpful hint: when performing calculations, be careful of your units!

Class Policies: 2, Exam Policy

- Both the midterm and final will be written examinations.
- Exam questions will be primarily quantitative (problem-solving), but there may be qualitative (definition, discussion) questions as well.
- Both examinations are *closed-book*, but students are permitted to use *personal note sheets*: one double-sided 8.5-by-11 inch sheet for the midterm, and two such sheets for the final exam. Personal note sheets must be hand-written -- no laser printing, scanning, photocopying, etc. Retrieval of information by other means during an examination will be considered cheating.
- The midterm exam will be given in class, probably during the week of October 6 or the week of October 13. The date will be finalized sufficiently in advance for students to prepare adequately.
- The final exam will be given at the time set by the registrar. The registrar's tentative final exam schedule has us down for Thursday, December 11, from 10:00–noon.
- Exams can be re-scheduled or "made-up" only in the event of a legitimate reason for absence and/or *prior* consent of the instructor. Re-scheduling of the final exam is not possible because the date and time are set by the registrar.
- The instructor's intention is to design exam questions such that students who have attended class and have done the homework assignments will be familiar with all the material needed to answer the question (i.e., it will not be my intention to "surprise" you, only to challenge you).
- Generally, exam questions are intended to test the most important concepts of the course. A good exam should require the students to demonstrate their mastery of the material by synthesizing and applying the most concepts of the course. Exam questions are not likely to test students on their recall of minutiae.
- Helpful hint: when performing calculations, be careful of your units!

Class Policies: 3, Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Office of Academic Support and Accommodations for Students with Disabilities (ASASD, 974-4309) as soon as possible.

Class Policies: 4., Academic Honesty

- The handouts used in this course are copyrighted. "Handouts" means all materials generated for this class, which include, but are not limited to: syllabi, notes, quizzes, exams, in-class materials, review sheets, and additional problem sets. This includes materials that are posted on the web as well as materials distributed in class. Because these materials are copyrighted, you do not have the right to copy the handouts unless the instructor expressly grants permission.
- No form of scholastic dishonesty (cheating, plagiarism, etc.) will be tolerated. As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you have permission of that person. This includes copying material from books, reports, journals, pamphlets, handouts, other publications, web sites, etc., without giving appropriate credit for those ideas and/or without identifying material as quotations when taken directly from another source.
- Cheating on homework and exams will not be tolerated. Cheating will be dealt with according to university policy.
- Examinations are *closed-book*, but students are permitted to use *personal note sheets*: one double-sided 8.5-by-11 inch sheet for the midterm, and two such sheets for the final exam. Personal note sheets must be hand-written -- no laser printing, scanning, photocopying, etc. Retrieval of information by other means during an examination will be considered cheating.
- Students may discuss the assignments among themselves, *but each student must conduct the actual computations and write up his/her work without referring to others' solutions*. Copying the work of others (including text, computations, figures, tables, sections of computer programs, or sections of lab reports) will be considered cheating. For assignments in which computer spreadsheets are used, each student should run the spreadsheet individually.
- Violation of these rules can result in disciplinary action including a grade penalty, up to and including an F or FF in the course, suspension, dismissal, and expulsion from USF. If you have any questions regarding plagiarism or other forms of scholastic dishonesty, please consult the relevant sections of the USF student catalogs, and/or ask the instructor.