Course Syllabus

EnvH 552 - Environmental Chemistry of Pollution - Winter 2015 (4 credits)

Monday, 3:30 - 4:50 pm, T 359 HSB;

Wednesday 3:30 - 4:50 pm, T498 HSB

Friday, 3:30 - 4:20 pm, T 359 HSB

Instructor: Dave Kalman, PhD.
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Office: ROOM 2336, 4225 ROOSEVELT BUILDING

Office Hours: W, 1-2 pm; Th 1:30-2:30 pm; and by appointment

Telephone: 206 543-1048

Course Description and Instructional Objectives

This course provides an overview of the concepts and applications used to predict and explain chemical concentratio environments, as they result from releases, transport, phase transfer and chemical reaction processes. Simply put, tl the connection between chemical uses and mishaps, and damage to human health or to ecologies ?"

The teaching methods for this course include didactic presentations, on-line recorded materials, class discussion of t problem solving.

This course introduces concepts that form a basis for rationalizing or predicting environmental behavior of pollutant cl properties and behavior, environmental conditions, and pollutant release scenario details to address the following que

- What parts of the environment (air, water, soils, etc) are likely to be most affected?
- What will determine the resulting environmental concentrations (over time, and location)?
- How may these concentrations be calculated or estimated?
- How do modifying factors like temperature, salinity, and mixtures affect these answers?

Lastly, the implications for understanding the resulting possible environmental exposures leading to human hea

Student Learning Objectives:

At the completion of the course, students should be able to:

- Describe what is meant by "environmental fate":

    discuss possible application to common chemicals of environmental concern

    identify key environmental compartments and processes

- Apply equilibrium concepts and equilibrium partitioning relationships for chemicals in different environmental mec

  classify different situations of environmental contamination as describable using chemical equilibrium cc

  identify limitations in applicability of chemical equilibrium assumptions

  recognize and state the thermodynamic concepts relating molecular structure with quantitative indices c equilibrium constants and rate constants

  perform calculations of chemical concentration based on equilibrium conditions

- Apply these thermodynamic relationships to key processes of environmental importance such as volatilization, sc
- Demonstrate familiarity with common groups of environmental pollutants, and summarize the reasons for the env
- List and compare several approaches for obtaining estimates of chemical properties for chemicals of environmen
- Write rate equations for a given chemical degradation mechanism and classify it as to kinetic order, and apply firs removal rates or half-lives.
- For pollutants introduced into surface water, subsurface water, air or in soils:

  identify the major transport mechanisms and perform basic calculations of transport velocity

  identify environmental partitioning behaviors of probable environmental importance and apply equilibriu environmental concentrations

  apply concepts of advection, dispersion, phase partitioning and chemical reaction and formation to calc distance from source.

- Identify conceptual approaches for environmental fate modeling and simplifying assumptions, and be able to con
- Analyze problem descriptions, frame computational approaches and solve for resulting concentrations or other sy relationships presented.

Course Format and Requirements

The course will meet 2 times per week in a 80-minute lecture format (MW 3:30 – 4:50), and one 50-minute session or I plan to record and post each session, as a "Panopto" file. The final exam is scheduled for Thursday, March 20, 201 on-line and/or take home final exam instead.

For most weeks in the quarter, I will introduce new material during the Wednesday and Friday sessions. Most Monda the material already presented, in problem solving or discussion formats.

1. Reading & Lectures:

We will follow the text and supplementary materials reasonably closely; major departures will be material skip the content of any reading assigned from a required text or handout.

Reading is assigned for each lecture (see accompanying schedule) and **should be completed before the lecture**. reading, so it is important that you read this material and come with questions or a good understanding and/or questi

2. Homework:

Important comments about homework: (1) the purpose of the homework is to solidify your understanding of the conce

problem is ok, if it leads to improved understanding; (2) as with any skill-building exercise, you get out of it what you p good thing; (3) spending hours of time struggling with a single problem is not a good thing. If you don't solve a proble out what the problem requires. If that doesn't help, get help.

THE MOST COMMON ERROR IN DOING HOMEWORK IS SPENDING TOO MUCH TIME IN FRUITLESS CALCUL

The objective of this course is to provide the conceptual theory of environmental science and then develop sk situations, through the working of problems. Homework problems will be assigned for each lecture from the text on a indicated on the course schedule).

The "examples" (i.e. supplementary text and worked problems) should be read and understood; these are us We'll try to allow time to discuss problems and will schedule extra sessions if necessary. It is important for your succ (including the worked examples). Occasionally, “problem sessions” will be held during class periods. These will cove students may be responsible for presenting solutions to the problems covered. "Optional questions" noted in reading be collected (any exceptions will be announced).

Homework problems are key to building the skills to apply the material in class. Up to three students may col collaborations should be indicated on the work turned in. Students are free to confer with each other on homework pr first to work each problem alone. However, students should spend no more than 3 or 4 hours on any one problem se to the problem is not clear after that amount of time and any hints provided have been considered, STOP and seek h email, discussion board, telephone, etc. It may occasionally be beneficial or even necessary to interact with me onc misunderstandings. I recommend posting your questions on the Class Discussion page. Late work will be penalized.

3. Quizzes:

Online quizzes will be assigned roughly every other week, to be completed by 10AM on the date due. Students must For calculation problems, I will routinely accept a worksheet completed while taking the quiz, to award partial credit. session following the due date for the quiz. If there are any unforeseen circumstances that prevent you from submitti and I will provide a second login opportunity. Answers to quizzes will be discussed in class.

4. Participation:

Asking questions and stimulating discussion during lectures is strongly encouraged. Preparation for flip sessions sho (when provided) looking at the questions to be covered in class.

Evaluation

Course grades will be based on the following:

- (35%) Homework & Quizzes
- (15%) Flip session and other in-class participation
- (20%) Midterm exam
- (30%) Final exam

Disability Accommodation: Students with disabilities are welcome to request academic accommodations due to a dis due to a disability, please contact Disability Resources for Students, 448 Schmitz Hall, 206-543-8924 (V/TTY). If you Students indicating that you have a disability which requires academic accommodations, please present the letter to

might need in this class.

Text and resource materials

Required:

- Chemical Fate and Transport in the Environment (3rd ed.), Hemond and Fechner-Levy, Academic Press, 2015. (

  comments: this is a quantitative but simplified overview, and is organized by major parts of the environment (surf predictive models, and does not cover much chemistry. The main strength of the book is in sections describing e processes by environmental medium (air, water, soil). The book is 90% similar to the 2nd edition, but I will be ref combination of the Schwarzenbach text (below) to supply the basis for chemical properties and behavior, and this a good introduction to the overall topic of environmental fate of pollutants.

  A limited number of copies were ordered by the UW Bookstore, Health Sciences branch. The text is available ne for purchase or rent. Online prices: $90.48 - $108.19, plus shipping. There is one copy in the Engineering librar

Other resources:

- Environmental Science & Technology, Journal: American Chemical Society, 1967-present
- *Journal of Exposure Science & Environmental Epidemiology,*

comments: In order to update the material in the above text, we will read and discuss recent articles in ES&T. This jo research through a critical peer-review process and has the highest impact factor for environmental scientists and en *Journal of Exposure Science & Environmental Epidemiology.* It publishes research important to exposure assessmer epidemiology that includes a strong exposure analysis component & related disciplines that advance the exposure as UW library system and the course website. From UW computers, you should have full access.

ES&T URL: http://pubs.acs.org/journal/esthag

JES URL: http://www.nature.com/jes/index.html

Other (non-required) Texts

- **Integrated Environmental Modeling (http://www.knovel.com/web/portal/basic_search/display?_EXT_KNOVEL_DI** Fate, and Risk in the Environment, by Ramaswami, Milford, Small. Wiley & Sons 2005.

comments: this textbook is available as an e-text via course reserves at UW libraries (and the SCC bookstore may h read it on line or download it, by chapters. It is strong on covering the range of topics from basic science to risk calcu a guide to environmental modeling packages, but we will not emphasize that aspect. We will focus on the book's pre relationships that are used by the various models to simulate environmental behavior.

- Environmental Organic Chemistry, Schwarzenbach, Gschwend and Imboden, Wiley Interscience, 1993 or 2002.

comments: this text emphasizes basic chemistry concepts and the accompanying workbook provides numerous prob in its grounding in physical chemistry, and is pretty encyclopedic (the current edition runs about 1300 pages!!). I use practice problems to supplement the homework, you can find them in this book. This text assumes a strong chemica

- Pollution Science, Pepper, Gerba, Brusseau (Eds.) Academic Press, 2006 or 1996.

comments: this text is less focused on physical chemistry principles and gives more coverage to other natural scienc descriptive and less rigorous than Environmental Organic Chemistry, but offers greater breadth and more "real world" inorganic pollutants.

- Multimedia Environmental Models, MacKay, Lewis Publishers, 2001 or 1991.

comments: this book is great at emphasizing the physical distribution processes and modeling approaches, but does reflects MacKay's system for using the thermodynamic property fugacity as a basis for the calculations. It would be a may find it useful for its introductory chapters.

- Aquatic Chemistry, Stumm and Morgan, Wiley-Interscience; 3rd edition (1996).
- Water Chemistry, Benjamin, McGraw-Hill (2001).
- Environmental Chemistry, Baird and Cann, W. H. Freeman (2008)
- Lastly, if you like the hands-on aspects of modeling, but don't want to learn to use the fully-developed and fairly con Ramaswami book details), a good book to look at is Andrew Ford's Modeling the Environment (Island Press, 2010). using two model-building packages, Vensim and Stella. There is a good graphical feature in each package, so you c and/or model algorithms.

NOTE: THE QUARTER SCHEDULE SHOWN BELOW IS SUBJECT TO CHANGE AND WILL REFLECT THE MOST WHEN VIEWED ON-LINE. DOWNLOADED VERSIONS OF THE SYLLABUS MAY NOT HAVE CURRENT SCHEDU CONFIRM ASSIGNMENTS AND OTHER KEY DATES.

Date	Details

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Mon Jan 5, 2015	COURSE INTRO. readings: Hemond text: 1.1-1.5
Wed Jan 7, 2015	Quiz 0 - SCORE DOES NOT COUNT!!
	CHEMICALS, STRUCTURES, PROPERTIES. readings: Supple 1.8
Fri Jan 9, 2015	Vapor Pressure and other equilibrium properties. readings: H
Mon Jan 12, 2015	FLIP session (1): background topics.
Wed Jan 14, 2015	Solubility; HENRY'S LAW. readings: Hemond: 1.7.1, 1.7.2
Fri Jan 16, 2015	HENRY'S LAW; MODIFIERS. readings: Hemond: 1.7.2
	Problem set 1
Mon Jan 19, 2015	No class - HOLIDAY
Wed Jan 21, 2015	Quiz 1
	SORPTION AND BIO-PARTITIONING. readings: Hemond: 1.7.3 partitioning (Kow)
Fri Jan 23, 2015	EQUILIBRIUM REACTIONS. readings: Hemond: 1.6.2; supplen and equilibrium constants
Mon Jan 26, 2015	flip session (2): MULTIMEDIA PARTITIONING
Wed Jan 28, 2015	KINETIC CONCEPTS. readings: Hemond: 1.6.7
	Problem set 2
Fri Jan 30, 2015	Quiz 2
	REACTION AND PHASE TRANSFER KINETICS. readings: Her

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	REACTION AND PHASE TRANSFER KINETICS. readings: Her
Mon Feb 2, 2015	FLIP session (3): MODELS, KINETICS, EXPONENTIAL DECAY
Wed Feb 4, 2015	TRANSFER AND TRANSPORT KINETICS. readings: Hemond:
	Problem set 3
Fri Feb 6, 2015	In-class Midterm Exam
Mon Feb 9, 2015	APPLICATION TO AIR, indoor air. readings: Hemond: 4.1, 4.4.
Wed Feb 11, 2015	Flip session (4): Box Models and IAQ
Fri Feb 13, 2015	STRUCTURE OF ATMOSPHERE - PHYSICAL TRANSPORT. re
Mon Feb 16, 2015	HOLIDAY
Wed Feb 18, 2015	POLLUTANT TRANSPORT. readings: Hemond: 4.4
Fri Feb 20, 2015	Quiz 3
	ATMOSPHERIC REACTIONS, REMOVAL; SMOG. readings: He
	Problem set 4
Mon Feb 23, 2015	FLIP session (5): OUTDOOR AIR POLLUTION
Wed Feb 25, 2015	Water 1 readings: physical transport; box models (Hemond 2
Fri Feb 27, 2015	Water 2: INTERPHASE TRANSFER, 02 SAG. readings: Hemor

Fri Feb 27, 2015	Water 2: INTERPHASE TRANSFER, 02 SAG. readings: Hemor
Mon Mar 2, 2015	Flip session (6): TRANSPORT IN SURFACE WATER
Wed Mar 4, 2015	Quiz 4
	Water 3: particles in water; transformation rxns. readings: He
Thu Mar 5, 2015	DELETED LECTURE: biotransformation (Hemond: 2.4; 2.6; Ra
	6: biotransformation kinetics
Fri Mar 6, 2015	GW 1: physical transport; Darcy's Law. readings: Hemond 3.1
Mon Mar 9, 2015	GW 2: pollutant transport, continuous sources. readings: Her
Wed Mar 11, 2015	Quiz 5
	WRAP UP TOPICS: ENVIRONMENTAL DECISION MAKING
	Problem set 5
Thu Mar 12, 2015	DELETED LECTURE GW 3 readings: retardation, transformati
	3.5)
Fri Mar 13, 2015	FLIP session (7): CLASS DISCUSSION
Thu Mar 19, 2015	scheduled date for final
	downloadable Final