CE 476 – SOLID AND HAZARDOUS WASTES
Spring 2010

Lecture: 12:20 – 1:10 pm MWF, 205 Henderson-S

Instructor: **Dr. Rachel A. Brennan, Ph.D.**
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http://www.engr.psu.edu/ce/directory/websites/brennan_r.html

Office hours: Tuesday 2:30 pm – 4:00 pm; Thursday 10:30 am – 12:00 pm; or by appointment
You may also email questions directly to rbrennan@engr.psu.edu.

Texts required: None.

Reference texts (on reserve at the Engineering Library, 325 Hammond Building):

Solid Waste Engineering, 2002, P. A. Vesilind, W. Worrell, and D. Reinhart, Brooks/Cole, ISBN 0-534-37814-5.

Hazardous Waste Management, 1994, M. D. LaGrega, P. L. Buckingham, J. C. Evans, and Environmental Resource Management, McGraw-Hill Co., ISBN 0-07-118170-9.

Contaminant Hydrogeology, 2nd Edition, 1999, C. W. Fetter, Prentice Hall, ISBN 0-13-751215-5.

Remediation Engineering: Design Concepts, 1997, S. S. Suthersan, CRC Press, ISBN 1-56670-137-6.

Handbook of Chemistry and Physics, CRC Press, any of the past fifteen years.

Primary learning objectives: 1) To discuss the technical and political issues surrounding solid and hazardous waste management; 2) to perform basic landfill design calculations including quantification of bioreactions, leachate production, and gas collection; 3) to calculate the fate and transport of hazardous chemicals in the subsurface, including equilibrium partitioning, advection, dispersion, sorption, and reaction; and 4) to provide basic designs for several currently available hazardous waste remediation technologies and to discuss the physical, chemical, and biological properties which control their application.

Lecture materials: Lectures will be conducted using PowerPoint on a Tablet PC, with fill-in-the-blank sections for problem solving, etc. Copies of the PowerPoint slides (without the blanks filled in!) will be provided in class, and will be posted on the course web page (angel.psu.edu).

Grading:

Exams (3)	= 300 points	= 31%
Homework (7)	= 525 points	= 54%
Group presentation	= 100 points	= 10%
Participation	= 50 points	= 5%
Total	**= 975 points**	**= 100%**

The standard grading system will be used to assign final letter grades in the course (A = 94 – 100%; A- = 90 – 93%; B+ = 87 – 89%; B = 84 – 86%; B- = 80 – 83%; C+ = 76 – 79%; C = 70 – 75%; D = 60 – 69%; F = 0 – 59%).

Homework: Seven homework assignments will be given over the semester, one approximately every two weeks. Each homework assignment will be worth 75 points. Homework problems are due by 5pm on the due date, and may be submitted in hard copy or electronically. Late assignments will be docked 20% of the total possible points for each 24 hour period (or fraction thereof) that they are late. Late homework assignments should be time-stamped to receive proper credit. Quantitative homework problems should be completed on engineering paper with a **box placed around the final answer**. You must show your work to receive credit. **Answers to essay questions must be typed.** Professional language style, grammar, punctuation, and neatness count, and may be penalized at the discretion of the grader. Solution sets will be placed on Angel after all assignments have been received.

Reading assignments: Reading assignments distributed with course notes must be read by everyone. Other readings in the course schedule are not required, and are intended to support the lectures if you are having difficulty understanding the material. You will only be tested on the material and concepts discussed in class or in the required reading. However, external reading assignments have good examples that will provide insights into the material being covered.

Group presentation: During the semester, student groups (of 3 – 4 people) will have the opportunity to present a short (5 – 10 minute) PowerPoint, prerecorded documentary video, or live music performance summarizing a topic relevant to the class. A sign-up sheet will be circulated early in the semester to allow students to indicate their group choice, topic, media, and date they would like to present. Digital video cameras may be rented free of charge from Media & Technology Support Services in 26 Willard (814-865-6314, http://www.medianet.libraries.psu.edu/up/). Presentations will be graded on accuracy, professionalism, creativity, and relevance to course material.

Participation & professional evaluation: All students are encouraged to attend class regularly and to participate in class discussion. If you come to class regularly and give me the impression that you are listening (i.e., ask and answer questions in or out of class) then you will get the full 5%. If not, you will get less. In addition to evaluating your participation directly in class, I will also give you points for the following:

> **Muddiest Points:** Each **Friday** at the end of class, all students will be asked to write out a short (1-2 sentence) question concerning a topic covered in class that week that they felt was not well-explained, and/or to provide constructive feedback for the instructor. These will be worth 1 point each. At the beginning of class the following Monday, the most commonly asked question(s) will be discussed. No makeup Muddiest Points will be allowed.
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> **Field trips & guest speakers:** Several field trips and guest speakers have been scheduled throughout the semester to cover such topics as: solid waste transfer stations and recycling centers, hazardous waste case studies, and Superfund sites. Attendance at these activities is highly recommended and will be reflected in your score under the participation category.

Exams: Exams will be based on material from the homework, lecture notes, assigned reading, and student presentations. Exams will be closed-book and closed-notes; however, a single one-sided 8 ½ x 11 inch equation sheet is allowed for each exam. Exam questions will be patterned after the homework assignments. Exams will primarily cover the material discussed in the previous month; but all material covered to date is fair game.

Exam I – Wednesday, February 17, in class
Exam II – Monday, March 29, in class
Exam III – Friday, April 30, in class

Extra credit: Periodically throughout the semester there will be Environmentally-oriented seminars or activities around campus which I will announce during class or through Angel. For each of the activities that you attend, you can earn up to 5 points of extra credit if you write up a one-page summary of what you've learned (12 pt font, 1" margins, double spaced). **Write-ups are due within one week of the seminar.**

Academic honesty: Students are encouraged to work together on homework assignments; however, original solutions from each student are required. If cheating or copying is suspected, all students involved will receive a zero for that assignment. **Cheating or plagiarism** on any graded activity (homework, exam, report, etc.) will be penalized with a minimum of a zero points for the assignment, and up to a **failing grade** in the class. I will also place academic integrity violation reports in the offenders' permanent files. If you are not familiar with what constitutes an academic integrity violation, I encourage you to read Penn State's policies on the following web site: http://www.engr.psu.edu/CurrentStudents/acadinteg.asp.

Adherence to course schedule: I expect that we will deviate from the class schedule with respect to lectures assigned to a given date. However, I will try to maintain the scheduled exam dates. In the review sessions prior to each exam I will tell you specifically what will be covered. The following page provides a tentative course schedule for the semester.

CE 476 – TENTATIVE COURSE SCHEDULE
Spring 2010

Date	Lecture Number, Topic	Reading	HW/Presentation
Jan 11, M	L1: Introduction/motivation/scope	LaGrega Ch.1	
Jan 13, W	L2: Solid/hazardous waste case studies	LaGrega Ch.1 & 2	
Jan 15, F	L3: Legislation/regulations	Vesilind, Ch. 4	
Jan 18, M	*No class – Martin Luther King, Jr. Day*		
Jan 20, W	L4: Municipal solid waste characteristics	Vesilind, Ch. 2 – 4	
Jan 22, F	L5: Design standards for MSW landfills	Vesilind, Ch. 2 – 4	**HW #1 Due**
Jan 25, M	L6: Bioreactions in landfills	Vesilind, p. 336 – 343	
Jan 27, W	L7: Leachate collection, treatment, & disposal	Vesilind, p. 121 – 143 LaGrega Ch. 13	
Jan 29, F	L8: Landfill gas collection & use	Vesilind, p. 143 – 151	
Feb 1, M	L9: Landfill closure, monitoring, & mining	Vesilind, p. 152 – 163	**HW #2 Due**
Feb 3, W	L10: Thermal destruction (incineration) mthds.	LaGrega Ch. 12	
Feb 5, F	L11: Combustion & energy recovery calcs.	Vesilind, Ch. 7	
Feb 8, M	***Student Group Presentations!***		***Presentations!***
Feb 10, W	L12: Materials separation & recycling	Vesilind, Ch. 6	
Feb 11, R	L13: Transfer Station & Recycling Center	***Meet there at 8 am***	***Field Trip!***
Feb 12, F	***No class*** *(to make up for Transfer Station tour)*		**HW #3 Due**
Feb 15, M	Catch-up & Review for Exam I		
Feb 17, W	**Exam I – Solid Waste Management**		**Exam I**
Feb 19, F	L14: Physical-chemical properties affecting remediation; equilibrium partitioning	LaGrega, p.105 - 118	
Feb 22, M	L15: Solid-water & air-water partitioning		
Feb 24, W	L16: Octanol-water & solid-vapor partitioning		
Feb 26, F	L17: Geohydrology; contaminant transport: advection	LaGrega, p.162 – 175; Fetter p. 47 – 66	
Mar 1, M	L18: Transport: dispersion, & sorption	Fetter p. 117 – 128; LaGrega, p.175 - 183	
Mar 3, W	L19: NAPL entrapment	Powers et al.	**HW #4 Due**
Mar 5, F	L20: Case study – NAPL remediation		***Guest Speaker!***
Mar 8 – 12	*No class – Spring Break*		
Mar 15, M	L21: Model advection, dispersion, & sorption	BioPlume handout	
Mar 17, W	L22: Groundwater management plans		
Mar 19, F	L23: Groundwater capture zones		
Mar 22, M	***Student Group Presentations!***		***Presentations!***
Mar 24, W	L24 Abiotic & biotic transformation reactions		**HW #5 Due**
Mar 26, F	Catch-up & Review for Exam II		
Mar 29, M	**Exam II – Fate & Transport of Haz. Waste**		**Exam II**
Mar 31, W	L25: Transformation thermodynamics (redox)	Vogel, et al.	
Apr 2, F	L26: Intro to haz. waste treatment technologies	Screening Matrix	
Apr 5, M	L27: Biological treatment methods	Suthersan, Ch. 5	
Apr 7, W	L28: Bioremediation	Suthersan, Ch. 5	
Apr 9, F	L29: DNAPL remediation case study		**HW #6 Due**
Apr 12, M	L30: Pump & Treat	Suthersan, Ch. 11	
Apr 14, W	L31 Soil Vapor Extraction (SVE)	Suthersan, Ch. 3	
Apr 16, F	L32: Centre County Kepone Superfund Site	Handout	***Field Trip!***
Apr 19, M	L33: Discussion of Superfund Site design		
Apr 21, W	***Student Group Presentations!***		***Presentations!***
Apr 23, F	L34: Permeable Reactive Barriers	Suthersan	
Apr 26, M	L35: Monitored Natural Attenuation	Suthersan	**HW #7 Due**
Apr 28, W	Catch-up & Review for Exam III		
April 30, F	**Exam III – Remediation Technologies**		**Exam III**