DRAFT FOR EARLY REGSITRATION PERIOD
(subject to change prior to the start of the fall term)

Environmental Science and Engineering 163: Pollution Control in Aquatic Ecosystems

Fall 2024
Class Meetings: Monday/Wednesday 12:00-1:15pm in Cambridge
Lab Meeting: Friday 12:45-3:30pm in SEC in Allston
https://canvas.harvard.edu/courses/137655

Instructor: Patrick Ulrich (pulrich@seas.harvard.edu), SEC 1.101-06, Phone: 617-496-0542
Office Hours (tentative): TBD prior to fall term

Prerequisites: Math 21a (or equivalent). A background in environmental science, at the level of ESE 6 or above, is also helpful. If you do not meet these prerequisites, please email to discuss your preparation.

Required Textbook: "Water-Quality Engineering in Natural Systems" by David A. Chin, Third Edition (2021), John Wiley & Sons, ISBN: 978-1-119-53202-6

Recommended Supporting Textbook (on reserve): "Surface Water-Quality Modeling" by Steven C. Chapra, 2008, Waveland Press Inc., ISBN: 978-1-57766-605-9

Recommended Supporting Textbook for hydrology unit (on reserve): "Ground and Surface Water Hydrology" by Larry W. Mays, 2012, John Wiley & Sons, ISBN: 978-0-470-16987-2

Course Description: This course is focused on aspects of environmental engineering related to the fate, transport, and control of pollution in surface water ecosystems. Course modules will cover ecological impacts of environmental contaminants; fundamental chemistry of natural waters; surface water aspects of engineering hydrology, including rainfall-runoff relationships; quantitative models of pollutant fate and transport in rivers, lakes, estuaries, and wetlands; best management practices for the prevention and control of aquatic pollution; and sustainable natural treatment systems for water quality improvement.

Learning Outcomes: By the end of the course, you should be able to:

- Describe natural and human needs and uses of water and how these uses are impacted by aquatic pollution
- Construct quantitative models to describe the fate and transport of contaminants in aquatic ecosystems. Apply a mass balance approach and use solutions to the advection-diffusion equation to model contaminant behavior in rivers, lakes, and estuaries.
- Apply principles of surface water hydrology to engineering problems, including quantifying rainfall-runoff relationships for urban watersheds.
- Explain the ecological principles and physical-chemical processes that make wetlands good natural treatment systems. Apply theoretical and empirical models to develop sizing and design constraints to treat contaminated waters with constructed wetlands.
- Evaluate and design best management practices for the prevention and control of pollution from non-point sources in urban watersheds.

Course Structure & Assessment: Evaluation will be completed from homework assignments, midterm exams, class and lab participation, and a final project/report (including an oral presentation):

45% Homework
30% Midterm Exams
15% Final Project
10% Participation

Course Policies & Expectations:

- **Lectures.** Class will meet two times a week from 12:00-1:15pm on Monday and Wednesday. These sessions will include a mix of lecture content and problem-solving activities. Regular attendance is expected and required. Classes will be carried out in "Airplane Mode" – any device with wireless capability should have the wireless feature turned off during class periods.
- **Class Preparation.** Required readings or brief videos covering course content to support the lecture sessions will be assigned from the textbook or materials provided on the course website. This material should be reviewed prior to class.
- **Participation.** All students are expected to participate in lecture activities and discussions, as well as all required lab components. Additionally, each student will prepare and give a few (number dependent on the final class size) Lecture Kickoffs throughout the semester.
- **Lecture Kickoff.** The first 5 minutes of most class periods will be spent reviewing and forming connections with material from the prior class meeting. Following the Course Enrollment Deadline, each student will sign up for their preferred Kickoff dates. On their assigned day, a student will use the first 3-5 minutes of class to present something related to the material covered in the prior class meeting. This is an open-ended assignment (creativity is encouraged) and full credit will be given for participation (i.e., content will not be assessed, as long as it is relevant to the prior class). In addition to increasing understanding of course material and providing a fun start to each class, these will also provide opportunities to develop presentation skills.
- **Homework.** Homework assignments will be due by 5pm on posted due date via PDF upload to Canvas. Late assignments will be accepted for the next 48 hours, but will receive a maximum of 70% credit.
- **Labs.** The course will include a **weekly required lab session on Fridays from 12:45-3:30pm** in the SEAS Active Learning Labs in the SEC in Allston most weeks during the term. Analysis for the lab exercises will be incorporated into the homework assignments.
- **Midterm Examinations.** Material from the first few units in the course (through homework 4) will be assessed on two in-person midterm exams, which will be held during the weekly Lab Period (Friday 12:45-3:30pm) on the dates posted in the final schedule for the course. A critical component of learning is individual responsibility for the material. The homework and projects are intended to be collaborative learning experience with other students in the course, and the midterm exams provide an opportunity for individual assessment.
- **Final Project.** In lieu of a final examination, students will develop and present a final project. The final project, including the written report and oral presentation, will be due on the date set by the Registrar's Office for final projects and exams in the course.
- **Grading:** Any questions on graded material must be made within 7 days of the date the assignment is returned. Any student that believes they should have received more points for any reason other than a simple addition error must provide a written statement making the case.
- **Course Website.** Information about required components of the course, including schedule updates, will regularly be disseminated via the course website. Students are responsible to ensure that their notification settings in Canvas are set to receive all course communications in a timely manner.
- **Generative AI.** The course policy on generative AI is still under consideration. It will be finalized prior to the start of the term and included on the syllabus for the first day of class.
- **Academic Integrity**. Discussion and the exchange of ideas are essential to academic work, but **all submitted assignments in this course must be identifiable as a student's distinct work**.
    - For homework assignments, students are encouraged to collaborate with classmates as they work on problem sets to enhance learning. However, after discussions with peers, each student must write up and turn in an individual set of solutions that represents their individual mastery of the problems.
    - For the final report, students may find it useful to discuss their project with peers. However, students must ensure that any written work submitted for evaluation is the result of their own research and writing, and that it reflects their own approach to the topic. Students must also adhere to standard citation practices for technical work and properly cite any books, articles, websites, etc. that have helped in the development of the project.

Course Schedule: The table on the following page contains the anticipated schedule of topics for the course. Please note that this schedule is subject to change, and the official schedule will be posted and kept current on the course website.

Course Topic	Day	Date	Class#	Lecture Topic	This Week:
Water Quality Fundamentals	W	4-Sep	1	Intro, WQ Asessment (Phys, Bio, Chem)	
	F	6-Sep	--	*No lab*	
	M	9-Sep	2	WQ Regulations, TMDL	
	W	11-Sep	3	Mass Balances for Completely Mixed Systems	
	F	13-Sep		**Lab 1 - Safety training & field methods**	
Introduction to Fate & Transport	M	16-Sep	4	Environmental Chemistry (EQ, kinetics for MBE, pH, Alkalinity)	
	W	18-Sep	5	Advection-Diffusion Equation	HW 1 due
	F	20-Sep		**Lab 2 - Water quality measurements in the field**	
	M	23-Sep	6	Advection-Diffusion Solutions in 1-Dimension	
	W	25-Sep	7	Advection-Diffusion Solutions in 1- and 2-Dimensions	
	F	27-Sep		**Lab 3 - Advection-Diffusion Simluation**	
	M	30-Sep	8	Advection-Diffusion Solutions in 2- and 3-Dimensions	
Rivers & Streams	W	2-Oct	9	Riverine Structure & Ecology; Transport and Mixing in Rivers	HW 2 due
	F	4-Oct		*No lab - Optional Review Session for MT 1*	
	M	7-Oct	10	Mixing Zone Analysis, BOD-DO Relationships	
	W	9-Oct	11	Streeter-Phelps Model	
	F	11-Oct		**Midterm 1 (Units 1 & 2)**	Exam 1
	M	*14-Oct*	--	*Campus Holiday - No Class*	
	W	16-Oct	12	Contaminant Fate & Transport; Riverine Management	
Lakes & Reservoirs	F	18-Oct		**Lab 4 - Stream Transect**	
	M	21-Oct	13	Lacustrine Structure & Ecology; Nutrients & Eutrophication	
	W	23-Oct	14	Stratification, Turnover & Heat Budgets	HW 3 due
	F	25-Oct	--	**Lab 5 - Fresh Pond Walkabout**	
	M	28-Oct	15	Lacustrine Water Quality Models; Lacustrine Management	
Estuaries	W	30-Oct	16	Mixing in Estuaries	
	F	1-Nov	--	*No lab - Optional Review Session for MT 2*	HW 4 due
Surface Water Hydrology	M	4-Nov	17	Watersheds and Hydrologic Processes	
	W	6-Nov	18	Rainfall-Runoff Analysis: Unit Hydrograph	
	F	8-Nov		**Midterm 2 (Rivers, Lakes, and Estuaries)**	Exam 2
	M	11-Nov	19	Rainfall-Runoff Analysis: Empirical Methods	
Non-Point Pollution & Natural Treatment Systems	W	13-Nov	20	Wetlands, Ecological Engineering / Natural Treatment Systems	
	F	15-Nov		**Lab 6 - Tour of SEC Treatment Wetlands**	HW 5 due
	M	18-Nov	21	Treatment Wetland Uses, Hydraulics, & Design	
	W	20-Nov	22	Empirical Design Models for Constructed Wetlands	
	F	22-Nov		**Lab 7 - Measurements in SEC Treatment Wetlands**	
	M	25-Nov	23	Urban Watersheds and Non-Point Pollution	
	W	27-Nov	--	*Thanksgiving Break*	
	F	29-Nov	--	*Thanksgiving Break*	
	M	2-Dec	24	BMPs for Urban Watersheds	
	W	4-Dec	25	Watershed Protection & Nutrient Trading	HW 6 due
Reading Period	F	6-Dec	--	*Reading Period*	
	M	9-Dec	--	*Reading Period*	
Final Report		?-Dec	--	**Final Project (Presentation and Report)**	Project
				Presentations and papers due during Final Exam period set by Registrar	