Engineering Sciences 6: Introduction to Environmental Science & Engineering (ESE-6/EPS-6)

Spring 2021
Tuesday & Thursday 10:30-11:45 am
https://canvas.harvard.edu/courses/79073

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Course Description

This course will provide students with an introduction to current topics in environmental science and engineering by providing an overview of current environmental issues, critically evaluating their underlying science and knowledge limitations, and exploring the best-available engineering solutions to some of our most pressing environmental problems. The course will emphasize the interconnected biological, geological, and chemical cycles of the earth system (biogeochemical cycles) and how human activity affects these natural cycles within each of the major environmental compartments (atmospheric, aquatic, and terrestrial).

Learning Outcomes

At the end of this course, students will be able to:

- apply knowledge of the fundamental chemistry and physics of the earth and the environment.
- identify, conceptualize, and analyze environmental issues with human causation
- identify, conceptualize, and analyze engineering solutions to environmental issues

Skills comprising the learning outcomes at the end of the course:

- At the start: ESE-6 is accessible to Freshmen with limited science preparation, and appropriate for science-oriented students.
- At the end: Students should be:
  - quantitative and numerate
  - capable of basic coding (making graphs, analyzing data; novice or higher level when using R/equivalent)
  - able to think and write analytically
  - able to prepare and deliver effective presentations

Recommended Prep

This course presumes a basic background in chemistry, physics and mathematics at the high school level. This course does not assume any background in programming or statistics and we will be developing these skills throughout the semester.

Required Readings

There is no required textbook for the course. Required readings will be assigned from a variety of sources and will be available on the course website and/or provided in class.

Course Structure and Assessment

10% Pre/In Class Exercises (1% each)
20% Problem Sets
20% Labs
50% Final Project & Presentation:
- 10% Proposal and questions
- 10% Identification and initial visualization of dataset
- 10% Discussions with instructors
- 20% Final oral presentation and written documentation

Course Policies & Expectations

- **Lectures.** The class will meet two times a week from 10:30am-11:45 am on Tuesday and Thursday. Regular attendance at lectures and participation in discussion and activities is expected and required.

- **Readings.** Required readings will be assigned periodically. Readings should be completed prior to class.

- **Problem Sets.** Problem sets will be used to reinforce concepts introduced in class and are due at the end of the day on the assigned due date. Requests for extensions must be submitted for approval by the instructors prior to the scheduled due date.

- **Labs.** There will be two labs in the course this semester. Lab kits will be mailed to students who enroll in the course. One will involve measuring fine particulate matter in air and the other will involve measuring properties of soils. Sessions will take place throughout the semester with some flexibility to accommodate students' schedules. These labs are intended to give you a sense of the type of measurements environmental engineers make and also familiarize you with analyzing environmental data.

- **Final Project.** Students will work in small groups of three students assigned by the instructors at the beginning of the semester to complete a final project throughout the semester. Any topic that involves identifying and proposing a solution for an environmental problem with an appropriate environmental dataset is acceptable and students are encouraged to choose topics of personal interest. Course staff will provide guidance on the appropriate elements and help students identify data sets that can be analyzed. This project should be fun and will introduce students to environmental research and data visualization techniques that complement in class assignments throughout the semester. A series of milestones for the project will be provided throughout the class. Examples of projects from previous years will be provided but new topics and ideas are encouraged.

- **Grading:** Any questions on graded material must be brought to a TF's attention within 14 days of the original due date. Any student who believes they should have received more points for any reason other than a simple addition error of the points awarded must provide a written statement making the case. We reserve the right to fully re-evaluate any graded material, which may result in an increase or decrease in the original grade.

- **Course Website.** Information about required components of the course will regularly be disseminated via the course website on Canvas. Students are responsible for ensuring that their notification settings in Canvas are set to receive all course communications in a timely manner.

- **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 and labs, students are encouraged to consult 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.
    - Photographing and/or copying another student's work is not permitted.

- **Course Schedule.** The following page contains the anticipated schedule of lectures and assignments 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. Students should regularly check the course website for updates.

Module	Day	Date	Class #	Class Topic	Lecturer	Hand-Out/Due
INTRO	Tu	Jan-26	1	Course Introduction	EMS/ SCW	
CLIMATE	Th	Jan-28	2	Fossil Fuels and Greenhouse Gases	SCW	
	Tu	Feb-2	3	Radiant Energy and Thermal Physics	SCW	
	Th	Feb-4	4	Greenhouse Effect Physics	SCW	Out: HW #1
	Tu	Feb-9	5	Greenhouse Effect Modeling *Discussion of Final Project*	SCW & EMS	*Final Project breakout groups*
AIR	Th	Feb-11	6	Sustainability Office Discussion	Sust. Office	Due: HW #1
	Tu	Feb-16	7	HazeL demo; discussion Q. Emissions & climate scenarios	SCW	
	Th	Feb-18	8	Aerosols	SCW	
	Tu	Feb-23	9	Aerosols	SCW	Air Lab #1
	Th	Feb-25	10	Physics and Chemistry of the Atmosphere (I)	SCW	Out: HW #2 Due: Final Proposal & Questions
	Tu	Mar-2	11	Physics and Chemistry of the Atmosphere (II)	EMS	Air Lab #2
	Th	Mar-4	12	Physics and Chemistry of the Atmosphere (III) – Final Project Break Out	EMS	
SOIL/ FOOD/ WATER	Tu	Mar-9	13	Photochemistry & Photochemical Smog	EMS	Due: HW #2
	Th	Mar-11	14	Photochemistry Roll-Up & Final Project Break Out Groups	EMS	
	M	Mar-15	-			Due: Air Lab
	Tu	Mar-16	-	No class – wellness day		
	Th	Mar-18	15	Air Toxics – Part I	EMS	
	Tu	Mar-23	16	Soil Lab Introduction/ Air Toxics Part II	EMS	
	Th	Mar-25	17	Air Toxics Part III	EMS	Out: HW #3
	Tu	Mar-30	18	Air Toxics Roll-Up and Ecosystem Impacts of Acid Deposition	EMS	Due: Final Data Identification & Visualization Soil Lab #1
	Th	Apr-1	19	Food Sustainability Discussion	GA	
	Tu	Apr-6	20	Ecosystem Impacts of Acid Deposition Part II	EMS	Soil Lab #2
	Th	Apr-8	21	Soils and Agriculture	EMS	

	Tu	Apr-13	22	Solutions to Soil Conservation Challenges	EMS	Due: HW #3
	Th	Apr-15	-	No class – wellness day		
	F	Apr-16	-	-	-	
	Tu	Apr-20	23	Harmful Algal Blooms (HABs)	EMS	Due: Soil Lab
	Th	Apr-22	24	Earth Day Discussion & Final Project Work	Class	
	Tu	Apr-27	25	Class Summary and Wrap Up	EMS/ SCW	
	Tu/ Th	May 4/6		Final Project Presentations	Class	

*__Out__ = Assigned task; __Due__ = Assigned material due at the end of the day (midnight).