

# CBE 375/SYS 360 Engineering and the Environment

**Department of Chemical & Biomolecular Engineering**  
**University of Pennsylvania, Philadelphia, PA 19104-6393**

**Instructor:** Professor Wen K. Shieh (347 Towne), 898-4634, [shieh@seas.upenn.edu](mailto:shieh@seas.upenn.edu)  
**Class Time:** Tu/Th 3:00-4:30PM (313 Towne).  
**Office Hours:** Tu/Th 10:30AM-12:00N (347 Towne).  
**Textbook:** No textbook will be assigned. Course materials compiled from different sources can be purchased from the Copy Center. Lecture notes will be distributed in classes.

**Course Goals:** This course will introduce emerging environmental issues, relevant engineering solutions, and problem-solving techniques to students. The course will demonstrate how environmental considerations can be an integral part of good engineering practices. The course will define environmental problems, assess associated environmental impacts, and develop and design feasible engineering solutions. The case study approach will be used to assist students to develop and apply the fundamental engineering skills and scientific insights needed to recognize a variety of environmental problems that have profound impacts on all aspects of modern society.

1. Introduce and list emerging environmental issues relevant to engineering professions.
2. Describe key physical, chemical, and biological principles that govern the fate of pollutants in the environment.
3. Apply the concept of material and energy balances to model the distribution and transformation of pollutants in the environment.
4. Develop problem-solving skills to simulate and analyze a variety of pollution phenomena in the environment.
5. Evaluate the technical options to solve environmental problems through improved engineering design, analysis, and practice.

## Course Syllabus:

1. Overview of Emerging Environmental Issues.
  - Water Resources, Water Quality, and Water Pollution.
  - Air Pollution and Global Atmospheric Changes.
  - Solid and Hazardous Wastes.
  - Energy Production and Utilization.
  - Depletion of Natural Resources.
  - Land Uses.
2. Material and Energy Transfer in the Environment.
  - Non-Reactive and Reactive Pollutants.
  - Material and Energy Balances and Reactor Flow Models.
  - Interfacial Transport and Partitioning Phenomena in the Environment.
  - Case Studies (*Bioaccumulation of DDT and Thermal Pollution of Surface Water Bodies*).

3. Emerging Water Pollution Issues.
  - Point and Non-Point Sources (Case Study: *Chesapeake Bay*).
  - Surface Water Quality.
  - PCBs in the Environment.
  - Groundwater Contamination and Remediation Technologies (Case Study: *Rocky Flat Arsenal*).
  - Stormwater and Wastewater Reclamation and Reuse.
  - Water Conservation in Manufacturing Processes.
4. Emerging Air Pollution Issues.
  - Indoor Air Pollution.
  - Urban Smog (Case Study: *Los Angeles, CA*).
  - Greenhouse Gas Emissions and Global Warming.
  - Acid Precipitation (Case Study: *Norwegian Lakes*).
  - Ozone Depletion (Case study: *Antarctic Ozone Hole*).
  - Control Strategies and Engineering Solutions.
5. Solid and Hazardous Waste Management.
  - Waste Audit and Source Reduction.
  - Recycling/Landfill/Resource Recovery (Case Studies: *Refuse Derived Fuels, Landfill Gas Utilization, and Waste-to-Energy Combustion*).
  - Hazardous Waste Management.
6. Environmental Risk Assessment.
7. Green (Ecological) Engineering.

**Grades:**

Homework	15%
Exams	$20\% \times 2 = 40\%$
Term Paper	45%

The term paper should be quantitative-oriented and it should address an emerging environmental issue that you believe is important. The environmental issue and its associated impacts should be clearly defined and described. You should propose engineering solutions to mitigate and/or eliminate the environmental impacts identified. The engineering solutions proposed should be ranked according to their cost benefits and feasibility. Group projects (2 students per group) are encouraged.

**CBE 375/SYS 360 Survey on Instructional Goals**

<b>Goal</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
List emerging environmental issues relevant to students' profession				
Describe key physical, chemical, and biological principles that govern the fate of pollutants in the environment				
Apply the concept of material and energy balances to model environmental processes				
Develop problem-solving skills to analyze a variety of pollution phenomena in the environment				
Evaluate the technical options to solve environmental problems through improved engineering design, analysis, and practice				

1: poor

2: fair

3: good

4: excellent