CEE 164: Hazardous Waste Site Investigation and Remediation  
(Alternative Suggested Title: Sustainable Waste Management)  
CEE 164 (Undergraduate)  
Quarter: W20; Lecture: Tuesday and Thursday at 4 pm – 5:50 am  
Location: Boelter Hall 5264

Sustainable Waste Management: Management of solid wastes, some of which are hazardous, is an integral part of infrastructure development, and it is required to achieve environmental sustainability. Appropriate selection of waste processing technologies and efficient waste management strategies can cost-effectively minimize environmental impacts, particularly through energy generation and materials recovery.

Course Description: This course provides all aspects of hazardous and municipal solid waste management technologies with a particular emphasis on reuse of some wastes for alternative applications or energy production. Students are expected to integrate economic, environmental, regulatory, policy, and technical considerations into the development of engineering designs of sustainable waste management. Student teams will design sustainable remediation or waste management plans through class project.

Instructor

Name: Sanjay Mohanty, Ph.D.  
Email: mohan@ucla.edu  
Phone: 310 206 7624  
Office: Boelter Hall 5732C  
Office hours: Monday 4-5 pm, or by appointment.

Prerequisites

(1) CEE 153 – Introduction to Environmental Engineering and Science or equivalent class (for undergraduate students only). Consent of the instructor.

(2) Students are expected to have basic knowledge in college-level chemistry and familiarity with a spreadsheet program like Excel.

Text book

There is no required textbook. Study materials will be uploaded on the class website. The list of reference text books and links to manuals are provided here.

Learning Objectives

The overall course objective is to help students apply engineering tools to design sustainable waste management plan and learn to view wastes as resources—a key factor in achieving environmental sustainability. Students will:
• **Identify** hazardous chemical properties based on their chemical structure and **assess** the fate and transport of chemicals in environments based on their chemical properties.
• **Review** fundamental physical, chemical, and biological processes of contaminant transport and removal in nature and **explain** the role microorganisms and plants in removing contaminants.
• **Apply** mathematics, engineering principle (mass and energy balance), general chemistry, and biology to evaluate best management plan for hazardous or municipal wastes.
• **Design** waste management plan to meet desired outcomes within realistic constraints such as economic, environmental, social, health and safety, and sustainability.
• **Understand** fundamental principles behind technologies to recover resources (material and energy) from wastes.
• **Develop** effective communication skills by **writing** report as a team and **presenting** their finding.

**ABET Goals**

This course contributes to the following ABET outcomes:

- An ability to identify, formulate, and solve engineering problems (e)
- An ability to communicate effectively (g)

**Grading**

**Letter grade.**
Homework 10 %; Quizzes 20%; Midterm Exam 30 %; Final Project 35 %; Class Participation 5 %.

**Course Format**

Lecture, four hours; outside study, Eight hours. Lectures supplemented with outside reading, homework, exams, and a project on waste management and sustainability.

**Schedule**

A list of topics and tentative schedule to cover those topics are provided [here](#).

**Lectures**

Copies of all handouts, annotated slides, and lecture notes will be made available on the class website. The material for which students are responsible is defined by the content and scope of the lectures and class discussions. Students are not required to be familiar with subjects in the handout that are not mentioned on the lecture notes.
Homework

Homework assignments will be given on approximately a weekly basis and will be due on the date indicated. Homework must be turned in at the beginning of class or a scanned copy can be uploaded to CCLE. Late homework will not be accepted unless prior permission is granted. You are encouraged to work in groups because of the multidisciplinary nature of each assignment, but each student must turn in their own assignment. Homework will be graded for effort, not necessarily for correct answers.

Exam

There will be one mid-term exam (two hours). The exam is close note/book, and no homework solutions are allowed. One page (both sides) hand-written notes are allowed. The exam books will be provided. There is no final exam in the class.

Quiz

At least four in-class quizzes (graded) with 5-10 multiple choice questions will be conducted. Demo quizzes (not graded) will be provided at least once per week for practice and teaching and learning assessment. You are required to participate in demo quizzes to earn participation credit.

Class Participation

Students are required to participate in discussion in classroom and on online forum (Piazza), post or comment on relevant news articles posted on Piazza, participate in polls and in-class activities (demo quizzes). Students can earn full 5% participation credit, if they have attended all in-class demo quizzes and meet as a team with instructor at least once for the class project.

Project Report

The project or term paper consists of sequential assignments described at the end. Students are to work on a project as a team of 3-5 students. Role of individual students in each team must be clearly identified and noted in the outline. Each team will be asked to write a project report (8.5 X 11; single space, maximum 10 pages, including figures and references).

The waste management technologies are rapidly evolving with new innovations. Students will learn skills to search in databases (Google Scholar, Web of Knowledge) and summarize findings of reports and journal articles online.

The class project will give students practice in communicating project report to their superiors, policymakers and the general public. Writing assignments will be graded and resubmission of poorly prepared
assignments will be required.

**Class Presentation:**

A sustainable waste management is not possible without public acceptance. Students will learn how to communicate technical findings to general public. The final presentation will be evaluated based on content, articulation of technical knowledge, and delivery of information without jargon.

**Course expectation**

Exam, quizzes, and assignments will be oriented towards evaluating a student’s understanding of the subject matter. Students are expected to synthesize material from lectures and read sections of handouts mentioned in the class notes. Students will do their independent research to complete the project, but they are required to work in a team. The classroom activities, assignments, and project report writing are intended to prepare students for real-world professional employment.

**Class website**

Slides, lecture notes, problem sets and solutions, handouts, and other material will be posted on CCLE (https://ccle.ucla.edu/) and Piazza (https://piazza.com/ucla/winter2020/cee164/home)

**Cell phone policy**

Cell phone use in class is not permitted, unless required for class activity.

**Academic integrity**

Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Details here: http://www.deanofstudents.ucla.edu/Academic-Integrity

**Reference materials**

**Books:**


**Web Resource:**

1. City of LA:

2. EPA:
   a. Remediation technologies: [https://clu-in.org/technologies/](https://clu-in.org/technologies/)
   b. Hazardous Waste: [https://www.epa.gov/hw](https://www.epa.gov/hw)
Tentative Schedule

Week 1

Topics:
- Concept of waste as resource
- Environmental laws on waste management
- Hazardous waste types and properties
- Risk Assessment

Assignments Due: January 9, 2020
- HW 1 out

Week 2

Topics:
- Fate and transport of contaminants in environment
- Hazardous waste site assessment

Assignments Due: January 16, 2020
- HW 1 Due; HW 2 out
- Quiz 1 in class

Week 3

Topics:
- Remediation technologies: Principles and fundamentals
- Ex situ remediation design: Air stripping and Carbon adsorption

Assignments Due: January 23, 2020.
- HW 2 Due; HW 3 out
- Project topic (title)

Week 4

Topics:
- Ex situ and in-situ remediation design: Oxidation
- In situ remediation: Bioremediation

Assignment Due: January 30, 2020.
- HW 3 Due; HW 4 out
- Quiz 2 in class

Week 5

Topics:
- In situ remediation: Phytoremediation
- Case studies: Example of remediation projects

Assignments Due: February 6, 2020.
- HW 4 Due
- Project outline due
Week 6

Topics:
- Municipal solid waste (MSW) management
- Collection, recycling, disposal

Assignment Due:
- Quiz 3 in class (February 11, 2020)
- Midterm February 13, 2020

Week 7

Topics:
- Resource recovery: Plastic and electronic waste
- Municipal solid waste disposal: Landfill design

Assignment Due: February 20, 2020
- HW 5 out

Week 8

Topics:
- Energy recovery technologies: principles and fundamentals
- Energy recovery: anaerobic digester and fuel cell

Assignment Due: February 27, 2020
- HW 5 due
- Project rough draft due
- Quiz 4 in class

Week 9

Topics:
- Waste management in energy sector: Nuclear Waste
- Waste management in energy sector: Produced Water

Assignment Due:
- None (Revised draft will be returned by March 5, 2020)

Week 10

Topics:
- Waste management in energy sector: Coal ash for rare earth elements

Assignment Due: March 12, 2020
- Class presentation

Final Exam Week

NO FINAL EXAM
- Final Report March 20, 2020 11:59 pm by email.
Class Project

Goals of Project

Students will develop in-depth expertise in formulating a waste management plan. Additionally, students will learn to:

- apply knowledge of mathematics, science, and engineering to design waste management;
- identify, formulate, and solve engineering problems related to hazardous waste management and/or treatment;
- develop professional writing skills and communicate their finding to public;
- design remediation/management plan to meet desired needs within realistic constraints such as economic, environmental, social, health and safety, and sustainability.
- develop skills to acquire knowledge across multiple disciplines and execute a project as a team.

The project or term paper consists of sequential assignments described below.

Topic of research

**Grade:** 5% of project grade  
**Due Date:** January 23, 2020

A topic should be submitted by Thursday, January 23 (5% of term project grade). The submittal should include a one paragraph description of your objectives and the type of information that you intend to present/collect. The students will be provided some guidance on topics of interest. It is critical to select a topic that is sufficiently narrow that it can be covered in a quarter, yet sufficiently broad that there is literature available. Students will learn to use Web of Science and Google Scholar as scientific literature search tool to confirm that there is ample literature available on the proposed topic. The primary sources of articles to be reviewed should be peer-reviewed journal articles and books but not trade publications.

Preliminary outline

**Grade:** 10 % of project grade  
**Due Date:** February 6, 2020.

Project outline (limit 2 pages) should describe the key aspects of the project analysis and include as much detail as possible in the space provided. Check the rough draft guideline for preparation of the outline.
Rough Draft

Grade: 25% of project grade
Due Date: February 27, 2020

The draft should be at least 5 pages or longer. The draft should include a detailed description of topics included in the outline as well as an annotated bibliography. The description should consist of a few to several sentences describing the data and/or information in the paper that is relevant to the analysis, and any relevant critique of the paper. The bibliography should include only the papers that are used in the text. The paper should present a critical review of the available literature. The draft will be returned with comments.

The actual report format can vary but each report should have at least the following:

1. **Abstract** - A one paragraph summary of the report which describes the topic of the paper and what can be concluded based on the available research. The summary should provide a busy reader with the key points of the report. The abstract is not an introduction, it is a summary of the entire report.

2. **Introduction** – Description of waste, sources, environmental impacts, and relevant background information and theory required to understand the waste management plan.

3. **Method**– site characteristic, and detailed design of waste management plan.
   a. Assessment of sites or waste
   b. Identify multiple strategies to minimize waste (replacement product, reducing use, and recycling).
   c. Prepare a comprehensive waste management or treatment plan for a particular type of waste.

4. **Discussion**
   a. Analyze advantages and disadvantages of proposed plan.
   b. Identify technological and societal challenges in implementing the plan.
   c. Critically analyze potential shortcoming and unintended consequence (e.g., treatment byproduct formation).
   d. Discuss long-term sustainability of the waste management plan.

5. **References** – Reference should have consistent format (adopt a format from any journal articles). When referencing a book, be sure to give the relevant page numbers, when referencing a URL give a date where the URL was last accessed.

6. **Appendices (optional)** - Appendix may include data that is not critical
to understanding the paper and is of interest to only some people. Equations may also be derived in an appendix. *Appendix is not part of the page limit.*

**Class Presentation**

**Grade:** 10% of project grade  
**Due Date:** March 12, 2020

**Final Report**

**Grade:** 50% of project grade  
**Due Date:** March 20, 2019 11:59 pm

The final paper should address any edits, comments, or corrections received on the rough draft and should be of a professional quality that the students would be confident in submitting to an employer. As such, the final paper will be graded more critically than the rough draft.

**Technical writing:**

The students will learn to write technical report and respond to critical comments. Student are encouraged to develop writing skills using online resources at UCLA ([http://gwc.gsrc.ucla.edu/Resources](http://gwc.gsrc.ucla.edu/Resources)) or elsewhere ([https://owl.english.purdue.edu/owl/](https://owl.english.purdue.edu/owl/)).

**Recommended book for (re)writing:**