

CEE 345: Geo-Environmental Engineering (3 CR)<http://parameterid.com/>**Instructor:**

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Course:

CEE 345, Geo-Environmental Engineering
Spring 2017
Class Hours: **T & R**, 10:45 – 12:00 PM
Classroom: **PA 503**

Office Hours: **M/W/F** 1:10-2:00PM, **T&R** by appointment

Grader:

Kepha Abong'O, (koa212@lehigh.edu)

Course Description:

This course offers important concepts in the design and construction of waste disposal facilities, and in the closure of existing disposal facilities. The emphasis is placed on the fundamental aspects of soils, soil-water movement, characterization of contaminated site and remediation technology. Prerequisite: CEE 242 or consent of the instructor.

References:

Geoenvironmental Engineering, Site Remediation, Waste Containment, and Emerging Waste management Technologies, by H.D. Sharma, and K. R. Reddy, John Wiley & sons Inc. 2004.
Geotechnical Aspects of Landfill Design and Construction, by X. Qian, R. Koerner, and D. H. Gray, Prentice Hall, 2002

Tentative Grading:

HW/ In-Class Work	30%
Project	30%
Exams	40%
Total = 100%	

(Less than 60% or failure to complete a requirement will result in "F")

Course Conduct:

- **Attendance at Lectures and Recitation Is Mandatory.** Attendance will be taken every class and section 3 notices will be issued for missing class or coursework. Make-up privileges for missed midterm examinations are based on documented reasons for absence. In general, the opportunity for make-up is granted only when there are extenuating circumstances.
- **Academic integrity.** It has been my experience in the past that when students study in groups, and communicate they perform better. However, please note that your submitted work for this course should be conducted individually. Academic Integrity is expected from all students in all matters related to this course. In particular, a student assumes responsibility for every assignment, project or exam that he/she submits. University Code of Conduct: <http://www.lehigh.edu/~indost/conduct/documents/20132014CC.pdf>.
- **Accommodations for Students with Disabilities:** If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, University Center 212 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.
- **Principles of Equitable Community:** Lehigh University endorses the Principles of Our Equitable Community (<http://www4.lehigh.edu/diversity/principles>). We expect each member

of this class to acknowledge and practice the Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

Assignments:

- Homework assignments are due at the beginning of class on the specified day. Late submissions will be penalized by 10%. Homework solutions will be posted 24 hours after they are due, and NO submissions will be accepted after they are posted. There will be in class unannounced quizzes.
- Homework solutions should conform to the standards of good engineering practice:
 - ✓ Discussing homework with classmates is encouraged; however, you must perform your own calculations and submit your own work.
 - ✓ Work should be done on one side of the paper and well organized.
 - ✓ Clearly label each problem on numbered pages.
 - ✓ Work should be done in pencil, and straightedge must be used for sketches.
 - ✓ Your name and assignment number should appear on each page.
 - ✓ Work should be organized and presented neatly. *Assumptions* should be clearly stated, *units* should be noted on answers and key intermediate results, and *answers should be clearly identified*.
- Course project statement will be discussed in the lecture.

Assignment **points will be deducted** if any of the requirements are not followed.

Course Learning Objectives:

By the end of this course, students will be able to

1. Understand the regulatory framework related to safe containment of wastes.
2. Understand soil-water system and contaminant transport.
3. Understand waste disposal siting, contaminated site investigation, monitoring and remediation technologies.
4. Understand waste containment systems, liners, barriers, cover and liquid collection components.

Tentative Schedule:

Course Topic
<i>Introduction and Historical Overview of Regulations</i> Geoenvironmental engineering problems and scope, wastes and sources, waste processing alternatives Historical background of regulations, Current Federal regulations
<i>Subsurface Contamination and Soil Composition</i> Sources of toxic compounds and types of sources, toxic compounds and impact on living organisms, Phases of compounds moving in the body, places of absorption, Surface and subsurface contaminant sources, Contaminated site groups & common contaminants, relevant regulations, Factors impacting remediation. Soil and soil formation, Clays and characteristics, Identification methods, and Clay-water interaction.
<i>Soil Properties and Chemistry</i> Gradation and weight-volume relationship review, Saturated vs. unsaturated soil, Deformation and Strength. Chemical properties, pH, Surface charge, Specific Surface, CEC/AEC.
<i>Geochemistry</i> Sorption, Inorganic geochemistry, Phases of metals in soil, Controlling distribution processes, Analysis methods, Organic geochemistry, Organic Contaminants, Hydrocarbons, NAPLs and their characteristics, Distribution of NAPLs, Controlling distribution processes, Chemical analysis methods.
<i>Groundwater Flow</i> Definitions, Darcy's law, Horizontal/vertical flow, Groundwater flow equations, Confined & unconfined aquifers, One-dimensional steady flow, Well flow, Steady and unsteady testing, Slug tests, Groundwater flow modeling.

Disclaimer: This document may change as the semester progresses.

Course Topic

Contaminant Transport and Fate

Overview of transport processes, Definitions and formulations for advection/diffusion/dispersion, Chemical mass transfer, Sorption-desorption theories and laboratory methods, Precipitation-dissolution, Acid-base reactions, Complexation and Ion exchange, Volatilization and Hydrolysis, Biological Processes, Biodegradation, Transport and fate modeling (analytical/numerical/application).

Geoenvironmental Site Exploration

Subsurface exploration purpose/planning/preparation, Boring and drilling methods, Geophysical methods, Groundwater monitoring, Wells and piezometer construction, Packer/Slug/Pumping tests, Chemical data, Methods of sampling for various chemicals, Methods of chemical analysis, Laboratory analysis & boring logs.

Select Representative Topics From the Listed Remediation Methods Below

Risk: Assessment and Strategy, EPA Procedure, ASTM procedure

In Situ Waste Containment

Containment Barriers: Vertical barriers (slurry walls, sheet piles, grouting, soil mixing), Bottom barriers

Soil Remediation: Soil Vapor Extraction, Soil Washing, Stabilization & Solidification, Electrokinetic remediation, Thermal desorption, Vitrification, Bioremediation,

Groundwater Remediation: Pump and treat (Capture zone, flow equations), In situ flushing, Permeable reactive barriers (types, design, evaluation and construction), In situ air sparging, monitored natural, Bioremediation.

Tentative/Further Topics of Interest

Landfill Regulations, Siting and Configurations, End Use and Closure

Waste classification, Landfill regulations (Federal/State/Local), Landfill classifications, Landfill Siting, Landfill Configurations, Design considerations for closed landfills.

Waste Containment Liner Systems

Soil liners, Geomembrane/Geotextiles, Geosynthetic clays liners, Material properties, Failure modes, Compacted soil liners/properties/preparation/measurement methods, Geocomposite drains and geomembranes, polymers, Geomembrane testing methods, Seaming and seam testing, GCLs, Geogrids.

Leachate Collection, Removal and Liner Design

Leachate generation and evaluation, Mass balance calculation for MSW leachate generation, HELP model, Fluid drainage layer (granular and geosynthetic drains), Landfill failures and stability (slope), Leachate collection and removal, trenches/inlets/piping/installation/flow rate/pipe deflection, Sump and riser pipes, Secondary collection systems.

Final Cover Systems

Subtitle C/D, Components of RCRA Cap, Evapotranspiration, Layout & grading, Material selection, Runoff design, Leachate recirculation, Erosion, Drainage capacity, Landfill settlement, Localized subsidence.

Final Exam or Project Presentation

Spring Break (March 13-17)