ENE 487 Environmental Biotechnology and Bioremediation 3 Units

USC | SONNY ASTANI DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

ABET Course Syllabus

Course Information, Textbook and Supplementary Materials

Course Description:

Environmental biotechnology utilizes microorganisms to improve environmental quality. These improvements include treatment of contaminated waters and wastewaters, clean up of industrial waste streams, and remediation of soils contaminated with hazardous and toxic chemicals. Environmental biotechnology is essential to society and truly important as a technical discipline.

Required for: BSENE Track 2

Prerequisites: CE 210L Introduction to Environmental Engineering Microbiology, and
BISC 320L Molecular Biology

Co-Requisite: None

Required Textbook: *Environmental Biotechnology: Principles and Applications,* Rittmann, B. E., and McCarty, P. L., McGraw Hill, 2001

Class Notes: *Applied Environmental Microbiology and Case Studies*, prepared by M. Pirbazari, 2002.

Reference: Prescott, L. M., Harley, 3. P., and Klein, D. A., *Microbiology,* Second Edition, Wm. C. Brown Publishers, Dubuque, Iowa, 1993.

Topics Covered	Learning Outcomes
	Students will learn the basics of microbiology, understand the topics, and be able to formulate biodegradation kinetics and remediate organic and inorganic compounds through case studies, laboratory demonstrations, and field studies.
Fundamental Aspects of Environmental Microbiology Study of Microbial Structure	1. Structure and Functions of Procaryotic Cells, Eucaryotic Cells, Taxonomy of Microorganisms: Bacteria, Algae, Fungi and Protozoa 2. Light Microscopy, Dark-field and Phase-contrast Microscopy, Electron Microscopy, Environmental Significance of Bacteria, Fungi and Algae
Microbial Metabolism, Growth and Biokinetics	3. Microbial Nutrition and Metabolism; Microbial Growth and Energy ; Enzymes and Their structures; Effect of Environment on Enzyme activity; Microbial Growth and Substrate Utilization Kinetics; Biokinetic Models; Batch and Continuous Chemostat Studies; Determination of Biokinetic Parameters; Examples of Growth Kinetics in Engineered Systems(air, water, and soil)
Microbial Genetics	4. General Principles of Recombination and Plasmids; DNA Transformation; Recombinant DNA Technology; Polymerase Chain Reactions; Isolating and Cloning Fragments; Concept of Gene Probes; Fundamentals of Cloning; Insertion and Expression of Foreign Genes; Recombinant DNA Techniques in Biotechnology; Applications in Environmental Engineering
Biological Reaction	5. Suspended Growth Reactors; Biofilm Reactors; Batch Reactors; Completely Stirred Tank Reactors; Plug Flow Reactors; Reactors in Series; Engineering Design of Reactors
Bioflim Processes	6. Trickling Filters and Biological Towers; Rotating Biological Contactors; Granular Media Filters; Fluidized-bed Reactors; Hybrid Biofllm Processes
Bioremediation for Soil Environment	7. Environment of Soil Microorganisms; Soil Organic Matter and Characteristics; Soil Microorganisms Association with Plants; Pesticides and Microorganisms; Petroleum Hydrocarbons and Microorganisms; Industrial solvents and Microorganisms;

	Biotechnologies for Ex-Situ Remediation of Soil; Biotechnologies for in-Situ Remediation of Soil; Phytoremediation Technology for Soil Decontamination
Bioremediation for Soil Environment	8. Atmospheric Environment for Microorganisms; Microbial Degradation of Contaminants in Gas Phase; Biological Filtration Processes for Decontamination of Air Stream-Biofiltration, -Biotrickling Filtration, -Bioscrubbers

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Topics Covered	Learning Outcomes
Bioremediation for Water Environment	9. Biochemical, Molecular, and Ecological Foundations of Bioremediation; Contaminants in Groundwater; Ex-situ Decontamination of Groundwater -Characterizing the Site and Contaminant Complexity, -Selecting the Bioremediation Option, Process Optimization, In-situ Bioremediation of Groundwater, -Factors Affecting Bioaugmentation, -Delivery Systems for Oxygen, Nutrients, and Inoculation; Landfill Leachate Biotreatment Technologies; Industrial Wastewater Biotreatment Technologies; Biotreatment of Surface Waters
Bioremediation of Metals	10. Microbial Transformation of Metals; Biological Treatment Technologies for Metals Remediation; Bioleaching and Biobenificiation; Bioaccumulation; Oxidation/Reduction Processes; Biological Methylation; Case studies
Overcoming Limitations of Bioremediation	11. Factors Affecting the Bioremediation Processes; Effects of Co-substrates on Microorganisms; Global Application of Bioremediation Technologies; Successful and Unsuccessful Case Studies
Emerging Environmental Biotechnologies	12. Phytoremediation; Sequestering Carbon Dioxide; Biomonitoring; Application of Microbial Enzymes; Biomembrane Reactors
Case Studies in Environmental Biotechnology	13. Environmental Biotechnology Research Activities in European Union; Environmental Biotechnology Research Activities in Japan; Environmental Biotechnology Research Activities in US; Environmental Biotechnology Research Activities in Other Countries
Fieldtrip; and Lab Demo	14. Students will take two fieldtrips to bioremediation sites; attend lab demonstration of the applications of light microscopy, fluorescence microscopy and electron microscopy to environmental samples

Lecture and Lab Schedule

Lecture		Lab	
Sessions per Week	Duration per Session	Sessions per Week	Duration per Session
2	1.5 hours	n/a	

Relation of Course Objectives to Program Outcomes

The Civil Engineering program is designed to teach beyond the technical content of the curriculum and prepare

Course Contribution to Program Outcomes *(a-k)*	✓ Key
a. An ability to apply knowledge of mathematics, science, and engineering.	
c. An ability to design a system component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	

the students to utilize what they learn in a professional setting. This course contributes to the program outcomes as outlined in the adjacent table.	e. An ability to identify, formulate and solve engineering problems.	
	g. An ability to communicate effectively.	
	h. The broad education necessary to understand the impact of engineering solutions in a global economic and environmental and societal context.	✓
	i. Recognition of the need for, and an ability to engage in life-long learning.	✓
	j. Knowledge of contemporary issues.	✓

Prepared by: Dr. Mike Pirbazari **Date:** August 2014
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