CE 210L
Course Syllabus

Fall 2013
Part I Course Organization
CE 210L
Introduction to Environmental Engineering Microbiology

Class Notes, Supplementary Reading Material, and Lab Handouts

Instructor: Professor Mike Pirbazari

Department of Civil and Environmental Engineering
University of Southern California
Fall 2013
CE 210L
INTRODUCTION TO ENVIRONMENTAL ENGINEERING MICROBIOLOGY (3 units)
Fall 2013

Collaborative Learning Strategy:

During the class we will be practicing the important concepts and skills of collaborative learning in small group of three or four students. The strategy is designed to increase you mastery of the course content. You will be expected to actively participate in an effort to ensure your own and your “team-mates” understanding of the ideas presented in the class. We need your commitment to demonstrate willingness to contribute ideas, listen to others, and to be a constructive force in the learning process.

Instructor: Professor Mike Pirbazari (Dr. P)
Office: KAP260; Phone: (213)740-0592, Fax:(213)744-1426
E-mail: pibazar@usc.edu
Office Hours: to be determined

Class & Lab Hours: Lecture: Tuesday and Thursday 12:00-1:45pm; KAP 138
Laboratory Sessions: BHE 210
Session 1: Monday 1:30 to 3:20pm
Session 2: Wed. 12:00 to 1:50pm

Teaching Assistant: Woonhoe Kim; BHE 213K
Office hours: to be determined
E-mail: woonhoek@usc.edu

Lab Coordinator: Erick Hernandez
erickjh@usc.edu

Course Content: Principles of environmental microbiology; water-borne pathogens; microorganisms and air pollution; microorganisms in soil; water pollution microbiology; biodegradation of hazardous chemicals. The course will include the following design topics:
1) Design of a small biological wastewater treatment plant
2) Biological treatment design for sanitary landfill leachate.

Course Objective: The purpose of this introductory course is to provide the students the fundamental principles of microbiology for environmental engineering applications. The course includes laboratory work to offer them a good experience in basic experimental techniques.

Suggested Prerequisite: CE 110 (Introduction to Environmental Engineering)
Grading Criteria:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Midterms</td>
<td>15% (7.5% each)</td>
</tr>
<tr>
<td>Final Exam</td>
<td>15%</td>
</tr>
<tr>
<td>2 Quizzes</td>
<td>10% (5% each)</td>
</tr>
<tr>
<td>Homework</td>
<td>10%</td>
</tr>
<tr>
<td>Lab Reports</td>
<td>25%</td>
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<tr>
<td>Term Project</td>
<td>15%</td>
</tr>
<tr>
<td>Class &amp; Lab Participation</td>
<td>10%</td>
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</tbody>
</table>

100%

Schedules for Exams and Quizzes:

1st Quiz: September 12, 2013
1st Midterm: October 10, 2013
2nd Quiz: October 24, 2013
2nd Midterm: November 14, 2013
Final: December 17, 2013 (11:00-1:00pm)

Textbook:

Class Notes:
Pirbazari, M; "Class Notes for CE210L, “Introduction to Environmental Engineering Microbiology” with Supplementary Reading Materials; adapted by Prof. Pirbazari, 2012.

References:

Students with Disabilities
Any student requesting academic accommodation based on disability is required to register with Disability Services and Programs Office (DSPO) each semester. A letter of verification for approved accommodations can be obtained from DSPO. Please be sure the letter is delivered to the instructor (or the TA) as early in semester as possible. DSPO is located in STU 301 and is open 8:30am – 5:00pm, Monday through Friday. The phone number for DSPO is (213) 740-0776. (This statement is suggested by the office of the Provost).

Academic Integrity
The use of unauthorized material, communication with fellow students during an examination, attempting to benefit from the work of another student, and similar behavior that defeats the intent of an examination or other class work is unacceptable to the University. It is often
difficult to distinguish between a culpable act and inadvertent behavior resulting from the nervous tension accompanying examinations. When the professor determines that a violation has occurred, appropriate action, as determined by the instructor, will be taken.

Although working together is encouraged, all work claimed as yours must in fact be your own effort. Students who plagiarize the work of other students will receive zero points and possibly be referred to Student Judicial Affairs and Community Standards (SJACS).

All students should read, understand, and abide by the University Student Conduct Code listed in SCampus, and available at:

http://web-app.usc.edu/scampus/university-student-conduct-code/
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INTRODUCTION TO ENVIRONMENTAL ENGINEERING MICROBIOLOGY
Fall 2013

Course Syllabus

1. Ecological Principles (1 week)
   - The Biosphere
   - The Community
   - Energy Transfer
   - Homeostasis
   - Ecosystem Management

2. The Protists (1 week)
   - Kingdoms in the Biological World
   - Procaryotes and Eucaryotes
   - Distribution of Microorganisms
   - Culture Techniques
   - Enumeration of Microorganisms
   - Light Microscopy and Electron Microscopy

3. Procaryotes and Viruses (1 week)
   - Bacteria
   - Actinomycetes
   - Blue-Green Algae
   - Viruses

4. Eucaryotes (1 week)
   - Fungi
   - Protozoa
   - Algae
5. **Microbial Nutrition and Growth (2 weeks)**
   - Nutrition
   - Heterotrophy and Autotrophy
   - Energy Transfer
   - Microbial Growth Kinetics
   - Growth Measurements

6. **Death of Microorganisms (1 week)**
   - Physical Destruction (temperature, sonication, uv irradiation, osmotic shock, etc.)
   - Chlorination Process and Chick’s Law
   - Heavy metals, Iodine, Ozone, and Permanganat as Disinfectants

7. **Waterborne Pathogens (1 week)**
   - Bacteria
   - Viruses
   - Protozoa
   - Schistosomiasis
   - Detection of Fecal Contamination
   - Detection of Viruses

8. **Sanitary Sewer Pipe Design (1 week)**
   - Gravity Flow in Circular Pipes
     - Manning Formula and Manning Nomograph
     - Gravity Flow in Partially-Full Sewer Pipes

9. **Conventional and Advanced Wastewater Treatment (1 week)**
    - Biochemical Oxygen Demand (BOD) and Suspended Solids
    - Activated Sludge Process
    - Biological Treatment for Nitrate Removal
10. Municipal Wastewater Treatment Design (2 weeks)
   - Role of Microorganisms in the Activated Sludge Process
   - BOD, Suspended Solids, and Discharge Standards
   - Flow Diagram and Schematics
   - Determining the size of the Grit Chamber
   - Determining the size and shape of the Primary and Secondary Clarifiers
   - Determining the Size of the Aeration Tank and Air Flow Requirements
   - Chlorination Tank Design

11. Biological Treatment Design for Landfill Leachate (2 weeks)
   - Leachate Characteristics and Discharge Guidelines
   - Leachate Collection System: piping layout, pumps, and holding tanks
   - Leachate Equalization Tank
   - Biological Aeration Tank (bacteria and powder activated carbon suspension)
     * Reactor size and carbon usage
     * Clarifier size and sludge re-circulation

12. Environmental Engineering Biotechnology (1 week)
   - In-Situ and Ex-Situ Bioremediation of Contaminated Soil and Groundwater
   - Vapor-Phase Biofiltration for Treatment of Industrial Emissions
   - Biodegradation/Adsorption Technology for Decontamination of Petroleum Hydrocarbons
   - Phytoremediation Technology for Decontamination of Environmental Pollutants
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Term Project

Each student group will be required to present a term project, which will constitute 15% of the semester grade. A list of suggested topics is provided below. Students are required to submit a choice of topic by September 18th, 2012.

A 20 minute Powerpoint presentation on the term project topic is mandatory. Student presentations will be made in class on 3rd and Dec. 5th, 2013. A sign up sheet will be passed around in class Nov. 26th, 2013.

Suggested Topics

- Biofiltration Processes for Treating Industrial Gas Emissions
- Microorganisms and Energy Production
- In Situ and Ex Situ Bioremediation of Petroleum Hydrocarbons in Soil
- Bioventing and Bioremediation of Volatile Organic Compounds (VOCs) in Soil
- Biological Treatment of Leachate from Landfills
- Bioremediation of Petroleum Hydrocarbons in Marine Environment
- Ex-Situ Bioremediation of Volatile Organic Compounds (VOCs) in Groundwater
- Microbial Ecology of Activated Sludge Process
- Microbiologically-Induced Corrosion (MIC)
- Biological Treatment of Toxic Metals
- Microbial Ecology of Anaerobic Digestion Tank
- Role of Enzymes in Environmental Engineering Biotechnology
- Microbial Fuel Cell
- Phytoremediation of Soil and Groundwater
- In Situ Bioremediation of Groundwater
- Producing Biofuels from Algae
## Laboratory Schedule

<table>
<thead>
<tr>
<th>Session #</th>
<th>Date</th>
<th>Experiment #</th>
<th>Experimental Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Week of Sept. 2</td>
<td>1</td>
<td>I. Laboratory Safety Overview</td>
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<td></td>
<td></td>
<td></td>
<td>II. Introduction to the Phase-Contrast Microscope</td>
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<tr>
<td>2</td>
<td>Week of Sept. 9</td>
<td>2</td>
<td>The Plankton Community</td>
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<tr>
<td>3</td>
<td>Week of Sept. 16</td>
<td>3</td>
<td>The Bacteria</td>
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<tr>
<td>4</td>
<td>Week of Sept. 23</td>
<td>4</td>
<td>Water Quality Testing: The Coliform Test</td>
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<tr>
<td>5</td>
<td>Week of Sept. 30</td>
<td>5</td>
<td>Water Quality Testing: Membrane Filtration</td>
</tr>
<tr>
<td>6</td>
<td>Week of Oct. 7</td>
<td>6</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Midterm (no lab.)</td>
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<tr>
<td>7</td>
<td>Week of Oct. 14</td>
<td>6</td>
<td>Microscopic Examination of Activated Sludge (Hanging Drop)</td>
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<tr>
<td>8</td>
<td>Week of Oct. 21</td>
<td>7</td>
<td>Enrichment Culture and Selective Techniques for Isolating Anaerobic Bacteria from Environment</td>
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<tr>
<td>9</td>
<td>Week of Oct. 28</td>
<td>8</td>
<td>Soil Microorganisms and Chemostat Studies</td>
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<tr>
<td>11</td>
<td>Week of Nov. 4</td>
<td>9</td>
<td>Electron Microscopy</td>
</tr>
<tr>
<td>12</td>
<td>Week of Nov. 11</td>
<td>10</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Midterm (no lab)</td>
</tr>
<tr>
<td>13</td>
<td>Week of Nov. 18</td>
<td>10</td>
<td>Microorganisms and Energy Production (Microbial fuel Cell, etc.)</td>
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<tr>
<td>14</td>
<td>Week of Nov. 25</td>
<td>11</td>
<td>Thanksgiving Week (no lab)</td>
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<tr>
<td>15</td>
<td>Dec. 4 and 6</td>
<td>12</td>
<td>Term Project Presentations</td>
</tr>
<tr>
<td>16</td>
<td>Dec. 17</td>
<td>13</td>
<td>Final Exam (11:00 to 12:00pm)</td>
</tr>
</tbody>
</table>
LABORATORY REPORT INSTRUCTIONS

1. Your laboratory data reports should be presented in 8” x 11” sheets stapled at the left-hand upper corner.

2. All data and experimental write-ups should be word-processed.

3. Laboratory reports will be collected at the beginning of the lab session for the experiment conducted on the previous session.

4. No late report will be accepted.

5. In your laboratory write-up, you must conform to the following format and regulations:

   I - The first page of your laboratory report should contain:

   LABORATORY REPORT
   EXPERIMENT #
   Experiment Title
   GROUP #
   YOUR NAME
   DATE

   II - Starting from the second page, the write-up must include the following sections:

   Purpose: (5 points)
   • Briefly describe the purpose of the lab, and what the lab aims to accomplish.

   Introduction / Background (10 points)
   • Elaborate on the purpose, and describe with some detail the lab’s significance to water quality engineering. Provide a detailed technical description of the chemical/physical mechanisms that provide the framework of the experiment.
**Methods:** (10 points)
- Briefly describe the experimental procedure.

**Results / Data:** (15 points)
- Provide all results obtained during the experiment, this may be data in tabular form, descriptions of observations, or shown in figures (whatever is most appropriate). Clearly label all figures, charts, or tables!

**Discussion / Questions (when applicable):** (40 points)
- Discuss the results of the lab and the implications. In this section, tie together the introduction, methods, and results to describe what happened in the experiment and why. If the data appears to be consistent with what was anticipated, describe why this was anticipated and describe the significance. If the results are inconsistent between classmates or what was anticipated, look into why this may have occurred and how the experimental procedure could have been modified/improved upon this.
- *This is the most important section of the lab report. In this section you are required to demonstrate a clear understanding of the concepts involved and the chemical/physical mechanisms, which govern the success of the each experiment.*
- Labs may or may not contain questions regarding the experiment and its significance. These questions must be clearly answered using original wording, and if outside references are used, they must be cited appropriately.

**Conclusion:** (20 points)
- Briefly summarize the experiment, the results, what was learned, and why it is significant. This should tie everything together in a clear, concise paragraph. Add any final thoughts in this section; *please do not simply repeat what was written in previous sections.*

**Additional Note:**
Please provide original work. All USC plagiarism rules must be observed and will be strictly enforced. Using outside resources to find more information on a subject is encouraged, but make sure to cite them properly.
Effective Class Participation

Please note the following suggestions for effective class participation:

1) Make every effort to interact with your class partner(s).

2) Try to stay active throughout the class period.

3) Don’t hesitate to ask questions in class.

4) Share your ideas with the rest of us.

5) Don’t hesitate to ask the instructor to repeat himself.

6) Keep an eye on your partner not to fall asleep in class!!

7) Try to bring new ideas to class.

8) Don’t read unrelated materials in class.

9) Share your ideas for class improvement with your instructor.

10) Put your fair share of efforts in preparing the term projects and the term paper. Be cooperative at all times.

11) Discuss your term paper and term project with the instructor periodically.

12) Come to class prepared.

13) Help your instructor make the class interesting.

14) Discuss your concerns and problems (if any) about the course with the instructor. He will do his best to accommodate your suggestions.

15) Late homework is not accepted.

16) Use of Lap tops in class is not permitted.

17) Tardiness is not acceptable.
Effective laboratory Participation

Please note the following suggestions for effective lab participation.

1. Follow laboratory safety regulations diligently (posted on Blackboard).
2. Wear your lab coat and safety goggles as soon as you arrive.
3. Bring a copy of the lab procedure with you to class (available on Blackboard).
4. Follow the lab procedure succinctly.
5. Be cooperative at all times.
6. Try not to be disruptive.
7. Don’t hesitate to ask questions.
8. Report accidents to the lab coordinators immediately.
9. Late lab reports are not acceptable.
10. Tardiness is not acceptable.
11. Make every effort to make the lab experience enjoyable for yourself and others.

Prepared by: Prof. Mike Pirbazari

Date: June 2013
Part II  Detailed Course Objectives
**Course Information, Textbook, and Supplementary Materials**

**Course Description:** Principles of environmental microbiology; water-borne pathogens; microorganisms and air pollution; microorganisms in soil; water pollution microbiology; biodegradation of hazardous chemicals. The course will include the following design topics: i) design of a small biological wastewater treatment plant, and ii) biological treatment design for sanitary landfill leachate.

**Required for:** BSCE-ENE and BSENE degree programs

**Suggested Prerequisite:** CE 110 (Introduction to Environmental Engineering)

**Co-Requisite:** None

**Required Textbooks:**
- Pirbazari, M; "Class Notes for CE210L, Introduction to Environmental Engineering Microbiology" with Supplementary Reading Materials ; adapted by Prof. Pirbazari, 2011 (available on the Blackboard)


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<thead>
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<th>Learning Outcomes</th>
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<tbody>
<tr>
<td>Ecological Principles</td>
<td>Students will know the principles of environmental microbiology; microorganisms and air pollution; microorganisms in soil; water pollution microbiology; biodegradation of hazardous chemicals, as follows:</td>
</tr>
<tr>
<td></td>
<td>1. The Biosphere, the Community, Energy Transfer, Homeostasis, and Ecosystem Management</td>
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<tr>
<td>Protists</td>
<td>2. Kingdoms in the Biological World, Procaryotes and Eucaryotes, Distribution of Microorganisms; Culture Techniques, Enumeration of Microorganisms, Light Microscopy, and Electron Microscopy</td>
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<td>Procaryotes and Viruses</td>
<td>3. Bacteria, Actinomycetes, Blue-Green Algae, Viruses</td>
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<td>Eucaryotes</td>
<td>4. Fungi, Protozoa, and Algae</td>
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<td>Microbial Nutrition and Growth</td>
<td>5. Nutrition, Heterotrophy and Autotrophy, Energy Transfer, Microbial Growth Kinetics, and Growth Measurements</td>
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<td>9. Bacteria, Viruses, Protozoa, Schistosomiasis, Detection of Fecal Contamination, and Detection of Viruses</td>
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<td>14. Role of Microorganisms in the Activated Sludge Process; BOD, Suspended Solids, and Discharge Standards; Flow Diagram and Schematics; Determining the size of the Grit Chamber; Determining the size and shape of the Primary and Secondary Clarifiers; Determining the Size of the Aeration Tank and Air Flow Requirements; Chlorination Tank Design</td>
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</table>
Topics Covered | Learning Outcomes
---|---
Environmental Engineering Biotechnology | 15. In-Situ and Ex-Situ Bioremediation of Contaminated Soil and Groundwater; Vapor-Phase Biofiltration for Treatment of Industrial Emissions; Microbial Decontamination of uranium waste; Microbial treatment Technology for oil and grease and microbial fuel cell technology for decontamination of groundwater

Lecture and Lab Schedule

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Lab</th>
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<tbody>
<tr>
<td>Sessions per Week</td>
<td>Duration per Session</td>
</tr>
<tr>
<td>2</td>
<td>1.5 hours</td>
</tr>
</tbody>
</table>

Contribution of Course to Meeting the Professional Component

Eng. Topics | Other

Constraints and Considerations. Students will understand the diverse constraints and considerations that are representative of what they will encounter in an engineering practice. This course covers the following topics:

- Economic
- Environmental
- Sustainability
- Health and Safety
- Social
- Political
- Energy

Relation of Course Objectives to Program Outcomes

The Civil Engineering program is designed to teach beyond the technical content of the curriculum and prepare the students to utilize what they learn in a professional setting.

This course contributes to the program outcomes as outlined in the adjacent table.

<table>
<thead>
<tr>
<th>Course Contribution to Program Outcomes (a-k)</th>
<th>Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. An ability to apply knowledge of mathematics, science, and engineering.</td>
<td></td>
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<tr>
<td>b. An ability to design and conduct experiments, as well as to analyze and interpret data.</td>
<td>✓</td>
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<tr>
<td>g. An ability to communicate effectively.</td>
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</tbody>
</table>

Prepared by: Dr. Mike Pirbazari
Professor of Environmental Engineering

Date: Fall 2013