CE 523
Process Kinetics and Dynamics in Environmental Engineering

Lecture Notes

Instructor: Professor Mike Pirbazari

Department of Civil and Environmental Engineering
University of Southern California
Spring 2012
CE 523  
Process Kinetics and Dynamics in Environmental Engineering  
Spring 2012

Course Description: Concepts and applications of processes that affect water quality in natural and engineered systems. Major processes include: flocculation, sedimentation, filtration, oxidation, adsorption, and membrane processes.

Instructor: Professor Massoud Pirbazari (Dr. P)  
Office: KAP 260; Phone: 213-740-0592  
E-mail: pirbazar@usc.edu

Class Hours: Tuesday: 6:30-9:10 p.m., OHE 100D

Office Hours: To be announced

Teaching Assistant: To be announced

Grading Criteria:

Two Midterm Exams 20 % (10 % each)  
Final Exam 25 %  
Quizzes 10 % (5 % each)  
Homework & Class Assignments 20 %  
Term Project 15 %  
Class Participation 10 %  
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100 %

Schedules for Exams and Quizzes:

Quiz 1 January 31, 2012  
Midterm 1 February 13, 2012  
Quiz 2 March 6, 2012  
Midterm 2 April 3, 2012  
Final Exam May 8, 2012 (7 – 9 p.m.)

Term Project Assignment: (details on page 5)
Textbooks:


Pirbazari, M., Class Notes, 2012 (available on Blackboard)

References:


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/

Students with Disabilities:

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to the instructor (or to your TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. - 5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.
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COURSE SYLLABUS

I. Process and System Modeling (2 weeks)
   1. Rational Approach
   2. Material Balance Equations
   3. Fluid flow and Mass Transport
   4. Elementary Process Equilibria
   5. Elementary Process Rates
   6. Complex Process Rates

II. Process Dynamics and Reactors (3 ½ weeks)
   1. Ideal System Modeling and Design
      - completely mixed batch reactors
      - completely mixed flow reactors
      - plug flow reactors
      - comparison of reactor performances
   2. Hybrid System Modeling and Design
      - sequencing batch reactors
      - CMFRs in series
      - reactors with recycle
   3. Nonideal System Modeling and Design

III. Chemical Precipitation, Coagulation, and Flocculation (2 ½ weeks)
   1. Solubility
   2. Precipitation Kinetics
   3. Stability of Colloids
   4. Destabilization Phenomena and Techniques
   5. Transport and Flocculation Phenomena
   6. Unit Operations and Processes

IV. Sedimentation (1/2 week)
   1. Sedimentation Processes
   2. Short Circuiting and Dispersion Pattern
   3. Sedimentation Tank Design
   4. Unit Operations and Processes

V. Filtration (1 week)
   1. Flow through Porous Media
   2. Mathematical Models for Deep Granular Filters
   3. Slow Sand Filtration
   4. Rapid Sand Filtration
   5. Unit Operations and Processes
VI. Adsorption (2 weeks)
1. Adsorption Equilibria and Adsorption Isotherms
2. Rates of Adsorption
3. Sorption Kinetics in Batch Reactors and Flow Reactors
4. Contacting Systems and Modes of Operation
5. Unit Operations and Processes
6. Adsorber Modeling and Design

VII. Membrane Processes (2 weeks)
1. Microfiltration
2. Ultrafiltration
3. Nanofiltration
4. Reverse Osmosis
5. Unit Operations and Processes

VIII. Advanced Oxidation Processes (1 ½ weeks)
1. Types of Advanced Oxidation
2. Hydroxyl Radical Production
3. Byproducts of AOPs
4. Major Factors Affecting AOPs
5. Assessing Feasibility of AOPs

Calendar

<table>
<thead>
<tr>
<th>Session</th>
<th>Date</th>
<th>Schedule of Quizzes &amp; Exams</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>01/10</td>
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<td>02/31</td>
<td>Quiz 1</td>
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<td>5</td>
<td>02/07</td>
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<td>6</td>
<td>02/14</td>
<td>Midterm 1</td>
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<td>03/06</td>
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<td>15</td>
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<tr>
<td>16</td>
<td>04/24</td>
<td>Term Project Presentation</td>
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<td>17</td>
<td>05/08</td>
<td>Final Exam 7:00 to 9:00pm</td>
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Term Project Topics
Fall 2012

Students in groups of ‘three” are required to choose one of the following topics by Feb. 1, 1012 and prepare a Power point report to be presented during the last day of classes. The length of each presentation should be about 20 minutes followed by 2 minutes questions/answers.

1. Ozonation Processes in Water & wastewater Treatment
2. Enhanced Coagulation in Water & Wastewater Treatment
3. Reverse Osmosis Processes in Water & Wastewater Treatment
4. UV Processes in Water Treatment
5. Microfiltration Processes in Water & Wastewater Treatment
6. Ultrafiltration Processes in Water & Wastewater Treatment
7. Nanofiltration in Water & wastewater treatment
8. Activated Carbon Adsorption in Water Treatment
9. Water Treatment for Removal of endocrine disruptor chemicals (EDCs) and disinfection byproducts
10. Nanomaterials and Water Purification

Note: Starting Monday February 12th each student group must set up appointment with Dr. P for guidance regarding their term projects.
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 unacceptable.
16) Tardiness is undesirable.
17) Class teamwork is encouraged.
18) Use of laptop is undesirable.