

**CE 485 Wastewater Treatment Design**  
**2019 Spring – Course Syllabus**

<b>Lecture</b>	Monday	6:30 – 9:10 pm	KAP 166
<b>Professor</b>	Wonho Warner Song, Ph.D., P.E., BCEE		
<b>Office</b>	Sanitation Districts of Los Angeles County 1955 Workman Mill Road Whittier, CA 90601 <a href="http://www.lacsd.org">www.lacsd.org</a>		
<b>Phone</b>	(562) 908 – 4288 x2822		
<b>Email</b>	<a href="mailto:wonhoson@usc.edu">wonhoson@usc.edu</a>		
<b>Office hours</b>	Monday 5:30 – 6:30 pm, KAP 200 (and also by appointment)		
<b>Prerequisites</b>	CE 451 Water Resources Engineering CE 463L Water Chemistry and Analysis CE 473 Engineering Law, Finance and Ethics		
<b>Textbook</b>	Metcalf & Eddy /AECOM. Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, McGraw-Hill, 2013 (ISBN 13: 978-0073401188, ISBN 10: 0073401188)		
<b>References</b>	WEF. Design of Municipal Wastewater Treatment Plants. WEF Manual of Practice No. 8 / ASCE Manual and Report on Engineering Practice No. 76. Fifth Edition, WEF Press / McGraw-Hill. 2010		
<b>Preparation Before Class</b>	Presentation materials, assignments, and supplementary class notes will be posted on Blackboard. Students are required to download and preview class materials prior to class. Reading assignments will be made from the textbook.		
<b>Course Description</b>	Process kinetics, mass balance, reactor design, pretreatment, clarification, chemical treatment, biological treatment (aerobic and anaerobic), disinfection, sludge treatment, nitrogen and phosphorus removal, carbon adsorption.		
<b>Grading Criteria</b>	Midterm Exam	25%	
	Final Exam	30%	
	Design Project	20%	
	Quizzes	15%	
	Homework	10%	
<b>Policies on Late Work</b>	Late assignments will be docked 10% (of the percent correct) for each day late to maximum of 50%. Late design projects will be reduced in grade.		
<b>Schedules for Exams, Quizzes: and Projects</b>	Quiz 1	Feb. 4, 2019	
	Midterm	Mar. 4, 2019	
	60% Design Project Due	Apr. 1, 2019	
	Quiz 2	Apr. 8, 2019	
	100% Design Project Due	Apr. 22, 2019	
	Final Exam	May 6, 2019	

<b>Grading Scale</b>	Course final grades will be determined using the following scale A 92-100 A- 88-91 B+ 84-87 B 80-83 B- 76-79 C+ 72-75 C 68-71 C- 64-67 D+ 60-63 D 56-59 D- 52-55 F 51 and below
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**WEEKLY SCHEDULE**

<b>Week No.</b>	<b>Date</b>	<b>Topic</b>	<b>Reading Assign</b>	<b>HW</b>
<b>Week 1</b>	1/7	<b>Introduction</b> ✓ Source of Municipal Wastewater ✓ Types of Collection Systems ✓ Classification of Wastewater Treatment Methods ✓ Complete Mix Reactor and Plug Flow Reactor ✓ Process Kinetics <b>Wastewater Characteristics</b> ✓ Solids (suspended-, dissolved-, volatile-, fixed-solids) ✓ Nitrogen and Phosphorous ✓ Measurement of Organic Content	<b>Chap 1</b>         <b>Chap 2.</b>	    HW 1 Due 1/14
<b>Week 2</b>	1/14	<b>Wastewater Flowrates and Constituent Loadings</b> ✓ Wastewater Sources and Flowrates ✓ Flowrate Parameters ✓ Analysis of Constituent Mass Loading Data ✓ Design Mass Loading rates <b>Process Selection, Design, and Implementation</b> ✓ Upgrading Existing Wastewater Treatment Plants ✓ Elements of Process Design	<b>Chap 3</b>         <b>Chap 4</b>	    HW 2 Due 1/28
<b>Week 3</b>	1/21	Dr. Martin Luther King Jr.'s Birthday	<b>Chap 5</b>	

Week No.	Date	Topic	Reading Assign	HW
Week 4	1/28	<b>Physical Unit Processes</b> ✓ Screening ✓ Coarse Solid Reduction ✓ Grit Removal ✓ Primary Sedimentation ✓ Dissolved Air Flootation <b>Design Project Overview 1</b>	Chap 5	HW3 Due 2/4
Week 5	2/4	<b>(Quiz 1)</b> <b>Chemical Unit Processes</b> ✓ Chemical Coagulation and Flocculation ✓ Chemical Precipitation ✓ Chemical Feed and Storage system <b>Fundamentals of Biological Treatment</b> ✓ Composition and Classification of Microorganisms ✓ Bacterial Growth, Energetics, and Decay ✓ Microbial Growth Kinetics	Chap 6  Chap 7	HW4 Due 2/11
Week 6	2/11	<b>Fundamentals of Biological Treatment</b> ✓ Microbial Growth Kinetics ✓ Biomass Concentrations ✓ MLSS, SRT, F/M Ratio, Organic Loading Rate ✓ Sludge Bulking and Foaming ✓ Nitrification and Denitrification ✓ Anammox	Chap 7	HW5 Due 2/25
Week 7	2/18	President's Day	Chap 8	
Week 8	2/25	<b>Suspended Growth Biological Treatment Processes</b> ✓ Evolution of Activated Sludge Process ✓ COD and Nitrogen Fractionation ✓ Kinetic Coefficients for BOD and N Removal ✓ Design of the Biological Nitrogen Removal Process	Chap 8	HW6 Due 3/18
Week 9	3/4	<b>Midterm Exam</b> <b>Design Project Overview 2</b>	-	
Week 10	3/11	Spring Recess	Chap 8	

Week No.	Date	Topic	Reading Assign	HW
Week 11	3/18	<b>Suspended Growth Biological Treatment Processes</b> <ul style="list-style-type: none"> <li>✓ Oxygen Requirement and DO Control</li> <li>✓ Simultaneous Nitrification and Denitrification</li> <li>✓ Complete Mix and Plug Flow Activated Sludge</li> <li>✓ High Purity Oxygen Activated Sludge process</li> <li>✓ MLE and Step-Feed Activated Sludge Process</li> </ul>	Chap 8	HW7 Due 3/25
Week 12	3/25	<b>Suspended Growth Biological Treatment Processes</b> <ul style="list-style-type: none"> <li>✓ Bardenpho and Modified Bardenpho Process</li> <li>✓ A<sup>2</sup>O and UCT Process</li> <li>✓ Secondary Clarifier Design</li> </ul> <b>Attached Growth and Combined Biological Treatment</b> <ul style="list-style-type: none"> <li>✓ Trickling Filter Process</li> <li>✓ IFAS and MBBR</li> </ul> <b>Anaerobic Biological. Treatment Process</b> <ul style="list-style-type: none"> <li>✓ Aerobic versus Anaerobic Process</li> </ul>	Chap 8  Chap 9  Chap 10	HW8 Due 4/1
Week 13	4/1	<b>Separation Processes for Removal of Residual Constituents</b> <ul style="list-style-type: none"> <li>✓ Granular Media Depth Filtration</li> <li>✓ Surface Filtration (Cloth Media Filter, Diamond CMF)</li> <li>✓ Pressurized Cross-Flow Membrane Filtration</li> <li>✓ Pressurized Dead-End Flow Membrane Filtration</li> <li>✓ Submerged Membrane with Vacuum Draw</li> </ul> <b>Disinfection Processes</b> <ul style="list-style-type: none"> <li>✓ Chlorination and Chloramination</li> <li>✓ UV and Ozone Disinfection</li> <li>✓ Sequential Chlorination</li> </ul> <b>60% Design Project Due</b>	Chap 11  Chap 12	HW9 Due 4/8
Week 14	4/8	<b>(Quiz 2)</b> <b>Plant Hydraulics</b> <ul style="list-style-type: none"> <li>✓ Friction and Minor Headloss Calculations</li> <li>✓ Head over Weir</li> <li>✓ Plant Hydraulic Profile</li> </ul>	Handout	HW 10 Due 4/15

Week No.	Date	Topic	Reading Assign	HW
Week 15	4/15	<p><b>Processing and Treatment of Sludges</b></p> <ul style="list-style-type: none"> <li>✓ Characteristics of Primary and Secondary Sludge</li> <li>✓ Gravity Thickening</li> <li>✓ Dissolved Air Flootation Thickening</li> <li>✓ Centrifugal Thickening</li> <li>✓ Gravity Belt Thickening</li> <li>✓ Anaerobic Digestion Design</li> </ul> <p><b>Biosolids Processing, Resource Recovery and Beneficial Use</b></p> <ul style="list-style-type: none"> <li>✓ Solid Bowl Centrifuge</li> <li>✓ Belt-Filter Press</li> <li>✓ Sludge Drying Beds</li> </ul> <p><b>Mass Balance</b></p>	<p><b>Chap 13</b></p> <p><b>Chap 14</b></p> <p><b>Handout</b></p>	<p>HW 11 Due 4/22</p>
Week 16	4/22	<p><b>Plant Recycle Flow Treatment and Nutrient Recovery</b></p> <ul style="list-style-type: none"> <li>✓ Sidestream Characteristics</li> <li>✓ Sidestream Impacts and Mitigation Measures</li> </ul> <p><b>Air Emissions from Wastewater Treatment Facilities and Their Control</b></p> <ul style="list-style-type: none"> <li>✓ Source of Odor in Wastewater Management</li> <li>✓ Chemical Scrubber</li> <li>✓ Activated Sludge Diffusion</li> <li>✓ Activated Carbon Adsorber</li> <li>✓ Biotrickling Filter</li> </ul> <p><b>100% Design Project Due</b></p>	<p><b>Chap 15</b></p> <p><b>Chap 16</b></p>	-
Week 17	4/29	Study day (No Class)		
Week 18	5/6	<b>Final Exam</b>		

- Exams are denoted in red.
- Design projects are denoted in green.
- Textbook chapter numbers and titles are denoted in blue.

## DESIGN PROJECT

### 1. Project Objective

The purpose of the class project is to practice the fundamentals for the design of wastewater treatment plant. A design team that is consisted of 2 students will provide preliminary design services for improvements to the existing wastewater treatment facility. The preliminary design report should describe how the upgraded plant will produce a plant effluent that will meet the regulatory requirements.

### 2. Project Time Line

- Week 4: Design Project Overview 1
- Week 5: Identifying Team Members
- Week 9: Design Project Overview 2
- Week 13: 60% Preliminary Design Report Due
- Week 16: 100% Preliminary Design Report Due

### 3. Design Components

- Headworks
- Grit removal facility
- Primary clarifier
- Biological nutrient removal system
- Secondary clarifier
- RAS/WAS pumping system
- Tertiary filter
- Disinfection facility
- Sludge treatment facility (WAS thickening, digestion, and dewatering)

### 4. Preliminary Design Submittal Requirements

- Cover page
- Table of contents
- Memorandum
- Process flow diagram (PFD)
- Tabular presentations of design criteria for the proposed facilities
- Constituent mass loadings
- Design calculations for the proposed and the existing facilities
- Calculations for oxygen demand and air flow rate with ceramic fine bubble diffuser
- Pipe sizing table showing the pipe label, number of parallel pipe, flowrate per pipe, and pipe diameter, and flow velocity
- General site layout with yard piping
- Mass balance for BOD and TSS under monthly peak conditions
- Plant Hydraulic Profile

5. Evaluation Factors (Grades will be assigned based on the following factors)

- Memorandum (10%)
- Design Calculations (10%)
- Proposed Plant Design Criteria Table (10%)
- PFD (10%)
- Pipe Sizing (10%)
- Site Layout (10%)
- Hydraulic Profile (10%)
- Mass Balance (10%)
- Overall Format and Neatness (10%)
- Overall Effort (10%)

### **STATEMENT ON ACADEMIC INTEGRITY**

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own.

All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: <http://www.usc.edu/dept/publications/SCAMPUS/gov/>. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>.

### **STATEMENT FOR 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 me (or to TA) as early in the semester as possible.

#### **DSP Contact Information**

Office location: STU 301

Hours open: 8:30 a.m. until 5:00 p.m. — Monday through Friday.

Phone number: (213) 740-0776