



CE 485 Water and Wastewater Treatment Design
Units: 4
Fall 2024—Wednesdays—Time: 6:30-9:30PM
Location: KAP 159

Instructor: Wonho Warner Song, PhD, PE, BCEE
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Teaching Assistant:

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Office Hours and TA Discussion Session: TBD

Course Description

Engineering design of unit operations and processes for water and wastewater treatment, including chemical coagulation, flocculation, sedimentation, filtration, and disinfection; preliminary, primary, secondary, tertiary, and advanced treatments; and sludge treatment and processing.

Expanded Course Description

Water and Wastewater Treatment Design provides the fundamentals for the design of water and wastewater treatment system. This course is appropriate for senior level or graduate-level students, who have background knowledge of physics, water chemistry, microbiology, and fluid mechanics. Throughout the course, the students will learn engineering design of unit operations and unit processes for water and wastewater treatment, including chemical coagulation, flocculation, sedimentation, filtration, and disinfection (chloramination, UV disinfection); preliminary treatment (screening, coarse solids reduction, grit removal), primary sedimentation, secondary treatment (carbonaceous and nutrient removal), tertiary (granular media filtration, cloth media filtration), and advanced water treatments (microfiltration and reverse osmosis); and sludge treatment and processing (thickening, aerobic/anaerobic digestion, dewatering). Additionally, the course provides the basics on technology selection, evaluation and comparison of different treatment alternatives, chemical feed and storage systems, life-cycle cost analysis, mass balance, and plant hydraulics.

Learning Objectives and Outcomes

- To apply principles of physics, chemistry, microbiology, and fluid mechanics to perform engineering analysis and design calculations for water and wastewater treatment systems.
- To provide students with a comprehensive theoretical and practical foundation, enabling them to proficiently design and operate water and wastewater treatment systems in a cost-effective manner.

Perquisite

- CE 453 Water Quality Science and Engineering
- CE 363L Water Chemistry and Analysis

Textbook

Metcalf & Eddy / AECOM. Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, McGraw-Hill, 2013 (ISBN 13: 978-0073401188, ISBN 10: 0073401188)

References

Kawamura, Susumu. Integrated design and Operation of Water Treatment Facilities, Second Edition, John Wiley and Sons, Inc. 2000

Preparation Before Class

Students are required to download and preview class materials prior to class. Reading assignments will be made from the textbook and the lecture notes.

Class Attendance

Attendance in lectures is mandatory. [Non-attendance may result in a lower grade](#). Students should provide [proper documentation prior to the missed class](#), such as a doctor's note for illness or a business trip itinerary for a conference.

Grading Breakdown

Midterm Exam	25%
Final Exam	30%
Design Project	20%
Quizzes	15%
Homework	10%

Policies on Late Work

[Late assignments will incur a 5% deduction per day](#), up to a maximum of 35%. Assignments will not be accepted if they are more than seven days late.

Schedules for Exams, Quizzes, and Projects

Quiz 1	Sep. 18, 2024
Midterm	Oct. 16, 2024
60% Preliminary Design Report (PDR) Due	Nov. 6, 2024
Quiz 2	Nov. 13, 2024
100% PDR Due	Dec. 4, 2024
Final Exam	Dec. 11, 2024

Grading Scale

Final grades for the course will be determined according to the following scale, which is based on [100% attendance in the classes](#).

A	91-100
A-	87-90
B+	83-86
B	79-82
B-	75-78
C+	71-74
C	67-70
C-	63-66
D+	59-62
D	55-58
D-	51-54
F	50 and below

Weekly Schedule

Week No.	Date	Topic	Reading Assign	HW
Week 1	8/28	Design Project Management Preliminary Studies Drinking Water Standards	Lecture Note	HW 1 Due 9/4
Week 2	9/4	Chemical Systems Coagulation Flash Mixer Design	Chap 6 Lecture Note	HW 2 Due 9/11
Week 3	9/11	Flocculation Design Sedimentation Design Filtration Design	Lecture Note	HW 3 Due 9/18
Week 4	9/18	Quiz 1 Filtration Design	Chap 11	HW 4 Due 9/25
Week 5	9/25	Disinfection Water Treatment Plant Mass Balance	Chap 12 Lecture Note	HW 5 Due 10/2
Week 6	10/2	Introduction to Wastewater Treatment Wastewater Characteristics Design Project Overview 1	Chap 1 Chap 2	HW 6 Due 10/9
Week 7	10/9	Wastewater Flowrates and Constituent Loadings Process Selection, Design, and Implementation Physical Unit Processes Identifying Team Members Due	Chap 3 Chap 4 Chap 5	HW 7 Due 10/16

Week No.	Date	Topic	Reading Assign	HW
Week 8	10/16	Midterm Exam Physical Unit Processes	Chap 5	HW 8 Due 10/23
Week 9	10/23	Fundamentals of Biological Treatments	Chap 7	HW 9 Due 10/30
Week 10	10/30	Suspended Growth Biological Treatment Processes Design Project Overview 2	Chap 8	HW 10 Due 11/6
Week 11	11/6	Suspended Growth Biological Treatment Processes Attached Growth and Combined Biological Treatment Separation Processes for Residual Constituents Removal 60% PDR Due	Chap 8 Chap 9 Chap 11	HW 11 Due 11/13
Week 12	11/13	Quiz 2 Plant Hydraulics	Lecture Note	HW 12 Due 11/20
Week 13	11/20	Processing and Treatment of Sludges Biosolids Processing, Recovery and Beneficial Use Wastewater Treatment Plant Mass Balance Design Project Overview 3	Chap 13 Chap 14 Lecture Note	HW 13 Due 12/4
Week 14	11/27	Thanksgiving holiday	Lecture Note	-
Week 15	12/4	100% PDR Due Biological Enhanced Phosphorous Removal Air Emissions from Treatment Facilities and Their Control	Lecture Note Chap 16	-
Week 16	12/11	Final Exam		-

- Exams are indicated in red.
- Design projects are indicated in green.
- Topics and textbook chapter numbers are indicated 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 of 3 students will collaborate to deliver preliminary design services aimed at improving the existing wastewater treatment facility. The preliminary design report (PDR) should describe how the upgraded plant will produce a plant effluent that will meet the regulatory requirements.

2. Project Timeline

- Week 6: Design Project Overview 1
- Week 7: Identifying Team Members
- Week 10: Design Project Overview 2
- Week 11: 60% PDR Due
- Week 13: Design Project Overview 3
- Week 15: 100% PDR Due (Grading will be based entirely on a 100% PDR)

3. Design Components

- Headworks (screens, grit removal facility)
- Primary clarifier
- Biological nutrient removal system
- Secondary clarifier
- RAS/WAS pumping system
- Disinfection facility
- Sludge treatment facilities (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
- Design calculations for the proposed and the existing facilities
- Pipe sizing table showing the pipe label, number of parallel pipes, 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

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

- Memorandum (10%)
- Design Calculations (10%)
- Proposed Plant Design Criteria Table (10%)
- Process Flow Diagram (10%)
- Pipe Sizing (10%)
- Site Layout (10%)
- Hydraulic Profile (10%)
- Mass Balance (10%)
- Overall Presentation and Neatness (10%)
- Collaborative Teamwork (10%)

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Student Health Counseling Services - (213) 740-7711 – 24/7 on call

engemannshc.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call

suicidepreventionlifeline.org

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 – 24/7 on call

engemannshc.usc.edu/rsvp

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) | Title IX - (213) 740-5086

equity.usc.edu, titleix.usc.edu

Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.

Bias Assessment Response and Support - (213) 740-2421

studentaffairs.usc.edu/bias-assessment-response-support

Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.

The Office of Disability Services and Programs - (213) 740-0776

dsp.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710

studentaffairs.usc.edu/ssa

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101

diversity.usc.edu

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

dps.usc.edu

Non-emergency assistance or information.