

USC Viterbi

School of Engineering
*Sonny Astani Department
of Civil and Environmental
Engineering*

CE 476: Design of Hydraulic Systems
Units: 4

Fall Semester, 2021

**Class Time: 4:00 pm -5:50 pm,
Tuesday and Thursday**

Location: KAP 166

Instructor: J. J. Lee

Contact Hours: Tu, & Th 1:00 to 3:00 pm

Campus Office: KAP 224A

Contact Info: Email: jjlee@usc.edu;

Cell Phone : 626-221-8536

CE 476 Design of Hydraulic Systems (4 units)

Course Description

Design of pressurized and free surface hydraulic systems, piping network, surge suppression, pumps, turbines, submarine outfalls, water waves interactions with marine structures, breakwater design.

Learning Objectives and Outcomes

By the end of the course, the student will be able to:

1. Use and interpret hydraulic principles to distinguish the similarities and difference in pipe flows and free surface flows.
2. Apply continuity, momentum, and energy equations to flows in pressurized conduits; compute head losses due to friction and flow separations.
3. Design pressurized conduits for given discharge and head losses.
4. Design pipe transitions and thrust anchors and compute forces at bends. Design and analyze piping network and cross-connection control
5. Design manifold outfall diffuser system for sewage and thermal effluents, Develop strategies to enhance mixing and dilution.
6. Develop strategies for surge suppression, surge tank and air chamber.
7. Design pump and turbine and analyze water hammer effects.
8. Use and interpret specific energy principle for channel transition analysis
9. Design and analyze steady uniform and non-uniform open channels and compute water surface profiles.
10. Design non-erodible channels for subcritical, supercritical flows and channel control structures.
11. Design channel transition, culverts and inverted siphons. Design flood detention basins.
12. Compute sediment transport rate in channels, rivers, and in coastal zones.
13. Compute propagation and transformation of linear and nonlinear waves onto coastal zones.
14. Use and interpret similitude principles and model laws for distorted and undistorted models.
15. Design marine structures: groins, jetties and breakwaters.

Prerequisite(s): CE 309

Course Notes

Lecture notes will be provided by the instructor.

Lecture notes will cover the topics listed in the weekly schedule. They are developed by the instructor, they will be given at least one week in ahead and distributed in the classroom.

Required Readings and Supplementary Materials

Reference Books:

(1) Hydraulic Engineering by Roberson, Cassidy and Chaudhry, 2nd edition, John Wiley, ASIN: B008VQOWWW

(2) Water Resources Engineering by Larry may, 2nd edition, John Wiley, ISBN: 978-0-470-46064-1

(3) Mixing in Inland and Coastal Water by Fisher, List, Koh, Imberger and Brooks, Academic Press. ISBN: 9780122581502.

Description and Assessment of Assignments

Weekly home work: 12 homework sets will be assigned. Each set contains an average of 2 problems. Some problems will be given 20 points, some problems will be given 50 points depending on the efforts required to complete the assignments. Total weight of the homework is 25% of the course grade.

The assignments are to be completed by individual students.

Grading Breakdown

Assignment	% of Grade
Class Participation	10
Homework Assignments	25
Midterm Examination	30
Final Examination	35
TOTAL	100

Grading Scale

Course final grades will be determined using the following scale

A	90-100
B	80-89
C	70-79
D	50-69
F	Below 50

Course Schedule: A Weekly Breakdown

LECTURE NOTES ARE DEVELOPED BY THE INSTRUCTOR TO COVER TOPIC COVERED EACH WEEK. THEY ARE INTENDED TO HELP STUDENTS LEARN THE PRINCIPLES INVOLVED.

	Topics/Daily Activities	Readings and Homework	Deliverable/ Due Dates
Week 1	Review of basic principles in fluid mechanics. Similarities and differences in pipe flows and free surface flows.	Lecture notes to be provided. Chapter 1 of Roberson's Book	Homework 1 assigned
Week 2	Application of continuity, momentum and energy equations to pipe flows. Head losses due to friction and flow separation in pipes.	Chapter 5 of Roberson's Book (Sections 5.1-5.5) Supplemental notes to be provided	Homework 2 assigned Homework 1 due
Week 3	Design of pressurized conduits for given discharge and head losses. Design of pipe transition and thrust anchors and bends.	Chapter 5 of Roberson's Book. (Sections 5.6-5.9) Supplemental notes to be provided	Homework 3 assigned Homework 2 due

	Flow measurement systems		
Week 4	Design and analysis of piping network and cross-connection control. General entrainment equations for jets and plumes	Supplemental notes to be provided	Homework 4 assigned Homework 3 due
Week 5	Design of outfall diffuser system for sewage and thermal effluents in large body of waters, oceans, rivers, and lakes. Similarities and differences of sewage and thermal effluents.	lecture notes to be provided	Homework 5 assigned Homework 4 due
Week 6	Unsteady closed conduit flows, pressure change produced by velocity changes. Pressure wave propagation and reflection. Waves equations, method of characteristics. Transients caused by pumps Hydraulic machinery, pump and turbine. Selection of pump and turbine	Chapter 11 of Roberson's book (Sections 11.1 – 11.13)	Homework 6 assigned Homework 5 due
Week 7	Mid Term Week Engineering problems in steady and unsteady free surface flows.	Lecture notes to be provided	Homework 6 due Homework 7 assigned
Week 8	Specific energy and its relationship to critical, subcritical and supercritical flow. Momentum principle. Hydraulic jump, specific forces. Design of energy dissipaters, stilling basin, drop structures. Open channel control.	Lecture notes to be provided	Homework 8 assigned Homework 7 due

Week 9	Analysis and design of steady uniform and non-uniform open channels. Water surface profiles. Optimum design of channel section, hydraulic efficiency of channels.	Lecture notes to be provided	Homework 9 assigned Homework 8 due
Week 10	Design of non-erodible channels for subcritical and supercritical flows. Design of channel control structures.	Lecture notes to be provided	Homework 10 assigned Homework 9 due
Week 11	Design of channel transitions, culverts and inverted siphons. Design of flood detention basins.	Lecture notes to be provided	Homework 11 assigned Homework 10 due
Week 12	Sediment transport in channels, rivers, and coastal zones. Design of movable-bed channels.	Lecture notes to be provided	Homework 11 due
Week 13	Introduction to coastal engineering. Propagation and transformation of linear and nonlinear waves unto coastal zones.	Lecture notes to be provided	Homework 12 assigned
Week 14	Significant wave heights, design wave heights. Similitude and model laws involving free surface. Distorted and non-distorted models. Interpretation of model results	Lecture notes to be provided	Homework 12 due
Week 15	Design of coastal structures: groins, jetties, and breakwaters. Stability of breakwaters.	Lecture Notes to be provided	
FINAL			Date: For the date and time of the final for this class, consult the USC <i>Schedule of Classes</i> at classes.usc.edu/ .

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.