AME 309 (Section 28716) Dynamics of Fluids, Spring 2023

Unit: 4 units

Schedule: Mon, Wed 4:00–5:50am at SOS B46

Instructor: Takahiro Sakai, PhD

Office: OHE430H, Phone: 213(740)5367

Contact hours: Mon 2–3:30pm

Contact info: tsakai@usc.edu

Textbook: F. White, *Fluid Mechanics*, 7th ed. or later, McGraw-Hill (Electronic version Ok)

Learning Management: This course will be managed by Blackboard (`https://blackboard.usc.edu`). All homework assignments will be managed by Gradescope (`https://www.gradescope.com/`).

Course description: An introduction to concepts and analysis methods of fluid mechanics. Topics covered include: hydrostatics; buoyancy; conservation of mass, momentum, and energy in integral and differential form; dimensional analysis; control volume analysis; boundary layers; drag on objects; laminar and turbulent pipe flow; compressible flow; potential flow.
Pre-requisite: AME 201; Co-requisite: MATH 245; Recommended Preparation: AME 310

Learning Objective:

1. Learn the fundamental concept of fluids as a continuum medium.

2. Learn three approaches of fluid flow analysis: integral analysis, differential analysis and dimensional analysis.

3. Learn problem-solving strategies in engineering applications of fluids, including fluid systems in static equilibrium and in motion.

4. Solve engineering problems of incompressible, viscous, compressible, internal and external flows by applying conservation laws and empirical correlations through analytical approaches learned in class.

Grading: Homework 30% + Midterm Exams $2 \times 20\%$ + Final Exam 30%

Midterm Exams: There will be two midterm exams during the class, scheduled on **Wednesday February 22 (Exam 1)** and **Monday April 10 (Exam 2)**. No make up exam.

Final Exam: A comprehensive final exam is scheduled on **Friday May 3, 4:30–6:30pm** in accordance with the University's final examination schedule (NO exception). No makeup exam.

Homework: There will be ten problem sets total, assigned weekly or bi-weekly. Write *all your work* legibly and organize all the algebra and calculation steps line-by-line. **First you must solve the problem algebraically in terms of symbols, and then plug in numbers at the end or maybe at every major step of work flow. You must also write actual plug-in of numbers with physical units for dimensional unit consistency and work traceability.** Some points may be deducted, if you did not follow this guideline. Work must be submitted to Gradescope. Late homework is penalized by 50% deduction, if turned in within 24 hours past due, even a second late. No submission will be accepted after 24 hours past due. The worst homework grade will be dropped at the end of semester. This one-drop is primarily purposed as a provision for some unforseen emergency, but not to reward a better grade or some escape from study duty during the semester.

Makeup policy: For homework, you may take advantage of one-drop policy for the first time, for whatever the excuse is. For the second time, extension of due date may be considered only for documented medical emergency encountered by the student. The due-extension will not be considered for the third time and after. Makeup of midterm exam may be considered only for documented medical emergency and the symptom has not alleviated by the exam day. The makeup exam is completely different from the original exam and is usually more difficult. This exception is allowed one-time only. Makeup is never allowed for the final exam.

Tentative Schedule

Week	Day	Topics	Hw	Due
1	1/9	Concept of fluids		
	1/11	Viscous shear stress, surface tension	Hw1	Wed 1/18
2	1/16	**MLK day (Holiday)**		
	1/18	Fluid statics (1) hydrostatic pressure, fluid manometry	Hw2	Wed 1/25
3	1/23	Fluid statics (2) hydrostatic forces on submerged surfaces, buoyancy forces		
	1/25	Conservation of mass (1) Control volume, Reynolds transport theorem	Hw3	Wed 2/1
4	1/30	Conservation of mass (2)		
	2/1	Conservation of momentum (1)	Hw4	Wed 2/8
5	2/6	Conservation of momentum (2)		
	2/8	Bernoulli Equation	Hw5	Fri 2/17
6	2/13	Conservation of energy (1)		
	2/15	Conservation of energy (2)	Hw6	Wed 3/1
7	2/20	**President's day (Holiday)**		
	2/22	**Midterm exam 1**		
8	2/27	Differential analysis (1) Navier–Stokes equations		
	3/1	Differential analysis (2) Inviscid flow, stream function, velocity potential		
9	3/6	Differential analysis (3) Potential flow	Hw7	Mon 3/20
	3/8	Differential analysis (4) Viscous incompressible flow		
*	3/13	**Spring recess**		
	3/15	**Spring recess**		
10	3/20	Dimensional analysis		
	3/22	Viscous flow in pipes and ducts (1) Laminar flow	Hw8	Wed 4/5
11	3/27	Viscous flow in pipes and ducts (2) Turbulent flow, minor losses		
	3/29	Viscous flow around bodies (1) Viscous boundary layer metrics		
12	4/3	Viscous flow around bodies (2) Laminar and turbulent boundary layers		
	4/5	Viscous flow around bodies (3) Boundary layer separation, drag force	Hw9	Mon 4/17
13	4/10	**Midterm exam 2**		
	4/12	Compressible flow (1) Isentropic flow		
14	4/17	Compressible flow (2) 1D isentropic flow in ducts		
	4/19	Compressible flow (3) Normal shock wave	Hw10	Fri 4/28
15	4/24	Compressible flow (4) Oblique shock and Plandtl-Meyer expansion waves		
	4/26	Final exam review		
*	5/3	**Final exam (4:30–6:30pm)**		

Course Letter Grade Policy: The course letter grade will be determined based on the U.S. college standard scaling applied to the total weighted score. Number under the decimal point will be truncated (e.g., 89.99 → 89 → B+). A (93–100); A− (90–92); B+ (88–89); B (83–87); B− (80–82); C+ (78–79); C (73–77); C− (70–72); D− (68–69); D (63–67); D− (60–62); F (59 and below) This scaling will be unchanged unless the class average falls below 80%, in which case, the scaling will be curved so that the average is set to the lower cutoff of B−.

Academic Integrity: The Department of Aerospace and Mechanical Engineering adheres to the University's policies concerning Academic Integrity as described in the USC Student Handbook (https://policy.usc.edu/studenthandbook/). All faculty, staff and students share the responsibility for maintaining an environment of integrity. Students are expected to be aware of, and to observe, the academic integrity standards set forth in the USC Student Handbook . We will collectively follow these standards in this section of AME 309.

Support Systems:

Counseling and Mental Health – (213) 740-9355 – 24/7 on call
studenthealth.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) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) – (213) 740-5086
eeotix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.
Reporting Incidents of Bias or Harassment – (213) 740-5086 or (213) 821-8298

usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) – (213) 740-0776
osas.usc.edu OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention – (213) 821-4710
campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion – (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.

Office of the Ombuds – (213) 821-9556 (UPC) / (323-442-0382 (HSC)
ombuds.usc.edu
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice – (323) 442-3340 or otfp@med.usc.edu
chan.usc.edu/otfp
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.

Disclaimer: This syllabus is tentative and subject to change as needed during the semester. Any change will be announced in class in advance.