AME 309 (Section 28716) Dynamics of Fluids, Spring 2021

Unit: 4 units

Schedule: Mon, Wed 9:00–10:50am (Los Angeles time) at SLH103 and ONLINE

Instructor: Takahiro Sakai, PhD

Office: OHE430H, Phone: 213(740)5367

Contact hours: Mon, Thu 3–5pm on Zoom + Slack

Contact info: `tsakai@usc.edu`

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

Course Delivery: This course will be managed by Blackboard (`https://blackboard.usc.edu`). Lectures will be delivered through Zoom. All the assignments including exams and their submissions will be managed through 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; open channel flows; boundary layers; lift and drag on objects; laminar and turbulent pipe flow; compressible flow; potential flow over bodies.
Pre-requisite: AME 201; Co-requisite: MATH 245; Recommended Preparation: AME 310

Learning Objective:

1. Introduce the fundamental concept of fluids as a continuum medium.
2. Provide exposure to 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 practical problems in incompressible, viscous and compressible flows by applying conservation laws of fluid motion and empirical correlations.
5. Integrate fluid flow analysis, basic numerical methods, design, experimental testing, data collection and postprocessing for a fluid-system of practical engineering relevance.

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 March 10 (Exam 1)** and **Monday April 12 (Exam 2)**. The exam will be taken remotely and to be submitted to Gradescope. No make up exam.

Final Exam: A comprehensive final exam is scheduled on **Friday May 7, 8–10am** in accordance with the University's final examination schedule. The exam is in online format and submission to be made on Gradescope. No makeup exam.

Homework: Total eight homework sets will be assigned. Late homework is penalized by 25% deduction per day. Write *all your work* legibly and organize all the steps. It is recommended that you first work on the problem algebraically in terms of symbols and then plugin numbers at the end or every major break points of work flow. Work must be submitted to Gradescope.

Online Discussion Board: Slack (`usc.slack.com`) will be used as our online discussion platform. As the semester begins, our class channel will be created in the Viterbi workspace in Slack. Please see `https://keepteaching.usc.edu/students/student-toolkit/classroom/slack/` for quick start.

Tentative Schedule

Week	Day	Topics	Hw	Due
1	1/18	**MLK day (Holiday)**		
	1/20	Concept of fluids		
2	1/25	Viscous shear stress, surface tension	Hw1	Wed 2/3
	1/27	Fluid statics (1) hydrostatic pressure, fluid manometry		
3	2/1	Fluid statics (2) hydrostatic forces on submerged surfaces, buoyancy forces	Hw2	Wed 2/10
	2/3	Conservation of mass (1) Control volume, Reynolds transport theorem		
4	2/8	Conservation of mass (2)	Hw3	Wed 2/17
	2/10	Conservation of momentum (1)		
5	2/15	**President's day (Holiday)**		
	2/17	Conservation of momentum (2)	Hw4	Fri 2/26
6	2/22	Bernoulli Equation		
	2/24	Conservation of energy (1)	Hw5	Mon 3/8
7	3/1	Conservation of energy (2)		
	3/3	Differential analysis (1) Navier–Stokes equations		
8	3/8	Differential analysis (2) Analytical solutions to viscous incompressible flows		
	3/10	**Midterm exam 1**		
9	3/15	Dimensional analysis		
	3/17	Viscous flow in pipes and ducts (1) Laminar flow	Hw6	Mon 3/29
10	3/22	Viscous flow in pipes and ducts (2) Turbulent flow, minor losses		
	3/24	Viscous flow around bodies (1) Viscous boundary layer metrics		
11	3/29	Viscous flow around bodies (2) Laminar and turbulent boundary layers	Hw7	Fri 4/9
	3/31	Viscous flow around bodies (3) Boundary layer separation, drag force		
12	4/5	Compressible flow (1) Isentropic flow		
	4/7	**Wellness day (No class)**		
13	4/12	**Midterm exam 2**		
	4/14	Compressible flow (2) 1D isentropic flow in ducts		
14	4/19	Compressible flow (3) Normal shock wave		
	4/21	Compressible flow (4) Normal shock wave in duct, Oblique shock wave	Hw8	Fri 4/30
15	4/26	Compressible flow (5) Oblique shock wave, Prandtl-Meyer expansion wave		
	4/28	Final exam review		
*	5/7	**Final exam (8–10am, LA time)**		

Academic Integrity: The Department of Aerospace and Mechanical Engineering adheres to the University's policies concerning Academic Integrity as described in SCampus. 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 SCampus. We will collectively follow these standards in this section of AME 309.