AME 309 (Section 28716) Dynamics of Fluids, Spring 2022

Unit: 4 units

Schedule: Mon, Wed 9:00–10:50am at SOS B41

Instructor: Takahiro Sakai, PhD

Office: OHE430H, Phone: 213(740)5367

Contact hours: Mon 2–4pm

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 23 (Exam 1)** and **Monday April 11 (Exam 2)**. No make up exam.

Final Exam: A comprehensive final exam is scheduled on **Friday May 6, 8–10am** 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 neatly all the algebra and calculation steps. **First you must work on the problem algebraically in terms of symbols, and then plug in numbers at the end or every major step of work flow.** 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 any urgent circumstance for the first time. For the second time, extension of due date may be considered only when you are diagnosed positive at COVID-19 test and the symptom has not alleviated by the due date. The due-extension will not be considered for the third time and after. Makeup of midterm exam may be considered only for the COVID situation as stated for the case of homework. This exception is allowed one-time only. Makeup is never allowed for the final exam.

Tentative Schedule

Week	Day	Topics	Hw	Due
1	1/10	Concept of fluids		
	1/12	Viscous shear stress, surface tension	Hw1	Wed 1/19
2	1/17	**MLK day (Holiday)**		
	1/19	Fluid statics (1) hydrostatic pressure, fluid manometry	Hw2	Wed 1/26
3	1/24	Fluid statics (2) hydrostatic forces on submerged surfaces, buoyancy forces		
	1/26	Conservation of mass (1) Control volume, Reynolds transport theorem	Hw3	Wed 2/2
4	1/31	Conservation of mass (2)		
	2/2	Conservation of momentum (1)	Hw4	Wed 2/9
5	2/7	Conservation of momentum (2)		
	2/9	Bernoulli Equation	Hw5	Wed 2/16
6	2/14	Conservation of energy (1)		
	2/16	Conservation of energy (2)	Hw6	Wed 3/2
7	2/21	**President's day (Holiday)**		
	2/23	**Midterm exam 1**		
8	2/28	Differential analysis (1) Navier–Stokes equations		
	3/2	Differential analysis (2) Inviscid flow, stream function, velocity potential		
9	3/7	Differential analysis (3) Potential flow	Hw7	Mon 3/21
	3/9	Differential analysis (4) Viscous incompressible flow		
*	3/14	**Spring recess**		
	3/16	**Spring recess**		
10	3/21	Dimensional analysis		
	3/23	Viscous flow in pipes and ducts (1) Laminar flow	Hw8	Wed 4/6
11	3/28	Viscous flow in pipes and ducts (2) Turbulent flow, minor losses		
	3/30	Viscous flow around bodies (1) Viscous boundary layer metrics		
12	4/4	Viscous flow around bodies (2) Laminar and turbulent boundary layers		
	4/6	Viscous flow around bodies (3) Boundary layer separation, drag force	Hw9	Mon 4/18
13	4/11	**Midterm exam 2**		
	4/13	Compressible flow (1) Isentropic flow		
14	4/18	Compressible flow (2) 1D isentropic flow in ducts		
	4/20	Compressible flow (3) Normal shock wave	Hw10	Fri 4/29
15	4/25	Compressible flow (4) Oblique shock wave		
	4/27	Final exam review		
*	5/6	**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.