AME 309: Dynamics of Fluids

Units: 4.0
Fall 2023—Tue, Thu—Time: 12.00-1.50pm

Locations:
SLH 100

Instructors:

Mitul Luhar
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Office Hours: Tue, Thu 2.00pm-3.30pm
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Teaching Assistants:

Shilpa Vijay
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Course Description

This course aims to provide junior-level aerospace and mechanical engineering students with an in-depth introduction to fluid dynamics. Topics covered will include: fluid statics; conservation of mass, momentum, and energy (in both differential and integral form); laminar and turbulent flows; potential (ideal) flows; compressible flows; as well as several applications

Learning Objectives and Outcomes

This course will:

- Introduce the concept of fluids as a continuum media
- Provide exposure to three different analytical approaches when considering fluids problems:
    - Dimensional analysis
    - Control volume (integral) balances of mass, momentum, and energy
    - Differential equations governing fluid flow
- Teach problem-solving strategies in engineering applications of fluid dynamics, including fluid systems in motion and in static equilibrium
- Enable students to identify the most appropriate methodology for solving engineering problems

Prerequisite(s): AME 201

Co-Requisite(s): MATH 245

Textbook and Other Resources

There is no required textbook for this class. Course notes will be provided in electronic format via Blackboard. However, ***A. Smits, A Physical Introduction to Fluid Mechanics, Princeton University*** is recommended. This textbook is available for free at: http://www.efluids.com/efluids/books/efluids_books.htm.
Readings will be suggested from the book to supplement course notes. Other good resources:

- *B.R. Munson, D. F. Young, and T. H. Okiishi, Fundamentals of Fluid Mechanics, Wiley*
- *R. L. Panton, Incompressible Flow, Wiley*
- *F. M. White, Fluid Mechanics, McGraw-Hill*
- *M. Van Dyke, An Album of Fluid Motion, Parabolic Press (a beautiful book!)*

There is a series of 39 videos developed by the National Committee for Fluid Mechanics Films (NCFMF) that I would highly recommend for anyone interested in the subject:
http://web.mit.edu/hml/ncfmf.html.

Grading Breakdown

Assignment	**% of Grade**
Homeworks (8)	24
In-class Assignments (6)	6
Midterm 1	20
Midterm 2	20
Final	30
TOTAL	

Discussion board

Piazza will be used for all electronic discussions. Please post your questions (regarding homework assignments, class logistics, exams, etc.) on these forums instead of using email. You can access these through the Blackboard page for this course.

Gallery of Fluid Motion

We will be running a Gallery of Fluid Motion competition! Students are encouraged to capture images of fluid flow as they go about their daily activities (milk in coffee, cloud formations, waves while surfing etc.) and share them together with a brief description. You may also submit results from simulations. The students

who provide the top 5 entries (as judged by your peers) will receive an extra 3% towards their grade. The exact submission format will be detailed in class. For a prior gallery, see https://padlet.com/luhar/GoFM21.

Homework and In-Class Assignment Policies

There will be a total of 8 homework assignments. You will generally have one week for each assignment.

- No late homework will be accepted without prior arrangement.
- Discussion of homework assignments with your classmates is allowed (and encouraged!) but each student should develop and write their own original solution.
- Assignments should be submitted electronically, with legible and logically organized solutions that explicitly include all necessary steps and assumptions (if any) made.
- Course grading policy and letter grade equivalence: http://arr.usc.edu/services/grades/gradinghandbook/gradingpolicies.html

In addition to the 8 homeworks, there will be 8 short (<10 min) in-class assignments scattered throughout the semester. These will involve simple thought problems or they might repeat elements of a homework assignment. Two lowest scoring in-class assignments will be discarded.

Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	**Notes**
Week 1 8/21	TU: Introduction, Continuum Hypothesis, Applications TH: Fluid Statics	
Week 2 8/28	TU: Kinematics TH: Control Volume Analysis	HW 1 Due
Week 3 9/4	**TU: Labor Day (No Class)** TH:Conservation of Mass	
Week 4 9/11	TU:Conservation of Momentum I TH:Conservation of Momentum II	HW 2 Due
Week 5 9/18	TH: Conservation of Energy TU: Bernoulli's Equation	
Week 6 9/25	TH: Differential Equations for Fluid Flow I **TU: Midterm 1**	HW 3 Due
Week 7 10/2	TU: Differential Equations for Fluid Flow II TH: Vorticity and Irrotationality	
Week 8 10/9	TU: Streamfunction, Velocity Potential **TH: Fall Recess (No Class)**	HW 4 Due
Week 9 10/16	TU: Potential Flow Solutions TH: Dimensional Analysis	HW 5 Due
Week 10 10/23	TU: Dimensional Analysis TH: Pipe, Channel, Duct flows	
Week 11 10/30	TU: Minor Losses, Systems of Pipes TH: **Midterm 2**	HW 6 Due
Week 12 11/6	TU: Laminar Boundary Layers TH: Turbulent Boundary Layers and External Flows	
Week 13 11/13	TU: Jets and Wakes TH: Compressible Flow: Isentropic Flow, Acoustics	HW 7 Due
Week 14 11/20	TU: Normal Shocks and Nozzle Flow **TH: Thanksgiving Break (No Class)**	
Week 15 11/27	TU: Oblique Shocks and Prandtl Meyer Expansions TH: Introduction to Turbulence and CFD	HW 8 Due
FINAL	**TBD**	

Academic Dishonesty: Sanction Guidelines

Violation	USC – Recommended sanction	AME – Recommended sanction
Copying answers from other students on any course work **	F for course	First offense: F on assignment Second offense: F for course
One person allowing another to cheat from his/her exam or assignment	F for course for both persons	If assignment: First offense: F on assignment Second offense: F for course If exam: F for course
Possessing or using material during exam (crib sheets, notes, books, etc.) which is not expressly permitted by the instructor.	F for course.	First offense: F on exam. Second offense: F for course.
Continuing to write after exam has ended.	F for course.	F on exam
Taking exam from room and later claiming that the instructor lost it.	F for course and recommendation for further disciplinary action (possible suspension).	F for course
Changing answers after exam has been returned.	F for course and recommendation for further disciplinary action (possible suspension).	F for course
Fraudulent possession of exam prior to administration.	F for course and recommendation for suspension.	F for course
Obtaining a copy of an exam or answer key prior to administration.	Suspension or expulsion from the university; F for course.	F for course
Having someone else complete course work for oneself.	Suspension or expulsion from the university for both students; F for course.	F for course
Plagiarism — Submitting other's work as one's own or giving an improper citation.	F for course.	First offense: F on assignment. Second offense: F for course.
Submission of purchased term papers or papers done by others.	F for course and recommendation for further disciplinary action (possible suspension).	F for course
Submission of the same assignment to more than one instructor, where no previous approval has been given.	F for both courses.	F for both courses
Unauthorized collaboration on an assignment.	F for the course for both students.	First offense: F on assignment. Second offense: F for course.
Falsification of information in admission applications (including supporting documentation).	Revocation of university admission without opportunity to reapply.	Revocation of university admission without opportunity to reapply.
Documentary falsification (e.g., petitions and supporting materials; medical documentation.)	Suspension or expulsion from the university; F for course when related to a specific course.	Suspension or expulsion from the university; F for course when related to a specific course.
Plagiarism in a graduate thesis or dissertation.	Expulsion from the university when discovered prior to graduation; revocation of degree when discovered subsequent to graduation.***	Expulsion from the university when discovered prior to graduation; revocation of degree when discovered subsequent to graduation.***

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.