

TAM 435 “Intermediate Fluid Mechanics”

University of Illinois at Urbana-Champaign

Fall 2023

Instructor: Prof. Jie Feng

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Group website: <https://fengfluidslab.web.illinois.edu>

Course Website: <https://canvas.illinois.edu/courses/39543>

Meeting Location: 2045 Sidney Lu Mech Engr Bldg

Lectures: Monday and Wednesday 3:00–4:50 PM

Instructor Office Hours: Monday 5:00-6:00 PM, or by appointment. Office: 4421MEL.

Teaching Assistant: Colton D. Willhardt, coltonw3@illinois.edu

Teaching Assistant Office Hours: To be determined, or by appointment. Office: 1203 MEL

Discussion Forum: Hosted at Canvas

TEXTBOOK

Panton, R. L., Incompressible Flow (4th Edition, 2013)

full text available online via University of Illinois library:

https://i-share-uiu.primo.exlibrisgroup.com/permalink/01CARLI_UIU/q1ojeg/alma99776939712205899

CLASS DESCRIPTION

Analytical solution methods for problems involving ideal and real fluids.

Prerequisite: TAM 335, ME 310, or AE 312.

Course Credit: 4 undergraduate or 4 graduate hours.

ME: MechSE or technical elective.

EM: Secondary field elective.

TOPICS COVERED

- Continuum viewpoint and the equations of motion
- Inviscid flow (differential approach): Euler’s equation, Bernoulli’s integral, and the effects of streamline curvature
- Control volume theorems (integral approach): linear momentum theorem, angular momentum theorem, first and second laws of thermodynamics
- Navier-Stokes equation and viscous flow
- Dimensional analysis
- Potential flow theory
- Vorticity and circulation

- Boundary layers, separation, and drag
- Surface tension and its importance
- Compressible flow

GRADING

Homework 35%

You can and are encouraged to discuss the homework with your classmates but the solution you submit should be written by you and reflect your own understanding.

Attendance 5%

Exam 1 30% (Tentatively Monday October 16, during scheduled lecture time)

Exam 2 30% (Finals week, exact date and time to be determined)

HOMEWORK PROBLEMS

The main purpose of this course is not so much to feed the students with “advanced” material (the topics covered do not in fact appear terribly advanced) as to help students develop a mastery of the underlying principles and the ability to solve, quickly and efficiently, a variety of real fluid mechanics problems from first principles. The lectures present and illustrate the fundamental laws and the methods and modeling approximations that form the basis of fluid mechanics. The homework problems help the students gain a mastery of the material and to develop, by practice and trial and error, the mindset of an effective problem solver in fluid mechanics.

Your chances of doing well in this course are minimal if you do not independently do the assigned problems, and understand them deeply to repair weaknesses and develop new insights. We are ready to help you in every way to master the course material. There is, however, a profound difference between being taught and learning.

EXAMS

There will be two exams which will permit a limited number of pages of open notes (and a calculator). No books will be allowed. The exams will not present you with routine problems, but will probe for mastery of the underlying material and for skill in modeling problems in the simplest possible realistic terms.

SUPPLEMENTAL TEXTS (ON RESERVE IN THE LIBRARY):

Currie, I. G., Fundamental Mechanics of Fluids (4th Edition, 2013)

Kundu et al., Fluid Mechanics, (6th Edition, 2015) *

Batchelor, G. K.; An Introduction to Fluid Dynamics*

Landau, L. D.; Course of Theoretical Physics, Volume 6: Fluid Mechanics, 2nd Edition*

Schlichting, Hermann; Boundary-Layer Theory (9th ed., 2017)*

Aris, Rutherford; Vectors, Tensors, and the Basic Equations of Fluid Mechanics (1962)*

White, Frank; Viscous Fluid Flow (3rd ed., 2006)

Guyon, Etienne, et al.; Physical Hydrodynamics (2001)

* full text available online via UIUC library

OTHER RESOURCES:

National Committee for Fluid Mechanics Films (NCFMF)

<http://web.mit.edu/hml/ncfmf.html>

Collection of classic educational videos on fluid mechanics from the 1960's, all quite detailed and prepared by experts in the field, which cover nearly all of the fundamental phenomena of fluid motions. "Reading" assignments will include some of these videos.

MIT Graduate Course: Advanced Fluid Mechanics

<http://ocw.mit.edu/courses/mechanical-engineering/2-25-advanced-fluid-mechanics-fall-2013/>

Course materials from 2013 version of this iconic course, in the Mechanical Engineering Department at MIT, home of the late Ascher Shapiro, founder of NCFMF (see above).

Fk Yeah Fluid Dynamics (FYFD)**

<http://fuckyeahfluidynamics.tumblr.com/>

Blog dedicated to sharing the awesomeness that is fluid dynamics with the world—whether or not you care for calculus. Current events and curiosities, shown with beautiful videos and images, interpreted by fluid dynamicist Dr. Nicole Sharp, PhD.

Multimedia Fluid Mechanics

DVD-ROM from Cambridge University Press, which we shall use occasionally in class. Available for purchase (2nd ed., 2008, only ~\$30)

Annual Review of Fluid Mechanics

<http://www.annualreviews.org/journal/fluid>

Excellent reviews of the state of the art in all areas of fluid mechanics.

ADDITIONAL INFORMATION FOR THE UNIVERSITY OF ILLINOIS AND THE GRAINGER COLLEGE OF ENGINEERING

<https://wiki.illinois.edu/wiki/display/ugadvise/Syllabus+Statements>

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: <http://studentcode.illinois.edu/>.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: <https://studentcode.illinois.edu/article1/part4/1-401/>. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Disability-Related Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to <https://www.disability.illinois.edu>. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. You may access these by visiting the DRES website and selecting “Request an Academic Screening” at the bottom of the page.

Religious Observances

Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at <https://odos.illinois.edu/community-of-care/resources/students/religious-observances/> to request appropriate accommodations. This should be done in the first two weeks of classes.

Family Educational Rights and Privacy Act (FERPA)

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See <https://registrar.illinois.edu/academic-records/ferpa/> for more information on FERPA.

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: wecare.illinois.edu/resources/students/#confidential.

Other information about resources and reporting is available here: wecare.illinois.edu.

Anti-Racism and Inclusivity Statement

The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs. The College recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course director if you feel comfortable. You can also report these behaviors to the Bias Assessment and Response Team (BART) (<https://bart.illinois.edu/>). Based on your report, BART members will follow up and reach out to students to make sure they have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.