SIO 214A, Fluid Mechanics, Syllabus – Fall Q 2024
section 702512, 4 units

Instructor: Sarah Giddings, sgiddings@ucsd.edu
Class meetings: 30 September - 04 December 2024, M/W 09:30-10:50
Problem Session: W 08:30-09:20
Location: This class will be taught IN-PERSON in Eckart 227. If you need to be absent, please let me know IN-ADVANCE so that we can discuss recording the lecture or other options.
Office hours: TBD! See the when2meet on canvas
Website: Please use Canvas to access course material.

Course Summary:
A survey of classical problems in fluid mechanics and approximate techniques of analysis. Topics include kinematics, conservation equations, laminar flows, stability of laminar flows, and turbulent flow through a series of problem vignettes. Prerequisites: Graduate standing or consent of instructor. We will use vector calculus and differential equations throughout the course.

Expectations:
Participation in class and problem sessions is critical as I expect you to become proficient at problem solving and intuitive reasoning. While many of the assignments, mini-labs, and participation are not directly graded, a lack of engagement and understanding will be evident during the final oral exam as the content and problem solving approaches build upon each other throughout the quarter. Thus, completing the assignments and participating in class and mini-labs are critical to success. Grades will be based on homework (20%), a take-home mid-term (20%), and an oral final exam (60%). Note that while the homework will not receive detailed grading, all homework is assigned a numeric value and missing questions will be penalized relative to the total for that assignment. Furthermore, late homework without an extension request in advance will be penalized with a significant grade reduction (10% per day) for that particular assignment and late midterms will not be accepted. Note that some homework will require working with data and/or plotting where you can use your program of choice (e.g., MATLAB, Python, etc.)

Ethics & Academic Integrity:
For most regular homework assignments, I encourage you to discuss with and work with your peers. Sometimes the best way to learn something is to try to explain it to someone else or to see the question from another's perspective. Yet, at times, it is important for you to reflect on what you personally have learned and test your own knowledge boundaries. It is at these times that I may ask you to work independently and to not discuss the assignment or problems with anyone, for example during a take-home exam or in preparation for your final oral exam. I trust that as students pursuing a graduate degree you will follow proper ethical conduct as academic integrity is expected throughout your career. If at any point, you are unsure of the expectations for a particular assignment, exam, or other situation, please ask me. I will maintain a strict policy of ethical conduct throughout the course and follow the appropriate UCSD Academic Integrity process if any violations occur. No exceptions. Please sign and submit the UCSD Excel with Integrity Pledge.

Absences and occasional remote/recorded instruction for Fall 2024:
This class will be primarily IN PERSON, however there may be necessary exceptions to that. I do request that if you are sick, please use your best judgment and stay home if you have significant symptoms. Try to notify me IN ADVANCE so that we can find a way for you to participate in class and catch-up (i.e., thorough synchronous or asynchronous participation, or via peers and course notes). Most importantly, let us all pledge to remain respectful, supportive, and adaptable to ensure that educational goals are met. All course participants are bound by the UCSD Code of Conduct.

We will likely have 2-3 days of remote and/or recorded instruction during the quarter. For these, if they are remote, we will use Zoom with links available through Canvas and I will record the lectures for both synchronous and asynchronous participation. If fully recorded, I will post the lecture in advance.

Please reach out to me directly if there are issues prohibiting your full engagement in the course so that we can find a workable solution.

Canvas Instruction Policies:
I will be posting all course material in Canvas, and also sending announcements via Canvas, so please make sure you are able to access Canvas and contact me if you are not.

Office hours, email, and other communication:
There will be regular office hours (timing TBD) which are a good time to get help from me. Moreover we will go through the HW problems during the problem sessions on Wednesday mornings as a group. Due to my own schedule, my regular hours for responding to email is a bit unusual so you may not hear back from me on an email until the late evening or the following morning. I try to prioritize student emails, but if you have not heard back within 24 hours after sending, please send me a follow up email to make sure it comes back to the top of my inbox.

References:
Fluid Mechanics, Pijush K. Kundu and Ira M Cohen (KC4), Fourth edition, 2008, Academic Press.

A sixth edition, with one more coauthor Dowling are available online at https://www.sciencedirect.com/book/9780124059351/fluid-mechanics (KC6). Most notes have been updated to refer to the latest (KC6) edition.

Other Fluids texts

Introduction to Fluid Mechanics, G. K. Batchelor (GKB), Cambridge University Press

Fluid Mechanics, Lev D. Landau and Evgeny M. Lifschitz (LL), 1959, Pergamon Press.

Lectures on Geophysical Fluid Dynamics, R. Salmon (RS), 1998, Oxford University Press.

Some classical texts that are valuable for specific topics

Boundary-Layer Theory, H. Schlichting (HS), 1968. McGraw-Hill.

Physical Fluid Dynamics, D. J. Tritton (DJT), 1988. Oxford Science.

Fundamentals of Ocean Dynamics, V. M. Kamenkovich, 1977, Elsevier Scientific Publishing Company (www.sciencedirect.com/science/bookseries/04229894/16), the first two chapters emphasize thermodynamic considerations needed in arriving at equations of motion.

Elementary Fluid Mechanics, R. L. Street, G. Z Watters, J. K. Vennard (SWV), seventh edition, 1996, John Wiley and Sons.

Math reference

Methods of Mathematical Physics, P. M. Morse and H. Feshbach (MF I, MF II), 1953 McGraw-Hill.

Approximate Schedule

Week 1-2: Introduction, mathematics refresher, kinematics
Week 2-3: Conservation laws
Week 3: Boussinesq, Bernoulli, hydrostatics
Week 4-5: Problem vignettes (Poiseuille-Couette flow, wind driven flow on a lake, lubrication problem, Stokes first and second problems, Blazius boundary layer, gravity current)
Week 6-7: Vorticity, potential flows, flow around bluff bodies, lift/drag
Week 8-9: Conservation of energy and hydraulics
Week 9-10: Horizontal convection
Week 10: Instability (Raleigh Bernard, KH instability, Reynolds experiment), turbulence, course review