SYLLABUS for SIO177

Fluid Dynamics, Fall 2024

Instructor:
Janet M. Becker, jmbecker@ucsd.edu

Lectures: Mondays, Wednesdays and Fridays at 11am in person in SPIESS 330. Lectures will be podcast.

Problem Solving Sessions: Tuesdays 3:30-4:20pm, on Zoom (tentatively)

Office Hours: Wednesdays, 4:30-5:30pm, on Zoom (tentatively) or by appointment (e-mail me)

Academic Prerequisites: Phys 2A, Math 20D and Math 20E or consent of instructor.

Prerequisites by Topic: elementary mechanics, differential and integral calculus, elementary ordinary differential equations, multivariable and vector (differential and integral) calculus. We will review the prerequisites as needed.

Textbook:

P.K. Kundu, I.M. Kohen and D.R. Dowling, Fluid Mechanics, various editions. The 5th edition of this text is available through your UCSD account at:
https://www.sciencedirect.com/science/book/9780123821003
The first edition of the text with Kundu as the sole author is more appropriate for this course. We only will use selected sections of this text. Downloading from sciencedirect is strongly encouraged. You may, however, purchase the e-book or a hard copy if you prefer.

An introductory text that is available online through the UCSD library is Nakayama, Yasuki, 2018, Introduction to Fluid Mechanics, 2nd edition:
https://www.sciencedirect.com/science/article/pii/B9780081024379010019

Canvas website: Assignments and other course content will be posted to Canvas.

Course description:

Fluid Mechanics is the study of the behavior of fluids (liquids and gases) under various forces and in various configurations. This course starts with an introduction to the mechanics of fluids including fluid statics and kinematics. Fluid conservation laws will be presented and used, for example, to describe surface gravity waves, the settling of microplastics in the ocean, and boundary layer flows. Applications will be focused on problems of relevance to oceanic and atmospheric science. SIO 177 is the first course of a two course series with SIO 178, Geophysical Fluid Dynamics, offered in the winter quarter.

Topics covered:

1. Vector calculus: Scalar and vector fields, divergence, gradient, curl, integral theorems (briefly)
2. Fluid fundamentals: Units, continuum hypothesis, transport, statics, classical thermodynamics (parts of Chapter 1).
3. Kinematics: Describing the motion and deformation of a fluid without considering the generating forces (parts of Chapter 3)
4. Conservation laws: Statements of mass, momentum, and energy conservation. Bernoulli equation, boundary conditions, engineering examples (parts of Chapter 4)
5. Ideal Flows: Irrotational motion, velocity potential, two- dimensional stream function and velocity potential (parts of Chapter 6)
6. Gravity waves: Long (shallow water approximation) and short surface gravity waves, dispersion relationship, phase and group velocity, standing and progressive waves, particle paths, energy flux (parts of Chapter 7)
7. Laminar flows of viscous fluids: Poiseuille and Couette flow, Stokes' first and second problems, Stokes flow past a sphere, Stokes' law of resistance (parts Chapter 8)
8. Boundary layers: Prandtl's boundary layer theory describing thin viscous layers introduced to enforce the no-slip boundary condition on the surface of bodies in a flow field, Blasius' solution for a flat plate, boundary layer thickness, drag coefficient (parts of Chapter 9)

Course grade:

The final course grade will be based on following:

Homework assignments (40%), mid-term exam (15%), and final exam (45%).

Homeworks: We will have weekly homework assignments due on Wednesdays to Gradescope unless otherwise specified on the assignment. Only selected problems will be assessed and count to your homework score. You are responsible for reviewing the homework solutions posted and for correcting any mistakes in your homework.

Exams:

• Midterm exam: 30 October 2024, 11am-11:50am SPIESS 330 (Wednesday).

• Final exam: 10 December 2024 11:30am-2:30pm (Tuesday).

Course policy and Academic integrity:

1. Homework assignments and solutions will be available on the Canvas website.
2. All students are expected to adhere to the UCSD Policy on Integrity of Scholarship. You may discuss homework problems, but must prepare and submit homework reports on your own. Exams will have clear rules provided to students, and will be designed and administered to uphold academic integrity. For problems assigned from the textbook, the use of online solutions is prohibited.
3. Homework must be written clearly and neatly. The homework is due at the time specified on the assignment and you will upload your solutions to Gradescope. No late homework will be accepted without a valid reason.
4. Asking questions during the lectures is encouraged and appreciated.
5. The lectures for this course will be delivered in person and podcast. Office hours and our discussion section will be remote over zoom.

Disability Resources: Students requesting accommodations for this course due to a disability must provide a current Authorization for Accommodation (AFA) letter issued by the Office for Students with Disabilities (OSD) which is located in University Center 202 behind Center Hall. Students should present their AFA letters to Faculty (please make arrangements to contact me privately) at least two weeks prior to an exam to ensure that accommodations may be arranged.

Contact the OSD for further information:
T: 858.534.4382
E: osd@ucsd.edu
W: http://disabilities.ucsd.edu

Disability Resources, Triton Testing Center: Exams requiring accommodation will be administered by the Triton Testing Center (TTC). Students authorized for accommodation must register with the TTC by completing the student registration form. Once the form is completed (they need only do this once), TTC will review their request and create or update the their RegisterBlast/TTC account. Then, TTC will send the students the RegisterBlast log-in information. If they are a student with accommodations and received their AFA letter(s) for the course(s) they have at the TTC, they can copy and paste their accommodations into the registration form.

How to access your TTC account:

To log into your account for the first time please visit this website, enter your UCSD email address, and select a new password:
https://www.registerblast.com/ucsd/ResetRequest/Password/4
Once you have your password, you can access your account at this link:
https://www.registerblast.com/ucsd/User/Authenticate

Answers to frequently asked questions and information on how to schedule a test may be found at the TTC webpage.

Students must schedule their test with TTC at least 3 days in advance.