

Syllabus

CHE 443: Chemical Engineering Fluid Mechanics Fall 2022

CHE 443 explores the fundamental principles of fluid mechanics as applied to chemical engineering and chemical processing operations.

Lectures

TTh, 12:00 – 1:50 pm, KAP 156

Discussion Sections

Thursdays, 3:00 – 3:50 pm, WPH 203

Fridays, 4:00 – 4:50 pm, CPA 161

Note: Please attend the discussion section you have registered for, as space is limited.

Instructor

Noah Malmstadt

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Office Hours: Wednesdays 10:00 – 11:00 am or by appointment

Teaching Assistant

Ricki Chairil

Office: RTH 521 (Meeting in the workspace in the hallway outside of room 512)

Email: chairil@usc.edu

Office Hours: Thursdays 2:30 – 3:30 pm

Prerequisites

One of either CHE 350 or MATH 245.

Text

Introduction to Chemical Engineering Fluid Dynamics by William M. Deen, 2016, ISBN 978-1-107-12377-9

Communication resources

Slack workspace: che443.slack.com

Blackboard will be used for posting information and assignments as well as turning in work.

Grading

Grades will be based on weekly homework assignments, two midterm examinations, and a final examination.

The proportions of the final grade determined by each of these elements will be as follows:

Homework: 10%

Midterms: 25% each

Final: 40%

For homework, each assignment will receive 0, 1, or 2 points. A score of zero points corresponds to an inadequate effort or missing assignment, a score of 1 point corresponds to a good effort that displays some understanding of the material, and a score of 2 points corresponds to an excellent effort that demonstrates and communicates a mastery of the material. Note that **communication** is a key element of this scoring system. If you have mastered the material, you should be able to clearly and unambiguously communicate a solution of the problem in a manner that is obvious to the graders. It will be difficult for us to assign 2 points to a homework assignment in which we must intuit, interpret, and make assumptions about your meaning.

Exams will be take-home; they will be due 24 hours after being distributed as a scanned / photographed file via Blackboard. Exams will be graded according to a rubric that will be made available following the administration of the exam. There will be no lecture on the day that exams are distributed. Midterm exams will be worth 50 points each, the final exam will be worth 80 points.

Final grades will be calculated as follows: Total points will be added and transformed into percentages; the arithmetic mean of the percentage scores will be determined. If the highest score in the class is ten or more percentage points higher than this mean, the mean score will receive a B, ten percentage points above the mean will receive an A, ten percentage points below the mean will receive a C, twenty percentage points below the mean will receive a D, etc. If the highest score in the class is less than ten percentage points above the mean, the highest score will receive an A, ten percentage points below the highest score will receive a B, ten percentage points below that will receive a C, etc.

Collaboration Policy

Students are encouraged to discuss and work together on homework assignments, but the work each student hands in must be their own. It is not acceptable to merely copy another student's effort; each student must be capable of fully understanding and describing everything they have written in the submitted homework assignment. To ensure that this is the case, it is recommended that when working in a group (group sizes of five or fewer are recommended), students plan their approach to a problem making notes on scratch paper or a blackboard. The work that each student submits, however, should be written independently without referencing these notes. If you have any doubts regarding whether a certain instance of collaboration is acceptable at any point in the semester, ask the instructor for clarification.

Work on exams will be completely independent.

Homework Due Dates

Homework assignments will be available at 12 pm each Tuesday, and they will be due in the at 2 pm the next Tuesday. Homework will be posted on Slack and Blackboard and can be turned in as a photograph or scan on Blackboard. There will be no homework due on exam weeks.

Lecture and Reading Schedule

This schedule is subject to change, with notice.

Part 1: Fluid Phenomenology

- Week 1: Definition and properties of fluids. Scaling, dimensionless groups, and dimensional analysis.
Chapter 1
- Week 2: Pipe flow. Friction factor, cylindrical and noncylindrical pipes, wall roughness.
Chapter 2
- Week 3: Flow around particles: drag and terminal velocity. Flow through porous media.
Chapter 3

Part 2: Macroscopic Analysis of Fluid Mechanics

- Week 4: Macroscopic mass, momentum, and energy balances
Chapter 11
- Week 5: Pipe flow, compressible flows, pumps.
Chapter 12

Part 3: Describing Forces and Motion in Fluids

- Week 6: Statics. Describing pressure, body forces, and surfaces. Review of scalar fields.
Chapter 4
- Week 7: Kinematics. Fluid velocity. Review of vector fields.
Chapter 5
- Week 8: Stress and momentum. Review of tensors.
Chapter 6

Part 4: Microscopic Analysis of Fluid Mechanics

- Week 9: Introduction to microscopic analysis. Unidirectional flow. Symmetry.
Chapter 7
- Week 10: Introduction to viscous flow. Lubrication approximation and creeping flow.
Sections 8.1-8.3
- Week 11: Introduction to finite element modeling of the equations of flow.
To be distributed
- Week 12: Pseudosteady flow and approximate solutions.
Sections 8.4-8.5

Week 13: Laminar flow with inertia. Boundary layers.

Chapter 9

Week 14: Flow considerations for microfluidics. Forces on particles and cells in microflows.

To be distributed

Week 15: Turbulence.

Chapter 10

Special Dates

Tues. Sept. 27: Exam 1 distributed

Thurs. Oct. 13: Fall Recess, no class

Tues. Nov. 1: Exam 2 distributed

Thurs. Nov. 24: Thanksgiving Recess, no class

Thurs. Dec. 1: Final CHE 443 class meeting

Tues. Dec. 13: Final Exam due, 1:00 pm

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 Section 11, *Behavior Violating University Standards*:

<https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/>

Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct:

<http://policy.usc.edu/scientific-misconduct>

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equality and Diversity* (<http://equity.usc.edu>) or to the *Department of Public Safety*:

<http://adminopsnet.usc.edu/department/department-public-safety/online-forms/contact-us>

This is important for the safety of the whole USC community. Another member of the university community—such as a friend, classmate, advisor, or faculty member—can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men*:

<http://www.usc.edu/student-affairs/cwm>

provides 24/7 confidential support, and the sexual assault resource center webpage (<https://sarc.usc.edu>) describes reporting options and other resources.

Support systems

A number of USC’s schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* (<http://dornsife.usc.edu/ali>), which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs*:

http://sait.usc.edu/academicssupport/centerprograms/dsp/home_index.html

provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* (<http://emergency.usc.edu>) will provide safety and other updates, including ways in which instruction will be continued by means of BlackBoard, teleconferencing, and other technology.