

CHEN 3200 Fluid Mechanics

Spring 2022

Tu/Th 10:00–11:15 AM

JSCBB A115

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Office Hours: (see Canvas for locations, Zoom links and times)

Course Management System: Canvas will be used for class problems, grades, reading assignments, lecture templates, and other announcements.

Email: Please send email related to class issues to chen3200@colorado.edu .

Pre-requisites:

CHEN 2120 Material and Energy Balances (grade of C or better)
APPM 1350, 1360, 2350 (grade of C- or better); co-req APPM 2360

Required text: *Fundamentals of Fluid Mechanics*, Gerhart *et al.*, 8th edition, Wiley

Materials including Ebook and online resources can be found through the Course Materials link on the Canvas site. These materials are being provided by the CU Book Store through a program called "Day 1 Digital Access". You should receive additional information about pricing and opting-out directly from the bookstore.

Grading

A flexible grading policy will be employed, permitting a balanced review of all aspects of the class to assign final letter grades. For example, students with 90% or above will receive an A, but students with total scores below 90% may potentially be upgraded based on overall performance. Thus, the final **overall** grade is subject to adjustment upward from a standard scale.

The weightings of the different course components are as follows:

Homework:	30%
Midterm 1:	20%
Midterm 2:	20%
Final Exam:	30%

Exams

There will be two midterms and one final exam. Listed below are the dates and times.

Midterm 1: Tuesday, February 15th, 10-11:15am

Midterm 2: Thursday, March 17th, 10-11:15am

Final Exam: Tuesday, May 3rd, 4:30–7pm

Any student who misses an exam without excuse will be dropped from the class. If a student has an excused absence for a Midterm Exam, that exam score will be automatically replaced by their Final Exam score. The Final Exam is required to complete the course. For the majority of students who take all three exams, if their Final Exam score is higher than their lowest Midterm score, the Final Exam score will replace that Midterm score. All exams are closed-book unless noted by the instructor. Please note that a final grade of C- or better is required in order to enroll in future chemical engineering courses that require CHEN 3200 as a pre-requisite.

Homework

Answers to homework problems will be submitted by one member of each three-person group through the Gradescope portal. Assignments will be made available through the site on Wednesday and will be due the following Wednesday by 9:00 am, unless otherwise indicated. Late submissions will not be accepted by the system. In the case of emergency circumstances, the student should inform the instructor before the due date to make alternative arrangements. The solutions to homework assignments will be posted immediately after the due date.

COURSE LEARNING GOALS

Fluid Mechanics Knowledge

1. Fundamentals of Fluid Mechanics

- understand characteristics of fluid behavior
- use force balances to solve basic fluids problems
- understand units and dimensions
- understand properties of fluids

2. Fluid Statics

- derive basic equation for a pressure field
- solve manometry problems
- analyze hydrostatic forces on different surfaces
- understand and use buoyancy equations

3. Incompressible Fluid Dynamics

- derive and understand when to use Bernoulli's equation
- interpret velocity and acceleration fields

4. Fluid Kinematics

- understand velocity and acceleration fields
- understand Eulerian and Lagrangian descriptions of flow
- understand the material derivative
- derive and use Reynolds Transport Theorem

5. Control Volume Analysis

- use finite control analysis to apply conservation of mass and Newton's second Law to analyze fluid flow
- understand and apply continuity, linear momentum, and energy equations

6. Differential Analysis of Flow

- understand differential mathematical formulation of flow
- use differential analysis to apply conservation of mass to fluid flow
- understand and apply equations of motion for inviscid and viscous flow

7. Dimensional analysis

- apply Buckingham Pi Theorem to develop dimensionless groups
- Correlate experimental data with pi terms
- understand and apply modeling and similitude

8. Pipe Flow

- understand and compare laminar and turbulent flow
- apply appropriate equations for entrance length/fully developed flow
- analyze major and minor losses in a pipe
- calculate parameters such as velocity and pressure drop in pipe systems

9. Flow over Immersed Bodies

- apply lift and drag concepts
 - derive and use boundary-layer equations
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Cross-Cutting Engineering Skills

- Understand Abstract Concepts – Engineering methods are based on complex underlying science and often expressed in the language of mathematics. By understanding these concepts, engineers are able to develop ways to solve specific problems that they have not previously encountered.
- Choose Correct Methods – Engineering problems are often complex and require different approaches in different scenarios. Engineers must therefore understand the distinctions between exact, approximate, numerical, and empirical approaches to solving engineering problems, the advantages and limitations of each, and when to use each approach.
- Get Resources – Engineers must be able to identify, find, and employ the necessary resources (e.g. tabulated data and/or governing equations) to solve engineering problems.
- Use Math – Engineers employ sophisticated mathematical concepts (e.g. symmetry) and methods (e.g. multivariable calculus and differential equations) to simplify and solve concrete engineering problems.
- Teamwork – Solve engineering problems with teams that comprise members with diverse backgrounds, skill-sets and perspectives.
- Solve Problems – Engineers are often presented a problem expressed in plain real-world language and use the skills described above (and others) to develop quantitative and accurate solutions, and express the solutions in ways that have practical utility.

Class Format:

This class will be taught via a combination of lectures and office hours. The textbook is an important resource, and you will be responsible for the material in the assigned reading assignments. To get the most out of lectures, you should read each assignment before class. To facilitate note-taking, lecture templates will be provided in advance for some classes.

Academic Dishonesty, Ethics, and Discipline:

Any discovered incidents of academic dishonesty will be reported to the departmental Academic Ethics Committee, which will recommend an academic sanction. Sanctions can range from an F for the particular assignment and a lowering of your grade at least a full letter grade to an F for the course. In addition, all confirmed incidents will be reported to the University Honor Code where further disciplinary action can be taken. Group activities in which a student asks another student for a helpful suggestion will not constitute such an incident. However, using someone else's work, or allowing another student to use your work will be considered a dishonest act. When in doubt, ASK!!! The following list includes some of the examples of acts (not all of them) for which a hearing will result:

- Communicating with anyone during an individual exam.
 - Using any information in an exam that is not expressly permitted.
 - Plagiarizing solutions to homework such as using information from an Official Solutions Manual. This includes using solutions from previous class takers.
 - Any alteration, forgery, or falsification of official records (such as modification of graded homework problems or exams for which you are seeking additional credit).
 - Allowing another person to take an exam for you (false identification).
 - Knowingly providing material of your own or of others to a fellow student.
 - Possession of or observation of examinations or solutions to examinations prior to the date and time of the exam.
 - Copying answers from other students during an exam.
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University Policies

Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Conduct & Conflict Resolution policies](#).

Requirements for COVID-19

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

CU Boulder currently requires masks in classrooms and laboratories regardless of vaccination status. This requirement is a precaution to supplement CU Boulder’s COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the [Public Health Office](#) (contacttracing@colorado.edu). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the [Public Health Office](#) (contacttracing@colorado.edu). Please contact Prof. Schwartz by email if you expect to miss class.

Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); (303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. See the [campus policy regarding religious observances](#) for full details.