FLUID MECHANICS

ENGR 3380

Fall 2024
Ingram School of Engineering
Texas State University

LECTURE
9:30 AM - 10:50 AM Mon & Wed
Family & Consumer Sci Building 00188

LAB (one meeting every other week)
Session 1: 2:00 - 3:20 pm Mon
Session 2: 12:30 - 1:50 pm Tue

In this course, we are committed to learning together to think for ourselves. Pursuit of this ideal relies upon civil behavior towards all course participants such that all have an equal opportunity for learning regardless of gender identity, gender expression, race, color, national or ethnic origin, religion or religious belief, political affiliation, age, marital status, sexual orientation, ability status, veteran status, familial background, or any other reason not related to intellectual merit. Participants in this course are expected to assist in sustaining this inclusive community.

Course description

This is an introductory course to fluid mechanics where we study fluid motion, the forces that fluids exert, and the forces that are exerted on them. The field of fluid mechanics is broad and has numerous science and engineering applications.

Fluids interact with structures such as dams, bridges and the static and dynamic loads imposed by the fluids must be considered in the design and construction of these structures. Cars, aircraft, and ships all move through fluids, and hydrodynamic and frictional forces (e.g., lift and drag) represent a major energy sink. Water, as one of the simple types of fluids, is an important resource to Texas and the world and fluid mechanical problems related to water interactions with dams, aqueducts, treatment plants, pipes, valves, as well as groundwater flow need to be solved to efficiently deliver water to urban and agricultural consumers.

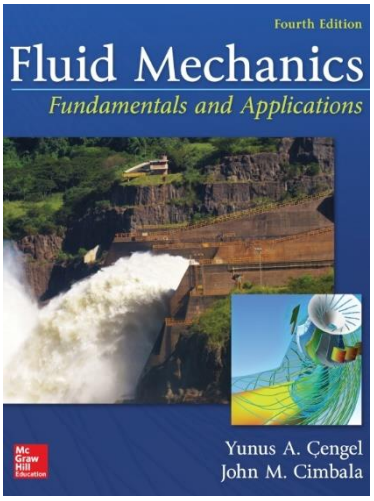
This course will be delivered as a combination of lecture with laboratory. Lectures discuss fundamental concepts in fluid mechanics and the application of different methodologies to monitor and measures fluid flow, pressure at a point, energy loss, drag and other fluid characteristics. Laboratory exercises will involve the use of standardized experimental methods and commercial sensing devices to run experiments, gather data, analyze and interpret test data, and prepare graphics to visualize the data.

GOALS

By the end of this course, participants will be able to 1) have a broad understanding of the scientific principles governing fluids,
2) apply fluid principles to several areas of engineering analysis and design,
3) be proficient in communicating knowledge of fluid mechanics results through written reports.

OPTIONAL TEXTBOOK

Fluid Mechanics: *Fundamentals and Applications*, 4th Edition, Cengel & Cimbala (2017). McGraw-Hill Higher Education



Other Sources

Engineering Fluid Mechanics, 12th Edition, Elger, LeBret, Crowe, & Roberson

+ HANDOUT from Dr. Cho

TEACHING MODALITY

The course will be offered in person.

COMMUNICATION

Use the office hours and/or email me. You are responsible for ensuring that the primary email address you have recorded with the university is the one you will check for course communications because that is the email address that Canvas uses.

ASKING FOR HELP

During a class:

If you don't understand something or think the class is going too fast, don't hesitate to raise your hand and ask! I'm sure others are feeling the same way. And don't worry if the questions slow us down - it's my job to adjust, and interactions make everyone's experience in class much more enjoyable.

Outside of class:

If you have a quick question regarding the course (the due date, syllabus, lecture, homework, test, etc.) that you think I can answer in a minute, you can ask me before or after the lecture.

Your instructor

Dr. Eunsang Cho

- Office
Ingram Hall (IGRM) 5311
- Office hours: 11:00 AM - 12:00 PM Mon & Wed and by appointment
- Email:
eunsang.cho@txstate.edu

"You can call me Prof. Cho or Dr. Cho"

Graduate TA & Lab instructors

Jipeng Liu
- Office hours: TBD
- Email: ibo20@txstate.edu

Himmat Basnet
- Office hours: TBD
- Email: gyc22@txstate.edu

If you have other questions that you think I cannot answer in a minute, I encourage you to find me or TAs without an appointment during office hours to ask any questions related to the course. I will make myself available outside of the given office hours if necessary.

Otherwise, Canvas will be the primary method of communication outside of class time. Students are recommended to communicate with the instructor or TA via Canvas. I will do my best to respond to the Canvas messages within 2 business days. If there is no reply after 2 days, please send the exact same message again.

FEEDBACK

I really care about what the students think about this class and take what they say seriously. I will always try to make the class better. So, I'd love to hear your thoughts on parts that work well and don't. And if you would like to provide feedback, don't hesitate to contact me by email, or talk to me during class and office hours. I want everyone to have a great time and learn something from this course.

GRADING WEIGHTS

- Lecture: 70%
  - Attendance/reflections 5%
    - Skipping the classes more than 2 consecutive times without a written excuse may lead to lower your final grade at the professor's discretion.
  - Assignments 10%
    - Assignments will be posted on the class Canvas and should be submitted on Canvas in time. It is students' responsibility to check the Canvas for notifications.
    - There will be a 50% penalty for any late submission.
    - No assignments will be accepted 3 business days past the deadline.
  - Quizzes 5%
  - Mid-term Exams (high: 15%, low: 10%)
  - Final Exam 25%
- Laboratory: 30% "*Attendance is mandatory for every lab session*".
  - Participation /cleanup 3%
    - Skipping the labs 2 times may lead to lower your final grade at the professor's discretion.
  - Pre-Lab Quizzes 3%
  - Lab Report 24%
    - Lab report should be submitted by group to Canvas in time.
    - There will be a 50% penalty for any late submission (all group members).
    - No lab reports will be accepted 3 business days past the deadline.

In general, A: 90-100, B: 80-89, C: 70-79, D: 60-69, and F: < 60.

Lecture Schedule (subject to change)

Week 1 [Aug 26]	Orientation, Introduction, Units, Fluid Properties	Chapter1	
2 [Sep 4]	Fluid Properties	2	**Labor Day Holiday (Mon)*
3 [Sep 9]	Pressure and Fluid Statics	3	
4 [Sep 16]	Pressure and Fluid Statics	3	
5 [Sep 23]	Fluid Kinematics	4	
6 [Sep 30]	Bernoulli and Energy Equations	5	
	First Mid-term Exam on **Oct 2 (Wed)**		
7 [Oct 7]	Energy & Hydraulic Grade Line	5	
8 [Oct 14]	Momentum Analysis of Flow System	6	
9 [Oct 21]	Guest Seminar (TBD) / Momentum	6	
10 [Oct 28]	Dimensional Analysis	7	
11 [Nov 4]	Internal flow	8	
	Second Mid-term Exam on **Nov 6 (Wed)**		
12 [Nov 11]	Differential Analysis of Fluid Flow	9	
13 [Nov 18]	External Flow: Drag & Lift	11	
14 [Nov 25]	Open Channel Flow	13	**Thanksgiving Holiday (Wed)*
15 [Dec 2]	Open Channel Flow; Exam Review	13	
	Final Exam on **Dec 7 (Sat)**		

Course Components and Policy

1. **The assigned reading is an indispensable component of the course.** The textbook covers the material at a level appropriate to this course. It also has several examples. In the few cases where the textbook coverage is deemed insufficient, handouts of "text supplements" will be supplied and assigned. The lectures will NOT systematically cover the assigned reading, but rather will emphasize general principles, questions and answers, and examples. Therefore, it is important that the assigned reading be completed before class.

2. **Assignments** There will be HW assignments over the course of the semester. **The lowest two homeworks will be dropped.** There will be a 50% penalty for any late submission. No assignments will be accepted 3 business days past the deadline. You are responsible for reviewing homeworks to assure that you fully understand the material.

3. The written **problem sets** you submit as part of your homeworks must conform to the following standards of good engineering policy:

    a. **Name, homework number, and due date** should appear on each page. *If you consulted with anyone on the solution of the problem, such consultation should also be explicitly acknowledged in writing*.
    b. If you prefer to do assigned by hand using pen/pencil and paper, work should be done on one side of the paper only, and it is preferable that it be done on 8-1/2" x 11" engineering computation paper. Make sure that scanned copy of your assignment that is submitted is of high resolution and clarity.
    c. Each problem should start on a new page and be clearly labeled (exceptions can be made for very short problems). Work should be organized carefully and presented neatly.
    d. Any text should be legibly printed or typed. A straight edge shall be used, and final answers shall be boxed.
    e. All plots should be generated using computer software (Excel, R, Python, Matlab etc.).

4. There are **two mid-term examinations** and **a final exam**. Absence from an examination without a certified medical emergence will result in a zero grade for that examination. Bring a TXST ID with you to each exam. All exams will be closed notes and closed book exams. You will be allowed to bring a 3 inch x 5 inch index card, and a reference sheet may be provided by the instructor. Only approved calculators may be used in the exam. It is your responsibility to

make sure you have an approved calculator to use in the exam – any non-approved calculator will be confiscated during the exam.

5. **Quizzes A short, closed book in class quiz will be given several times over the semester**. Quizzes will be announced in advance. The lowest quiz grade will be dropped. **No** make-ups will be given for missed quizzes. The 15-minute quiz will be given at the beginning of the lecture period. **Be certain to bring a pocket calculator (see policy below), and a writing implement to the quizzes.**

6. **All requests for reevaluation** of homework assignment, laboratory, or exam grades must be made in writing to Professor Cho within **one week** of the assignment's return. The request should include the student's original assignment and a thorough description of the perceived error.

7. **Classroom-behavior expectations:** To ensure a climate of learning for all, disruptive or inappropriate behavior (repeated outbursts, disrespect for the ideas of others, etc.) may result in exclusion (removal) from this class.
   Cell phones are distracting in class or lab. If it must be on during class time, then don't come to class, there are more important things in life than fluid mechanics. If you use your phone during class for any purpose including calls, texting, and internet access, you will be required to leave that day's class. If your phone goes off in an exam or you are using your cell, your exam will be collected and a grade of zero will be recorded. As a reminder, cell phone, etc. use, including text messaging, is not permitted in this class by Faculty Senate rule unless by instructor permission.

8. Calculator policy will apply to all exams and quizzes. Only **NCEES approved calculators** are to be used in exams and quizzes. Casio: All fx-115 and fx-991 models (Any Casio calculator must have "fx-115" or "fx-991" in its model name.) Hewlett Packard: The HP 33s and HP 35s models, but no others. Texas Instruments: All TI-30X and TI-36X models (Any Texas Instruments calculator must have "TI-30X" or "TI-36X" in its model name.) See https://ncees.org/exams/calculator/ for a list of approved calculators.

9. It is strongly recommended that **study teams** be formed to foster a cooperative effort in learning the course material. Teams are encouraged to study, work, and learn together. However, the work you submit must be your own.

10. **Cramster/Chegg Policy**: You may not receive help on laboratories and homework assignments from anyone or any source other than your fellow students, TAs, and Professor. External help is a violation of the TXST academic honor code.

11. **All students are required to abide by the Texas State University honor code.** The Pledge for Students states: Students at our University recognize that, to insure honest conduct, more is need than an expectation of academic honesty, and we therefore adopt the practice of affixing the following pledge of honesty to the work we submit for evaluation:
I pledge to uphold the principles of honesty and responsibility at our University.
The complete honor code may be found at http://www.txstate.edu/effective/upps/upps-07-10- 01.html under attachment I.

12. **Academic Dishonesty**
Academic honesty is fundamental to the activities and principles of a university. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The University regards academic dishonesty as an extremely serious matter, with serious consequences that range from probation to expulsion. If it is determined that a student has cheated on an exam, he or she will begiven 0 on the exam or a failing grade in the course regardless of the student's performance beyond the act of academic dishonesty.

13. **Disabilities:** The University is committed to providing students with documented disabilities equal access to all university programs and facilities. If you think you have a disability requiring accommodation, you must register with Student Accessibility Services (SAS). If you have received an accommodation letter for this class, please contact me immediately so we can discuss the necessary arrangements.

14. **Students with Special Needs**
Students with special needs (as documented by the Office of Disability Services) should identify themselves at the beginning of the term and let the instructor know so that appropriate accommodations can be arranged.

15. **Emergency Management**
In the event of an emergency, students, faculty, and staff should monitor the Safety and Emergency Communications web page. This page will be updated with the latest information available to the university, in addition to providing links to information concerning safety resources and emergency procedures. Faculty, staff, and

students are encouraged to sign up for the TXState Alert system.

16. **Sexual Misconduct Reporting** (SB 212) Effective January 2, 2020, state law (SB 212) requires all university employees, acting in the course and scope of employment, who witness or receive information concerning an incident of sexual misconduct involving an enrolled student or employee to report all relevant information known about the incident to the university's Title IX Coordinator or Deputy Title IX coordinator. According to SB 212, employees who knowingly fail to report or knowingly file a false report shall be terminated in accordance with university policy and The Texas State University System Rules and Regulations.

LABORATORY

- ✓ Lab meets every other week (starting on **9/16 Mon**).
- ✓ Lab section meet every other week in **RFM 1240**
- ✓ Lab groups are responsible for all **data collection** and clean-up.
- ✓ Each lab will start with **a brief closed-book quiz** based on the laboratory instructions (Pre-Lab Quizzes).
- ✓ Coordination: For each lab, each group must identify a group leader. **Group leader** is responsible for ensuring that all lab facets are completed, written, and submitted on time. Group leader grade is worth **3 times** that of other group members.

- **Lab Materials**: Lab materials will be made available on Canvas. Please read the materials before you come to class. Some labs will require a lot of work in a relatively short amount of time, being prepared before class will help.
- **Lab Rules**
  - Attendance is **mandatory** for every lab session.
  - Attire: Casual, Safe, Shoes, not flip-flops/sandals, no dangling attire that could get caught in equipment.
  - If you have questions, ask your instructor.
  - If you have problems with any equipment, tell the instructor immediately.

- **Lab Reports**
  You will work in groups of **4 or 5 to complete each lab**. Each group will be required to turn in one report for the entire group. One person from each group must submit the final report signed by all members. Every group member is expected to do his/her responsibility share. The report should be a maximum of 10 pages with font size 12 and should be neat, legible, well organized, using the given format below. Note on Verb Tense: The experiment is already finished. Use the past tense when talking about the experiment. The report still exists; use the present tense when talking about the report.

- **Components of Lab Report**

  (i) *Cover Sheet (max 1 page)*
  Laboratory Title, Course Number (ENGR 3380), Your Names, Group Number, and Contribution of each team member. Each **member** in the group **signs the cover page** indicating that they have **read the report** and **approve of the contents** contained within.

  (ii) *Abstract (max 0.5 page)*
  An abstract is an "executive summary," which briefly describes the experiment and states the main findings. It summarizes the entire report in one main paragraph. Write the abstract last but resist the temptation to copy chunks of text from other parts of the report. Your abstract should emphasize the objective (why), procedure (how), results (what you learned), and significance (why it is important). Be precise and specific.

  (iii) *Introduction (max 1.5 Page)*
  Include a brief introduction that explains the purpose of the report and the purpose of the
  experiment. The introduction should also include any other introductory/background information or theory that the reader needs to know. This is where you tell the reader what you did and why you did it. At the end of the introduction, include a paragraph that "forecasts" the remainder of the report (i.e., tell the reader about the contents of the remaining sections).

  (iv) *Methods and Materials (max 1 page)*
  Use a paragraph form to describe the steps taken to perform the experiment, describe measurement techniques and discuss the apparatus (include diagrams or sketches of the apparatus – you may copy any diagrams from lab material but be sure to cite them).

Use your own words. Do not copy the procedure from the lab handout. This is where you tell the reader how you did the experiment, and you describe the equipment and materials used to conduct the experiment. You should provide enough information so that another researcher in your field could use your description to replicate the experiment.

(v) *Results (max 3 pages)*

Present your results to the reader. Although results are usually presented quantitatively, you should always introduce each block of information with simple, clear language. Include measured results, an estimate of the experimental uncertainty, and any calculations used. In most cases, it is sufficient to provide a sample calculation with a clear explanation of the equations. Use tables and figures as necessary. All tables and figures should be labeled with a Figure/Table number and a descriptive caption. Presentation of results is extremely important so take time to determine the best way to present them. Compare your data to theoretical or empirical results.

Note on Graphics: In Engineering reports, we use Figures and Tables (not Graphs and Charts); figure captions should be numbered consecutively and placed underneath each Figure. Table captions should be placed above each table.

(vi) *Discussion (max 2 page)*

Interpret the results of the experiment. This is the most important part of your report. Here you can show that you understand the experiment. You must explain, analyze, and interpret your results. Discuss experimental and theoretical results and why they do or do not agree. Explain any errors. Focus your discussion on the following questions:

- What results were expected? What results were obtained? If there were any discrepancies, how would you explain them?
- Do any of your results have technical or theoretical interest?
- How do your results relate to your experimental objective(s)?
- What are the strengths and limitations of your experimental design?
- If you encountered difficulties in the experiment, what were their sources? How might they be avoided in future experiments?

(vii) *Conclusions (max 0.5 page)*

Draw conclusions from the results and discussion that answer the

question, "So what?" Then go on to explain your conclusions with reference to the results that support the conclusions. You must list engineering applications that are closely related to this experiment. In this section, you may also criticize the technical part of the lab experiment and make recommendations for improvement. Such criticisms and recommendations, however, should focus on the lab as a learning experience; mere complaints about faulty equipment or the amount of time spent are not appropriate.

(viii) *References (max 1 page)*

Provide bibliographical information for any material that is not original and which you cited in your report — for example, technical specifications, equations, tables, figures done by someone else.

(ix) *Appendices (max 2 pages)*

Appendices should include raw data, calculations, graphs, and other quantitative materials that were part of the experiment but not detailed in any of the above sections. Refer to each appendix at the appropriate point (or points) in your report. For example, at the end of your results section, you might have the note, "See Appendix A: Raw Data."

Last revised on 8/20/2024