# Computational Fluid Dynamics Lab

## Instructor:

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Office Hours: 9:00am - 9:50am (M, W-F). Other times by chance or appointment.

## Recommended preparation:

ME 3370, Fluid Mechanics, is suggested, but not required, as a corequisite. I will introduce the necessary concepts in fluid mechanics. However, those who already have some exposure to fluid mechanics will find the course more digestible.

## Goals:

In this 1−credit class, we aim

- to learn some fundamental concepts in fluid dynamics.
- to become acquainted with the tool of computational fluid dynamics (CFD).
  - What is it?
  - Why is it useful?
  - What are its strengths and limitations?
- to develop a basic competence with a commercial CFD code. In our case, the code will be ANSYS CFX.

## Class policies:

1. Interaction in the laboratory is encouraged. I will often enlist students who seem to be "getting it" to help communicate their success to others.
2. There will be no quizzes or tests, but occasional written reports will be required (probably, four or five). These reports will be submitted by groups of approximately 4 students.
3. Lab attendance is mandatory. If you miss two labs, at a minimum a full letter grade will be deducted from whatever grade you otherwise would have obtained for your course grade. If you miss more than two labs, you will not pass the course.
4. Lab meetings occur whenever Texas Tech is officially in session. Do speak to me, however, if you are faced with extraordinary circumstances.
5. While in lab, you must make a good-faith effort to achieve our goals. Any off-topic activities will weigh against you. Outside of lab, you should spend your time working on all your other important courses (with small intervals set aside for eating and sleeping). If you think carefully, work efficiently, and ask the appropriate questions when in need

of guidance, then you probably will not have to devote very much time to this class outside our lab hours.

## Class Methods:

We will do four or five projects together this semester. Most projects will therefore span more than one lab meeting. Each project will consist of three parts:

1. Introduction. In a short presentation (20 minutes), I will introduce a topic that you will explore via CFD. I hope to suggest why the topic is interesting and why it is amenable to the CFD approach.

2. CFD exercise. You will then spend the remainder of the class and possibly portions of subsequent classes working on the topic according to the guidelines that I have prepared. At the end of the exercise, you will write a short report to be submitted for grading. I will be available in the lab to help you with the exercise. Most of our time will be spent on this second step.

3. Summary. In another short presentation (20 minutes), I will try to summarize the topic we have addressed. I hope that we will also be able to discuss questions originating from the class.

## Reports:

The reports are not meant to be time-consuming; however, you should do them carefully. You will always have at least a week from the time a topic is introduced to the time a report is due. Therefore, there is no excuse for sloppy work or for skipping questions.

1. There will be four people in each report group. One person will be the lead author on a given report. The other three will assist. All participants in preparing the report will sign the coversheet. Anyone who has not participated should not sign the coversheet.

2. The members of the group will take turns being lead author. No one can be lead author for a second time until everyone in the group has been lead author once.

3. All members of the group will receive an identical grade.

4. Successful engineering depends on communication. The correct answer is often not enough. Answers must also be clear, unambiguous and convincing. Thus, spelling counts. Grammar counts. Units count. Avoid sentence fragments. Box final numerical answers and report them to three significant figures (or four if the first digit is "1"). Hand calculations should be shown explicitly. Express them first in algebraic symbols. Then substitute numbers and units. Then show the result.
   I will provide a sample report to suggest the ideas here.

Review these guidelines and the sample report each time before you prepare your own report.

## Grades:

I will attempt to post grades and return the reports in a timely fashion. It will be your responsibility to review your returned work within one week of the grade posting. After that week, I will not revisit the grading of the assignment with you under any circumstances.

## Topics:

- What is CFD?
- ANSYS CFX: a commercial code
- Pipe flow
- Running before the wind and the Blasius boundary layer
- Flow over a cylinder
- Door vs. wing

## Resources:

Here are some interesting books and web resources (none of which are required for this course):

1. White, Frank, M. *Fluid Mechanics*. New York: McGraw Hill Companies, 6th edition, 2006. Tech's textbook for the undergraduate fluid mechanics course. An excellent resource for fundamental concepts in fluid mechanics.

2. Panton, Ronald L. *Incompressible Flow*. New York: Wiley-Interscience, 2nd edition, 1996. A textbook in fluid mechanics from the mechanical engineer's perspective at the graduate level. A big thick square book.

3. Versteeg, H.K., Malalasekera, W. *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*. Harlow, England: Pearson Education Limited, 2nd edition, 2007. A fantastic nuts and bolts look at computational fluid dynamics, especially as it is embodied in the typical commercial code. This is an advanced text. Sadly, we do not have it in the Tech library. I have a copy in my office, though, for anyone who wishes to browse.

4. www.cfd-online.com. A good website.