Chemical Engineering 374—Fluid Mechanics
Fall 2019

Time & Location 3:00-3:50 PM, MWF, 321 EB

Prerequisites Ch En 273; Math 214 or 302 or equiv; Professional program admission

Instructor Douglas R. Tree, 330B Engineering Building, (801) 422-5162, tree.doug@byu.edu

TAs Rami Alhasan, ramialhasan91@gmail.com
Jansen Berryhill, jansenberryhill@gmail.com
Beverly Delgado, whsbeverlydelgado@gmail.com

Office hours Please refer to the course website for the specific location and hours. If you cannot make those times, please contact me via email at tree.doug@byu.edu to make an appointment.

Course Website Content: www.et.byu.edu/~treedoug/teaching/ChEn374
Grades or Copyrighted material: Learning Suite

Course Description This course provides an introduction to fluid mechanics from a chemical engineering perspective. The principles of fluid mechanics are ubiquitous in both everyday life and engineering practice. Examples include pipe flow, ketchup bottles, microbial swimmers, and combustion processes. Additionally, as a sub-discipline of continuum mechanics, fluid mechanics will help students build upon and enhance their knowledge of mathematics and physics.

Course Objectives Similar to the aims of the University, I hope through the course of the semester you:

1. Are spiritually strengthened by a deeper understanding of God and His nature by learning the patterns the Lord has given in fluid mechanics (Alma 30:44, D&C 52:14),

2. Enlarge your intellect by learning the fundamentals of fluid mechanics, practical skills for chemical engineering design and techniques for creatively solving engineering problems,

3. Build character by striving for excellence in your work, by coping with adversity and by learning to work with others,

4. Are aided and inspired to pursue a lifetime of learning and service by your rigorous technical training and a burgeoning enthusiasm for fluids :).

Technical course outcomes (i.e. competencies) are listed below.

Textbook Introduction to Chemical Engineering Fluid Mechanics

Last updated: 09/04/19
Lectures
Aside from exams and a few days of review (see the course schedule), most days of class will consist of interactive lectures. I will provide occasional handouts in class or supplemental notes online, but in general I will not provide you with a copy of my lecture notes. I do this for pedagogical reasons; Taking notes helps you pay attention in class.

Reading
With a few deviations, we follow the sequence of topics outlined in Deen’s text (which is required for the course). You are encouraged to read the sections in the textbook corresponding to the lecture (see the course schedule) as a supplement to class time and homework that most enhances your learning. This means that unless I say otherwise, I do not expect that you will have read the outlined sections before you come to class.

Despite the lack of direct enforcement to read, I hope you will still value your textbook as an important resource. The textbook contains far more information than we have time to discuss in class, contains fewer errors than my lecture notes (despite my best attempts) and can provide an alternate perspective if you are struggling with a concept. A list of additional texts is also provided for your benefit.

Homework
Homework assignments will be due at the beginning of class every Friday. Each homework will contain two types of problems: practice problems and challenge problems. Both types of problems will be graded for credit.

Practice Problems: These problems are identified by which lecture they correspond to and are meant to help you practice what we learned in lecture. To help you have confidence that you have the right idea, the full solution to the practice problems will be posted next to my office door on Tuesday afternoon. Think of this solution like an extra TA; You are expected to work through the practice problems before you check the key. You may not take pictures of the key. Limited access to this key will help you learn better.

Challenge Problems: For these problems, you will not be given a solution and the key concepts will not be identified for you. Challenge problems may be focused on a single idea or it might weave together multiple concepts from multiple lectures. Please do not “check your answer” with The TAs for challenge problems. They have been instructed to not give you a number answer. This will help you prepare for the exam. The full solution to the challenge problems will of course be available after the HW is due to help you check what you did or did not understand.

Group Work: Working in groups to solve homework is encouraged, but you must turn in your own assignment. Since learning is an individual activity, I strongly recommend you to try the homework on your own before seeking help from a group or TA. Copying the work of someone else, including students from previous years, is academic dishonesty. Using the solutions manual of this or any other textbook or an illicitly obtained key from a previous version of this course is also academic dishonesty.

Electronic Only: You will submit your homework electronically via Learning Suite. To do so, please generate a single pdf file from your electronically or handwritten work and then submit it to Learning Suite. You can generate a pdf file by using a scanner or by using...
your phone. SmallPDF is a great cloud-based resource (https://smallpdf.com/jpg-to-pdf) for turning the photos you take with your phone into a single PDF file.

Late HW: Finally, because our class is so large, I cannot accept late homework. To account for extenuating circumstances, I will drop your lowest HW score.

Quizzes
We will often have short, low-stakes in-class quizzes at the beginning of class reviewing material from the previous lecture. These quizzes cannot be made up, but I will drop the lowest two quizzes from your grade.

Special Project
You will complete a project with a team of your fellow students and some students from a local high school. You will choose either investigate a scientific question or complete an engineering project related to fluid mechanics and present it with a poster to the class. This will be like a class “science and engineering fair.” I will provide more details about the project later in the course.

Midterms
There will be two, two-hour midterms administered in the testing center during the semester (see the schedule for dates). No books, notes or electronic devices (except a calculator) will be permitted during the exams. However, I will provide you with an equation sheet.

Similar to the case with homework assignments, I cannot accommodate makeup exams. If you cannot take an exam, you must notify me 24 hours in advance in order to be excused. If you are excused from taking an exam, your final exam score will make up for the missing percentage of your grade. So, for example, if you miss exam 1 which is 16.5% of your grade, your final exam would count for 49.5% of your grade instead of the regular 33%.

Final Exam
The final will be at the time and place scheduled by the University: 312 EB on Thursday, December 19, 2019 from 3:00 pm – 6:30 pm. Due to University policy, I cannot move this time or make exceptions. You must take the exam at this time on this day. Note that this is the last day of finals. Please adjust your travel plans accordingly.

Regrade Policy
Occasionally, students find mistakes in grading or summing the scores on an exam or a homework. If you find yourself in this situation, please send me (Dr. Tree) an email that: (1) Identifies the assignment or exam, (2) Describes the mistake and (3) Includes the graded assignment/exam as a scanned attachment. I ask you to do this because email provides a very convenient way for me to keep track of these requests. You are of course also welcome to talk to me about these issues during my office hours or briefly after class, but I will still ask that you send me an email.

I have three additional requests concerning re-grades. (1) Please submit your re-grade requests within one week of the assignment or exam being returned to you. (2) Please do not approach the TAs about re-grades, even if you suspect they are the one who graded the assignment. To keep the process fair, I have decided that I will handle all re-grades. (3) Please be considerate and do not abuse the privilege. It is not fair to the other students,
can consume a lot of my time and it reflects poorly on you as a student.

**College Lectures**

The department requires that you attend two of the scheduled College Lectures during the semester (or two other approved technical lectures). To get credit for these lectures, you must complete the two corresponding assignments on Learning Suite. Failure to complete these assignments will result in a 1/3rd letter reduction in your grade (e.g. from an A to an A-).

**Grading**

Grades for the course will be based on the following point distribution.

- Homework (30 pts) & Project (100 pts) – 30%
- Quizzes (5 pts) – 4%
- Exams (100 pts ea.) – 33%
- Final (200 pts) – 33%

I will determine the grade scale at the end of the semester. However, I will guarantee that it will be no harder than:

<table>
<thead>
<tr>
<th>Grade</th>
<th>A-</th>
<th>B-</th>
<th>C-</th>
<th>D-</th>
<th>D+</th>
<th>67%</th>
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<tbody>
<tr>
<td>Grade</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td></td>
<td></td>
<td>93%</td>
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<td></td>
<td>90%</td>
<td>83%</td>
<td>80%</td>
<td>70%</td>
<td>73%</td>
<td>87%</td>
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<td></td>
<td>60%</td>
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<td>67%</td>
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**Teaching Philosophy**

I view my role as a teacher as being analogous to a coach. Like a coach, it is my job to help you know what your goal is (i.e. set an expectation of excellence), provide structure to reach that goal, help motivate you to achieve it, provide critical feedback and cheer you on when the pressure is on. However, just like a coach, I can’t do the work for you or perform when it is “game-time.” I am trying to use the best pedagogy that I know to help you succeed, but no pedagogy can succeed without your best effort.

This philosophy colors my view of the activities we do in class. I view lectures as a time where I outline the concepts and try and provide motivation to learn. However, once you leave class it is up to you to put in the work to master the material. To this end, I provide homework assignments that help you practice. Finally, the exam is “game time” where you need to perform and show what you have learned.

I know it is difficult as a student to balance all of the many things you need to do, and that you are trying to be efficient. However, I believe if you will think of your assignments as practice and if you will not let yourself off the hook when you don’t understand something, you will get a lot more out of the class (and get a much better grade)!

**FAQ**

**Q:** Why don’t you give out copies of your lecture notes? I have a hard time writing quickly.

**A:** There are several reasons that I don’t give out my notes. The primary reason is that it is my experience that most students, most of the time, learn better when they take their
own notes. Taking notes is a useful way to engage with technical content. I also don’t give out my notes because sometimes they contain mistakes, and I don’t want my notes to become the de facto book for the course. I try to pace the lecture so that it is possible to take notes and be engaged. If you are struggling with this, please come talk to me and we will work something out.

Q: Why aren’t your exams open book?

A: I want to be able to ask you conceptual questions as well as calculation questions. If I allow you to have a book, this restricts the types of questions I can ask. Ultimately, this means I would need to make a much longer exam, which really doesn’t benefit anybody. Also, I think a little bit of rote memorization is an okay thing.

Q: Why do you use your course website instead of Learning Suite?

A: I use an external web site so persons not enrolled in the course have access to course materials. Sometimes my colleagues at BYU or other universities are interested in what we are doing and it is an easy way to share. Also, you may find it useful after you have left the course to revisit some of the notes I post online.

Q: Why do you do weekly homework?

A: I think that a Junior in Chemical Engineering is mature enough to be able to manage their schedule to turn in a longer homework assignment once a week instead of needing to be rigidly tied to an assignment every lecture. The weekly homework format also allows me to ask questions that involve multiple concepts within a single problem. This helps you to learn better and better prepares you for the exam. Finally, the problems inherent to fluid mechanics are sometimes longer and more involved than you have seen in the past, so it makes sense to give you more time to solve these longer problems.

Q: Why don’t you post the practice problem key online?

A: I purposefully make the practice problem key a little bit annoying to access to encourage you to try the problem before looking at the answer. You learn a lot more by first trying (and failing) to get the problem right than by looking at the answer before you try. I promise I am not doing this to make your life harder or because it is more convenient for me. Posting things online is more convenient for me too.

Q: Will we need to know multivariable calculus for this course? Why do you do so much math?

A: Yes, you will need to know multivariable calculus. I will admit, I am biased here. I love math! However, I recognize that this is an undergraduate course and that not everyone loves math as much as I do (it’s sad, but true :). Believe it or not, I have actually tried very hard to limit the difficulty of math required for the course. However, we do have a section of the course (part II) where we make significant use of multivariable calculus. There are three reasons why I have made this curriculum decision: (1) Fluids is inherently a mathematically rigorous subject. It is actually very difficult to teach fluids.
without using multivariable calculus. It is similar in this respect to other subjects with field theories such as electricity and magnetism and solid mechanics. (2) A significant fraction of you will go on to graduate school. Students that go to graduate school absolutely need to be introduced to the mathematical treatment of fluid mechanics that is provided here. (3) Just like you needed math in your physics class, using math in this course provides the precision and technical detail needed to truly understand many (most? all?) of the concepts we will talk about in the course. (4) It is a great way to re-learn math! In my experience, math is usually best mastered the second time through. If you dedicate yourself to remembering and filling in the holes now, you will retain a lot more this time through and it will benefit you greatly.

Q: Is the course curved?

A: Yes and no. The grade scale given above is an absolute scale that I guarantee will not be made harder (i.e. an ‘A’ will never require more than 93%). Additionally, I do not curve exams, nor do I intentionally make them extra hard or confusing. From my perspective, there is nothing stopping the whole class from earning an ‘A’. Unfortunately, this doesn’t seem to happen. Some students don’t do their homework or prepare for an exam. Sometimes, the material is hard for someone who is not as prepared as they might have been. As such, we usually have a grade distribution that starts with A’s and drifts down to E’s :(. To make things as fair as possible, at the end of the semester, I usually revise the grade scale downward (e.g. an ‘A’ might become a 92%, an ‘A-’ starts at 89%, etc). I use my discretion to make this shift in the grade scale, (e.g. I think an exam was too difficult) but it rarely results in a move of more than a few percentage points.

Q: Will you accept my late homework? I have a really, really good excuse.

A: No. I drop one homework score because you have a really, really good excuse. I do this for logistical reasons. It is too hard to run a large class where I have to track late homework.

Q: Can I take the midterm on a different day?

A: No. For logistical reasons it is too difficult to give midterms on different days to different students. It also creates a cheating risk.

Q: Can I take the final on a different day?

A: No. This is against University policy, so I can’t allow it.

Q: Do I need to rent/buy the book?

A: Yes. Please rent/buy the book. We follow the subjects outlined in the book and use it for homework problems. One reason I chose the book is that is only costs about $90, whereas other books can cost upwards of $250-$300. Also, I strongly recommend that you buy the book and keep it. I have found my textbooks to be a very valuable resource after I am out of the class.

Last updated: 09/04/19
## Chemical Engineering 374 Course Outcomes

### ABET Student Outcomes

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<tr>
<th>Complex Problem Solving (1)</th>
<th>Students will be able to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.</th>
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<tbody>
<tr>
<td>Engineering Design (2)</td>
<td>Students will be able to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.</td>
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<tr>
<td>Knowledge and Learning (7)</td>
<td>Students will be able to acquire and apply new knowledge as needed, using appropriate learning strategies.</td>
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### BYU Course Objectives

<table>
<thead>
<tr>
<th>Engineering Intuition</th>
<th>Students will be able to make order of magnitude estimates, assess reasonableness of solutions, and select appropriate levels of solution sophistication.</th>
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<tr>
<td>Critical Thinking</td>
<td>Students will exhibit critical and creative thinking skills for analysis and evaluation of problems and cause-effect relationships.</td>
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<td>Chemical Properties</td>
<td>Students will understand the physical/chemical behaviors of materials.</td>
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<td>Dimensional Analysis and Dimensionless Numbers</td>
<td>Students will be able to nondimensionalize equations, will understand the significance of dimensional analysis, and will be able to interpret the physical significance of dimensionless numbers</td>
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<tr>
<td>Fluid Statics</td>
<td>Students will be able to solve simple fluid statics problems.</td>
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<td>External Flow</td>
<td>Students will understand qualitatively how external flow around objects affects drag and be able to calculate drag forces and terminal velocities.</td>
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<td>Momentum Balances</td>
<td>Students will be able to formulate steady-state, integral and differential, momentum balances in one dimension.</td>
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<tr>
<td>Advanced Fluid Mechanics Concepts</td>
<td>Students will understand and be able to use advanced fluid mechanical concepts including boundary-layer theory, non-Newtonian flow, and turbulent flow.</td>
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<tr>
<td>Pumps and Valves</td>
<td>Students will have a practical understanding of the function and use of pumps and valves and be able to make design decisions accordingly.</td>
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<tr>
<td>Flow System Design</td>
<td>Students will be able to use a mechanical energy balance and/or the concepts of system demand and pump supply curves to design flow systems involving pipes, valves, fittings and/or pumps.</td>
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<tr>
<td>Non-Newtonian Fluids</td>
<td>Students will be able to calculate the pressure drop in flow systems involving pipes and pumps for non-Newtonian fluids.</td>
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<tr>
<td>Compressible Flow</td>
<td>Students will understand basic concepts relating to compressible flow including Mach numbers and choked flow.</td>
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Last updated: 09/04/19
BYU Policy Statements

Academic Honesty
The first injunction of the BYU Honor Code is the call to “be honest”. Students come to the university not only to improve their minds, gain knowledge, and develop skills that will assist them in their life’s work, but also to build character. President David O. McKay taught that “character is the highest aim of education” (The Aims of a BYU Education, p. 6). It is the purpose of the BYU Academic Honesty Policy to assist in fulfilling that aim. BYU students should seek to be totally honest in their dealings with others. They should complete their own work and be evaluated based upon that work. They should avoid academic dishonesty and misconduct in all its forms, including but not limited to plagiarism, fabrication or falsification, cheating, and other academic misconduct.

Honor Code
In keeping with the principles of the BYU Honor Code, students are expected to be honest in all of their academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact be your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university. Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university's expectation, and every instructor's expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 422-2847 if you have questions about those standards.

Preventing Sexual Misconduct
As required by Title IX of the Education Amendments of 1972, the university prohibits sex discrimination against any participant in its education programs or activities. Title IX also prohibits sexual harassment—including sexual violence—committed by or against students, university employees, and visitors to campus. As outlined in university policy, sexual harassment, dating violence, domestic violence, sexual assault, and stalking are considered forms of "Sexual Misconduct" prohibited by the university.

University policy requires any university employee in a teaching, managerial, or supervisory role to report incidents of sexual misconduct that come to their attention through various forms including face-to-face conversation, a written class assignment or paper, class discussion, email, text, or social media post. If you encounter Sexual Misconduct, please contact the Title IX Coordinator at t9coordinator@byu.edu or 801-422-2130 or Ethics Point at https://titleix.byu.edu/report or 1-888-238-1062 (24-hours). Additional information about Title IX and resources available to you can be found at http://titleix.byu.edu.

Students Disability
Brigham Young University is committed to providing a working and learning atmosphere that reasonably accommodates qualified persons with disabilities. If you have any disability which may impair your ability to complete this course successfully, please contact the University Accessibility Center (UAC), 2170 WSC or 422-2767. Reasonable academic accommodations are reviewed for all students who have qualified, documented disabilities. The UAC can also assess students for learning, attention, and emotional concerns. Services are coordinated with the student and instructor by the UAC. If you need assistance or if you feel you have been unlawfully discriminated against on the basis of disability, you may seek resolution through

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established grievance policy and procedures by contacting the Equal Employment Office at 422-5895, D-285 ASB

Inappropriate Use Of Course Materials  All course materials (e.g., outlines, handouts, syllabi, exams, quizzes, PowerPoint presentations, lectures, audio and video recordings, etc.) are proprietary. Students are prohibited from posting or selling any such course materials without the express written permission of the professor teaching this course. To do so is a violation of the Brigham Young University Honor Code.