Chemical Engineering 374—Fluid Mechanics, Fall 2024

Location: 393 CB
Time: 9:00-9:50 AM, MWF
Prerequisites: Ch En 273, Math 214 or 302 or equivalent, Ch En 311 (or concurrent), prof. prog. admission

Instructor: Matthew J Memmott
330K Engineering Building
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Website: http://www.et.byu.edu/~mjm82/che374/che374.html
Office Hours: M-F 10:00-11:00 AM

TAs: Parker Johns, pknjohns@byu.edu
TA Office Hours: T,Th 12:00 PM 1:00 PM, F 11:00 AM – 12:00 PM

Course Objectives: This course is an introduction to fluid mechanics for chemical engineers. Fluid mechanics is a very important subject with applications all around us. Fluid mechanics is the study of mass, momentum, and energy transport in fluids. Thus, in this course you can expect to learn both the behavior of fluids, and about the design of fluid-handling systems and equipment such as piping networks, pump sizing, and fluid properties. The following can be considered the broad course objectives for this class:

(1) Development of fluid mechanical skills to be used in a future career to:
   a. Design fluid systems,
   b. Analyze the performance of fluid systems, and
   c. Draw informative observations/conclusions relating to fluid systems.

(2) Improve your ability to identify, formulate, and solve open-ended engineering problems based on application of mathematics and physical phenomena,

(3) You will gain an appreciation for the field of fluid mechanics that will hopefully lead to a desire for further learning and study beyond just this course.

The specific details and requirements of this course are indicated in the following sections. Also, a "roadmap" specific to the course along with applicable competencies is included to give a general overview of course trajectories.

Textbook: Fluid Mechanics—Fundamentals and Applications, 3rd edition, by Cengel and Cimbala

Reading: Lectures are designed to help students learn the course content, but many details and examples are given in the text. Your learning will require repeated exposure to the material and dedicated study. **You will do significantly better in this course if you actually read the assignments!!** Daily (almost) concept quizzes are given via Learning Suite, and must be completed before the beginning of class.

Homework: Homework assignments will be due almost every class period. Homework is designed to help you learn the course material through direct application. You are encouraged to work in groups, but you must turn in *your own* assignment, representing *your own* work. Homework late by up to one week will be accepted for 50% credit. Homework solutions will be posted in a book kept by the department secretaries. **You are on your honor not to use posted solutions in the working of late homework**.

OEPs: In addition to the standard homework assignments, there will be one (1) open ended problem (OEP) due each week. These problems are designed to teach you how to approach a problem without a clearly defined solution, method, or even structure. These types of problems are extremely common in engineering industries. As a result, the ability to **set up** and **solve** problems with **reasonable confidence** in the solution is one of the most valuable skills in engineering, be it research or industry. The OEPs assigned in this class are designed to help you learn and apply an organized method to solving complex problems without a single discrete solution. They are also structured to help you learn how to think about the validity, meaning, and general feasibility of your solutions. **In essence, the OEP solution checks (part 7 of each OEP) will help you develop engineering "horse-sense".** These problems also reflect the types of tasks most often encountered in post-school life, and will thus help you to be more successful not only in your

job, but in all aspects of your life. The focus of the OEPs in this class is centered around three principles:

1) less focus on the answer, and **more on the process used to obtain the answer,**
2) focus on demonstrating your grasp of whether the answer is "reasonable", and
3) emphasis on checking your answer based on known information or additional calculations.

These problems will be graded based on your approach to the problem and on your assessment of the solution obtained. In addition to the weekly OEPs, there will be ***at least*** one (1) OEP-style problem on each exam.

Exams: Three (3) midterm exams and one (1) comprehensive final exam will be administered. The final exam is scheduled for Saturday, December 17, 2024, from 7:00-11:00 AM. The exam will be held in the regular lecture room unless otherwise stated. If you are unable to attend an exam you must notify me *well before* the exam and have a *good excuse*.

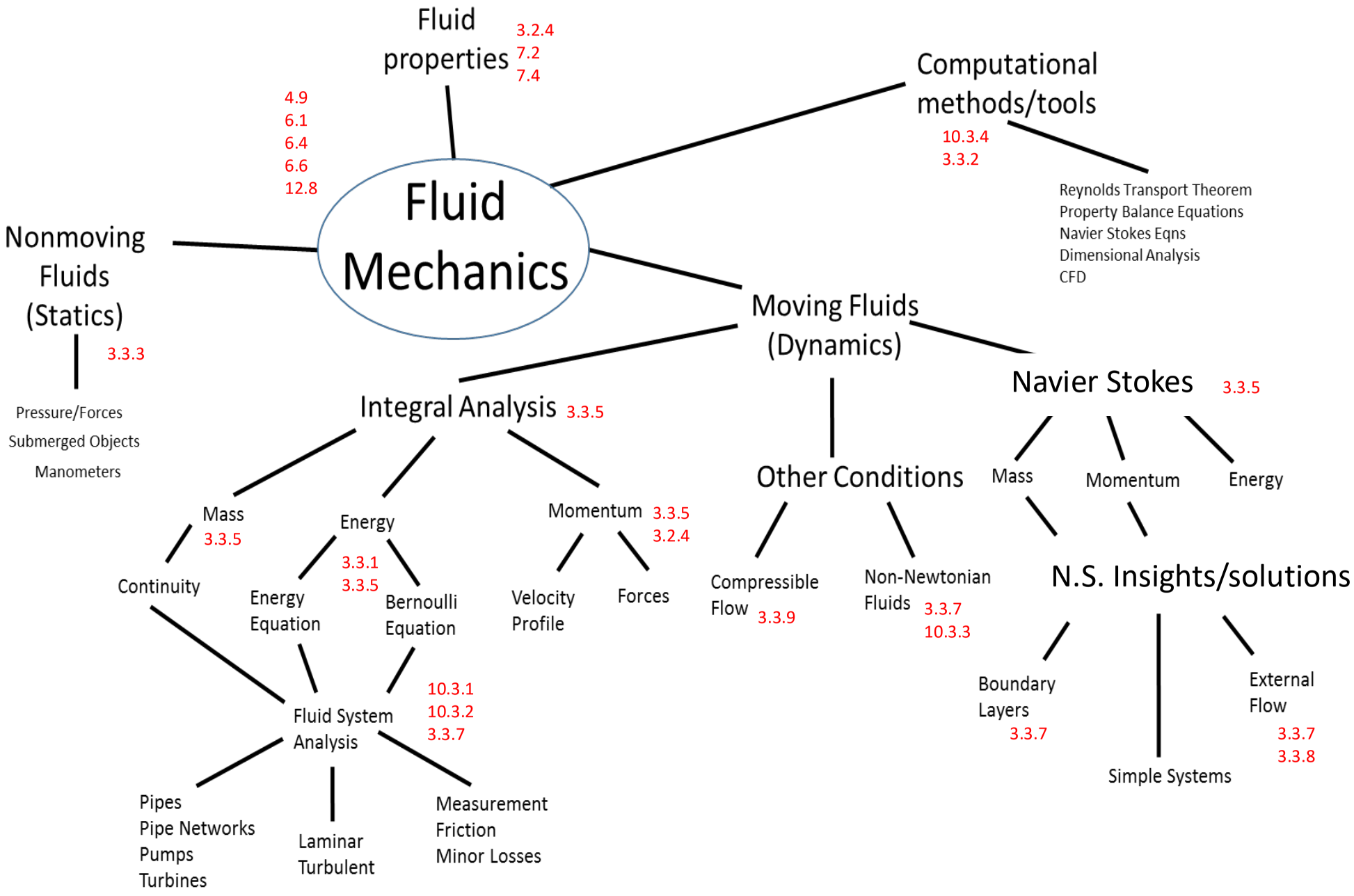
Special Project: You will complete a project with a team of other students and present your results as a group at the end of the semester. The project will involve some aspect of measuring a fluid property or exploring/demonstrating a fluid phenomenon.

College Lectures: Through this course, the department requires that you attend two of the scheduled College Lectures (or two other approved technical lectures). **These are required to pass this class.**

Grading: Grades for the course will be based on the following distribution:

Homework	15%	Open Ended Problems	10%
Concept Quizzes	5%	Midterm Exams (3)	40%
Special Project	10%	Final Exam	20%

Chemical Engineering 374 Competencies			
Comp.	**Level**	**Usage**	**Outcome**
3.2.4	2	M	Students will understand **mechanical behavior of materials** including elastic, viscous, surface, and stress phenomena as it pertains to fluid flow applications.
3.3.1	3	M	Students will be able to use the **mechanical energy balance** equation to solve fluid flow problems both with and without friction.
3.3.2	3	M	Students will understand and be able to describe the physical significance of key **dimensionless quantities** including Re and f.
3.3.3	2	M	Students will be able to solve simple **fluid statics** problems.
3.3.4	2	M	Students will be able to determine **velocity profiles** for steady-state, laminar flow in simple geometries for Newtonian fluids based on the molecular concepts of viscosity.
3.3.5	1	M	Students will understand the significance of steady-state, integral and differential **mass, energy, and momentum balances**.
3.3.7	1	M	Students will understand and be able to use advanced fluid mechanical concepts including **boundary-layer theory, creeping flow, non-Newtonian flow, rheology, and turbulent flow.**
3.3.8	2	M	Students will understand qualitatively how **external flow** around objects affects **drag** and will be able to calculate drag forces and **terminal velocities**.
3.3.9	1	M	Students will understand basic concepts relating to **compressible flow**, including Mach numbers, shock waves, and choked flow.
4.9	1	P	Students will demonstrate effective **interpretation of graphical data**.
6.1	3	P	Students will demonstrate an ability to **solve engineering problems**.
6.4	2	P	Students will exhibit critical and creative **thinking skills** for analysis and evaluation of problems and cause-effect relationships.
6.6	2	P	Students will be able to rationalize **units**, make order of magnitude **estimates**, assess reasonableness of solutions, and select appropriate levels of **solution sophistication**.
7.2	2	P	Students will understand and have a basic knowledge of how **safety considerations** are incorporated into engineering problem solving.
7.4	2	P	Students will understand and have a basic knowledge of how **environmental considerations** are incorporated into engineering problem solving.
10.3.1	3	M	Students will be able to calculate **pressure drop** in flow systems involving pipes and pumps for **Newtonian** fluids.
10.3.2	2	M	Students will be able to **select**, based on performance characteristics and operational constraints, the appropriate kind of **pumps** (positive displacement, radial, axial, etc.) and valves for a specific application Students will have a qualitative understanding of the role of valves in process control.
10.3.3	2	M	Students will be able to **calculate pressure drop** in flow systems involving pipes and pumps for **non-Newtonian fluids.**
10.3.4	1	I	Students will be familiar with the use of **computational fluid dynamics** as a tool for solving fluid flow in complex geometries.
12.8	1	P	Students will demonstrate effective **reading of technical materia**l.
Levels	1- exposure to material, but may not be assessed		
	2- competency assessed in course		
	3- competency is assessed in course at again before graduation		
Usage	M=main course content; P=developed throughout the program; I=Introduction		



Red text = course competencies

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 Standards

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 my own 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 Harassment

Title IX of the Education Amendments of 1972 prohibits sex discrimination against any participant in an educational program or activity that receives federal funds. The act is intended to eliminate sex discrimination in education. Title IX covers discrimination in programs, admissions, activities, and student-to-student sexual harassment. BYU's policy against sexual harassment extends not only to employees of the university, but to students as well. If you encounter unlawful sexual harassment or gender-based discrimination, please talk to your professor; contact the Equal Employment Office at 422-5895 or 367-5689 (24-hours); or contact the Honor Code Office at 422-2847.

Students with Disabilities

If you suspect or are aware that you have a disability, you are strongly encouraged to contact the University Accessibility Center (UAC) located at 2170 WSC (801-422-2767) as soon as possible. A disability is a physical or mental impairment that substantially limits one or more major life activities. Examples include vision or hearing impairments, physical disabilities, chronic illnesses, emotional disorders (e.g., depression, anxiety), learning disorders, and attention disorders (e.g., ADHD). When registering with the UAC, the disability will be evaluated and eligible students will receive assistance in obtaining reasonable University approved accommodations.