

## APPL285 Fluid Relationships

*An Intuition-Building Approach to Fluid Mechanics*  
Fall, 2021

<p><b>Introduction</b></p> 	<p>Fluids are literally all around us. The air we breathe, the water we drink, our bodies themselves -- all primarily fluid. The purpose of this course is to lead you to an intuitive understanding of the fundamental properties and behaviors of fluids. This is an immersive treatment of the concepts and methods of fluid mechanics - the study of behavior of fluids at rest and in motion.</p> <p>Areas covered will include pressure, pressurized flow, gravity flow, viscous flow, boundary layers, system losses, microfluidics, and measurement techniques. Equations of state for both liquids and gases will be explored as well as conservation of mass and momentum for moving fluids. The course will include exposure to standard fluid appurtenances such as pumps, blowers, gauges, valves, ducts, pipes, and fittings. We will also explore fluid sensors such as flow meters, pressure gauges, etc.</p>
<p><b>Methods</b></p>	<p>Instructional time will center around guided activities, review of problem sets, and preparation for individual and group lab experiences.</p> <p>A typical class session will begin with review of material covered by students outside of class. In most cases, the classroom activity will extend into a homework assignment that will be completed prior to the next class meeting.</p> <p>In the laboratory section, we will design and conduct hands-on experiments demonstrating basic fluid mechanics principles. This will include design and fabrication of our own flow devices and sensors. Lab sections will also visit the large-scale fluids lab in Chapman Hall.</p>
<p><b>Results</b></p>	<p>In brief our objectives are to:</p> <ul style="list-style-type: none"> <li>• Develop a solid foundational understanding of the basic principles of fluid mechanics</li> <li>• Develop intuitive understanding of these principles and their application</li> <li>• Create connections between observed phenomena and underlying theory</li> <li>• Promote application of knowledge and experience to real-world needs and problems</li> </ul> <p>On completion of this course of study, you should be able to:</p> <ul style="list-style-type: none"> <li>• Explain and demonstrate basic conservation relationships in fluid mechanics</li> <li>• Apply continuity and conservation relationships to real-world problems by constructing model systems and solving those systems.</li> <li>• Apply pressure and flow relationship analysis methods to the design of devices.</li> <li>• Demonstrate principles of pressure and flow through the design, fabrication, and operation of devices in the lab.</li> <li>• Identify and explain the function of a variety of common fluid control and measurement devices.</li> </ul>

<b>Philosophy</b>	Our goal in this course is to empower you to build a knowledgebase, develop a working understanding of the principles of fluid mechanics, apply those principles to design ideas, and bring those ideas to reality. Learning and practicing technical skills is an important component of this process.
<b>Engineering Student Outcomes</b>	<p>On completion of this course of study, you should be able to:</p> <ul style="list-style-type: none"> <li> Demonstrate the ability to communicate effectively with a range of audiences.</li> <li> Demonstrate the ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.</li> <li> Demonstrate the ability to acquire and apply new knowledge as needed, using appropriate learning strategies.</li> <li> Demonstrate constant curiosity about our changing world.</li> <li> Explore a contrarian view of accepted solutions.</li> <li> Integrate information from many sources to gain insight.</li> <li> Persist through and learn from failure.</li> <li> Fulfill commitments in a timely manner.</li> </ul>

## Course Content

### ➤ COURSE TOPICS

- Basic principles – unit notation, characteristics of fluids, internal flow, external flow
- Static analysis – Pressure, manometry, hydrostatic forces, buoyancy
- Conservation laws – Control volume analysis
- Bernoulli and energy equations
- Fluid kinematics
- Turbulence
- Boundary layer considerations
- Viscous flow in pipes
- Compressible flow
- Open channel flow
- Microfluidics – Basic concepts and principles
- Fluid Fittings – Fundamentals and Applications
- Fluid sensor technologies – flow, pressure, level, and viscosity

### ➤ COURSE SCHEDULE

The current course calendar is available in Sakai under Resources

### ➤ MAJOR COURSE MILESTONE DATES

<b>FDOC</b>	
<b>Project Presentations</b>	
<b>LDOC</b>	
<b>Final Exam Period</b>	

## Class Essentials

### CONTACT INFORMATION

Dr. Glenn W. Walters



 **Office Location**  
158 Caudill Labs (in the Caudill Knuckle)

 **Email**  
walters@unc.edu

 **Phone/Text**  
(919) 451-1750

### LOGISTICS

 **Class meeting times**  
TTH 9:45 – 11:00

 **Class meeting location**  
Kenan A705 Lab  
Take the elevator to the 7<sup>th</sup> floor of Kenan Labs. Turn left, go through the double doors into the A tower. A705 is the first door on the right.



 **Office Hours**  
Thursdays 2:30 – 4:30  
or by appointment

#### Required Texts

Cengel, Yunus A. and John M. Cimbala. **Fluid Mechanics: Fundamentals and Applications**, 4th ed. New York: McGraw Hill, 2018

McGraw Hill Connect/eBook Student Account enrollment available through Student Stores

Additional readings will also be assigned during the semester.

#### Software

**Adobe Illustrator/Adobe Creative Cloud** – available at no cost to UNC students at

<https://software.sites.unc.edu/software/adobe-creative-cloud/>

**Tinkercad** – create your free account at

<https://www.tinkercad.com/>

**Autodesk Fusion 360** – Create a free educational account available at the [Fusion 360 students and educators page](#).

**Matlab** – Available at no cost to UNC Students from [UNC Software Distribution](#)

## Assignments & Evaluation

➤ YOUR COURSE GRADE	
<b>30% Homework</b>	Practice problems and simple design assignments
<b>10% Quizzes</b>	Quizzes on readings and class material
<b>30% Group/Lab Projects</b>	Group design and fabrication labs
<b>15% Individual Project</b>	Individual design and fabrication project
<b>15% Final</b>	Qualitative and quantitative skills assessment
<b>100%: total</b>	

➤ GRADE INTERPRETATION & HONOR CODE	
Your final course grade will be determined from a standard scale: A 94+ A- 90.0 - 93.9 B+ 87.0 - 89.9 B 84.0 - 86.9 B- 80.0 - 83.9 C+ 77 - 79.9 C 74 - 76.9 C- 70 - 73.9 D+ 67 - 69.9 D 60 - 66.9 F <60	<b>ACADEMIC HONESTY</b> There will be clear communication if assignments are individual or group. For individual assignments, while I encourage collaboration, it is a violation of the honor code if a student duplicates work or obtains solutions from another student and submits it as their own. Please reference the honor code: <a href="http://honor.unc.edu">http://honor.unc.edu</a> .

➤ STUDENT RESOURCES	
<b>SEE, SAY, DO SOMETHING</b> We're happy you are here and eager to learn. Despite our best intentions to follow a plan, life may throw us a curve ball. If you or someone you know is experiencing some distress or you are concerned about the well-being of a student, please report it here: <a href="https://deanofstudents.unc.edu/carereport">https://deanofstudents.unc.edu/carereport</a> . It is important to support one another. If you see something, say, and do something.	<b>ACCESSIBILITY RESOURCES</b> UNC-CH provides accommodations for any students with documented disabilities. If you have a disability and believe you require accommodations, please contact the Department of Accessibility Resources at <a href="http://accessibility.unc.edu">http://accessibility.unc.edu</a> . Please contact me early in the semester so we can make any necessary arrangements and discuss the learning checks.
<b>TITLE IX Resources</b> <i>Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Please contact the Director of Title IX Compliance (Adrienne Allison –<a href="mailto:Adrienne.allison@unc.edu">Adrienne.allison@unc.edu</a>), Report and Response Coordinators in the Equal Opportunity and Compliance Office (<a href="mailto:reportandresponse@unc.edu">reportandresponse@unc.edu</a>), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (<a href="mailto:gvsc@unc.edu">gvsc@unc.edu</a>; confidential) to discuss your specific needs. Additional resources are available at <a href="http://safe.unc.edu">safe.unc.edu</a>.</i>	

## ➤ COURSE EXPECTATIONS AND POLICIES

- Community Standards in Our Course and Mask Use.  
This fall semester, while we are in the midst of a global pandemic, all enrolled students are required to wear a mask covering your mouth and nose at all times in our classroom. This requirement is to protect our educational community — your classmates and me — as we learn together. If you choose not to wear a mask, or wear it improperly, I will ask you to leave immediately, and I will submit a report to the [Office of Student Conduct](#). At that point you will be disenrolled from this course for the protection of our educational community. An exemption to the mask wearing community standard will not typically be considered to be a reasonable accommodation. Individuals with a disability or health condition that prevents them from safely wearing a face mask must seek alternative accommodations through the [Accessibility Resources and Service](#). For additional information, see [Carolina Together](#).
- This course is highly interactive and attendance at all sessions is required unless previously arranged with the instructor. Attendance is regularly recorded and is a factor in your final grade.
- In the event of an unavoidable absence (e.g. medical), a written explanation is required. I expect all students to abide by the [UNC Class Attendance Policy](#).
- During class time, do not use your phone or computer for something unrelated to class; research shows that this is distracting to other students in the class. If there is an urgent situation, then you can leave the classroom to use your phone or computer. Unless specifically instructed otherwise, **all electronic devices should be packed away during class**.
- You will be working closely with your classmates and should accord them all of the respect and honor that you yourself expect in return. Our goal is to overcome inhibitions to creativity so it is very important to give and receive critique in an objective and professional manner. There are no bad ideas in this class, just a whole lot of ideas that are part of the pathway to a solution. Remember that the crazy, stupid, and impossible ideas have often been the early steppingstones to world-changing innovation.
- Due dates are given with each assignment. It is expected that assignments be submitted at the beginning of class, on the due date.
- This is a course in engineering fundamentals. As such, there is a need to acquire definitive and quantitative knowledge. Homework assignments allow you to develop and hone the necessary quantitative skill sets and are graded based on problem solving process, format, and content. For project and lab assignments, I primarily use a system known as specifications grading which focuses more on successful completion of assignments rather than quantitative ranking of your work relative to some ideal standard. In this system, I expect you to meet the specifications provided in the rubric to receive points for the assignment. For most such assignments, individual specifications will be assigned point values and points will be awarded on the basis of whether or not each specification is met.
- I also require evidence and documentation of your problem-solving process. For homework problems, we will use the Engineering Homework Format (see handout). For design exercises, we will use an engineering portfolio documentation process which can include sketches, narrative journaling, design files, and photographs. Demonstrated artistic and engineering skills are not primary factors in project evaluation. This does not, however, relieve the student from the obligation to produce neat, well thought-out work.

**I reserve the right to make changes to the syllabus, including project due dates and test dates (excluding the officially scheduled final examination), when unforeseen circumstances occur. These changes will be announced as early as possible so that students can adjust their schedules.**