Fluid Mechanics - EGR 346
Block 2, 2019-20

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Textbook: *Fluid Mechanics,* Third Edition, Yunus A. Cengel, John M. Cimbala

Prerequisite: Engineering Mechanics - EGR 231, Engineering Thermodynamics - EGR 271, and Calculus of Several Variables - MAT 122.

Class location: 111 West Science Hall

Daily Schedule: We start the day at 9 am by discussing the homework assignments that you already worked on and there might be a quiz from the homework or the materials from the day before. From 10 to 11 am, we work on the new materials, and in the afternoon we solve examples and deepen our understanding of the subject of the day.

We will attend Engineering Career Fairs on Thursday October 3rd , and we'll be visiting University of Iowa fluid labs on Wednesday October 9th.

Course Description: This is a four semester credit, selected elective class. It is an introduction to the mechanics of liquids and gases. Topics include classifications of flows, fluid statics, Lagrangian and Eulerian descriptions of fluids, Bernoulli and energy equations, closed system and control volume concepts, dimensional analysis and similarity. Applications of fluids to engineering including internal flow, flow in pipes and ducts, external flow, lift and drag forces.

Course Objectives: This course supports the Educational Priorities and Outcomes of Cornell College with emphases on knowledge, inquiry, reasoning, and communication. Upon completion of this course, students will have a good understanding of the following concepts:

1- The basic concepts in fluid mechanics such as classification of fluid flow, system formulation versus control volume, dimensions, units, significant digits, and problem-solving techniques.
2- Fluid properties such as density, vapor pressure, specific heats, speed of sound, viscosity, surface tension and capillary effect.
3- Fluid statics and pressure, hydrostatic forces on submerged surfaces, buoyancy, stability, and fluids in rigid body motion.
4- Lagrangian and Eulerian descriptions of the fluid, flow patterns, flow visualization, vorticity and rotationality, and Reynolds transport theorem.
5- Bernoulli and energy equations.
6- Momentum analysis of flow system, and the control volume concept.

7- Dimensional analysis; the physical and mathematical significance of dimensionless numbers.
8- Internal flow, flow in pipes, laminar and turbulent flow in pipes and ducts, friction losses and minor losses in piping network and how to properly select a pump or fan to match a piping network.
9- External flow, drag and lift, different flow for common geometrics.

This course supports the student outcomes in Criterion 3 of ABET for baccalaureate level programs including: 1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics, 3. an ability to communicate effectively with a range of audiences, 4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Assignments:

Homework: There are homework assignments for every day. You are expected to work on them and reach an understanding of the problem and have a good idea on how they are being solved, and the best is when you solve a problem to the end. We discuss the problems the day after (you need to come to class ready and bring your questions regarding the problems; I don't solve and explain the problems from the scratch). I might ask you to come to front of the class and explain your solution.

I grade your homework based on two criteria: 1) the work that you have done before coming to the class, 2) the work you turn in after we went over your homework questions.

Ch1- Introduction *Ch2- Properties of Fluids* Crash course: https://youtu.be/ouTJkNLepF0 , https://youtu.be/bRrfsv9hiX4 Read 1-1 introduction Read 1-2 a brief history of fluid mechanics No - Slip Condition: https://youtu.be/DOMvJUDWepY Read: 1-7 modeling in engineering, 1-8 problem-solving technique, 1-10 accuracy, precision, significant digits **Solve Ch1: 36, 60, 61, 63, 66, 68** Cavitation: https://youtu.be/U-uUYCFDTrc, https://youtu.be/azAGgCvIyXI Vapor cloud: https://youtu.be/4RgXQlnPMc8 Water hammer: https://youtu.be/YgjRZq70GR4, https://youtu.be/ujNGaQKap98, https://youtu.be/xoLmVFAFjn4 Sonic boom: https://youtu.be/JO4_VHM69oI, https://youtu.be/k4IzBIezhB4 Concorde: https://youtu.be/a_wuykzfFzE Non-Newtonian Fluids: https://www.youtube.com/watch?v=DQoelYi6qfw https://www.youtube.com/watch?v=RkLn2gR7SyE **Solve Ch2: 13, 25, 36, 46, 62, 80, 93, 108**
Ch3- Fluid Statics Hydraulic lift: https://youtu.be/TQRM-7kSNmI, https://youtu.be/Xz60Psx_Cp0 Barometer: https://youtu.be/EkDhlzA-lwI, https://www.youtube.com/watch?v=GgBE8_SyQCU Archimedes' principle: https://youtu.be/ijj58xD5fDI, https://youtu.be/0v86Yk14rf8 **Solve Ch3: 30, 35, 41, 45, 58, 72, 92, 103, 125, 129**
Ch4-Fluid Kinematics Schlieren Imaging: https://youtu.be/4tgOyU34D44, https://youtu.be/K7pQsR8WFSo. Contour plot: http://www.afs.enea.it/project/neptunius/docs/fluent/html/tg/node54.htm

Ansys CFD: https://www.ansys.com/products/fluids **Solve Ch4: 22 (general eq. for parabola: $u = a + b(x - c)^2$), 24, 30, 35, 45, 72, 73, 78, 94, 96**
Ch5- Bernoulli and energy equation **Read p.203 on different pressure probes and p.204 limitations on the use of the Bernoulli eqn. and p.206&207 on HGL and EGL** **Solve Ch5: 14, 16, 25, 27, 44, 62, 66, 80, 84, 97**
Ch6- Momentum analysis of flow systems **Read 6-1 Newton's laws and 6-2 Choosing a control volume88** **Read examples 6-2, 6-3, 6-4, 6-5 before attempting homework problems** **Solve Ch6: 25, 27, 42, 59, 60, 65**
Ch7- Dimensional analysis and modeling **Read example 7-3, look at table 7-5** **Solve Ch7: 31, 32, 34, 40, 44** **Read tables 7-2, 7-3 and 7-4, Solve Ch7: 67, 70, 75** **Read example 7-10, Solve Ch7: 86, 87**
Ch8- Internal flow **Read sections 8-1 and 8-2, why a higher pump power to flow a turbulent flow comparing to laminar flow?** Laminar & turbulent flows: https://youtu.be/y7Hyc3MRKno https://youtu.be/PMerSm2ToFY, https://youtu.be/S3i6tJ4XNqA **Read pages 368-370, learn more about Moody chart and the types of flow problems.** **Solve Ch8: 39, 41, 46, 51, 64, 66, 90, 93**
Ch11- External flow: drag and lift **Read Chapter 11** Lift: https://youtu.be/aFO4PBolwFg Flow separation: https://youtu.be/SiOiVHUEYao, https://youtu.be/Lr7KgJl6NsQ Vortex Generators: https://youtu.be/eP-YUDe9HF0, https://youtu.be/WH8kCTzy91A **Solve Ch11: 27, 29, 37, 42, 50, 59, 79, 87, 88** Floating Ping Pong Ball: https://youtu.be/5zD7Le2mGFg
Extra videos: Water and Classical Civilizations: https://www.youtube.com/watch?v=rP54LFFSZ1Q The role of water in ancient civilizations: https://www.youtube.com/watch?v=9trO4aLaOG8 Municipal water supply in antiquity: http://www.romanaqueducts.info/webteksten/waterinantiquity.htm Hooke's Law - Stress and Strain Test: https://www.youtube.com/watch?v=D23hzv-3Tf0

Grades:

First exam (second Monday)	100	Homework/Quizzes	50
Second exam (third Monday)	100	Bonus points	10
Final exam (Cumulative)	150	**Total grade out of**	**400**

Bonus points: for brief written reports, up to two, on events/talks/discussions on campus or off campus which contribute to your liberal arts education.

A	93-100		C	74-76
A-	90-92		C-	70-73
B+	87-89		D+	67-69
B	84-86		D	64-66
B-	80-83		D-	60-63
C+	77-79		F	<60

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Academic Honesty: Cornell College expects all members of the Cornell community to act with academic integrity. An important aspect of academic integrity is respecting the work of others. A student is expected to explicitly acknowledge ideas, claims, observations, or data of others, unless generally known. When a piece of work is submitted for credit, a student is asserting that the submission is her or his work unless there is a citation of a specific source. If there is no appropriate acknowledgement of sources, whether intended or not, this may constitute a violation of the College's requirement for honesty in academic work and may be treated as a case of academic dishonesty. The procedures regarding how the College deals with cases of academic dishonesty appear in The Compass, our student handbook, under the heading "Academic Policies – Honesty in Academic Work."