Course     CE/ME 318—Fluid Mechanics  
Room:      Kettler 249  
Time:      9:00 a.m.–10:15 a.m. M W  

Instructor  Donald W. Mueller, Jr., Ph.D., P.E.  
Office:     ET 327H  
Hours:      11:00–12:00 T R  
            4:30–5:30 M T W R†  
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Email:      mueller@engr.ipfw.edu  
Web:        http://www.engr.ipfw.edu/~mueller  

Text        Introduction to Fluid Mechanics, 7th ed.  
            Fox, Pritchard, and McDonald  

Prerequisites MA 363, ME 200, CE/ME 251  

Description Fluid mechanics is a branch of the field of mechanics that deals with fluids. A fluid is a  
substance that can be classified as either a liquid or a gas. The study of fluids at rest  
is known as fluid statics, or sometimes hydrostatics, and the study of fluids in motion is  
referred to as fluid dynamics.  

The study of fluid dynamics is also a fundamental part of the broad area of thermal-fluid  
sciences, which also might include thermodynamics and heat transfer. The study of fluid  
dynamics might further be divided into subcategories such as hydraulics, gas dynamics, aero-  
dynamics, hydrology, and turbomachinery.  

The basic laws that govern fluid mechanics are the conservation of mass, conservation of  
momentum, conservation of energy, and the second law of thermodynamics.  

Topics   1. Fundamental Concepts  
          2. Fluid Statics  
          3. Control Volume Analysis  
          4. Inviscid Flow  
          5. Viscous Flow in Pipes  
          6. Dimensional Analysis, Scaling, and Similarity  
          7. External Flow  
          8. Open Channel Flow  
          9. Compressible Flow  
         10. Turbomachinery  

†Please stop by anytime that I am in my office.
Quizzes  
Brief quizzes will be given throughout the semester. These quizzes will be (mostly) unan-
nounced. The quizzes will be from the assigned reading and homework. You might be
allowed to make use of your notes from the reading or your worked homework assignment.
No xeroxed or printed material is allowed. Each quiz will be worth 10 points. *No make-up
quizzes will be given*, but you may drop your lowest quiz score.

Homework  
Homework problems are listed on the class schedule. You are expected to work these prob-
lems. I will collect and grade at least seven homework assignments (see the class schedule).
Please start each problem that you submit on a new sheet of paper. *No late homework will
be accepted.*

Projects  
At least one design-oriented project will be assigned during the semester. This project will
cover topics in a somewhat open-ended manner and will probably require some computer
use. A brief technical memo summarizing your work will be required. *Late projects will
not be accepted.*

Exams  
There will be three in-class, closed-book/closed-note exams. You will be allowed to use the
Fluids Notes from the Fundamentals of Engineering Handbook. These notes are located
on my webpage and at the NCEES website (www.ncees.org). Please download and print a
copy. *Do not write on these notes.*

Final Exam  
There will be a comprehensive final exam on Monday, December 15 from 8:00–10:00 a.m.
The final exam will consist of five or six problems—problems similar to those on the hour
exams.

Grades  
Averages will be based on the following distribution:

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<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Quizzes</td>
<td>10%</td>
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<tr>
<td>Homework</td>
<td>5%</td>
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<tr>
<td>Projects</td>
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<td>Exams</td>
<td>60%</td>
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<td>Final</td>
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<td>Total</td>
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Grades will be assigned in accordance with the following criteria:

\[
A \geq 90\%, \ 89\% > B \geq 80\%, \ 79\% > C \geq 70\%, \ 69\% > D \geq 60\%, \ F < 59\%.
\]

With the plus/minus grading system, the following grades are also available for assignment
in this class: A-, B+, B-, C+, and C-. These grades will be used to differentiate performance
if warranted.
Policies

As a courtesy to the instructor and other students, do not be late for class and turn off your cell phone.

No late homework or project submission.

No make-up quizzes.

Consult the student handbook for information pertaining to a grade appeal or grievance policies.

Students with a disability in need of assistance should contact the SSD office in Walb 113 (481-6658 or www.ipfw.edu/ssd) for a description of services available.

Comments

Fluid Mechanics should be an enjoyable course for mechanical and civil engineers—it is certainly my intention to make it enjoyable for you. In this course, you will apply fundamental concepts from Statics, Dynamics, and Thermodynamics to calculate the forces on submerged objects and produced by jets, to design piping networks and select pumps, and to find the friction drag on an automobile and the lift of an airplane wing.

I plan to work hard in this course and expect you to do the same. I expect you to attend class regularly and stay caught up with the reading and homework.

Finally, please feel free to stop by any time if you have any comments or suggestions. Certainly, any suggestions that will benefit the class are appreciated, and I will try my best to address any concerns that you might have.

†These are maximum cut-offs.
Course Outcomes

Upon successful completion of the FLUID MECHANICS course, students should be able to:

1. Know the definitions of fundamental concepts of fluid mechanics including: continuum, velocity field; viscosity, surface tension and pressure (absolute and gage); flow visualization using timelines, pathlines, streaklines, and streamlines; flow regimes: laminar, turbulent and transitional flows; compressibility and incompressibility; viscous and inviscid. (a, e)

2. Apply the basic equation of fluid statics to determine forces on planar and curved surfaces that are submerged in a static fluid; to manometers; to the determination of buoyancy and stability; and to fluids in rigid-body motion. (a, e)

3. Use of conservation laws in integral form and apply them to determine forces and moments on surfaces of various shapes and simple machines. (a, e)

4. Use of conservation laws in differential forms and apply them to determine velocities, pressures and acceleration in a moving fluid. Understand the kinematics of fluid particles, including the concepts of substantive derivatives, local and convective accelerations, vorticity and circulation. (a, e)

5. Use Euler’s and Bernoulli’s equations and the conservation of mass to determine velocities, pressures, and accelerations for incompressible and inviscid fluids. (a, e)

6. Understand the concepts of rotational vs. irrotational flows; stream functions, velocity potentials. Laplace equation and its relation to elementary plane flows of inviscid fluids: sinks, sources, vortex flows, and superposition of these flows. (a, e)

7. Understand the concepts of static, thermodynamic, stagnation, total, and dynamic pressures and how they are used in instrumentation. (a, c, e, g, j)

8. Apply principles of dimensional analysis and similitude to simple problems and use dimensionless parameters. (a, c, e, g, j)

9. Determine flow rates, pressures changes, minor and major head losses for viscous flows through pipes, ducts, simple networks and the effects of pumps, fans, and blowers in such systems. (a, e)

10. To design simple pipe systems to deliver fluids under specified conditions. (a, c, e, g)

11. Understand principles of flow measurements using such as direct methods, flow-restriction methods, linear methods, traversing methods, open-channel flow meters. (a, e)

12. Understand the concepts of viscous boundary layers and the momentum integral and use them to determine integral thicknesses, wall shear stresses, and skin friction coefficients. (a, e)

13. Understand the mechanics of viscous flow about immersed boundaries, as it relates to flow separation, wakes, profile drag, drag coefficients and the determination of drag forces exerted on such bodies. (a, c, e)

14. Understand the mechanics of viscous flow about immersed boundaries as it relates to flow separation, wakes, stall, profile and induced drag, lift coefficients and the determination of lift forces exerted on such bodies. (a, c, e)

15. Apply principles of fluid mechanics to the operation, design, and selection of fluid machinery such as pumps, blowers, fans, compressors, and turbines. (a, c, e, i)

16. Understanding ethical issues associated with decision making. (f)