Course Organization/Management:
This course will be managed through the Information Technology Clark School Online Internet course software (https://myelms.umd.edu). All of the information that you need for this course will be available to you online through this system. Assistance is available through the Clark School of Engineering Information Technology via http://elms.umd.edu. It is your responsibility to regularly check the site for course announcements, assignments, grade records, and course information such as project descriptions and lecture notes. Hardcopies of these materials will generally not be distributed in class.

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Textbook:

WileyPlus is a website that provided by the publisher that provides an integrated learning environment. We will be utilizing WileyPlus to assign homework problems, and to provide instant feedback and grading on select problems of the homework. A subscription to WileyPlus is required for the course. If you choose not to purchase the custom softcover text listed above, you may purchase older editions of the book, but a separate subscription to WileyPlus will have to be purchased directly from the publisher. Note that a subscription to WileyPlus includes an electronic version of the text, which you may also use in lieu of a physical text if you prefer.
To sign up, please see the separate flyer posted on canvas for details. In summary: 1) go to www.wileyplus.com, 2) provide the course ID 531319 (this corresponds to “Fluid Mechanics ENME 331 Fall 2016”), 3) log in using your existing WileyPLUS account or create a new one if needed, 4) enter your registration code purchased with the book or bought directly from Wiley.

Lectures:
Mon & Wed 11:00am–11:50am. KEB 1110 (sections 020x, Kiger)
Mon & Wed 12:00am–12:50am. EGR 1202 (sections 010x, Kiger)

Studies/Lab:
Section 0101 Balint/White/Zhao Tue 1–2:50pm 1200 KEB Building
Section 0102 Das/Hoganson/Erinin Wed 1–2:50pm 1200 KEB Building
Section 0103 Riaz/White/Chen Thu 1–2:50pm 1200 KEB Building
Section 0104 Das/Haedrich/Chen Thu 3–4:50pm 1109 JMP Building
Section 0201 Riaz/Chen/Said Fri 1–2:50pm 1200 KEB Building
Section 0202 Balint/Haedrich/Zhao Tue 3–4:50pm 1111 ITV Building
Section 0203 Riaz/Hoganson/Erinin Wed 3–4:50pm 1200 KEB Building

Office Hours:

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<tr>
<td>9:00–10:00</td>
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<td>Riaz</td>
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<td>Zhao</td>
<td>Erinin</td>
<td>Ahmed</td>
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<td>5:00–6:00</td>
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<td>Zhao</td>
<td>Erinin/White</td>
<td>Ahmed</td>
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Homework and Quizzes:
Homework is typically assigned in lecture on Mondays and Wednesdays. It will be due on Fridays of the following week at 5pm. Homework assigned online at WileyPlus must be completed by 5pm on Friday, which any hardcopy problems must be placed in the drop boxes outside office of Dr. Kiger’s office by 5pm. Since the solutions are posted as soon as the homework is due, no late homework can be accepted. The lowest homework grade will be dropped.

Midterm Exams:
There will be two midterm exams, given approximately Monday, October 10 and Monday, November 14.

Final Exam:
Friday, December 16, 8:00 am – 10:00 am OR Monday, December 19, 8:00 am – 10:00 am.

Grades:
Your final grade will be determined by the following components:

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<th>Component</th>
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<tr>
<td>Homework &amp; Participation</td>
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<tr>
<td>Midterm Test #1</td>
<td>16%</td>
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<tr>
<td>Midterm Test #2</td>
<td>16%</td>
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<tr>
<td>Semester Project Preliminary Report 1</td>
<td>7%</td>
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<tr>
<td>Semester Project Final Report</td>
<td>14%</td>
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<tr>
<td>Labs</td>
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<td>Final</td>
<td>31%</td>
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<td>TOTAL</td>
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Philosophy:

The goal of this course is to provide an environment for the students to become proficient in the fundamental principles of fluid mechanics. The specific topics to be learned are outlined in this syllabus. Our goal is to use diverse teaching methods including visual, verbal, and other multi-media techniques to aid you in understanding the concepts, that will enable you to solve fluid mechanics problems. Many of the sections will start with demonstrations and applications as an entry point for the student to go past the mechanics of solving problems to a real understanding of the fundamentals.

The students will be organized into small teams. The intention is for them to be an internal support group for all aspects of the course. There also will be a semester long project and classroom activities which will be for the groups. Our work in making the curriculum content and classroom climate supportive of growth of the students in engineering has resulted in (hopefully) a pedagogy more humanizing to all participants. By providing various forms of on-going support, you, the students, can undertake the course material at greater depth and pursue your own learning process.

How does Fluid Dynamics fit into The Big Picture?

Fluid Mechanics is one of several courses which comprise the subject of *continuum mechanics*. Continuum mechanics is a framework in which we treat materials as a continuous substance at a macroscopic scale (as opposed to detailing the microscopic, or atomic scale of motion), and represents one of the main foundations of 19th and 20th century engineering accomplishments. This course will build upon the fundamentals learned in Statics, Dynamics, Strength of Materials, and Thermodynamics through the concepts of dynamic force balances, acceleration, stress, strain, and mass and energy conservation. This course is required for the study of Heat and Mass Transfer, Industrial Fluid Mechanics, and HVAC.

Specifically, Fluid Mechanics is the study of the behavior of fluids (i.e. a gas, liquid or plasma), and how one can quantitatively describe and predict their motion and its effects on the surrounding environment.

Phenomena which depend on Fluid Mechanics and interesting applications related to fluid behavior literally surround you 24 hours a day:

- Lubrication flow in internal combustion engines, the mixing and combustion of fuel in all types of power-plants, the drag force on vehicles, lift produced by aircraft (Mechanical and Aerospace Engineering)
- Cooling of electronic parts in computers (Manufacturing)
- Construction of dams, wind loads on buildings (Civil Engineering)
- Transport of oxygen through your lungs and cardiovascular system to your muscles, how insects and birds fly (Bio-mechanics)
- The formation of thunderstorms, hail, rain, tornadoes, and hurricanes, El Niño, and global warming (Meteorology)
- The motion of subterranean groundwater, sediment transport in rivers and oceans, and dispersal of pollutants (Environmental Engineering)
- The formation of stars and galaxies, magnetically confined fusion, tectonic plate motion, generation of planetary magnetic fields (Astronomy, Physics, Geophysics)

Although we cannot begin to touch on all of these topics in this course, the main point is that fluid mechanics is a subject that can lead you down many diverse career paths, depending on your own personal interests. Our intention is to provide you with the groundwork for these possible pursuits.

Learning Outcomes:

- Develop an ability to solve basic and fundamental problems such as
- The force distribution on a dam.
- The pump size required to move water though a practical pipe network.
- The engine power required to keep a car moving forward at a specified velocity.
- The wind speed required to test a model car in a wind tunnel.

- Expand your ability to apply mathematics and physics to engineering problems involving fluid mechanics. This is strongly emphasized through lectures and homework.
- Expand your ability to conduct experiments, as well as to analyze and interpret data through performing the planned laboratories and writing the lab reports. Analysis of experimental error is emphasized.
- Enhance your ability to identify, formulate, and solve engineering problems through your participation in the problem-based team project this semester. This problem involves the design of scaled model experiments of a complex full-scale engineering device.
- Enhance your skills related to team work through the semester project which is performed in groups of 3 to 5 students.
- Enhance your ability to communicate effectively through the written reports on the semester project.
- Enhance your ability to learn new material on your own through the problem-based learning aspects of the semester project. In this work, you will learn about an area of fluid mechanics by library research with your group.
- Enhance your ability to work with modern engineering measurement equipment through the performance of five laboratory assignments.

**How will I use this professionally:**

The technical matter on fluid mechanics taught in this class is directly used for solving a variety of practical engineering problems at corporations and government laboratories. The training on group interaction during technical projects is also invaluable for later professional work.
SYLLABUS

The following is a list of the material that will be covered; the dates are, however, approximate and could be changed during the course of the semester.

Week 1

Mon, Aug. 29: Introduction (Chapter 1)\(^1\)
   What is a fluid?
   Fluid properties

Wed, Aug. 31: Fluid Properties (cont. Chapter 1) and Kinematics (Sections 4.1–4.3)
   Eulerian and Lagrangian reference frames
   The Material Derivative and fluid acceleration

STUDIO: Group organization, teaming, discussion of labs, assignment of project.

Week 2

Mon, Sept. 5: Labor Day, No Class

Wed, Sept. 7: Fluid Kinematics (section 4.1-4.3)
   Streamlines, Streaklines and Pathlines

STUDIO: Problem solving

Week 3

Mon, Sept. 12: Generalized Equations of Motion
   Fluid deformation and Conservation of Mass (section 6.1-6.2)
   the streamfunction

Wed, Sept. 14: Generalized Equations of Motion (cont.)
   Forces acting on a differential fluid element (Section 6.3)
   Navier-Stokes equations (Section 6.8)

STUDIO: Problem solving

Week 4

Mon, Sept. 19: Fluid Statics (Sect. 2.1–2.6, 2.8)
   Wrap-up and overview of equations for course
   Hydrostatic equations
   Manometry

Wed, Sept. 21: Fluid Statics (cont.) (Sect. 2.10, 2.11)
   Manometry (cont), Hydrostatic forces on a plane surface

STUDIO: Problem solving

Week 5

Mon, Sept. 26: Fluid Statics (cont.) (Sect. 2.10, 2.11)
   Hydrostatic forces on a plane surface
   Hydrostatic forces on a curved surface

Wed, Sept. 28: Buoyancy (Section 2.11)

STUDIO: Hydrostatics Lab, Problem solving

\(^1\)The numbers in parenthesis refer to reading assignments in chapters or sections of the text by Munson et al.
Week 6

Mon, Oct. 3: Inviscid Flow
   Euler’s equation (Section 6.4)
   Bernoulli’s equation (Sections 3.1–3.5)

Wed, Oct. 5: Inviscid Flow (cont.)
   Examples (Sections 3.6 - 3.8)

STUDIO: Problem Solving

Week 7

Mon, Oct. 10: Midterm Exam #1 (tentative date)

Wed, Oct. 12: Inviscid Flow: restrictions on Bernoulli’s equation
   effects of compressibility, unsteady effects

STUDIO: Bernoulli’s equation lab, Problem solving

Week 8

Mon, Oct. 17: Control Volume analysis
   Rate equations for control volumes (Section 4.3-4.4)

Wed, Oct. 19: Control Volume analysis (cont.)
   Continuity equation (Section 5.1)
   Examples

STUDIO: Project Oral Presentation #1

Week 9

Mon, Oct. 24: Control Volume analysis (cont.)
   Linear momentum equation (Section 5.2)
   Examples

Wed, Oct. 26: Control Volume analysis (cont.)

   Examples

STUDIO: Preliminary project report due. Problem solving

Week 10

Mon, Oct. 31: Control volume analysis
   Energy equation (Section 5.3)

Wed, Nov. 2: Viscous flow
   Exact solutions of N-S equations (Section 6.9)

STUDIO: Control Volume Lab; Problem solving

Week 11

Mon, Nov. 7: Viscous flow
   Exact solutions of N-S equations (Section 6.9)

Wed, Nov. 9: Viscous flow (cont.)
   Examples
   Introduction to pipe flow (Sections. 8.1 - 8.2)
STUDIO: Problem solving

Week 12
Mon, Nov. 14: Midterm Exam #2 (tentative date)
Wed, Nov. 16: Pipe flow (cont.)
   laminar and turbulent flow (Sections. 8.1 - 8.3)
STUDIO: Problem solving

Week 13
Mon, Nov. 21: Pipe flow (cont.):
   Moody diagram (Section 8.4.1)
Wed, Nov. 23: No Class
STUDIO: No Studio

Week 14
Mon, Nov. 28: Pipe flow (cont.):
   Minor losses (Section 8.4.2)
   Examples
Wed, Nov. 30: External flow
   Introductions and Boundary Layers (Section 9.1-9.2)
STUDIO: Final project presentation

Week 15
Mon, Dec. 5: External flow (cont.)
   Boundary Layers (Section 9.2)
Wed, Dec. 7: External Flow (cont.)
   Lift-Drag (Section 9.3)
STUDIO: Pressure/Drag Lab, problem solving

Week 16
Mon, Dec. 12: External Flow (cont.)
   Lift-Drag (Section 9.3)
   Final Project Report Due Problem solving
STUDIO: No studio
ENME 331: A Few Misconceptions

1. **Theory versus Problems:**
   From past experience, we have discovered that some students think that this course should consist only of instructions on how to solve a number of different kinds of engineering fluid mechanics problems. We think that the above type of course is a bad way to prepare students for a career in engineering. We would like our graduates to be able to do more than just solve engineering problems that are almost exactly like those given in the course. Our goal is for our graduates to be able to understand and solve a broader range of problems than can possibly be covered in a one semester course. This goal requires students to have a good understanding of the basic equations of fluid mechanics and a physical understanding of fluid flows. We want our students to solve problems by starting with these basic equations and then simplifying and/or approximating them to fit the problem at hand. In order to emphasize this goal, each examination in this course includes at least one problem that requires the student to answer a direct question about the theory or to solve a new type of problem using direct application of the theory.

2. **Beware:** This course is NOT structured with theory exclusively in lectures and examples and homework exclusively in studios. Theory and examples will be presented in both lecture and studio. NEW MATERIAL MAY BE PRESENTED IN STUDIOS, NOT JUST IN LECTURE. MATERIAL COVERED IN STUDIOS MAY NOT BE MENTIONED IN LECTURES.

3. **Labs:** There are several labs during the semester. ALL STUDENTS MUST ATTEND ALL OF THE LABS. If you have to miss a lab, tell your TA ahead of time and make arrangements to attend one of the labs at a different time.

4. **Mathematics:** Without calculus, most of the advances that have occurred in engineering, physics and other sciences since the time of Newton would not have occurred. Thus, we believe that it is not possible to study modern engineering without calculus. In order to do well in BIOE331/ENME331, you will need to understand and use elementary differentiation and integration, surface and volume integrals, partial derivatives, the solution of linear ordinary differential equations and Taylor expansions. Though these topics are covered in the prerequisite mathematics courses, we realize that some students do not feel comfortable using them. These students are encouraged to contact either of us or one of the TAs for assistance; the mathematics is sometimes easier to learn when it is being applied to an engineering problem.