San José State University
Department of Mechanical and Aerospace Engineering
ME 111, Fluid Mechanics, Section 1, Course No. 22285
Spring 2023

Instructor:	Dr. Paul Kutler
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Office Hours:	Tuesday & Thursday, 1:45-2:45 PM/In-person, Virtual and by Appointment
Class Days/Time:	Tuesday & Thursday, 3:00-4:15 PM Lecture/In person and Virtual
Classroom:	Engineering 343
Prerequisites:	Math 32 (Calculus III), CE 95 or 99 (Statics)

Class Format

A copy of the Course Syllabus will be published on Canvas for you before the first day of classes. You are responsible for regularly checking Canvas and your email account for updates to the Course Syllabus, messages and your class status.

Course Description

This course covers the study of fluid properties, and the statics and dynamics of fluids. It presents the continuity, linear and angular momentum and energy principles for describing the behavior of fluids. Both viscous and non-viscous flows are covered. Fluid flow systems including machines such as pumps and turbines are analyzed. The equations governing flow in pipes and around submerged obstacles are presented and used to analyze such systems.

Course Goals and Student Learning Objectives

Course Goals

Fluid mechanics encompasses a large variety of problems, from blood flow through the human heart and capillaries to oil flow through the 800-mile-long, 4-ft diameter Trans-Alaskan pipeline. It is concerned with the forces on the 726.4 ft-tall Hoover dam, which can hold over 32 million acre-feet of H_2O (enough to cover the entire state of New York to a depth of one foot). It is also concerned with the design of the Antonov 225 Mriya (the largest airplane in the world with a maximum gross weight of 1.3 million pounds). Fluid mechanics plays an essential part in many sports, such as golf (dimples on the balls), baseball, tennis, and ping-pong (spin on the ball), and all kinds of racing (wind-surfing, skiing, auto-racing, etc.). But perhaps the most beautiful applications of fluid mechanics can be seen in nature from the descent of rain and snow, the powerful tornadoes and tsunamis to the airborne dispersal of seeds and fruits and the graceful flight of birds and insects.

This course will give you an understanding of:
1. Fluids in general and how they differ from solids.
2. The basic principles of fluid mechanics (continuity, momentum, energy).
3. Viscous flow over a surface and through a pipe.

This understanding will lead to an appreciation of the phenomena, problems, and engineering applications mentioned above. In addition, the course will help you:
4. Develop and practice communication and team skills.

Course Content Learning Outcomes

Fluid Properties
1. Define a fluid and describe how it differs from a solid.
2. Describe the differences between liquids and gases and explain the origin of these differences.
3. Define the various properties of fluids, such as density, specific weight, specific gravity, pressure, temperature, viscosity, surface tension, and vapor pressure.
4. Distinguish between Newtonian and Non-Newtonian fluids.
5. Identify, formulate, and solve problems involving viscosity and vapor pressure.

Fluid Statics
6. Define and distinguish between absolute pressure, gage pressure, and vacuum.
7. Explain Blaise Pascal's law of pressure transmission.
8. Derive the basic differential equation of hydrostatics starting with the equilibrium of a fluid element.
9. Derive the equation for the pressure variation of a uniform-density fluid.
10. Identify, formulate and solve problems involving manometers

Fluid Flow – Continuity
11. Classify a flow as uniform or non-uniform, steady or unsteady, incompressible or compressible, 1-D, 2-D, or 3-D.
12. Calculate mass flow rate, volume flow rate, and mean velocity for a flow.
13. Derive the integral form of the continuity equation for a control volume.
14. Identify, formulate and solve problems involving the continuity equation for a variety of cases involving one-dimensional,
uniform and non-uniform, compressible and incompressible, steady and unsteady flows.

Fluid Flow – Bernoulli's Equation

15. Derive Euler's equation of motion for a fluid.
16. Derive Bernoulli's equation and list the assumptions made in the derivation.
17. Apply Bernoulli's equation in a variety of problems including flow velocity measurements and pressure calculations.
18. Predict cavitation in enclosed pipes or hydraulic machines.
19. Describe the differences between ideal (fully attached) and real (separated) flow over a circular cylinder.

Fluid Flow – Momentum Equation
20. Derive the momentum equation for a fluid, starting with Newton's 2nd law of motion.
21. Identify, formulate, and solve problems involving the momentum equation in a variety of applications including stationary and moving vanes, nozzles, pipes with bends, and propulsion systems.

Fluid Flow – Energy Equation
22. Derive Reynold's transport theorem (control volume equation).
23. Derive the integral form of the energy equation starting with Reynolds transport theorem.
24. Identify, formulate, and solve problems involving the energy equation in a variety of applications including reservoirs, pipes with minor losses, pumps, turbines, and nozzles.
25. Identify, formulate, and solve problems involving the simultaneous application of continuity, momentum, and energy equations.
26. Plot the hydraulic and energy grade lines for a variety of flow systems involving reservoirs, pipes of varying diameters, pumps, turbines, and nozzles.

Pipe Flow
27. Describe qualitatively and quantitatively both laminar and turbulent flow in a pipe and predict transition from laminar to turbulent flow.
28. Derive the equation for the shear stress distribution across a pipe section.
29. Derive the equation for the velocity distribution across a pipe section in laminar flow.
30. Use the Moody diagram in a variety of problems involving head losses in pipes, including the design of pipes for certain discharge with a given head loss per unit length.
31. Calculate minor losses (i.e., head losses in pipe inlets, outlets, valves, and other fittings.
32. Select the right size pump for a given pipeline / system.

Teamwork and Communication Skills
33. Work effectively on a team to solve fluid mechanics problems.
34. Communicate effectively ideas and problem solutions relating to fluid mechanics.

Contemporary Problems Related to Fluid Mechanics
35. List several examples of regional, national, and/or global contemporary problems related to fluid mechanics (ex. environmental issues, natural resources and energy conservation, etc.) articulate a problem / position statement for each, and explain what makes these issues particularly relevant to the present time.
36. Suggest reasonable theories regarding the root cause(s) of these problems.
37. Identify possible solutions to these problems, as well as any limitations of these solutions.

Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of forty-five hours over the length of the course (normally 3 hours per unit per week with 1 of the hours used for lecture) for instruction or

preparation/studying or course related activities including but not limited to internships, labs, clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus.

Required Texts/Readings

Textbook

Fluid Mechanics, by Cengel and Ceimbala, McGraw Hill Education, Fourth Edition, 2018 (ISBN: 978-1-259-69653-)

Classroom Protocol

Students are expected to complete the assigned reading for the day before class. We will be covering a significant amount of material, and if you don't do the readings, it may be more difficult to completely understand the lectures. Not all of the reading material will be covered in class. Questions during lecture are encouraged. It is your responsibility to learn the material and to seek help if you don't understand the material. Failure to understand the concepts in the homework will result in poor performance on the quizzes and exams, which will impact your grade. To use the homework assignments to practice for the quizzes and exams, your work should appear professional and be easy to follow. Conceptual problems should be answered in complete sentences. Problems involving calculation must include at a minimum a list of assumptions and all calculation steps with a box around the answer. Collaboration with your classmates is strongly encouraged.

Two midterm exams will be given during the semester, and a comprehensive final exam at the end of the semester. They must be taken on the scheduled dates except for documented emergencies. For the quizzes, midterm exams and final only a calculator, a single one-sided page of notes and an exam supplement, provided by the instructor, will be permitted. A calculator will be required on all exams. Academic dishonesty will not be tolerated and may result in a course grade of "F". See the Academic Integrity section below for more detailed information.

Dropping and Adding

Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's Catalog Policies section at http://info.sjsu.edu/static/catalog/policies.html. Add/drop deadlines can be found on the current academic calendar web page located at http://www.sjsu.edu/academic_programs/calendars/academic_calendar/. The Late Drop Policy is available at http://www.sjsu.edu/aars/policies/latedrops/policy/**.** Students should be aware of the current deadlines and penalties for dropping classes.

Information about the latest changes and news is available at the Advising Hub at http://www.sjsu.edu/advising/.

Assignments and Grading Policy

In-class problems: 10 points each: approximately 14 problems. In-class, cooperative-learning problems will be given during class at various times throughout the semester. Collaboration with your classmates is strongly encouraged, as the in-class problems will be both an assessment tool and a learning experience. In-class problems will be solved in small groups. The problems will be selected from the text or provided by the instructor and administered near the end of a class period. Missed in-class problems can be made up one week after they've been assigned, but no later.

Homework: 155 Points; This semester, the homework assignments will be collected for credit. Three problems, randomly selected, will be graded from the assigned textbook problems for 5 points each. Students are encouraged to work in teams to solve the assigned homework problems (See Schedule below). However, each student is responsible for understanding the solutions.

Quizzes: 120 points; Four single problem/short answer quizzes worth 30 points each will be given (See schedule). There will be no make-up quizzes, except for documented emergencies. For the quizzes, a calculator and one page of notes, single sided will be permitted. An exam supplement with important formulas and tables of fluid properties will be provided. The quizzes will be approximately 15 to 20 minutes in duration. The quiz will cover topics from the homework assignment that is due on that day.

Tests: 500 points; 2 midterms worth 100 points each, final exam worth 300 points

Total: Approximately 1,095 points
Grade Distribution:
Final grades will be based on a percent of points earned, out of the points available according to the following formula:

96.7-100 A+ | 93.4-96.96 A | 90.0-93.3 A- | 86.7-89.9 B+ | 83.4-86.6 B | 80.0-83.3 B-76.7-79.9 C+ | 73.4-76.6 C | 70.0-73.3 C- | 66.7-69.9 D+ | 63.4-66.6 D | 60.0-63.3 D- | 0-59.9 F

Student's status in the class will be periodically emailed to them throughout the semester to preclude surprises near the end of the semester.

University Policies

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information webpage at http://www.sjsu.edu/gup/syllabusinfoP'

F13-12 Technology Intensive, Hybrid, and Online Courses and Programs
S12-7 Consent for Recording of Class and Public Sharing of Instructor Material

Academic integrity

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University's Academic Integrity policy, located at http://www.sjsu.edu/senate/S07-2.htm, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sa.sjsu.edu/judicial_affairs/index.html.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the Disability Resource Center (DRC) at http://www.drc.sjsu.edu/ to establish a record of their disability.

Computer Resources

Computers are also available in the Martin Luther King Library. Students make contact IRC at 408-924-2867 to make an appointment to borrow visual and audio equipment for the duration of the fall semester.

Learning Assistance Resource Center

The Learning Assistance Resource Center (LARC) is located in Room 600 in the Student Services Center. It is designed to assist students in the development of their full academic potential and to motivate them to become self-directed learners. The center provides support services, such as skills assessment, individual or group tutorials, subject advising, learning assistance, summer academic preparation and basic skills development. The LARC website is located at http:/www.sjsu.edu/larc/.

SJSU Writing Center

The SJSU Writing Center is staffed by professional instructors and upper-division or graduate-level writing specialists from each of the SJSU colleges. The Writing Center website is located at http://www.sjsu.edu/writingcenter/about/staff/.

Approach to Success

- Before attending the lectures, read the assigned sections from textbook and jot down any questions you have over the material you've read.
- Work through the example problems provided in the text and jot down any questions you have about the example problems.
- Attend the lectures and take notes not only on what's written on the board but also on what's spoken in class.
- Ask questions during the lecture about any confusing material.
- Work the homework problems, both in the textbook and the after-lecture problems.
- Seek answers from the instructor with any additional questions you have about the theory or problems.
- Use study groups to help with understanding the material and solving the homework problems.

Suggested Written Paper Outline

I.   Title/Authors/Affiliation (i.e., Civil, Mechanical, Aerospace Engineering)
II.   Abstract
III.   Introduction
IV.   Approach
V.   Analysis
VI.   Results
VII.   Conclusions/Summary/Future Directions
VIII. References
IX.   Acknowledgements

Suggested Oral Presentation Outline

I.   Introduction
II.   Approach
III.   Analysis
IV.   Results
V.   Conclusions

- PowerPoint slides using the computer or overhead projection system should be used
- Each group member should perform part of the presentation

ME 111 Fluid Mechanics, Spring 2023, Course Schedule

Table 1 Course Schedule

Week	Date	Topics, Readings, Assignments, Deadlines
1	1/26	**Course Syllabus**, Introduction & Basic Concepts, Chapter 1 (1-1 – 1-10): Homework; 1-21, 1-24, 1-27, 1-30, 1-32, 1-40; **Due 2/2**
2	3/31 & 2/2	Properties of Fluids, Chapter 2 (2-1 – 2-4 & 2-6 – 2-7): Homework; 2-11, 2-25, 2.75, 2.76, 2-79, 2-85, 2-95, 2-97; **Due 2/9, Video on Cavitation,** http://web.mit.edu/hml/ncfmf.html https://www.youtube.com/watch?v=K_w3gcvA87I&list=PL0EC6527BE871ABA3&index=16&feature=plpp_video
3	2/7 & 2/9	Pressure & Fluid Statics, Chapter 3 (3-1 – 3-7): Homework; 3-8, 3-10. 3-17, 3-37, 3-70, 3-76, 3-98, 3-113, 3-135; **Due 2/16,**
4	2/14 & 2/16	Fluid Kinematics, Chapter 4 (4-1 – 4-6): Homework; 4-4, 4-19, 4-59, 4-79, 4-86; **Due 2/23: Quiz 1 (2/16, 15 minutes, Chapter 1 & 2)**
5	2/21 & 2/23	Bernoulli & Energy Equations, Chapter 5 (5-1 – 5-4): **Quiz 2 (2/23, 15 minutes, Chapter 3 & 4),**
6	2/28 & 3/2	**Review** Chapters 1, 2, 3 & 4: **Midterm 1 (3/2 on Chapters. 1, 2, 3 & 4)**
7	3/7 & 3/9	Bernoulli & Energy Equations, Chapter 5 (5-5 – 5-6), Homework; 5-7, 5-15, 5-21, 5-52, 5-59, 5-72, 5-91; **Due 3/16**: Momentum Analysis of Flow Systems, Chapter 6 (6-1 – 6-4): **Research Project Assigned,**
8	3/14 & 3/16	Momentum Analysis of Flow Systems, Chapter 6 (6-5 – 6-6): Homework; 6-22E, 6-24, 6-26E, 6-32, 6-39, 6-56; **Due 3/23** Dimensional Analysis & Modeling, Chapter 7 (7-1 – 7-2): Homework; 7-12, 7-26, **Due 3/23**
9	3/21 & 3/23	Internal Flow, Chapter 8 (8-1 – 8-5): **Quiz 3 (3/23 15 minutes, Chapter 5 & 6)**
10	3/27 & 3/31	**Spring Recess**
11	4/4 & 4/6	Internal Flow, Chapter 8 (8-6 – 8-8): Homework; 8-31, 8-33E, 8-34E, 8-45E, 8-64, 8-85E, **Due 4/14, Midterm 2 (4/6) on Chapters. 5 - 7), Research Project Proposals Due 4/6, Group Names & Topic**
12	4/11 & 4/13	External Flow: Drag & Lift, Chapter 11 (11-1 – 11-7): Homework; 11-41, 11-48, 11-55, 11-68, 11-87, 11-91; **Due 4/20**
13	4/18 & 4/20	Open Channel Flow, Chapter 13 (13-1 – 13-2, 13-5 – 13-6): Homework; 13-30, 13-34, 13-45, 13-54, 13-60; **Due 4/27, Quiz 4 (4/20, 15 minutes, Chapters 8 & 11)**

Week	Date	Topics, Readings, Assignments, Deadlines
14	4/25 & 4/27	Turbomachinery, Chapter 14 (14-1 – 14-2):
15	5/2 & 5/4	Turbomachinery, Chapter 14 (14-4): Homework; 14-34, 14-35E, 14-39 14-77, 14-84E; **Due 5/11,** **Research Project Presentations**
16	5/9 & 5/11	**Final Exam Review (5/9)** **Research Project Presentations**
Final Exam	**5/18/23 Friday**	**Friday, May 19, 2023, Engr. 343, 2:45-5:00 PM**

Important Dates:
January 25, 2023: First day of instruction
February 20, 2023: Last day to drop course without penalty
February 22, 2023: Last day to add course without penalty
March 27-March 31, 2023 Spring Recess
March 31, 2023: Cesar Chavez Day – Campus Closed
May 15, 2023: Last day of instruction
May 29, 2023: Memorial Day – Campus Closed
Final Exam, Friday, May 19, 2023; 2:45-5:00 PM

This schedule is subject to change, and you will be notified via email or during the classroom lecture of any changes.