

San José State University
Department of Mechanical Engineering
ME 111 – Fluid Mechanics
Spring 2020 – Section 01

Course and Contact Information

Instructor:	Prof. Farzan Kazemifar
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Office Hours:	Mon/Wed 4:30–5:30 pm
Class Days/Time:	Mon/Wed 3:00–4:15 pm
Classroom:	Clark Hall 222
Prerequisites:	MATH 032 and either CE 095 or 099 (with a grade of "C-" or better in each)

Proof of Prerequisites

You must submit proof of prerequisites to your instructor before the **second day of class** to stay enrolled. Please hand in a hard copy of your unofficial transcript with the prerequisite courses highlighted. If your courses are being evaluated for equivalency, please attach a course description to your unofficial transcript. Graduate students may take ME 111 with recommendation from a graduate advisor.

Course Format

This course takes the in-person lecture format utilizing both written notes on the board and PowerPoint slides. Each lecture will also include in-class problem solving time on worksheets. Canvas will be used to post lecture notes, worksheets, handouts, grades, homework solutions, and weekly announcements. It is your responsibility to check Canvas regularly for any updates or course materials. I strongly suggest having all announcements forwarded to an email address you check daily. To use Canvas, go to <http://my.sjsu.edu>, click "Canvas", and login with your 9-digit SJSU ID and password.

A separate online system called McGraw-Hill Connect will be used to facilitate the learning. There will be assigned readings as well analytical and conceptual problems. Access to the system requires that you purchase either the bundled book with access code from the bookstore, or otherwise purchase an access code (which gives you access to an e-book). To start using Connect, visit <https://connect.mheducation.com/class/fkazemifar>.

Course Description

Fluid properties, statics, dynamics of fluids; continuity, linear and angular momentum and energy principles. Viscous and non-viscous flow. Pumps, turbines, flow in pipes and around submerged obstacles. Dimensional analysis and dynamic similitude.

Course Learning Outcomes (CLO)

Upon successful completion of this course, students will be able to:

Fluid Properties

1. Define a fluid and describe how it differs from a solid.
2. Describe the differences between liquids and gases.
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.
6. Convert English and SI units involving fluid properties properly.

Fluid Statics

7. Define and distinguish between absolute pressure, gage pressure, and vacuum.
8. Explain Blaise Pascal's law of pressure transmission.
9. Derive the basic differential equation of hydrostatics starting with the equilibrium of a fluid element.
10. Derive the equation for the pressure variation of a uniform-density fluid.
11. Identify, formulate and solve problems involving manometers and barometers.
12. Calculate forces and moments exerted by a fluid at rest on submerged plane and curved surfaces.
13. Analyze rigid-body motion of fluids in containers experiencing linear acceleration or rotation.

Fluid Flow – Continuity

14. Explain the origin of the Reynolds Transport Theorem and how it can be used to develop important fluid mechanics equations.
15. Classify a flow as uniform or non-uniform, steady or unsteady, incompressible or compressible, 1-D, 2-D, or 3-D.
16. Calculate mass flow rate, volume flow rate, and mean velocity for a flow.
17. Derive the integral form of the continuity equation for a control volume.
18. Identify, formulate and solve problems involving the continuity equation for a variety of
19. cases involving 1-D, uniform and non-uniform, incompressible, steady and unsteady flows.

Fluid Flow – Bernoulli's Equation

20. Derive Bernoulli's equation and list the assumptions made in the derivation. Apply Bernoulli's equation in a variety of problems including flow velocity measurements and pressure calculations.
21. Predict cavitation in enclosed pipes or hydraulic machines.

Fluid Flow – Momentum Equations

22. Derive the linear momentum equation for a fluid, starting with Newton's 2nd law.

23. Identify, formulate, and solve problems involving the steady linear momentum equation in a variety of applications including stationary and moving vanes, nozzles, and pipes with bends.
24. Identify, formulate, and solve problems involving the steady angular momentum equation in a variety of applications including radial-flow devices and bending moments in piping networks.

Fluid Flow – Energy Equation

25. Derive the integral form of the energy equation starting with Reynolds transport theorem.
26. Identify, formulate, and solve problems involving the energy equation in a variety of applications including reservoirs, pipes with minor losses, pumps, turbines, and nozzles.
27. Identify, formulate, and solve problems involving the simultaneous application of continuity, momentum, and energy equations.
28. Plot the hydraulic and energy grade lines for a variety of flow systems involving reservoirs, pipes of varying diameters, pumps, turbines, and nozzles.
29. Choose a flowmeter for a particular application.

Pipe Flow

30. Describe qualitatively and quantitatively both laminar and turbulent flow in a pipe and predict transition from laminar to turbulent flow.
31. Explain how shear stress varies with distance from the entrance to a pipe. Calculate the entrance region for a pipe for both laminar and turbulent flow.
32. Use the Moody diagram or turbulent or laminar flow friction factor equations 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.
33. Calculate minor losses (i.e., head losses in pipe inlets, outlets, valves, and other fittings).

External Flow

34. Explain the difference between form (pressure) and friction drag. Predict which will dominate in different external flow situations. Explain the effect of flow regime on flow over cylinders and spheres.
35. Calculate the drag force over common 2-D and 3-D geometries.
36. Calculate skin friction coefficients and drag over flat plates experiencing laminar, all
37. turbulent, and combined flows. Distinguish when to use skin friction coefficients and when to use drag coefficients to calculate drag.

Pumps

38. Calculate pump head and brake and water horsepower.
39. Determine a pump operating point given pump and system performance curves.
40. Place a pump at an elevation to prevent cavitation; determine if cavitation will happen in a given pump and system.
41. Explain the effect of placing pumps in series or parallel.
42. Apply affinity laws to predict pump performance.

Lifelong Learning Skills (ABET Outcome i)

43. Access information effectively from a variety of sources and evaluate its quality and applicability to a fluid mechanics problem

Problem-Solving Skills (ABET Outcome e)

44. Determine fundamental theory that applies to a particular fluid mechanics problems and apply appropriate equations and assumptions to solve it.

Contemporary Problems Related to Fluid Mechanics (ABET Outcome j)

45. Research a contemporary fluid mechanics problem, apply fluid mechanics fundamentals, and discuss broader impacts on society.

ABET Learning Outcomes

- a. ability to apply knowledge of mathematics, science and engineering
- d. an ability to function on multi-disciplinary teams
- e. an ability to identify, formulate and solve engineering problems.
- g. an ability to communicate effectively.
- h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- i. a recognition of the need for, and an ability to engage in, life-long learning.
- j. a knowledge of contemporary issues.

Required Texts, Readings, and other material**Textbook**

Cengel and Cimbala, "Fluid Mechanics: Fundamentals and Applications" 4th Ed, *McGraw-Hill* (2017) + Connect Package

McGraw-Hill Connect® online platform

An access code comes bundled with the book from the bookstore. Connect will be used for homework problems and reading assignments.

Your course materials are being delivered digitally via Canvas through the Inclusive Access program. Please access the material through Canvas on the first day of classes to make sure there are no issues in the delivery, and if you are having a problem or question, they can be addressed quickly.

You automatically have access to the course materials on day one without entering a code or being charged upfront. After the add drop period, your bursar account will be billed at a discounted rate for the required course materials representing significant savings for you as the student. If you choose to not have your account be billed, you must "opt out" before the required deadline. If you do not opt out, you will be charged. We highly recommend you do not opt out if you are going to continue in this course because this is the lowest cost available for this product. After you have paid for the product, you will have access for the remainder of the term.

iClicker

The iClicker audience response system will be used in this class for attendance and quizzes. You can use iClicker smartphone app or its website on a laptop, tablet or other smart device. For

instructions regarding account setup and adding the course, please refer to <https://www.sjsu.edu/ecampus/teaching-tools/iclicker/index.html>.

Course Requirements and Assignments

Expected Time Commitment

SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of forty-five hours for each unit of credit (normally three hours per unit per week), including preparing for class, participating in course activities, completing assignments, and so on. More details about student workload can be found at <http://www.sjsu.edu/senate/docs/S12-3.pdf>.

In plain English: For a 3-credit class, you should devote approximately 6-9 hours per week outside classroom to learning the material. You should spend this time completing homework assignments, reviewing assigned reading, re-reading notes, working on practice problems, etc.

Class Attendance

Note that University policy F69-24 at <http://www.sjsu.edu/senate/docs/F69-24.pdf> states that “Students should attend all meetings of their classes, not only because they are responsible for material discussed therein, but because active participation is frequently essential to insure maximum benefit for all members of the class. Attendance per se shall not be used as a criterion for grading.”

If you are unable to attend class for any reason, you are responsible for making up any missed assignments, notes, and quizzes.

Connect Problems

In Connect, I will post conceptual and analytical problems related to each homework. After submission, you can access them in “study mode” throughout the semester.

Connect Reading Assignments

There will be online reading and problem assignments on McGraw-Hill Connect. You can have multiple attempts at each assignment and the best score will be recorded.

Practice Problems

Practice problems will be posted on Canvas on an approximately weekly basis with the solutions. These problems will not be collected nor graded but you are encouraged to treat them as homework problems and to try your best to solve them on your own, and then refer to the posted solutions to check your work. Reviewing the solutions without any serious attempt at solving the problems will not prepare you for the quizzes and exams.

Quizzes

There will be in-class quizzes (iClicker, and paper) during the semester with 1-week advance notice. Bring a calculator to class so that you are prepared to take the quiz. Two lowest quiz grades will be dropped, which should be considered as allowances for inevitable illnesses, interviews, special events conflicts, etc. that will occur during the term. No makeup quizzes will be given. The quizzes will be closed book/notes.

Midterms

There will be two midterm exams held in class on the dates shown below. The exam is cumulative, that is, Midterm II will include the chapters covered in the Midterm I.

Two midterm exams will be given. Each will consist of approximately 30% multiple choice or short answer conceptual questions and 70% calculation problems.

Midterm I: February 26, 2020

Midterm II: April 8, 2020

Final Examination

A final exam will be given at 12:15–2:30 pm on Wednesday May 13, 2019. The exam will be cumulative.

Research Project

You will complete a research project in small teams of 3–4 students on a fluid mechanics topic of your choice. Your team members will be randomly assigned, but you may request your preferred team members. Each group will conduct research on the chosen topic with credible sources and upload recorded PowerPoint slides to present their results. Further details will be given in a separate handout.

Exam Policy

All exams (quizzes, midterms, and final) will be CLOSED BOOK and CLOSED NOTES. A formula sheet will be provided for the exams and quizzes. The formula sheet will be made available ahead of time for you to make yourself familiar with it. No electronic device with wireless communication (cell phones, tablets, etc.) will be allowed during the exams. Violation of academic integrity will result in zero in the exam and a report to Student Conduct and Ethical Development.

Without a documented excuse, exams must be taken on the indicated dates. If you have any serious problems with the examination dates, please see me ASAP and I will attempt to make alternative arrangements.

Calculator Policy

The calculator use policy for this course is the same as the policy put forth by National Council of Examiners for Engineering and Surveying (NCEES) for Fundamentals of Engineering (FE) exams stated at <https://ncees.org/exams/calculator>. The acceptable calculator models are:

- **Casio:** All fx-115 and fx-991 models (Any Casio calculator must have “fx-115” or “fx-991” in its model name.)
- **Hewlett Packard:** The HP 33s and HP 35s models, but no others
- **Texas Instruments:** All TI-30X and TI-36X models (Any Texas Instruments calculator must have “TI-30X” or “TI-36X” in its model name.)

Grading Information

Grading Philosophy

In engineering, getting the right answer is important. If you attempt to solve a problem, I will try my best to give you partial credit. The more clearly you write your solution, the easier it is for me to do this. A good solution contains the following:

- A summary of the problem statement.
- A drawing or illustration of the problem.
- A list of all assumptions.
- Equations written in symbolic form first, before plugging in numbers.
- The final answer indicated clearly, including units.

Grade Errors and Regrades

Grading errors (points added or recorded incorrectly) or regrading (when you believe you deserve more points for something) may only be requested within one week of the date the graded assignment/exam is returned to class. If you are absent when a graded assignment/exam is returned, it is your responsibility to collect it in person during my office hours or another arranged time. To bring an error to my attention or request a regrade, return the document to me in class with an attached note about why you believe you deserve more points. Please note that, your grade may increase, decrease or not change as a result of regrade.

Grading Policy and Weights

97.0 – 100%	A+	77.0 – 79.9%	C+
93.0 – 96.9%	A	73.0 – 76.9%	C
90.0 – 92.9%	A-	70.0 – 72.9%	C-
87.0 – 89.9%	B+	60.0 – 69.9%	D
83.0 – 86.9%	B		
80.0 – 82.9%	B-		

Attendance		5%
Connect® (Reading + Problems)		15%
Quizzes		10%
Research Project		10%
Midterm I	(Wed Feb 26, 2020)	15%
Midterm II	(Wed Apr 8, 2020)	20%
Final	(Wed May 13, 2019)	25%

For students with a final exam grade in the top 10th percentile of the class, an alternative weighting formula for the final course grade will be considered where the final exam is weighted at 35%, and the weight of the other items are decreased proportionally. The final score will then be the maximum obtained from the two formulas.

Classroom Protocol

Please place your cellphones on silent and refrain from using them during class. If you absolutely must take an emergency phone call, please leave the room quietly to do so. Important announcements and homework submission will be at the beginning of class at the beginning of class, so please be punctual. Bring an engineering calculator for in-class worksheets.

Library Liaison

When completing the research project (information to follow), the library liaison may be helpful. She can point you to databases of papers, useful books on your topic of interest, citation managers, etc. Her contact information is as follows:

Rachel Silverstein

Phone: 408-808-2106

Email: rachel.silverstein@sjsu.edu Subject guide: <http://libguides.sjsu.edu/me>

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 web page at <http://www.sjsu.edu/gup/syllabusinfo/>.

Academic integrity

Your own commitment to learning, as evidenced by your enrollment at San José State University and the University's Academic Integrity Policy (<http://info.sjsu.edu/static/schedules/integrity.html>), requires you to be honest in all your academic course work. Faculty members are required to report all alleged violations of the Academic Integrity Policy to Student Conduct and Ethical Development. Instances of academic dishonesty will not be tolerated. Cheating or plagiarism will result in a zero in the exam involving the instance of academic dishonesty and administrative sanctions by the University.

"SOS!"

Sometimes, life happens. If you are really struggling with the course material, and/or if something is going on outside of class that may significantly disrupt your studies (financial concerns, upheaval in your home life, physical or mental health issues, etc.), I will do everything I can to help you succeed. If I am personally unable to help you, I will direct you to the appropriate resource. The earlier you ask for help with a problem, the easier it is to solve.

**ME 111 – Fluid Mechanics
Spring 2020 – Section 01
Course Schedule**

Course Schedule

Tentative Course Outline

Week # Approximate	Topic	Textbook Chapter(s)
1	Introduction and basic concepts	1
2	Fluid Properties	2
3–4	Pressure and Fluid Statics	3
MIDTERM I (Wednesday, Feb 26, 2019)		
5	Fluid Kinematics, Reynolds Transport Theorem	4
6–7	Bernoulli and Energy Equations	5
7–8	Linear Momentum Equation	6.1–6.4
8–9	Angular Momentum Equation	6.5–6.6
MIDTERM II (Wednesday, April 8, 2019)		
11	Dimensional Analysis and Similarity	7.1–7.3
12	Internal Flow – Laminar	8.1 – 8.4
13	Internal Flow – Turbulent	8.5
13–14	Internal Flow – Minor losses and piping networks	8.6–8.7
14–15	External Flow (Flow over immersed bodies)	11
FINAL EXAM		
Refer to university's final exam schedule		

The above schedule is subject to change with advance notice made through Canvas.