

**San José State University**  
**Mechanical Engineering Department**  
**ME 111: Fluid Mechanics – Section 1, Spring 2018**

**Course and Contact Information**

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<b>Office Hours:</b>	MW 9-10 am, TR 1:30-2:30
<b>Class Days/Time:</b>	Tues/Thurs 9:00-10:15 AM
<b>Classroom:</b>	Engineering Building Room 329
<b>Prerequisites:</b>	MATH 032 and either CE 95 or 099 (with a grade of "C-" or better in each)

**Faculty Web Page and MYSJSU Messaging (Optional)**

All lectures will be delivered in class via PowerPoint and written notes. Notes will be posted to Canvas regularly, along with the syllabus, announcements, study guides, grades, and so on. If you need to meet with me outside of office hours, please email me for an appointment. You are responsible for checking the class page regularly to keep up to date on coursework. 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. If you have any questions about using Canvas, please see me or visit [http://www.sjsu.edu/at/ec/canvas/student\\_resources/index.html](http://www.sjsu.edu/at/ec/canvas/student_resources/index.html).

**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 cases involving 1-D, uniform and non-uniform, incompressible, steady and unsteady flows.

### ***Fluid Flow – Bernoulli's Equation***

19. Derive Bernoulli's equation and list the assumptions made in the derivation.
20. 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 turbulent, and combined flows. Distinguish when to use skin friction coefficients and when to use drag coefficients to calculate drag.

### ***Pumps***

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

### ***Lifelong Learning Skills (ABET Outcome i)***

42. 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)***

43. 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)***

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

### **Relevant ABET Outcomes**

- a. an 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

This classes uses the programs “Connect” and “Learnsmart”, which are included in the custom package shown below. The programs are used for the required homework.

Cengel and Cimbala, Fluid Mechanics: Fundamentals and Applications, 4<sup>th</sup> ed., 2018, custom package that includes Connect Access. ISBN 9781307018431.

The other option at the bookstore that’s a little cheaper includes only Connect Access and not the textbook – you can save a few \$\$ if you can get a free book somewhere. If you do get your own text elsewhere, I recommend using the same author (although any introductory fluid mechanics text should be OK). A different edition is fine.

You can access Connect and Learnsmart through the assignments posted on the class Canvas site. If you want to check things out before buying anything, you can sign up for a two week free access and then convert it later.

## Library Research

When completing the research paper (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:

Linda Crotty

Phone: 408-808-2636

Email: [linda.crotty@sjsu.edu](mailto:linda.crotty@sjsu.edu)

Subject guide: <http://libguides.sjsu.edu/me>

## Proof of Prerequisites

You must turn proof of prerequisites into me on or before the **second day of class** in order to stay enrolled. Please hand in a copy of your unofficial transcript with the prerequisite courses highlighted. For courses taken elsewhere, you do not need to provide the articulation agreement. Please hand these in rather than emailing them to me.

## Homework

Homework will be assigned using McGraw Hill’s Connect. It will be due at 11:59 pm most Wednesday evenings. Access the assignments via Canvas using the link for Connect.

No late homework will be accepted without a university-authorized excuse; however, the two lowest homework scores will be dropped. You may consider these assignments “freebies,” but use them wisely!

## In-Class Problems

There will be five graded in-class problems throughout the semester. These will be assigned during class and must be handed in at the beginning of the following class or uploaded to Canvas by 11:59 pm the evening of the next class. Collaboration with your classmates is strongly encouraged, and you are welcome to work in groups of two or three (no more than three allowed except for IC #1). Missed in-class problems will be posted on Canvas immediately after class. If you miss an assignment, you’ll be expected to download it and complete it on your own by the due date. The one lowest in-class problem score will be dropped from your final grade.

For all in-class problems, please include the following:

- List your name(s), date, and homework assignment number at the top of your assignment.
- Summarize the problem statement before beginning each problem. Give enough information that you could return to this problem a month or a year from now and understand what it is asking without looking up the problem in the book.
- Drawing a figure may be helpful as well, particularly on more complex problems.
- List all assumptions.
- Write down all equations in symbolic form first, before plugging in numbers.
- Write units next to all equations! This will keep you from making mistakes. If you learn nothing else from this class, please learn to keep track of your units.

## **Learnsmart**

Learnsmart assignments will be posted on Canvas. Learnsmart is a McGraw Hill program that emphasizes knowledge of fundamentals. There will be 9 assignments (1 per chapter, excluding Chapter 4). If you receive 70% or more on the problems, you will receive credit for an assignment. The program tells you if you are incorrect and allows you to change your answer, so you should be able to achieve a 100% score.

Scoring is as follows:

7 assignments completed:	5 points (out of 5 possible)
6 assignments completed:	4 points
5 assignments completed:	3 points
4 assignments completed:	2 points
3 assignments completed:	1 point
0-2 assignments completed:	0 points

Tentative due dates are on the schedule. Any changes will be show up in Canvas and will be announced in class.

## **Quizzes**

There will be four short quizzes throughout the semester to test your understanding of the material. These will consist of short problems to test your understanding of the material, and they will take approximately 30 minutes each.

## **Midterm Exams**

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

## **Research Paper**

You will complete a research project in small teams of 4-5 students on a fluid mechanics topic of your choice. Your team members will be randomly assigned. This way, you get experience working with other people. Deliverables will be a research paper with citation, along with several interim assignments. Further details will be given in a separate assignment.

## **Final Examination or Evaluation**

A written final exam will be given on the date listed in the schedule (last page). It will consist of approximately 30% multiple choice or short answer conceptual questions and 70% calculation problems.

## **Time Commitment**

University policy states that “success in this course is based on the expectation that students will

spend, for each unit of credit, a minimum of 45 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.”

In plain English: for each hour of class time, you should devote approximately 2-3 hours of time outside of class to learning the material. For a 3-credit class, this amounts to approximately 6-9 hours per week. You should spend this time completing homework assignments, reviewing assigned reading, watching instructional videos, rereading notes, completing extra problems, etc.

### **Grading Information**

In engineering, getting the right answer is obviously important, but right now, I am more concerned with helping you become good problem-solvers, not good answer-finders. This means that the process will be weighted more heavily than the question.

If you attempt 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 figure depicting the system, with boundaries indicated where appropriate
- A list of assumptions
- All equations written in symbolic form first, before plugging in numbers
- Units included whenever applicable
- The final answer indicated clearly (circled, underlined, etc.)

A lot of students have problems with English units in this class. Appropriate use and conversion of units is extremely important, and errors in conversion will result in major loss of points.

### **Letter Grades**

	A 93.0-100	A- 90.0-92.9
B+ 87.0-89.9	B 83.0-86.9	B- 80.0-82.9
C+ 77.0-79.9	C 73.0-76.9	C- 70.0-72.9
	D 60.0-69.6	

### **Weighting**

Homework	10%
In-Class Problems	5%
Learnsmart Assignments	5%
Quizzes	12%
Research Project	12%
Midterms (2@15% each)	30%
Final Exam	26%*

\*An exceptional final exam (10 or more points higher than your average grade before the final) will result in the final exam being weighted at 36% of your semester grade, with the weight of the other items being decreased proportionally.

## **Extra Credit**

No extra credit will be made available at any time.

## **Grade Errors and Regrades**

Clear grading errors (points added or recorded incorrectly) may be corrected at any time. Regrading (when you believe you deserve more points for something) may only be requested *within two weeks of an assignment being returned to you*. To bring an error to my attention or request a regrade, please return the document to me in class with an attached note about why you believe you deserve more points.

## **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. In-class problems will be collected and exams and quizzes will be given at the beginning of class, so please be punctual.

## **University Policies (Required)**

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](http://www.sjsu.edu/gup/syllabusinfo/) at <http://www.sjsu.edu/gup/syllabusinfo/>

## **“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. I will maintain a list on Canvas of all the resources available to you as an SJSU student. The earlier you ask for help with a problem, the easier it is to solve.

## ME 111: Fluid Mechanics, Spring 2018, Tentative Course Schedule

Date	Topics	Reading	Assignments Due
25-Jan	Greensheet and course policies, Introduction	Ch. 1	
30-Jan	Fluid Properties	2.1-2.4	
1-Feb	Fluid Properties, IC 1 with assigned research paper team	2.6-2.7	HW 1, LS 1
6-Feb	Pressure	3.1-3.2	IC 1, LS 2
8-Feb	Fluid Statics, Quiz 1 (Ch 1,2)	3.3-3.6	HW 2
13-Feb	Problem-Solving Day**, IC 2		project topic, LS 3
15-Feb	Fluids in Motion	3.7	IC 2, HW 3
20-Feb	Reynolds Transport Theorem, Research Paper Writing	4.6	
22-Feb	Conservation of Mass, Quiz 2 (Ch 3, 4a)	5.1-5.3	HW 4, LS 5
27-Feb	Bernoulli Equation	5.4	
1-Mar	<b>Midterm 1: Chapters 1-4</b>		
6-Mar	Energy Analysis	5.5-5.6	bibliography
8-Mar	Problem-Solving Day, IC 3		HW 5
13-Mar	Control Volumes, Linear Momentum	6.1-6.4	IC 3, LS 6
15-Mar	Problem-Solving Day, IC 4		HW 6
20-Mar	Angular Momentum	6.5-6.6	IC 4
22-Mar	Problem-Solving Day, IC 5		HW 7, LS 7
3-Apr	Dimensional Analysis, Quiz 3 (Ch 5, 6)	Ch 7	IC 5, outline
5-Apr	Laminar Internal Flow	8.1-8.4	HW 8, LS 8
10-Apr	Turbulent Internal Flow, Minor Losses	8.5, 8.6	
12-Apr	Piping Networks, Flow Measurement	8.7-8.8	HW 9
17-Apr	Problem-Solving Day, IC 6		LS 11
19-Apr	Drag	11.1-11.4, 11.6	IC 6, HW 10
24-Apr	<b>Midterm 2: Chapters 5-8</b>		
26-Apr	Drag over Flat Plates	11.5	
1-May	Pumps	14.1-14.2	research paper
3-May	Pump Scaling Laws, Quiz 4 (Ch 11)	14.3	HW 11, LS 14
8-May	Pump Problem-Solving		
10-May	Review		HW 12
16-May	<b>FINAL EXAM, 7:15-9:30 AM</b>		

Feb. 5: Last day to drop without an entry on your permanent record

Feb. 12: Last day to add a class and register late