SJSU SAN JOSÉ STATE UNIVERSITY

Charles W Davidson College of Engineering · Mechanical Engineering

Fluid Mechanics Section 02

ME 111

Spring 2023 3 Unit(s) 01/25/2023 to 05/15/2023 Modified 01/24/2023

Contact Information

Instructor: Crystal Han

Office Hours

- Wednesdays 3:30 - 4:15 pm (Zoom link: https://sjsu.zoom.us/j/85124110678 (https://sjsu.zoom.us/j/85124110678))
- Thursdays 10:15 - 11:30 (In person @E217)

Email: crystal.m.han@sjsu.edu

If you need to meet with me outside of office hours, please email me for an appointment. Please do not forget to always include the course and section number in the title of your email. You can expect a reply to an email related to this course within 24 hours during weekdays.

Course Description and Requisites

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.

Prerequisite(s): CE 95 or 99, and MATH 32 or MATH 32X (each with a grade of "C-" or better). Sophomore or upper division standing. Allowed Declared Majors: Engineering, Civil Engineering, Industrial and Systems Engineering, Materials Engineering, Mechanical Engineering.

Letter Graded

Classroom Protocols

Learning sequence

The course will operate in an in-person flipped classroom format where guided independent learning is followed by in-person group problem-solving activities to consolidate the learning. Your learning of each topic in this course will take place in the sequence outlined below.

- Watch lecture **videos** of the week for up to 2 hours duration. Set aside a regular time for this.
- Submit the **homework (HW)** by the day before the class.
- Attend class meetings and actively participate in **group worksheet activities**.
- Submit your **individual worksheet** by the next day of the class meeting day.
- Earn **extra credits** by solving Connect problems (concept questions and additional problems).
- **Test** your knowledge through quizzes, midterms, and final.

Classroom protocols

1. Preparedness

Plan for sufficient time to watch lecture videos, take notes on the lecture note slides, and solve homework problems every week. This could take 4-6 hours in total. Block your weekly calendar for ME 111 independent learning time.

2. On-time attendance

Thursday class meetings are dedicated to active learning, which sharply starts at 9 am in the morning. Take into account traffic and parking situations to make sure you be on time for quizzes, group problem-solving, and more. There will be student submissions every class.

3. Learning by doing

Get ready for active participation. Do not hesitate to tackle the problems and make mistakes. You do not go through this process of learning alone but as a group. Encourage your peers' participation, and be receptive to others' thoughts and efforts.

4. Seeking support

As soon as you feel the need, seek support. When you are stuck, ask your group members, ask the instructor, come to the office hours, email the instructor, and attend the SI leader's sessions, attend peer connection tutoring. Seeking these support early can reduce your struggle significantly.

Course Learning Outcomes (CLOs)

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. Place a pump at an elevation to prevent cavitation; determine if cavitation will happen in a given pump and system.

Course Materials

Fluid Mechanics: Fundamentals and Applications

Author: Cengel and Cimbala
Publisher: McGraw-Hill
Edition: 4th

E-book included in tuition via First Day Solution. The E-book can be accessed via McGraw-Hill Connect.

McGraw-Hill Connect

McGraw-Hill Connect provides both E-book and access to chapter-by-chapter extra credit problem sets including concept and calculation questions. Your access to McGraw-Hill Connect is included in your enrollment through First Day Solutions program. Although NOT recommended, you can choose to Opt-Out by **February 20**, but you will be responsible for purchasing your course materials at the full retail price.

Link to your Connect: https://connect.mheducation.com/class/c-han-s23-me111-sec-02-fluid-mechanics (https://connect.mheducation.com/class/c-han-s23-me111-sec-02-fluid-mechanics)

Opting Out of First Day for your eTextbook: https://vimeo.com/304674616

Technology Requirements

Internet

Students need to be able to scan their assignments and upload them on Canvas. Students are responsible for ensuring that they have access to reliable Wi-Fi to watch lecture videos as well. SJSU has a free equipment loan program available for students (https://www.sjsu.edu/learnanywhere/equipment/index.php). See Learn Anywhere website (https://www.sjsu.edu/learnanywhere/) for current Wi-Fi options on campus.

Adobe scan app

All assignments except for group worksheet write-ups are supposed to be submitted in a single PDF file format. To easily scan multiple pages and convert them into a single PDF, a mobile Adobe scanner app is recommended: https://acrobat.adobe.com/us/en/mobile/scanner-app.html.

Printing

If you need a printer to print out any course materials including lecture notes, campus print stations can be a useful resource (https://www.sjsu.edu/it/services/collaboration/print/index.php (https://www.sjsu.edu/it/services/collaboration/print/index.php)).

Canvas

Canvas will be extensively used for posting lecture videos, assignments, grades, and announcements. It will also be used to submit scanned copies of your assignments. To use Canvas, use the link https://sjsu.instructure.com/, and log in with your 9-digit SJSU ID and password. If you have any questions about using Canvas, please visit http://www.sjsu.edu/at/ec/canvas/student_resources/index.html. 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. "Modules" tab on the left sidebar will be the place you will follow through and accomplish week-by-week assignments.

Peer Connection

Peer Connections is your online, campus-wide resource for mentoring (time management, note taking, study skills, getting involved, etc.), tutoring (undergraduate writing, lower division Math, Science, History, Humanities, etc.), supplemental instruction (review and study sessions for select courses), and learning assistants in classes across campus. Make appointments to meet with a tutor or mentor by visiting Spartan Connect. For more information on services, online workshops, and a step-by-step guide to making an appointment, please visit the website at https://peerconnections.sjsu.edu/.

Our class has the privilege to have an assigned Supplementary Instruction leader (SI leader) this semester. The SI leader will lead two sessions weekly to provide supplemental instruction including but not limited to homework support, review of materials to prepare for quizzes and exams, post-exam review of the exam problems, and review of important concepts.

Course Requirements and Assignments

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 three hours per unit per week) for instruction, preparation/studying, or course-related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus. This means 9 hour/week commitment is expected for success in the 3-unit ME 111 course.

Proof of Prerequisites

The most important task of the first week is to clear your prerequisites. Your unofficial transcript with the **prerequisite courses and your name highlighted** will serve as a proof of prerequisites. Submit your proof of prerequisites online as a file attachment on the corresponding Canvas assignment by **January 27** in order to stay enrolled. If your courses are being evaluated for

equivalency, please attach a course description in addition to your highlighted unofficial transcript.

Weekly Guided Independent Learning

The following **assignments are due at noon (12 pm) of the day before classes** as a part of weekly guided independent learning.

Lecture video quizzes

Three to five pre-recorded videos will be assigned for you to watch weekly. Videos are broken into clips topic by topic, and the total runtime does not exceed 2 hours. Simple questions asking about the understanding of the materials will pop up at an undetermined time. You have unlimited attempts and feel free to adjust the playback speed to suit your needs.

Homework

Homework problems are closely related to the examples solved in the lecture videos, so it's highly encouraged that you attempt homework while or immediately after watching the assigned lecture videos of the week. You will submit a single PDF that includes scanned pages of your hand-written homework. Always combine multiple pages into a single PDF file before submission for smooth online grading.

Worksheet

Group worksheet report

During class meetings, you will solve worksheet problems in groups and submit **your hard copy write-up as a group at the end of each class**. As a group of 2-3 people, you will discuss the core parts of the analysis and fill in the blanks in a group worksheet. I will provide any help you need during the worksheet time and answer any questions except for the direct answers to the problems. The same points will be assigned to the group members who participated in the group worksheet session, so only list the members who were present during the worksheet session in your submission. Group worksheet write-up will determine the 50% of the worksheet score.

Individual worksheet write-up

Individual submission of full analysis to all worksheet problems is **due at noon of the next day of classes.** It will be submitted online as a PDF file on Canvas. The group discussion during the class meeting is supposed to provide a clear plan for completing the worksheet problems. You are highly encouraged to resolve any doubts about completing your individual worksheet during the class meeting. Your individual worksheet submission will be graded for accuracy in both answer and analysis steps and will determine 50% of the worksheet score.

Extra Credits

Concept questions and additional problems in McGraw Hill Connect

Concept questions and additional problem sets will be posted chapter by chapter on Connect, and you can solve them to earn extra credits. The concept questions can be useful for preparing for midterms and finals since those will include concept problems. A single attempt will be allowed to earn extra points, but you can check your answers 10 times. Once submitted, you can access the questions and detailed solutions throughout the semester. If you do not have time to attempt these but still want to get practice, you can choose to submit these with blank answers to reveal solutions so that you can use them as resources to prepare for your exams.

Exams

Quizzes

There will be four short quizzes throughout the semester based on the tentative schedule shown below. The quizzes will start promptly at 9 am, so please plan to arrive early. There will be no make-up quizzes, but **the lowest quiz score will be dropped from your final grade**.

Exams

There will be two 75-minute midterms and a 135-minute final on the dates shown in the course schedule below. Exams are cumulative, so an exam will cover all chapters covered previously in this class. There will be questions testing your understanding of key concepts, which will comprise 10% of your score.

Exam Protocols

Exams (midterms and final) will be CLOSED BOOK and CLOSED NOTES with one single or double-sided 8.5 by 11-inch crib sheet and an engineering calculator allowed. The use of the internet or communication with others (via talking, cell phones, tablets, laptops etc.) is NOT allowed during the exams. Earbuds, headphones, or headsets are not allowed during exams and quizzes.

✔ Grading Information

Grading Philosophy

In engineering, getting the right answer is obviously important, but in this class, 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 getting the number right. If you attempt a problem correctly using relevant equations, 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.

Late submission of assignments

The score **deduction of 2% for each hour late** submission will apply to the assignments that you will submit on Canvas. Roughly speaking, you will receive 50% of your earned points after 1 day, and after 2 days, no points. Late submission is **not applicable to quizzes and group worksheet write-ups since they are submitted as hard copies in class**.

Make-ups

There will be **no make-ups** in this course. However, **the two lowest scores on homework and worksheet assignments, and the lowest quiz score will be dropped from your final grade calculation** to mitigate the effects of unexpected circumstances including absences.

Grade Errors and Regrades

Clear grading errors (points added or recorded incorrectly) may be corrected at any time. Re-grading (when you believe you deserve more points for something) may only be requested **within one week of the assignment grade post date**. To bring an error to my attention or request a regrade, please email me with an explanation about why you believe you deserve more points.

Criteria

An exceptional final exam (10% higher than your average grade before the final) will result in the final exam being weighted at 35% of your final grade, with the weight of the other items being decreased proportionally.

Type	Weight	Topic	Notes
Lecture Video-embedded quiz	5%		
Homework	10%		
Quizzes	20%		
Worksheet	10%		
Midterms	30%		
Final	25%		
Connect problems	up to 2% extra		

Breakdown

Grade	Range	Notes

Grade	Range	Notes
A+	97.0 to 100	
A	93.0 to 96.9	
A-	90.0 to 92.9	
B+	87.0 to 89.9	
B	83.0 to 86.9	
B-	80.0 to 82.9	
C+	77.0 to 79.9	
C	73.0 to 76.9	
C-	70.0 to 72.9	
D+	67.0 to 69.9	
D	63.0 to 66.9	
D-	60.0 to 62.9	
F	< 60.0	

University Policies

Per University Policy S16-9 (http://www.sjsu.edu/senate/docs/S16-9.pdf), relevant university policy concerning all courses, such as student responsibilities, academic integrity, accommodations, dropping and adding, consent for recording of class, etc. and available student services (e.g. learning assistance, counseling, and other resources) are listed on Syllabus Information web page (https://www.sjsu.edu/curriculum/courses/syllabus-info.php) (https://www.sjsu.edu/curriculum/courses/syllabus-info.php). Make sure to visit this page to review and be aware of these university policies and resources.

Course Schedule

When	Topic	Notes
Week 1	Syllabus, Basic Concepts (Ch1.1-1.5)	
Week 2	Dimensions and Unit (Ch1.6), Density (2.1-2.2), Viscosity (2.6)	
Week 3	Cavitation (2.3), Pressure (3.1-3.2), Buoyancy (3.6)	
Week 4	Fluid Statics (3.3-3.5)	Quiz 1 (2/16)
Week 5	Fluids in Motion (3.7)	
Week 6	Ch1, Ch2, Ch3	Midterm 1 (3/2)
Week 7	Fluid kinematics (4.1-4.6), Conservation of Mass (5.1-5.2)	
Week 8	Bernoulli's Equation (5.3-5.4), Energy Analysis (5.5-5.6)	
Week 9	Linear Momentum Equation (6.1-6.4)	Quiz 2 (3/23)
Week 10	Spring Recess	No meeting
Week 11	Angular Momentum Equation (6.5-6.6)	

When	Topic	Notes
Week 12	Laminar Internal Flow (8.1-8.4)	Quiz 3 (4/13)
Week 13	Ch4 , Ch5, Ch6	Midterm 2 (4/20)
Week 14	Turbulent Internal Flow and Piping Network (8.5-8.7)	
Week 15	Drag on common geometries (11.1-11.4), Flow over flat plate or cylinders (11.5-11.6)	Quiz 4 (5/4)
Week 16	Review	
Week 17	Ch1 to Ch6, Ch8, Ch11	Final (5/17 Wed 7:15 - 9:30 am)