

SAN JOSE STATE UNIVERSITY
Department of Mechanical Engineering

ME111 - Fluid Mechanics - Section 1

Fall 2019

Instructor: Dr. Davood Abdollahian
Class hours: M-W 1:30 – 2:45 PM
Class room: E-343
Course Code: 42632
Office hours: M-W 12:00 PM– 1:00 PM, or by appointment
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Course Description

This course covers definition of a fluid and its properties, hydrostatic condition and fluid statics; continuity, momentum and energy equations. The governing conservation equations for fluid flow in pipes and around submerged bodies are developed and used to analyze such systems. Flow in systems with pumps and turbines are analyzed.

Prerequisites: Math 32 (Calculus III), and either CE 95 or CE 99 (Statics) with a grade of “C-“ or better in each.

Please turn in an unofficial transcript with the prerequisites highlighted by the second class period, or you will be dropped from the class.

Required Text/Reading: *Fluid Mechanics*, by Cengel and Ceimbala, McGraw Hill Education, Fourth Edition, 2018. ISBN: 978-1-259-69653-4

This classes uses the programs “Connect” and “Learnsmart”, which are included in the Inclusive Access package described below. The programs are used for the required homework. You can access Connect and Learnsmart through the assignments posted on the class Canvas site.

From McGraw-Hill:

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. After you have paid for the product, you will have access for the remainder of the term.

Online Course Resources

Electronic copies of the course material including Greensheet, homework assignments, and presentation slides will be posted on Canvas site for the class. The course material may be updated during the semester.

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.

Course Goals

The main objectives of this class are:

- Develop and demonstrate the application of hydrostatic equation.
- Apply Bernoulli equation for solving engineering problems.
- Derive the fundamental conservation equations for a control volume and apply them to solve basic fluid mechanics problems.
- Cover velocity profile and losses for laminar and turbulent flow in pipes.
- Flow over submerged bodies.

Student Learning Objectives

Upon successful completion of this course the students should be able to demonstrate their ability to:

Fluid Properties

1. Understand the fundamental differences between solids and fluids, and liquids and gasses.
2. Describe the basic fluid properties, dimensions and unit systems, and the concept of dimensional homogeneity.
3. Understand the definition and role of viscosity in characterizing the fluids and the concept of inviscid flow.
4. Describe the difference between Newtonian and non-Newtonian fluids.
5. Understand surface tension, capillary forces, and contact angle.

Fluid Statics

6. Describe the differences between absolute, gage, and vacuum pressures.
7. Explain Pascal’s law for pressure transmission and application in hydraulic machines.
8. Derive the hydrostatic differential equation and apply the concept to evaluate pressure variation in a constant density fluid.
9. Apply hydrostatic equation to evaluate forces on submerged surfaces.

Fluid Kinematics and Continuity Equation

10. Understand the differences between a closed system and a control volume and the concept of Lagrangian/Eulerian descriptions.
11. Understand and apply Reynolds transport theorem to derive conservation equations for control volume from fundamental equations for closed systems.
12. Follow the derivation of conservation of mass (continuity) for a control volume and generate the simplified forms of the equation.
13. Formulate and solve problems involving application of continuity equation.

Fluid Flow – Bernoulli’s Equation

14. Derive Euler's and Bernoulli's equations of motion for a fluid and describe the assumptions made in the derivation.
15. Apply Bernoulli equation for calculating pressure and flow velocity, and in application of velocity measurement devices.

Fluid Flow – Momentum Equation

16. Derive the conservation of momentum equation from Newton's second law and the basis of the simplified forms of the equation.
17. Formulate and solve problems involving application of momentum equation for fluid jets, vanes, nozzles, and pipe bends.

Fluid Flow – Energy Equation

18. Derive the integral form of the energy equation and understand the definitions of shaft work, pump and turbine head and the head loss.
19. Identify, formulate, and solve problems involving the energy equation in a variety of applications including reservoirs, pipes with minor losses, pumps, turbines, and nozzles.
20. Identify, formulate, and solve problems involving the simultaneous application of continuity, momentum, and energy equations.
21. Define and plot the hydraulic and energy grade lines for a variety of flow systems involving reservoirs, pumps, turbines, and nozzles.

Pipe Flow

22. Understand the criterion for transition to turbulent flow in a pipe and the criteria for fully developed flow.
23. Derive the velocity distribution and friction factor for fully developed laminar flow in a pipe.
24. Use the Moody diagram to calculate the friction factor and head losses in pipes.
25. Calculate minor losses due to transitions, valves, and fittings, and evaluate combined piping system head loss or pumping requirements.

External Flows

26. Understand lift and drag on submerged bodies and calculate the drag force on blunt objects.

Contemporary Problems Related to Fluid Mechanics

27. Demonstrate capability to use available sources of information to research a contemporary issue related to fluid mechanics and work effectively in a team to identify possible solutions and their limitations.
28. Communicate effectively to present the research problem statement and possible solutions

Classroom Protocol

- Please arrive in class on time.
- Complete the assigned reading before class. We will be covering a significant amount of material and not all the reading material will be covered in class. It will be helpful to better understand the lecture if the material is reviewed before the class.
- Students are encouraged to ask questions in the classroom and during the office hours. Special arrangements can also be made for consultation with the instructor.
- This is an engineering course. As such, students are expected to be *precise* in answers to problems in quizzes and examinations. Partial credits will be given in quizzes and examinations with incorrect answers only if correct method is used in solution procedure.
- Students are encouraged to use pocket electronic calculators in quizzes, midterms, and final examination. However, they must show the proper procedures used in solutions. Use of lap-top computers is not allowed during exams. Also, students are not allowed to share calculators and written materials with others during the examinations.

- There will be no make-up for quizzes or exams except for students with extenuating circumstances. Supporting documentation such as a medical doctor's note or jury summons is required to support such request.
- Homework assignments submitted past the due date will not be accepted.
- Please turn your cell phones off or place them on vibrate. Do not answer your cell phones during class and no texting. During exams, all cell phones must be put away out of sight.
- Use of internet devices in the classroom are discouraged. Students should sit in the first two rows if they want to use laptops for taking notes.
- Students should exhibit a respectful and professional attitude towards everyone in the class.

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](http://info.sjsu.edu/static/catalog/policies.html) 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/provost/academic_affairs/resources/Academic_Calendars/. The [Late Drop Policy](http://www.sjsu.edu/aars/policies/latedrops/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.

Assignments and Grading Policy

Grading: Homework 10%, LearnSmart 4%, quizzes 10%, two midterm exams 18% each, research paper 10%, final exam 30%. Letter grades will be assigned based on overall class performance, with Grade C+ or B- to be the median of the overall class grade distribution

Homework: Homework will be assigned using McGraw Hill's Connect. Access the assignments via Canvas using the link for Connect.

Homework assignments submitted past the due date will not be accepted; however, the two lowest homework scores will be dropped.

Some assignments may require you to scan and upload a solution done by hand, so make sure that you find a place to do this. These solutions must be uploaded as doc (Word) or pdf files. Camera phones typically will not provide enough resolution, it is your responsibility to make sure the scanned documents are legible.

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: 4%

6 assignments completed: 3%

5 assignments completed: 2%

4 assignments completed: 1%

0-3 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: Three short answer quizzes will be given at specified dates. They will cover the topics from the homework assignments and are intended to test your understanding of the material. The quizzes will take approximately 20 to 30 minutes each.

Research Paper: Research paper involves identification and evaluation of a contemporary topic related to fluid mechanics. The topic can be in any area of personal, national or global interest including environmental issues, energy conservation, biotechnology, etc. Students will work in teams of approximately 6-8 people and the teams should be decided within 5 weeks. Proposals for the research topics are due by October 16. The deliverables will be a short presentation and a written paper. More details will be provided in the class.

Exam Policy: All students are expected to complete the exams and quizzes in class as scheduled. There are no make-up exams or quizzes. Alternative accommodations or extended time will be considered only in partnership with the Disability Resource Center (<http://www.drc.sjsu.edu/>)

University Policies

Academic integrity

Students in this course are expected to maintain high ethical standards in all matters pertaining to the course, including, but not limited to, examinations, homework, course assignments, presentations, writings, team work, treatment of class members, and behavior in class. All exams and homework (unless otherwise instructed) must be your own work. Copying the work of others or allowing another to copy your work are both considered cheating and may result in failing the course. Cheating and plagiarism are violations of the SJSU Policy on Academic Dishonesty (S98-1) and will not be tolerated in the class.

Students are expected to have read the Policy, which is available at:

<http://www.sjsu.edu/senate/docs/S07-2.pdf>

Plagiarism is defined as, *the use of another person's original (not common-knowledge) work without acknowledging its source*. Thus plagiarism includes, but is not limited to:

- copying in whole or in part, a picture, diagram, graph, figure, etc. and using it in your work without citing its source
- using exact words or unique phrases from somewhere without acknowledgement
- putting your name on a report, homework, or other assignment that was done by someone else

Instances of academic dishonesty will not be tolerated and faculty members are required to report all infractions to the office of Student Conduct and Ethical Development.

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](http://www.drc.sjsu.edu/) (DRC) at <http://www.drc.sjsu.edu/> to establish a record of their disability.

Student Technology Resources

Computer labs for student use are available in the Academic Success Center located on the 1st floor of Clark Hall and on the 2nd floor of the Student Union. Additional computer labs may be available in your department/college. Computers are also available in the Martin Luther King Library.

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](http://www.sjsu.edu/larc/) is located at <http://www.sjsu.edu/larc/>.

Course Schedule

	Date	Topic	Reading Assignment	Assignment
Week 1	8/21	Review of Syllabus. Introduction & Basic Concepts, Chapter 1	1-1, 1-3, 1-4, 1-6	
Week 2	8/26 – 8/28	Fluid properties (Chapter 2)	2-1–2-4 & 2-6- 2-7	LS 1 Due 8/26 HW 1 Due 8/28
Week 3	9/2 – 9/4	Labor Day - Campus Holiday. Fluid statics (Chapter 3): pressure, hydrostatic equation, hydraulic machines, and pressure measurement.	3.1 and 3.2	LS 2, Due 9/4 HW 2 Due 9/4
Week 4	9/9 – 9/11	Fluid statics (Chapter 3): Pressure measurement, forces on plane surfaces. System & Control Volume. Fluid Kinematics, Chapter 4. Quiz 1 (Ch. 1 & 2) on 9/11	3.3 and 3.4 1-5, 4.1	LS 3, Due 9/9 HW 3 Due 9/11
Week 5	9/16 – 9/18	System & Control Volume. Fluid Kinematics, Chapter 4 Conservation of mass, Bernoulli equation (Chapter 5)	4.2, 4.6 5.2, 5.4	LS 4
Week 6	9/23 – 9/25	Review of Chapters 1 to 4 and Midterm 1 on 9/25		
Week 7	9/30 – 10/2	Application of Bernoulli equation, Energy equation Mechanical, Energy analysis and steady state analysis (Chapter 5)	5.4, 5.5 5.3, 5.6	LS 5, Due 10/2
Week 8	10/7 – 10/9	Momentum analysis (Chapter 6): Derivation and application of linear momentum equation Quiz 2 (Ch. 3, 4 & 5) on 10/9	6.1 to 6.4	HW 4 Due 10/7
Week 9	10/14 – 10/16	Angular momentum equation (Chapter 6) Research project proposals due on 10/16	6.5, 6.6	LS 6, Due 10/14 HW 5 Due 10/16
Week 10	10/21 10/23	Internal Flow (Chapter 8): Laminar flow in pipes Quiz 2	8.1 to 8.4	
Week 11	10/28 – 10/30	Review of Chapters 5 and 6 and Midterm 2 on 10/3		
Week 12	11/4 – 11/6	Internal Flow (Chapter 8): Turbulent flow in pipes and minor losses	8.5, 8.6, 8.8	LS 8, Due 11/6 HW 6 Due 11/6
Week 13	11/11 – 11/13	Veterans Day – Campus Closed External flow (Chapter 11): Drag, lift, and drag coefficient Quiz 3 (Ch. 6 & 8) on 11/13	11.1-11.4	
Week 14	11/18 – 11/20	External flow (Chapter 11): Flow over flat plate, cylinder, and sphere Turbomachinery (Chapter 14): Pumps	11.5, 11.6 14.1, 14.2	HW 7 Due 11/18 LS 11
Week 15	11/25 – 11/27	Turbomachinery (Chapter 14): Turbines No class, Non-instructional day	14.4	LS 14
Week 16	12/2 – 12/4	Research project presentations		HW 8 Due 12/2
Week 17	12/9	Review for final exam		

Final Exam: Friday, December 13, 2019; 12:15-14:30, E-343

NOTE: The above schedule may be modified as needed.