

SAN JOSE STATE UNIVERSITY
Department of Mechanical Engineering

ME111 - Fluid Mechanics - Section 3

Fall 2016

Instructor: Dr. Davood Abdollahian
Class hours: T Th 1:30 – 2:45 PM
Class room: E-401
Course Code: 42858
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Course Description

This course covers definition of a fluid and its properties, hydrostatic condition and its application in manometry and forces on submerged surfaces. It introduces Lagrangian and Eulerian descriptions of flow and the definition of streamlines. Euler and Bernoulli equations for inviscid flow are derived. Control volume concept is introduced and the equations for conservation of mass, momentum, and energy are derived. Laminar and turbulent flow are defined, and the applications for pipe flow, calculating head loss, pumps and turbines are covered. Lift and drag for submerged bodies are defined and estimated.

Prerequisites: Math 32 (Calculus III), CE 99 (Statics)

Required Text: *Engineering Fluid Mechanics*, by Elger, Leuret, Crowe, & Roberson, John Wiley & Sons, Eleventh Edition, 2016. ISBN: 978-1-118-88068-5

Online Course Resources

Electronic copies of the course material including Greensheet, homework assignments, and presentation slides will be posted on my ME111 course shell in Canvas. The course material may be updated during the semester.

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.
- Calculate lift and drag on submerged bodies.

Student Learning Objectives

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

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. Describe the ideal gas law and the equation of state.
4. Understand the definition and role of viscosity in characterizing the fluids and the concept of inviscid flow.
5. Describe the difference between Newtonian and non-Newtonian fluids.
6. Understand surface tension, capillary forces, and contact angle.
7. Describe the differences between absolute, gage, and vacuum pressures.
8. Understand the derivation of hydrostatic equation and apply the concept to evaluate pressure variation in atmosphere, forces on submerged surfaces, and manometry.
9. Understand the assumptions and derivation of Euler and Bernoulli equations.
10. Apply Bernoulli equation for calculating pressure and flow velocity, and in application of velocity measurement devices.
11. Understand the differences between a closed system and a control volume.
12. Understand and apply Reynolds transport theorem to derive conservation equations for control volume from fundamental equations for closed systems.
13. Follow the derivation of conservation of mass (continuity) for a control volume and generate the simplified forms of the equation.
14. Formulate and solve problems involving application of continuity equation.
15. Understand the derivation of conservation of momentum equation from Newton's second law and the basis of the simplified forms of the equation.
16. Formulate and solve problems involving application of momentum equation for fluid jets, vanes, nozzles, and pipe bends.
17. Understand the derivation of energy equation and the definitions of shaft work, pump and turbine head and the head loss.
18. Formulate and solve problems involving application of energy equation to determine head loss or flow rate, and pump or turbine power.
19. Formulate and solve problems involving application of combined momentum and energy equations.
20. Plot and interpret hydraulic grade line and energy grade line for systems involving reservoirs, pumps, turbines, and nozzles.
21. Understand the concept of boundary layer. Calculate boundary layer thickness, shear force, and skin friction factor for laminar boundary layer over a flat plates. Understand the transition criterion and the differences with turbulent boundary layer.
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.
26. Understand lift and drag on submerged bodies and calculate the drag force on blunt objects.
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

- 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.
- All the assumptions for the calculations or the basis for applicability of an equation should be clearly stated.
- 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 arrive in class on time.
- 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](http://www.sjsu.edu/calendars/) web page located at <http://www.sjsu.edu/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%, quizzes 10%, two midterm exams 20% 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 problems will be assigned at least one week before the due date. No late homeworks.

Quizzes: Three short answer quizzes will be given at the specified dates. They will cover the topics from the homework assignments.

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 5 people and the teams should be decided within 5 weeks. Proposals for the research topics are due by October 20. 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/>).

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 another's work or allowing another to copy your work are both considered cheating and may result in failure of 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://www2.sjsu.edu/senate/S04-12.pdf>

Plagiarism is defined as, *the use of another person's original (not common-knowledge) work without acknowledging its source.*¹ Thus plagiarism includes, but is not limited to²:

- 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

Students are expected to familiarize themselves with how to avoid plagiarism. Several helpful resources can be found at:

<http://www.stanford.edu/dept/vpsa/judicialaffairs/students/plagiarism.sources.htm>

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.

¹ Definition adapted from "Defining and Avoiding Plagiarism: The WPA Statement on Best Practices," <http://www.ilstu.edu/~ddhesse/wpa/positions/WPAplagiarism.pdf>; and "What is Plagiarism?," <http://www.stanford.edu/dept/vpsa/judicialaffairs/students/plagiarism.sources.htm>.

² Adapted from, "Avoiding Plagiarism," http://owl.english.purdue.edu/handouts/research/r_plagiar.html.

Course Schedule

	Date	Topic	Reading Assignment
Week 1	8/25	Review of Greensheet, Introduction (Chapter 1):	Sections 1.1 to 1.3, 1.5 to 1.7
Week 2	8/30 – 9/1	Fluid properties (Chapter 2) Fluid statics (Chapter 3): pressure, hydraulic machines.	Sections 2.1 to 2.7 Section 3.1
Week 3	9/6 – 9/8	Fluid statics (Chapter 3): hydrostatic equation, pressure in atmosphere, pressure measurement, forces on plane surfaces	Sections 3.2 to 3.4
Week 4	9/13 – 9/15	Bernoulli equation (Chapter 4): Streamlines, velocity and acceleration fields, Euler and Bernoulli equations	Sections 4.1 to 4.6
Week 5	9/20 – 9/22	Bernoulli equation (Chapter 4): Velocity and pressure measurement, pressure over cylinder	Sections 4.7, 4.9, 4.10
Week 6	9/27 – 9/29	Review of Chapters 1 to 3 and Midterm 1 on 9/29	
Week 7	10/4 – 10/6	Control volume and continuity equation (Chapter 5)	Sections 5.1 to 5.5
Week 8	10/11 – 10/13	Cavitation video, Momentum equation (Chapter 6): Derivation of momentum equation	6.1 to 6.3
Week 9	10/18 – 10/20	Momentum equation (Chapter 6): Application. Research project proposals due on 10/20	6.4, 6.5
Week 10	10/25 10/27	Energy Equation (Chapter 7): Derivation of energy equation, shaft work, mechanical efficiency.	7.1 to 7.5
Week 11	11/1 – 11/3	Review of Chapters 4 to 6 and Midterm 2 on 11/3	
Week 12	11/8 – 11/10	Energy Equation (Chapter 7): Abrupt expansion, hydraulic and energy grade lines. Viscous flow over flat plate (Chapter 9): Uniform flow, Couette/Poiseuille flows	7.6 to 7.8 and 9.1 to 9.3
Week 13	11/15 – 11/17	Viscous flow over flat plate (Chapter 9): Boundary layer description, velocity profile, shear stress and drag force	9.4 to 9.6
Week 14	11/22	Flow in conduits (Chapter 10): Laminar, turbulent flow, pipe sizes, pipe head loss, velocity and friction for laminar flow, Turbulent flow and Moody diagram.	10.1 to 10.3
Week 15	11/29 – 12/1	(Chapter 10): stress distribution, velocity and friction for laminar flow, Turbulent flow and Moody diagram, combined head loss. Drag and lift (Chapter 11): Drag equation and drag for axisymmetric and 3-D bodies	10.4 to 10.8 11.1 to 11.3
Week 16	12/6 – 12/8	Research project presentations	

Final Exam: Friday, December 16, 2016; 12:15-14:30, E-401

NOTE: The above schedule may be modified as needed.