

January 20 Course Outline

Catalog Description

Prerequisite: Mathematics 250; Physics 220A/L. Fundamental equations of fluid mechanics are derived and applied to engineering problems, with emphasis on understanding the physical principles involved. Basic developments are applied to compressible as well as incompressible fluids. Selective exploration of the state of the art of experimental knowledge in major areas of applications. Applications to design.

Instruction information	
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Course Information	
Course number	11971
Class hours	Tuesday and Thursday, 5:30 to 6:45 pm
Class location	Jacaranda (Engineering) 1610
Web site	http://www.csun.edu/~lcaretto/me390

Expanded Description

The analysis of fluid mechanics is an essential part in the design of many engineering systems, including rocket engines, irrigation projects, the plumbing in your house, the flow of air and fuel in your car engine, and industrial processes such as electric power generation and oil and chemical refining. As a discipline, fluid mechanics is the simplest study of the mechanics of deformable media. A fluid is defined as a substance that can sustain a compressive stress, but not a tensile stress. The mechanics of a fluid are governed by basic laws of force and momentum balances, but because fluids are in motion and deform to a large degree, the analysis is somewhat more complex than the usual free body diagram in solid mechanics.

The course begins by defining fluid properties of density, specific weight, viscosity and surface tension that are used throughout the course. Next simple force balances in fluids that are not in motion are considered followed by analysis of simple fluid flows using equations of mass balance (continuity equation), momentum balance (Bernoulli equation) and energy balance (first law of thermodynamics). Definitions of systems (a fixed mass) and control volumes (a fixed or deformable geometry which can have inflows and outflows) are used in problem solving.

Important empirical results, including the use of dimensionless quantities and similitude, and empirical equations for pressure drops in pipes and lift and drag of objects in external flows such as aircraft and ground vehicles are used for solving problems in these areas.

Finally all students will be introduced to the basics of flow in open channels and compressible flow then students will be given a choice of additional study in either of these areas. Civil engineering students are expected to study open channel flows; mechanical engineering students, compressible flows.

Although advanced applications of fluid mechanics are based on the application of partial differential equations, the emphasis in this introductory course will be on the use of basic principles, in an integrated form, to solve common engineering problems in fluid mechanics.

Text

Bruce R. Munson, Donald F. Young, and Theodore H. Okiishi, *Fundamentals of Fluid Mechanics* (fifth edition), Wiley, 2006.

Course Conduct

Course Learning Objectives – As a result of taking this course, students should be able to

- Understand the and be able to formulate and solve problems using basic fluid properties: density, specific weight, viscosity and mechanical quantities: pressure, velocity, force and stress
- solve problems to determine pressures in static fluids and manometers
- understand limits of and solve problems with the Bernoulli equation
- understand definitions of and be able to use concepts of system and control volume
- use the continuity equation to solve problems where mass conservation can be applied
- solve problems to determine forces in moving fluids using control volumes
- use dimensionless parameters and apply the concept of similitude for fluid mechanics experimentation
- understand the differences between laminar and turbulent flows and be able to determine if a flow is laminar or turbulent based on the Reynolds number for the flow
- solve problems in laminar and turbulent flows in pipes
- be familiar with the basic ideas of boundary layers and irrotational flows outside these boundary layers
- solve problems of lift and drag in external flows
- understand the important variables used to solve problems in open channel and compressible flows
- solve basic problems in one of the following areas (a) compressible flows (b) open channel flows

Relation to program outcomes – As part of the accreditation process, the BS degree programs in civil and mechanical engineering have a set of outcomes that students should achieve by the time that they graduate. This course is designed to contribute to the following program outcomes for the two degree programs: (a) the ability to apply knowledge of mathematics, science and engineering, and (b) the ability to formulate and solve engineering problems.

Class participation – Learning engineering subjects is a difficult task that can only be done by working problems on your own. Your learning in this course will be a combination of textbook material, lecture material and in-class discussion. Your active participation in class exercises and

discussion is essential to your learning of the subject matter. Your own work in problem solving is a key to your mastery of the subject matter.

Class courtesy – To keep a good learning environment your fellow students you should come to class on time and not leave before class is over. Turn off your cell phone and other personal electronic devices while you are in class. Do not disturb others by talking during lecture. If you do not understand some point of the lecture, ask the instructor for clarification. During group work, encourage all members in your group to participate. Answer questions your fellow students ask you, in a respectful manner (as you would like to have your questions answered when you ask.) Do not wear perfumes, colognes, after-shave lotions, and the like that upset others in the class, especially individuals with allergies.

Homework – Weekly homework assignments will be given, but not graded. Solutions to the homework will be posted on the course web site. Doing the homework is important practice for learning the subject material.

Class sessions – The course is organized into 12 subject matter units. Starting in the second week of the semester each unit will be presented as follows. On Tuesday there will be a lecture on the subject matter for the unit. Reading will be assigned for this material on the date of the lecture. The following Thursday, you will work with a small group of your fellow students to solve problems on the subject matter. Homework problems, although not collected, will have a due date of the following Tuesday. At the start of class on this Tuesday, there will be a thirty-minute quiz on the unit, based on the material in the group problem solving and homework. Following the quiz, the lecture material for the next unit will be presented, continuing the cycle.

Grading – Your grade in this course will be based on weekly quizzes, a midterm and a final examination, and a design project. More information about the design project will be provided later in the course. The weights for these individual components in your final grade are shown below.

Weekly quizzes	45%
Midterm Examination	22%
Final	33%

Only the ten highest quiz grades will be counted in computing the quiz grade for the semester. Students who take eleven or twelve quizzes will have their lowest grade or two lowest grades, respectively, removed before computing the quiz grade for the semester. The quiz grade for students who take ten or fewer ten quizzes will be calculated from the quizzes taken; there will be no make-up or adjustment for students who take fewer than ten quizzes.

The translation of a final numerical score into a letter grade rests solely on the judgment of the instructor. The following criteria will be used for letter grades:

- A: Student knows almost all of the course material and is able to apply it to new problems.
- B: Student satisfies one, but not both, of the conditions for an A grade.
- C: Student knows fundamentals of the course and is able to apply this knowledge to routine problems.
- D: Student has learned some course material but is not able to apply all the fundamental points of the course.
- F: Student has failed to demonstrate knowledge of the course material beyond a minimal level.

Plus/minus grading will be used in this course. A plus grade indicates that the criterion for a given grade has been clearly met, but the student performance does not begin to approach the requirements for the next highest grade. A minus grade is given when the student performance

does not quite meet the requirements for the grade, but the criterion for the next lower grade has been substantially exceeded.

No make-up exams – There are no make-up exams or quizzes. Students who miss the midterm exam will receive a calculated midterm grade, based on their performance on all the other exams and quizzes that they took. See the grading section above for the treatment of quiz grades. Students who do not take the final examination will receive a grade of withdrawal unsatisfactory (WU) in the course; this grade counts as an F in your grade point average.

Plagiarism vs. Collaboration – Students often work together on assignments. This collaboration is helpful and encouraged. By working together, each of you can improve your learning of the subject. However, there is a difference between working together to learn the material and copying another student's work and passing it off as your own. Submitting another person's work as your own is a violation of engineering ethics, university academic standards and CSUN regulations. It is unethical behavior for people working in engineering or studying to work in this field. Each student must submit his or her own work to pass the course.

Exam solutions that are identical and, in the instructor's judgment, indicating copying, will result in an F grade in the course for both students involved. The instructor will notify the Associate Dean of the College of Engineering and Computer Science and the Dean of Students of any cheating incidents in this class.

Add-drop policy – Students are expected to be familiar with the University regulations for adding and dropping classes. Students who find that they do not have enough time to prepare for this class or whose performance on the initial quizzes is poor should drop the class within the appropriate deadline. (Students can withdraw from the class on line up to February 8; Between February 9 and February 15 a petition approved by the instructor and department chair is required. Withdrawals after February 15 are not permitted.) Students who do not complete the course work and do not withdraw from the class will receive a grade of WU, denoting an unsatisfactory withdrawal. Such grades count the same as an F grade in the computation of students' grade point averages.

Changes – Students are responsible for all changes to this outline announced in class.

Schedule of lecture topics, exams and quizzes

The reading column below gives the pages to be read from the text by Munson, Young, and Okiishi, unless otherwise stated. Readings should be completed prior to the lecture. During the last two weeks of the course, two different topics will be covered: open-channel flow for Civil Engineering majors and compressible flow for Mechanical Engineering majors. This will be done by having a brief introduction of each topic for the entire class, distributing an outline of the important ideas and equations for each subject, then spending the remainder of the classes for group work on each topic.

Date	Lecture Topic	Reading
January 22	Discussion of course outline. Introduction to fluid properties.	1 – 30
January 24	Conclusion of fluid properties. Introduction to fluid statics.	38 – 44
January 29	Unit 1: Application of fluid statics to manometers	45 – 57
January 31	Group study on unit 1.	
February 5	Unit 1 quiz. Unit 2: Forces on submerged surfaces and buoyancy.	58 – 79
February 7	Group study on unit 2.	

Date	Lecture Topic	Reading
February 12	Unit 2 quiz. Unit 3: Bernoulli's equation.	94 – 114
February 14	Group study on unit 3.	
February 19	Unit 3 quiz. Unit 4: Static and dynamic pressure. Continuity equation. Application of Bernoulli's equation to flow measurement.	114 – 135
February 21	Group study on unit 4.	
February 26	Unit 4 quiz. Unit 5: Reynolds transport theorem and control volume analysis. Continuity equation.	168 – 183, 192 – 205
February 28	Group study on unit 5.	
March 4	Unit 5 quiz. Unit 6: Applications of control volume analysis to momentum and energy equations.	205 – 245
March 6	Group study on unit 6.	
March 11	Unit 6 quiz. Review for midterm.	
March 13	Midterm exam	
March 18	Spring Break	
March 20	Spring Break	
March 25	Review midterm results. Energy equation..	
March 27	Group study on unit 7	
April 1	Unit 8: Dimensional analysis, similitude and flow models.	346 – 349, 351 – 390
April 3	Group study on unit 8; review for midterm exam	
April 8	Unit 8 quiz. Unit 9: Introduction to laminar and turbulent flow in pipes and channels.	401 – 429
April 10	Group study on unit 9.	
April 15	Unit 9 quiz. Unit 10: Continue study of flow in pipes and channels. Minor losses.	430 – 471
April 17	Group study on unit 10.	
April 22	Unit 10 quiz. Unit 11: External flows	483 – 493, 518 – 544, 549 – 550
April 24	Group study on unit 11.	
April 29	Unit 11 quiz. Unit 12: Introduction to open-channel flow and compressible flow. Group study of open-channel flow (OCF) for Civil students and compressible flow (CMP) for Mechanical students.	OCF: 562 – 585; CMP: 614 – 646
May 1	Group study on unit 12.	
May 6	Unit 12 quiz. Review for final	
May 8	Group study to review for final.	
May 13	Final Exam, Tuesday, 5:30 – 7:30 pm	

Homework Assignments

The suggested homework assignments should be done by the completion date shown below. Except for the first assignment, with a January 29 completion date, the dates shown are the dates of the quizzes on the unit. Note that problems with an * are designed to be solved by a programmable calculator, spreadsheet, or other computer tool. The homework assignment May 6 depend on the subject matter you are studying. Homework problems for students studying

open-channel flow are denoted by **OCF**; homework for students studying compressible flow are denoted by **CMP**.

Date	Homework problems assigned
January 29	1.6, 1.17, 1.34, 1.49, 1.53, 1.85
February 5	2.5, 2.11*, 2.26, 2.40, 2.42, 2.46
February 12	2.49, 2.52, 2.57, 2.68, 2.83, 2.89
February 19	3.6, 3.8*, 3.10, 3.13, 3.14, 3.18
February 26	3.23, 3.24, 3.25, 3.32, 3.33, 3.39
March 4	4.56, 4.61, 5.7, 5.11, 5.12, 5.23
March 11	5.41, 5.43, 5.52, 5.61, 5.83, 5.109
March 18	Spring break – no homework
March 25	No homework – schedule gap for midterm exam
April 1	Schedule adjustment – review energy equation problems in March 11 homework
April 8	7.1, 7.35, 7.38, 7.46, 7.55, 7.57
April 15	8.5, 8.6, 8.15, 8.20, 8.22, 8.29
April 22	8.37*, 8.39, 8.47, 8.54, 8.66, 8.75
April 29	9.9, 9.12, 9.39, 9.42, 9.56, 9.70
May 6	OCF: 10.2, 10.13, 10.22, 10.34, 10.44, 10.51 CMP: 11.5, 11.16, 11.31, 11.33, 11.45(a), 11.47(c)