MECHANICAL & AEROSPACE ENGINEERING
ME 111 – Fluid Mechanics
3 Units; Spring 2009

Lecture: TTh 4:00- 5:15 PM, ENG 341 (Section 2) Course # 21040
Prerequisites: Math 32 (Calculus III), CE99 (Statics),

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Course Webpage: http://www.engr.sjsu.edu/pkutler

Office Hours: Tuesday/Thursday 3:00 – 4:00 PM in Room ENG 348 or by appointment

Text: *Fundamentals of Fluid Mechanics*, *Sixth Edition* by Munson, Young & Okiishi, John Wiley & Sons, 2006

Course goals: Fluid mechanics encompasses a large variety of problems, from blood flow through the human heart and capillaries to oil flow through the 800-mile-long, 4-ft diameter Trans-Alaskan pipeline. It is concerned with the forces on the 726.4 ft-tall Hoover dam, which can hold over 32 million acre-feet of H2O (enough to cover the entire state of New York to a depth of one foot). It is also concerned with the design of the Antonov 225 Mriya (the largest airplane in the world with a maximum gross weight of 1.3 million pounds). Fluid mechanics plays an essential part in many sports, such as golf (dimples on the balls), baseball, tennis, and ping-pong (spin on the ball), and all kinds of racing (wind-surfing, skiing, auto-racing, etc.). But perhaps the most beautiful applications of fluid mechanics can be seen in nature from the descent of rain and snow, the powerful tornadoes and tsunamis to the airborne dispersal of seeds and fruits and the graceful flight of birds and insects.

This course will give you an understanding of:

1. Fluids in general and how they differ from solids.
2. The basic principles of fluid mechanics (continuity, momentum, energy).
3. Viscous flow over a surface and through a pipe.

This understanding will lead to an appreciation of the phenomena, problems, and engineering applications mentioned above. In addition, the course will help you:

4. Develop and practice communication and team skills.

Ethics: High ethical standards are required of every student at San Jose State University. It is your responsibility to foster an atmosphere of honesty and integrity. 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. You **may** discuss homework and labs with other students in the class, but to prevent copying (intentional or not), do not look at another person's written solution or let another person look at yours until it has been graded. The SJSU academic dishonesty policy can be found at http://www2.sjsu.edu/senate/S04-12.pdf.

Lecture: Complete the assigned reading for the day before class. We will be covering a significant amount of material, and if you don't do the readings it may be more difficult to completely understand the lectures. Not all reading material will be covered in class. Questions during lecture are encouraged.

Grading:

In-class problems: 10 points each: approximately 8 problems. In-class, cooperative-learning problems will be given during class at various times throughout the semester. Collaboration with your classmates is strongly encouraged, as the in-class problems will be both an assessment tool and a learning experience. In-class problems will be solved by small groups. The problems will be selected from the text or provided by the instructor and administered near the end of a class period. Missed in-class problems can be made up two weeks after they've been assigned, but no later.

Homework: Students are encouraged to work in teams to solve the assigned homework problems (See Schedule). However, each student is responsible for understanding the solutions. Homework solutions will be posted on the class website. One problem of each chapter's homework set will be graded and worth 5 points. Two additional problems will be graded in Chapter 5. (60 total points).

Quizes: 160 points; Four single problem/short answer quizzes @ 40 points each will be given (See schedule). There will be no make-up quizzes, except for documented emergencies. The quizzes will be open-text, calculator and one page of notes, and will be approximately 10 to 15 minutes in duration. The quiz will cover topics from the homework assignment that is due on that day.

Tests : 500 points; 2 midterms @ 100 points each, final exam @ 300 points

Reflection Paper: 20 points: A one-page reflection on the entire course must be turned in on the last day of class. See notes at end of this greensheet or http://www.engr.sjsu.edu/nikos/courses/me111/pdf/reflect.pdf

Research Paper: 60 points, to be performed in teams. Proposals are due by the 7th week of classes. Written papers are required. All teams must present their paper in class meetings near the end of the semester. Students will be graded on the paper and their presentation. See notes at the end of this green sheet.

Total: Approximately 1000 points
Grade Distribution:
899 points < A-, A, A+ < 1,001 points
799 points < B-, B, B+ < 900 points
699 points< C-, C, C+ < 800 points
599 points < D-, D, D+ <700 points
F< 600 points

Grade progress will be posted on my website to keep you informed of your standing in the class. Student must submit to me a password that will be used to identify the data and maintain anonymity.

Homework: This semester, the homework assignments will be collected for credit. Solutions to the homework problems will be posted on my website the week after they're due. It is your responsibility to learn the material and to seek help if you don't understand before the due date (on which a quiz is scheduled). Failure to understand the concepts in the homework will result in poor performance on the quizzes and exams, which will impact your grade. To use these assignments to practice for the quizzes and exams, your work should appear professional and be easy to follow. Conceptual problems should be answered in complete sentences. Problems involving calculation must include at a minimum a list of assumptions and all calculation steps with a box around the answer. Collaboration with your classmates is strongly encouraged.

Exams: Two midterm exams will be given during the semester, and a comprehensive final exam at the end of the semester. They must be taken on the scheduled dates except for documented emergencies. The midterm exams will be open book, calculator and one page of notes, single-sided, permitted. An 8 "x 11" page of notes, single-sided, will be allowed for the final exam. A calculator will be required on all exams. Academic dishonesty will not be tolerated and may result in a course grade of "F". See Ethics section above for more detailed information.

MECHANICAL & AEROSPACE ENGINEERING
ME111 Learning Objectives

Fluid Properties

1. Define a fluid and describe how it differs from a solid.
2. Describe the differences between liquids and gases and explain the origin of these differences.
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.

Fluid Statics

6. Define and distinguish between absolute pressure, gage pressure, and vacuum.
7. Explain Blaise Pascal's law of pressure transmission.
8. Derive the basic differential equation of hydrostatics starting with the equilibrium of a fluid element.
9. Derive the equation for the pressure variation of a uniform-density fluid.
10. Identify, formulate and solve problems involving manometers

Fluid Flow – Continuity

11. Classify a flow as uniform or non-uniform, steady or unsteady, incompressible or compressible, 1-D, 2-D, or 3-D.
12. Calculate mass flow rate, volume flow rate, and mean velocity for a flow.
13. Derive the integral form of the continuity equation for a control volume.
14. Identify, formulate and solve problems involving the continuity equation for a variety of cases involving one-dimensional, uniform and non-uniform, compressible and incompressible, steady and unsteady flows.

Fluid Flow – Bernoulli's Equation

15. Derive Euler's equation of motion for a fluid.
16. Derive Bernoulli's equation and list the assumptions made in the derivation.
17. Apply Bernoulli's equation in a variety of problems including flow velocity measurements and pressure calculations.
18. Predict cavitation in enclosed pipes or hydraulic machines.
19. Describe the differences between ideal (fully attached) and real (separated) flow over a circular cylinder.

Fluid Flow – Momentum Equation

20. Derive the momentum equation for a fluid, starting with Newton's 2nd law of motion.

21. Identify, formulate, and solve problems involving the momentum equation in a variety of applications including stationary and moving vanes, nozzles, pipes with bends, and propulsion systems.

Fluid Flow – Energy Equation

22. Derive Reynold's transport theorem (control volume equation).
23. Derive the integral form of the energy equation starting with Reynolds transport theorem.
24. Identify, formulate, and solve problems involving the energy equation in a variety of applications including reservoirs, pipes with minor losses, pumps, turbines, and nozzles.
25. Identify, formulate, and solve problems involving the simultaneous application of continuity, momentum, and energy equations.
26. Plot the hydraulic and energy grade lines for a variety of flow systems involving reservoirs, pipes of varying diameters, pumps, turbines, and nozzles.

Pipe Flow

27. Describe qualitatively and quantitatively both laminar and turbulent flow in a pipe and predict transition from laminar to turbulent flow.
28. Derive the equation for the shear stress distribution across a pipe section.
29. Derive the equation for the velocity distribution across a pipe section in laminar flow.
30. Use the Moody diagram 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.
31. Calculate minor losses (i.e., head losses in pipe inlets, outlets, valves, and other fittings.
32. Select the right size pump for a given pipeline / system.

Teamwork and Communication Skills

33. Work effectively on a team to solve fluid mechanics problems.
34. Communicate effectively ideas and problem solutions relating to fluid mechanics.

Contemporary Problems Related to Fluid Mechanics

35. List several examples of regional, national, and/or global contemporary problems related to fluid mechanics (ex. environmental issues, natural resources and energy conservation, etc.) articulate a problem / position statement for each, and explain what makes these issues particularly relevant to the present time.
36. Suggest reasonable theories regarding the root cause(s) of these problems.
37. Identify possible solutions to these problems, as well as any limitations of these solutions.

MECHANICAL & AEROSPACE ENGINEERING
"Fundamentals of Fluid Mechanics"
6th Edition
Munson, Young and Okiishi
Tentative Schedule – Spring 2009

Week	Topics	Reading	Assigned problems due on Thursday of the week after they're assigned
1(1/19)	**Greensheet** Introduction & Fluid Characteristics	Chapter 1	1.14, 1.15, 1.57, 1.58, 1.61, 1.77 1.88
2(1/26)	Fluid Statics	Chapter 2	2.9, 2.12, 2.42, 2.49, 2.93, 2.99
3(2/2)	Elementary Fluid Dynamics-The Bernoulli Equation; **Quiz 1 (2/5, 15 mins, Chapter. 2)**	Chapter 3	3.14, 3.21, 3.33, 3.60
4(2/9)	Elementary Fluid Dynamics-The Bernoulli Equation; **Film on Cavitation (2/10);**	Chapter 3	3.71, 3.83, 3.93, 3.98
5(2/16)	**Review** Chapters 1, 2 & 3 **Midterm 1 (2/19, Chapters 1, 2 & 3)**		
6(2/23)	Fluid Kinematics	Chapter 4	4.21, 4.26, 4.55, 4.58
7(3/2)	Finite Control Volume Analysis; **Quiz 2 (3/5,15 mins, Chapter. 4);**	Chapter 5	5.3, 5.23, 5.33, 5.39, 5.46 **Project Proposals Due-3/5: Group Names & Title**
8(3/9)	Finite Control Volume Analysis; **Rainy-Day Problem Assigned (3/10)**	Chapter 5	5.54, 5.95, 5.105, 5.119, 5.120
9(3/16)	Finite Control Volume Analysis	Chapter 5	5.121, 5.122, 5.123, 5.131
10(3/30)	**Review** Chapter 5 **Midterm 2 (4/2, Chapter 5)**		
11(4/6)	Viscous Flow in Pipes	Chapter 8	8.2, 8.11, 8.16, 8.22, 8.31
12(4/13)	Viscous Flow in Pipes. **Film on Boundary Layer Control (4/14)**	Chapter 8	8.42, 8.45, 8.53, 8.85, 8.110; **Rainy-Day Problem due 4/9**
13(4/20)	Flow Over Immersed Bodies. **Quiz 3 (4/23, 15 mins, Chapter 8)** **Project Presentations**	Chapter 9	9.10, 9.16, 9.22, 9.56
14(4/27)	Flow Over Immersed Bodies. **Project Presentations**	Chapter 9	9.87, 9.99, 9.102, 9.109
15(5/4)	Flow Over Immersed Bodies. **Review** Chapters 8 & 9 **Quiz 4 (5/7, Chapters 9)** **Project Presentations**	Chapter 9	
16(5/11)	**Project Presentations**		
	Tuesday, May 13, Last day of classes		

Important Dates

January 22: First day of instruction
February 10: Last Day to Add Courses & Register Late
March 23-27: Spring Recess
March 31: Cesar Chavez Day Observed-Campus Closed
May 13: Last day of instruction
May 15, May 18-21: Final Examinations

ME 111 Final Exam: Wednesday, May 18, 2009; 2:45-5:00

Research Paper Guidance

Suggested Process

- Determine group members
- Select leader
- Assign responsibilities, for example
    - Lead
    - Scribe
    - Web searcher
    - Library searcher
    - Paper writer
    - Slide design
    - Figure design
- Design criteria for selecting research topic, for example
    - Liquid or gases
    - Civil/ Mechanical/ Aerospace Engineering Related
    - Level of technical detail
    - Uses theory presented in class
    - Is of contemporary interest (e.g., environmental, energy)
- Brainstorm ideas for research topic
- Identify specific topic using criteria
- Each member performs a search for papers on topic selected
- Compose written paper on research/experiment performed using outline below
- Compose oral presentation using outline below
- Rehearse oral presentation

Suggested Written Paper Outline

I. Title/Authors/Affiliation (i.e., Civil, Mechanical, Aerospace Engineering)
II. Abstract
III. Introduction
IV. Approach
V. Analysis
VI. Results
VII. Conclusions/Summary/Future Directions
VIII. References
IX. Acknowledgements

Suggested Oral Presentation Outline

I. Introduction
II. Approach
III. Analysis
IV. Results
V. Conclusions

- Powerpoint slides using the computer or overhead projection system should be used
- Each group member should perform part of the presentation

Reflection Paper Guidance

Suggested Topics

I. Impact of fluid mechanics on your everyday life
II. “Eye openers” you learned about fluids
III. Highlights and challenges you encountered
IV. Your strengths and weaknesses in this area
V. Your opinion of course process for conveying information
   a. Lectures
   b. In-class problems
   c. Videos
   d. Quizzes/Mid-terms
   e. Extra-credit problems
   f. Research paper
VI. Constructive suggestion for course improvements
VII. Anything else you would like to add