ASE 320 INTRODUCTION TO FLUID MECHANICS
UNIQUE # 12565

Class meets:	TTh 9:30 - 11:00 a.m., WRW 102
Instructor:	Dr. David Goldstein
Office:	WRW 313C
Office Hours:	M (in WRW 102) 4:00 - 5:00pm. W 3:00-4:00 p.m. or by appointment/walk-in
Phone:	471-4187
Grader:	LC Colmenero, 471-7205, gecolmen@mail.utexas.edu
Text:	*Fluid Mechanics*, 5th, Edition, Frank M. White, McGraw-Hill, 2003
Additional References:	*Introduction to Fluid Mechanics,* 4th Edition Robert Fox & Alan McDonald, Wiley, 1992
Course Evaluation:	College of Engineering standard format at the end of the semester. I welcome feedback on all aspects of the course at any time, either in person or with a note. I appreciate helpful suggestions.
Important Dates:	Sept. 22 - Last day to drop without penalty Week of Oct. 11 (probably) – Midterm test University scheduled date – Final Exam

Grading:

Homework	20%
Quizzes	10%
Midterm	25%
Final	45%

Typically, 5-6 homework problems per week. They must be submitted at the beginning of class on the day due. Solutions to the homework will probably be available in the library on the following day; hence, no homework will be accepted after it is due, unless you have obtained permission in advance for late submission. To encourage you to do your homework, there will be a few unannounced quizzes throughout the semester. Each quiz will consist of a problem from that week's homework with the numbers slightly altered. There will be no makeup quizzes given but your lowest quiz grade will not be counted toward your final grade.

Discussion of homework problems with your classmates is welcome, however, the solutions you submit should represent your own work. Copying someone else's work and presenting it as your own is a violation of professional ethics. On each homework assignment submitted indicate in the upper left corner the number of hours the assignment took and the other students with whom you discussed the problem.

In all your solutions on tests and homework if your answer is clearly intuitively wrong (e.g. lead weights float in water) and you do not point this out, expect a very low mark on that problem. In your answers, neatness counts; if I can't read it, it gets a low grade. You must show a complete solution to receive full credit, particularly if the answer is in the back of the book. Any student found cheating on a quiz or test will get an F for the course.

You are encouraged to take advantage of our office hours. I aim to have the Monday office hours be organized as a group problem session. I will gladly help you with any homework problem you have already tried and with which you had trouble. If you cannot make it to office hours, come discuss this with me and we will make other arrangements.

If possible, several films on fluid mechanics will be shown to aid in the development of an intuitive feel for the subject.

Do not schedule job interviews, plan trips, etc. which conflict with test dates. The final exam will be comprehensive.

Knowledge, Abilities, and Skills Students Should Have Before Entering This Course:
Mathematics of calculus and differential equations and background in physics.

Knowledge, Abilities, and Skills Students Should Gain From This Course:
Physical understanding of the various physical phenomena that can occur in fluid flow.
Basic tools of analysis of fluid mechanics: conservation of mass, momentum and energy and equations of state.
An understanding of the analysis of simple inviscid incompressible flows and the application of these to the flow over airfoils and finite wings.

Impact on Subsequent Courses in Curriculum:
The basic tools of fluid mechanics and the extensive applications to inviscid incompressible flows, including airfoils and wings, serve as a foundation for subsequent courses in compressible fluid mechanics (ASE 362K), propulsion (ASE 376K), and heat transfer (ASE 340).

POLICY ON CHEATING: Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and dismissal from the University. Since dishonesty harms the individual, fellow students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced.

"The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4241 TDD or the College of Engineering Director of Students with Disabilities at 471-4382."

"In spring 2001, Web-based, password-protected class sites will be associated with all academic courses taught at The University. Syllabi, handouts, assignments and other resources are types of information that may be available within these sites. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of the sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1."
For information on restricting directory information see:
http://www.utexas.edu/student/registrar/catalogs/gi00-01/app/appc09.html

ABET CRITERIA 2000 OUTCOMES ACHIEVED:
This course contributes to the following EC2000 Criterion 3 outcomes and those specific to the EAC accredited program.

Outcome	√	Outcome	√
a. An ability to apply knowledge of mathematics, science, and engineering	√	g. An ability to communicate effectively	√
b. An ability to design and conduct experiments, as well as to analyze and interpret data		h. The broad education necessary to understand the impact of engineering solutions in a global/societal context	
c. An ability to design a system, component, or process to meet desired needs		i. A recognition of the need for and an ability to engage in life-long learning	
d. An ability to function on multi-disciplinary teams		j. A knowledge of contemporary issues	
e. An ability to identify, formulate, and solve engineering problems	√	k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	√
f. An understanding of professional and ethical responsibility		l. Begin list of any other outcomes unique to the program.	

ABET PROGRAM CRITERIA OUTCOMES ACHIEVED:

Criterion	√	Criterion	√	Criterion	√
A. Aerodynamics	√	G. Orbital Mechanics		M. Preliminary/Conceptual Design	
B. Aerospace Materials		H. Space Environment		N. Other Design Content	
C. Structures		I Attitude Determination and Control		O. Professionalism	
D. Propulsion	√	J. Telecommunications		P. Computer Usage	
E. Flight Mechanics	√	K. Space Structures			
F. Stability and Control		L. Rocket Propulsion	√		

PROFESSIONALISM TOPICS:
none

TOPICS:
1. Introduction (1 class)
2. Fundamental Concepts (2 classes)
3. Fluid Statics (3 classes)
4. Integral Relations for Control Volumes (4 classes)
5. Differential Analysis (2 classes)
6. Incompressible Inviscid Flow (3 classes)
7. Internal Viscous Flows (1 class)
8. Flow About Immersed Bodies (7 classes)
9. Dimensional Analysis & Similitude (2 classes)
10. Introduction to Compressible Flow (2 classes)

DESIGN ASSIGNMENTS
none

LABORATORY ASSIGNMENTS:
None, though you should be enrolled in ASE 120k

COMPUTER:
Several homework problems might require the use of computer software tools such as integrators and graphing routines.

ASE 320 Expected Subject Outline

READING

All of Chapter 1

Introduction (1/2 week)
- How to solve problems
- What is/is not a fluid, Tacoma Bridge movie
- Recall $p = \rho RT$
- No slip

Fundamental Concepts (1 week)
- Def.:
  - Gage/abs. Pressures
  - Control/volumes
  - Lagrangian va. Eulerian
  - Molecular vs. continuum
  - 1D vs. 2D vs. 3D flows
  - Stream, path, time and streaklines
- Surface vs. body forces
- Stress field
- Newtonian fluid
- Viscosity (how to read charts), no slip again
- What is a boundary layer
- Separation
- Laminar vs. Turbulent
- Incompressible vs. compressible
- Mach number
- Internal vs. external flows

Chapter 2
Except stability

Fluid Statics (1 1/2 weeks)
- Derive - $\Delta P + \rho g = 0$ with differential volume element
- Isothermal atmosphere example
- US Standard atmosphere
- $\Delta P = \rho g h$
- Manometers
- Forces/moments on flat submerged surfaces
- Forces/moments on curved submerged surfaces
- Buoyancy/Archimedes princ.
- Accelerating fluids in rigid body motion
- Cavitation

Chapter 3

Integral Relations for Control Volumes (2 weeks)
- Derive Reynolds transport theorem
- Conservation of Mass
- Discuss good control volumes
- Boundary layer/pipe flow bent pipe examples

Conserv. of momentum
  Surface/body forces
  Few examples inc. flat plate drag
Differential control volume analysis:
  Derive Bernoulli equation/limitations
Energy equation (and integral form)
  Compressor example
Accelerated control volumes & reference frames
(Probably skip rotating frames, angular momentum, arbitrary motion)
Rocket example

Chapter 4
Skip 4.4, 4.5,

<u>Differential Analysis</u> (1 week)
Derive continuity
Cylindrical coordinates
Stream functions
Substantial derivative
Fluid rotation/vorticity/circulation
Fluid deformation
Write out the Navier-Stokes equations
Euler equations

<u>Incompressible Inviscid Flow</u> (11/2 weeks)
Streamline coordinate/curvature (?)
Re-derive Bernoulli from Euler
Pitot static tubes
Limits on Bernoulli equation again
Irrotational flow
Velocity potential/stream function (again)
Lines of constant potential
Uniform stream
Line source/sink
Line vortex

Chapter 6
Skip p. 377-383, 393-404 & 417-425

<u>Internal Viscous Flows</u> (1/2 week)
Laminar/turbulent transition
Planar Couette/Poiseuille flow
Laminar pipe flow
Turbulent profiles

Chapter 8
Read especially p. 493-503
Skip 8.5, 8.8 & 8.9

<u>Flow About Immersed Bodies</u> (31/2 weeks)
Boundary layers
Drag
Doublet
Arrays of vortices/sheets of vorticity
Magnus effect
Kutta-Joukowski lift theorem
Theory vs. experiment for cylinder flows
Airfoils and wings
Kutta condition

$C_{L_3} C_{D_3} C_P$
Flat plate at angle of attack
Lift curves, drag polars, reading charts
Slots, slats, flaps
Camber
Finite span wings
Down wash
Induced drag

Chapter 5

<u>Dimensional Analysis & Similitude</u> (1 week)
Define dimensions
Principal of Dimensional Homogeneity
Pi theorem, detailed examples
Important dimensionless groups: Re, Fr, M, We
Flow similarity
Non-dimensionalizing continuity & Navier-Stokes equations

Chapter 9
Through 9.5

<u>Introduction to Compressible Flow</u> (as available~1 week)
(Brief) review thermodynamics
$P = \rho RT$
Def. enthalphy, internal energy, reversible adiabatic, isothermal
Mach number ranges
Flow in tube example
Speed of sound
Mach wave
Zone of silence
Adiabatic & isentropic steady flows
Define sonic point
Nozzle flow (isentropic)
Area changes: nozzles vs. diffusers/subsonic
Normal Shock Waves