ASEN 5327 Computational Fluid Dynamics
Spring 2009

Tu, Th 17:00-18:15 EECR 118

Professor Thomas S. Lund

Office:	ECOT 534
Hours:	15:00-17:00 Wednesday
	Other times by appointment
e-mail:	tom.lund@colorado.edu
Phone:	(303) 492-2270

Course Web Site: https://bross.colorado.edu/asen5327

Text: *Computational Methods for Fluid Dynamics* by J.H. Ferziger and M. Peric, Springer, 3rd edition, 2002, ISBN 3-540-42074-6.

Prerequisites:

Fluid Mechanics, Linear Algebra, Fourier Analysis, Computer Programming.

Purpose of the course

To provide and introduction to numerical methods applied to the equations of fluid mechanics. Important topics to be covered are classification of partial differential equations, finite difference and finite volume approximations, truncation error, consistency and convergence, conservation of physical quantities, numerical methods for convective and diffusive processes, the treatment of non-linearities, finite volume methods for inviscid flow equations.

Course Outline

1. General introduction

    Historical perspective, equations of fluid dynamics, simplified forms of the governing equations, model equations, mathematical classification.

2. Introduction to numerical methods

    General approach, mathematical model, discretization method, numerical grid, finite approximations, truncation error, consistency, stability, convergence, conservation of physical quantities, polynomial fitting, finite difference and finite volume methods.

3. Finite difference methods

    Taylor series expansion, polynomial fitting, approximation of an arbitrary derivative, error analysis, spectral methods, boundary conditions, resulting algebraic equation system.

4. Finite volume methods

    Approximation of volume and surface integrals, interpolation schemes, boundary conditions, resulting algebraic equation system

5. Time marching methods

    Explicit versus implicit methods, stability, accuracy, examples.

6. Compressible Euler and Naier-Stokes equations

    Conservation properties, conservative form, wave propagation and characteristic analysis, upwind differencing schemes splitting methods, flux-difference splitting methods, boundary conditions.

7. A finite volume method for the Euler equations.

    Choice of an interpolation method, time advancement, boundary conditions.

8. Incompressible Navier-Stokes equations

    Incompressibility constraint, Poisson equation for the pressure, grid arrangement, pressure-velocity coupling.

Course Mechanics

Homework:	Approximately 7 homework assignments will be given. Homework exercises will be a combination of analysis and computational results
Computer Project:	A major component of the course is to write a flow solver for the Euler equations. You may use any computer system that is convenient for you. The only restrictions are that you must be able to compile and run code (most likely FORTRAN or C), obtain a printout, and preferably two-dimensional graphs and contour plots.
Exams:	Mid-term exam: Tuesday, March 17, 17:00-18:15. Final exam: Tuesday, May 5, 19:3022:00.

Grades:

Homework	25%
Mid Term Exam	20%
Computer Project	30%
Final Exam	25%
	100%