ASE 8423
Computational Fluid Dynamics II

CATALOG DATA: ASE 8423. Computational Fluid Dynamics II. (3) (Prerequisite: ASE8413 or equivalent). Three hours lecture. Compressible viscous methods; Navier-Stokes equation methods; turbulence models; incompressible methods; panel methods; finite element methods, current literature.

PREREQUISITES:

1. CFD I (ASE 8413) or equivalent

TEXTBOOK: no text required

Reference Text--

Toro, E.F., *Riemann Solvers and Numerical Methods for Fluid Dynamics - A Practical Introduction*, second edition, Springer-Verlag, 1999.

Tannehill, John C., Anderson, Dale A., and Pletcher, Richard H., *Computational Fluid Mechanics and Heat Transfer*, second edition, Taylor & Francis, 1997.

Hoffmann, Klaus A., *Computational Fluid Dynamics for Engineers*, Engineering Education Systems, Wichita, KS, 1989.

Hirsch, C., *Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics, 2nd Edition*, Butterworth-Heinemann (Elsevier), Boston, MA, 2007.

OBJECTIVES:

1. To introduce the equations of motion for viscous fluids (both compressible and incompressible).
2. To develop and analyze methods for the numerical solution of the equations of fluid motion.
3. To develop a basic understanding of turbulence modeling.
4. To develop a basic understanding of the limit of compressiblity and ways around the associated numerical issues.
5. To develop the logic skills necessary to translate numerical formulas for computer solution, i.e. code development.
6. To develop an understanding of the physical and numerical fluid behavior within numerical solutions and to develop an ability to recognize each.

TOPICS COVERED: (approx. TTh Classes)

1. Viscous flow equations (compressible and incompressible) (2)
2. Boundary conditions (2)
3. Flux formulations
   - -- Inviscid (1)
   - -- Viscous (2)
4. Implicit solution and linearization strategies
   - -- Linearization approximations (1)
   - -- Newton method (1)
   - -- Factorization and iterative methods (2)
5. Soln acceleration, convergence and processing efficiency
   - -- CG based methods (2)
   - -- Concurrent processing concepts (1)
6. Turbulence modeling (2)
7. Incompressible solution methods
   - -- Pseudo-compressiblity (1)
   - -- Preconditioning (2)
8. Domain decomposition and dynamic grids (2)
9. Solution interrogation and visualization (2)
10. Test cases
    - -- Unsteady (2)
    - -- Steady (1)
11. Exams (2)

PERFORMANCE CRITERIA:

1. Demonstrate a knowledge of the equations of fluid motion (both viscous and inviscid) in multiple dimensions.
2. Demonstrate the ability to perform detailed analysis of numerical algorithms and develop algorithms with tailored properties.
3. Demonstrate an understanding of turbulence models.
4. Demonstrate a knowledge of the numerical issues associated with approaching the limit of compressibility and the remedial efforts devised to address such issues.
5. Demonstrate an understanding of the software logic and routines developed to produce a numerical solution beginning with numerical formulas.
6. Demonstrate the ability to recognize and delineate the physical and numerical fluid behavior within a numerical solution.

COORDINATOR: J. Mark Janus, Associate Professor of Aerospace Engineering

Grading: Homework 30%, Two Exams 30%, Final Exam (comprehensive) 40%
Grades will be assigned as follows:

$90 < A < 100$
$80 < B < 90$

70 < C < 80
60 < D < 70
F < 60

Comments: Mississippi State University has implemented a new honor code. Simply stated it reads, "**As a Mississippi State University student I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do.**"

Academic honesty is expected under all circumstances. Cheating, including copying homework or allowing others to copy homework, will be dealt with in accordance with University regulations.
Homework is due at the beginning of class. Homework is to be handed in early and quizzes taken early for absence due to a University event.

Professor: J. Mark Janus

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Office Hours: TBA