AERO 4970/7970 – Computational Fluid Dynamics (CFD) :: Fall 2022

Class MWF, 1:00 - 1:50 pm, 304A Ramsay Hall

Instructor Dr. Nek Sharan, nsharan@auburn.edu

Office Hours Wednesday, 3:00 - 5:00 pm, 332 Davis Hall
https://auburn.zoom.us/j/3302840089

Course Description

This course will discuss finite-difference and finite-volume methods for solving partial differential equations of interest in fluid dynamics. Simplified (model) equations will be used to explain concepts before application to inviscid and viscous flows. Emphasis will be placed on developing scientific programming skills and analyzing numerical methods applicable to practical fluid flow problems. Some topics that will be covered include:

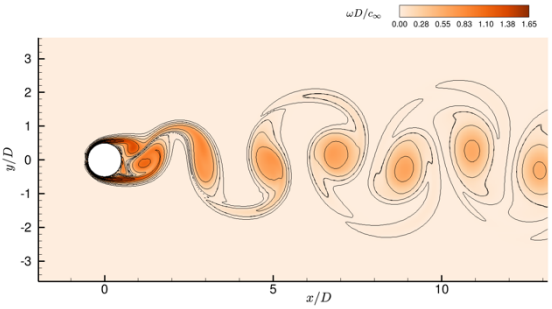

Figure 1 CFD simulation of the flow over a cylinder.

- Fluid flow conservation laws and model equations
- Finite-difference methods
  - Order of accuracy: Taylor Series Expansion
  - Discretization errors: Numerical dispersion and dissipation
  - Numerical stability: Fourier Analysis
  - Boundary treatment: Method of characteristics
- Unsteady flow computations
  - Time-marching methods: Runge-Kutta schemes
  - Time-space stability and convergence of ODEs
- Finite-volume methods
  - Riemann problem for the Euler Equations
  - Approximation of surface and volume integrals
  - Boundary condition implementation and solution of linear systems
- Numerical methods for incompressible flow calculation
- Turbulent flow computation and modeling

Additional topics based on students' interest may be included.

Prerequisites

Undergraduate-level fluid mechanics, Basic calculus and differential equations, Introductory linear algebra, Some programming skills in a language of your choice

Grading

Homework	40%
Midterm	25%
Final exam or project	35%

Suggested Texts

Lomax, Pulliam, & Zingg, *Fundamentals of Computational Fluid Dynamics*
Moin, *Fundamentals of Engineering Numerical Analysis*
LeVeque, *Finite Volume Methods for Hyperbolic Problems*
Hirsch, *Numerical Computation of Internal and External Flows*
Tannehill *et al.*, *Computational Fluid Mechanics and Heat Transfer*
Gustafsson *et al.*, *Time-Dependent Problems and Difference Methods*

Homework Policy

- Typeset your homework or write neatly.
- Provide a main document with answers/figures/tables. Include all source code at the end of the document and reference programs/modules/functions as necessary.
- You may work together in study groups but you must provide comments/conclusions/code independently.
- Late homework policy: 20% off per day.

Honor code

It is assumed that the Auburn Academic Honesty Code will be followed at all times, including during completion of homework and during exams. For more details visit:

https://www.auburn.edu/academic/provost/academic-honesty/_assets/pdf/academic-honesty-code-20201028.pdf