선박난류전산해석

Course number: 414.650

Spring 2019

Instructor: Prof. Shin Hyung Rhee

Time: 2:00 PM – 3:15 PM Tue. & Thu.

Classroom: 34-204

SNUTT
Seoul National University
Towing Tank

Course Objectives

- 전산유체역학의 기본을 이해하고 수학적 모형 정립 및 수치해석 기법 등을 습득한다. 기초적 적용문제들을 문제의 정의부터 시작하여 해석까지 실습함으로 현장 적응력을 배양한다.
- This is the first graduate-level course in computational fluid dynamics (CFD) for the naval architecture and ocean engineering program.
- As such, its principal objective is to provide basic knowledge on CFD, such as mathematical modeling of physical phenomena and numerical solution methods for the mathematical equations.
- Secondly, apply the knowledge to some of most basic, yet practical, problems.

Course Description

- CFD Basics
  - Fluid flow
  - Mathematical modeling
    - Time integration for unsteady problems
    - Navier-Stoke equation solutions
    - Complex geometries
    - Turbulent flows
  - Numerical method
    - Fundamentals of numerical methods
    - Finite difference methods
    - Finite volume methods
    - Linear equation solutions
  - Solution improvement
- CFD Programming
  - Term projects

Course Materials

- Primary: An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Versteeg & Malalasekera, Prentice Hall, 2007
  - Secondary: Computational Methods for Fluid Dynamics (3rd rev.), Ferziger & Peric, Springer, 2002
  - Secondary: Numerical Heat Transfer and Fluid Flow, Patankar, McGraw-Hill, 1980
  - Secondary: OpenFOAM 교육자료, NEXTFOAM

Coding Projects

- Evaluation: # lines, meshing strategy, CPU time, Memory usage, accuracy (error)
- Project 1: Laminar (Re = 1,000) flat plate boundary layer (Blasius)
- Project 2: 2D turbulent (Re = 1×10^6) boundary layer over a NACA 0012 airfoil @ AoA 0° & 3°
- Project 3: Laminar (Re = 1,000) flow in a lid-driven cavity of square shape
- Project 4: Inviscid (Re = ∞)/ laminar (Re = 100) / turbulent (Re = 100,000) flows over a circular cylinder
- Project 5: Turbulent (Re = 4.2×10^6) flow over a 6:1 spheroid with separation and vortices @ AoA 0° & 10°

Evaluation

- Attendance: 10%
- Projects: 30%
- Mid-term exam: 30%
- Final exam: 30%

Schedule

Week	Classes
1 (3/5 & 3/7)	Introduction (Ch. 1), Conservation laws (Ch. 2)
2 (3/12 & 3/14)	Conservation laws (Ch. 2)
3 (3/19 & 3/21)	Turbulence modeling (Ch. 3)
4 (3/26 & 3/28)	FVM for diffusion (Ch. 4)
5 (4/2 & 4/4)	FVM for convection-diffusion (Ch. 5), OpenFOAM basics
6 (4/9 & 4/11)	FVM for convection-diffusion (Ch. 5)
7 (4/16 & 4/18)	P-V coupling (Ch. 6)
8 (4/23 & 4/25)	Solution of discretized equations (Ch. 7)
9 (4/30 & 5/2)	FVM for unsteady flows (Ch. 8), Project #1 due
10 (5/7 & 5/9)	Boundary conditions (Ch. 9), Mid-term exam, Project #2 due
11 (5/14 & 5/16)	Boundary conditions (Ch. 9), Mesh generation training, Project #3 due
12 (5/21 & 5/23)	Errors and uncertainties (Ch. 10)
13 (5/28 & 5/30)	Project code presentations: compile & run, Project #4 due
14 (6/4 & 6/6)	Complex geometries (Ch. 11)
15 (6/11 & 6/13)	Complex geometries (Ch. 11), Final exam, Project #5 due