# Graduated course

## ME 747 Special topics in thermal and fluids

## (Introduction to computational fluid dynamics)

**Credit: 3(3-0-6)** **Semester 2 Year 2008**

---

**Lecturer:** Dr. Chainarong Chaktranond

**Office:** Room Eng. 413

**Phone:** 3144

**E-mail:** cchainar@engr.tu.ac.th

**Lecture time:** Monday, 13.30 – 16.30

**Lecture room:** 306 Research building

**Consulting time:** Make an appointment via E-mail

**Objectives:**

- Describe the physical significance of each term in the governing equations for CFD.
- Construct computer code to solve the CFD problem with Fortran programming
- Quantify and analyze the numerical error in solution of the CFD partial differential equations
- Develop finite difference discretized forms of the CFD equations.
- Formulate explicit & implicit algorithms for solving the Euler Equation & Navier-Stokes Equations.
- Demonstrate verification strategies for evaluating CFD code.

**Lecture schedule**

| Session | Topics |
|---|---|
| 1 | **1. Overviews of computational fluid dynamics**<br>- Overviews and importance of heat transfer in real applications |
| 2 - 3 | **2. Introduction to Fortran programming**<br>- Basic commands in Fortran programming |
| 4 | **3. Overviews of governing equations for flow and heat transfer**<br>- Elliptic, Parabolic and Hyperbolic equations |
| 5 | **4. Introduction to numerical methods**<br>- Finite different method<br>- Finite volume method<br>- Finite element method |
| 6 – 7 | **5. Introduction to solve engineering problems with finite-different method**<br>- Taylor series expansion<br>- Approximatation of the second derivative<br>- Initial condition and Boundary conditions |
| 8 - 9 | **6. Basics of discretization methods**<br>- Principle of discretization method<br>- Truncation error, Round-off and Discretization errors<br>- Convergence for marching problems<br>- Stability analysis, Von Neumann analysis |
| 10 - 12 | **7. Application of numerical methods to selected model equations**<br>- Wave and Heat equations<br>- Euler explicit and implicit methods<br>- Second-order upwind method<br>- Second central different method |
| 13 – 14 | **8. Application of numerical methods to selected model equations (Continue)**<br>- Laplace's and Burges equations<br>- Adam-Bashforth and Crank-Nicolson methods<br>- Solve the matrices with ADI, SOR methods, and etc. |
| 15 - 16 | **9. Numerical techniques to solve fluid flow problems** |

**Materials**

- Lecture note provided via homepage (http://www.engr.tu.ac.th/~cchainar)

**Reference sources**


1. Numerical recipes  http://www.nr.com/oldverswitcher.html
2. Joel H. Ferziger (1981). Numerical methods for engineering application. John Wiley & Sons.
3. John C. Tannehill, Dale A. Anderson, and Richard H. Pletcher (1997). Computational fluid mechanics and heat transfer. Taylor & Francis.
4. John D. Anderson, JR. (1995). Computational fluid dynamics: The basics with applications. McGraw-Hill.


**Score:**

| | |
|---|---|
| Attendance and Quiz | 10% |
| Project I | 20% |
| Project II | 20% |
| Assignment | 30% |
| Final examination | 20% |
| Total | 100% |

**Evaluations**

| | | |
|---|---|---|
| | **A** | $\geq 80$ |
| $75 \leq$ | **A -** | $< 80$ |
| $70 \leq$ | **B +** | $< 75$ |
| $65 \leq$ | **B** | $< 70$ |
| $60 \leq$ | **B -** | $< 65$ |
| $55 \leq$ | **C+** | $< 60$ |
| $50 \leq$ | **C** | $< 55$ |
| $45 \leq$ | **D** | $< 50$ |
| $45 >$ | **F** | |