University of Victoria
Department of Mechanical Engineering

Mech 495/535

Computational Fluid Dynamics and Heat Transfer

Instructor
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Text
T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002.

References
J.H. Ferziger & M. Perić, Computational Methods for Fluid Dynamics, Springer, 1996.
Patankar, S.V., Numerical Heat Transfer and Fluid Flow, Hemisphere, 1980.
Anderson, et.al. Computational Fluid Mechanics and Heat Transfer, Hemisphere, 1984.
Cebeci T. & Bradshaw, P., Physical and Computational Aspects of Convective Heat Transfer, Springer-Verlag, 1984.
Fletcher, C.A.J., Computational Techniques for Fluid Dynamics, Springer-Verlag, 1988.
Hirsch, C., Numerical Computation of Internal and External Flows, 2 Vols., Wiley, 1990.
Minkowycz et. al., Handbook of Numerical Heat Transfer, Wiley, 1988.

Calendar Description
Methods of predictions and historical perspective; governing differential equations of heat transfer and fluid flow; finite difference methods; discretization schemes; application to heat conduction problems; introduction to control volume formulation for fluid flow and to turbulence modeling; accuracy and convergence considerations. Individual term projects using a CFD program.

Lectures
Tuesday, Wednesday, Friday 11:30 - 12:20 DSB C108

Note: There are no tutorials throughout the term.

Laboratory
Wednesday Time TBA (March) ELW B238

Objectives

Computational Fluid Dynamics and Heat Transfer has been used by leading academic and industrial R&D centres to provide insight into a variety of complicated problems: turbulent mixing and combustion, flow-induced vibration of various structures, solidification of molten metals in castings, pulsatile flow of blood in artificial heart valves, dispersion of pollutants in the atmosphere. The range of the problems that can be approached by CFD is rapidly increasing with the development of new algorithms, turbulence models, and the availability of increasingly more powerful computers.

This course will concentrate on the finite-difference and finite-volume solution methods for solving general heat transfer and fluid flow problems. Specific objectives are (i) to provide the necessary background in discretization methods, accuracy, stability and convergence aspects of numerical solutions; (ii) to develop an understanding of the capabilities and limitations of various numerical and mathematical models of fluid flow, and (iii) to introduce some of the models required to compute turbulent flows and transport processes.

Assignments and Project

Individual assignments will require the application of a CFD code to investigate a problem involving fluid flow and/or heat transfer phenomena. In-class qizzes based on the assignment problems will test conceptual understanding of the specific computational approaches, as well as their properties and features. A project involving the application of the STAR CCM+ software package to perform a parametric study of a separated flow will have to be completed in order to qualify for a passing grade in this course. Further details regarding the project will be discussed in class and a handout will be available outlining the projects requirements and expectations.

In addition, MECH 495 students will be required to take a written final examination at the end of the course, and MECH 535 students will be requited to complete a term project including a written report and an oral in-class presentation.

Grading*

MECH 495		MECH 535	
STAR CCM+ Project	pass	STAR CCM+ Project	pass
Assignments	40%	Assignments	40%
Quizzes	20%	Quizzes	20%
Final Exam	40%	Term Project	40%
Total	**100%**	**Total**	**100%**

*This policy represents a guideline for the grade distribution, which can be adjusted in individual cases.

Course Contents

1. Background
   - Historical perspective
   - Scope of CFD
   - Review of transport equations
   - Classification of flows

2. Overview of numerical methods

3. Discretization approaches

4. 1-D diffusion

5. 2-D diffusion

6. Finite-volume method for convection-diffusion problems

7. Solution of Navier-Stokes equations

8. Turbulent flows