Mechanical Engineering 431/538 - Advanced Fluid Mechanics

Instructors:	Nathanel Machicoane, nmachico@uw.edu, MEB 223, Office hours: Monday and Wednesday 2:30-3:30pm
TA:	Brad Perfect, bperfect@uw.edu, MEB 236, Office hours: Tuesday and Thursday 2:00-3:00 pm
Text:	A Physical Introduction to Fluid Mechanics, by Alexander J. Smits (2nd Edition).
Schedule:	MW Lectures 1:30-2:20pm: MEB 238 F Lectures 12:30-1:30pm: MEB 248 F Recitation 1:30-2:20pm: MEB 248
Grading:	Homework 40%, Midterm 25%, Computer Project 35%.
Course Website:	Homework assignments and solutions posted at: **http://courses.washington.edu/me431**
Policy:	You are encouraged to discuss homework problems with the instructor, the TA, and with other students. However, the homework that you hand in should be your own work. Explain your answers carefully, listing your principal assumptions, and do your work neatly. Please indicate at the top of the first page whether you are an undergraduate or a graduate student. Homework must be turned in in class on the indicated due dates. Late homework that is handed in at the main office will downgraded 25% per day late. If you need an extension on homework due to unusual circumstances, ask the instructor at least one day prior to the deadline.

Mid term 12:30-2:20, Friday, November 2

Computer project due 5:00pm, Friday, December 7

Computing Software

STAR-CCM+ is available on the ME Remote Desktop Server. It can be downloaded for use on personal computers.
Information on accessing and using STAR-CCM+ is available on the website
Matlab is available on the ME Remote Desktop Server. A student version can also be purchased at:
http://www.mathworks.com/academia/student_version

Although it's not required to have access to a personal laptop for the course, it is highly recommended. Laptop rentals are available through UW at https://stlp.uw.edu/equipment/laptops.

Course Objectives

Understanding

Enhanced understanding of fluid mechanics, including the equations of motion in differential form, and turbulence.
Understand the basic concepts in computational fluid dynamics (CFD).
Understand the basic elements in the use of commercial CFD software.

Capabilities

For a given problem, be able to determine the appropriate differential equations of motion, initial conditions, and boundary conditions.
For a given problem, be able to determine whether the flow is laminar or turbulent, and whether a turbulence model is required in its solution.
For an application involving fluid mechanics, be able to utilize a commercial CFD software program in the problem solution.

Syllabus

Introduction

outline of course
computing facilities
homework, grading policies

Equations of motion in differential form

conservation of mass, including the streamfunction, streamlines, examples
momentum balance, including the definition of a Newtonian fluid, examples
vorticity, velocity potential
Bernoulli's equation revisited, examples

Introduction to STAR-CCM+ software (in parallel with Equations of motion)

accessing STAR-CCM+; computer laboratories; remote desktop connection; install on own computer
starting up STAR-CCM+; GUI
overview of STAR-CCM+, documentation
overview of the modeling process

Laminar flows

some inviscid flow solutions
some steady, parallel, viscous flows
some unsteady, parallel, viscous flows

Introduction to numerical methods

introduction, including various methods
introduction to the use of STAR-CCM+
finite-volume methods, including examples
solving problems in fluid mechanics using numerical methods
solution methods

Turbulent flows

qualitative definition
time averaging, including the closure problem, modeling
Some applications

Numerical methods (cont'd)

solution of nonlinear equations
solution of system of equations

Turbulent flows (cont'd)

turbulent jets, including visualizations
similarity analysis, laboratory data
turbulence modeling

Compressible flows

introduction; acoustic waves
shock waves
effects of area changes