Computational Fluid Dynamics (5C1212), 5p.

Lecturers:

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Literature:

Computational Fluid Dynamics, John D. Anderson, Jr., McGraw-Hill, 1995, (And)

Lecture notes on Computational Fluid Dynamics (D. Henningson)

Lecture notes on Basic Numerics (K. Gustavsson)

Grading:

Test total of 50p, homeworks (required) 3*X*5 = 15p.

Total points > 30 (3), > 43 (4), > 55 (5).

Web links:

http://www.mech.kth.se/

http://www.ave.kth.se/staff/aero/gunilla/

Homeworks:

- Homework 1A, due 31/1: Homework on NS equations.
- Homework 1B, due 31/1: Numerical methods for model equations. Different schemes. Dispersion, diffusion. Stability analysis.

  NOTE: you do either homework 1A OR 1B
- Homework 2, due 9/2: Numerical methods for non-linear conservation laws. Shock-tube.
- Homework 3, due 19/2: Quasi-1D Nozzle Flow
- Homework 4, due 1/3: FV homework + numerical project.
- Homework 5, due 12/3: FEM homework.

Course plan

Wed	17 jan	08-10	L52	Fluid dynamics I: Introduction and outline of the course. Derivation of the governing equations.	AH
Fri	19 jan	08-10	L52	Fluid dynamics II Derivation of the governing equations , cont.	AH
Mon	22 jan	10-12	L51	Basic numerics I: Mathematical behavior of hyperbolic, parabolic and elliptic equations. Well-posedness.	GE
Tue	23 jan	10-12	Q36	Basic numerics II: Discretization by finite differences. Analysis of discretized equations; order of accuracy, convergence	GE
Wed	24 jan	08-10	Q36	Basic numerics III: Analysis of discretized equations, cont.	GE
Thu	25 jan	15-17	Q36	Fluid dynamics III: Derivation of the governing equations , cont.	AH
Mon	29 jan	08-10	L51	Fluid dynamics IV: Dimensionless form, fluid phenomena, simplified equations	AH
Tue	30 jan	10-12	L51	Basic numerics IV: Numerical methods for model equations.	GE
Wed	31 jan	08-10	L51	Compressible flow I: Introduction to compressible flow. Euler equations, conservative/non-conservative form. Some thermodynamics.	GE
Fri	2 feb	15-17	L51	Compressible flow II: Scalar conservations laws. Numerical methods for scalar conservation laws.	GE
Mon	5 feb	08-10	L51	Compressible flow III: System of conservation laws (Euler equations).	GE
Wed	7 feb	08-10	L51	Compressible flow IV: Numerical methods for systems of conservation laws. Boundary conditions. Shock tube.	GE
Fri	9 feb	15-17	L51	Compressible flow V: Numerical methods for Euler equations. Riemann invariants.	GE
Mon	12 feb	08-10	Q36	Compressible flow VI: Numerical methods for Euler equations, cont. Nozzle flow.	GE
Tue	13 feb	10-12	Q36	volume and finite difference methods I: Laplace equation on arbitrary grids, equivalence with finite-differences, linear systems: Gauss-Seidel as smothers for multi-grid.	AH

Wed	14 feb	08-10	L52	Finite volume and finite difference methods II: Introduction to incompressible flow. Properties of the equations, role of the pressure: artificial compressibility and projection on divergence free space, Navier-Stokes in integral form.	AH
Mon	19 feb	08-10	L51	Finite volume and finite difference methods III: Staggered grid/volume formulation + BC. Unsteady equations: projection and MAC method, discrete Poisson pressure eq.	AH
Tue	20 feb	10-12	Q36	Finite elements I: An advection-diffusion problem. Variational form of the equation, weak solutions, essential and natural boundary condition. Finite-element approximations, stability and accuracy, the algebraic problem, matrix assembly.	AH
Wed	21 feb	08-10	L52	Demonstration of COMSOL MULTIPHYSICS software (to be used for homework No. 4)	EÅ
Tue	27 feb	10-12	Q36	Finite elements II: Navier-Stokes equations. Mixed variational form, Galerkin and FE approximations, the algebraic problem. Stability, the LBB condition, mass conservation	AH
Wed	28 feb	08-10	L52	Finite elements III: Navier-Stokes equations. Mixed variational form, Galerkin and FE approximations, the algebraic problem. Stability, the LBB condition, mass conservation.	AH
Thu	1 mar	15-17	Q36	Finite elements IV: Navier-Stokes equations. Mixed variational form, Galerkin and FE approximations, the algebraic problem. Stability, the LBB condition, mass conservation	AH
Tue	13 mar	08-12	M31, M32, M33	**Examination**	