

## **Computational Fluid Dynamics (SG2212), 7.5 ECTS cred.**

### **Lecturers:**

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### **Assistants:**

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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 Numericss* (K. Gustavsson)

### **Grading:**

Test total of 50p, homework (compulsory)  $3 \times 5 = 15$ p.

Total points  $>28$  (E),  $>30$  (D),  $>40$  (C),  $>50$  (B),  $>55$  (A).

### **Web links:**

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

### **Homework: (Compulsory)**

- Homework 1A, due 4/2: Homework on NS equation.
- Homework 1B, due 11/2: Numerical methods for model equation. Different schemes. Dispersion, diffusion. Stability analysis.

*NOTE: you do either homework 1A OR 1B*

- Homework 2, due 18/2: Numerical methods for non-linear conservation laws. Shock-tube.
- Homework 3, due 22/2: Quasi-1D Nozzle Flow
- Homework 4, due 27/2: FV homework
- Homework 5, due 10/3:

**Course plan**

Wed	23 Jan	08-10	L52	Fluid dynamics I: Introduction and outline of the course. Derivation of the governing equation.	AH
Thu	24 Jan	08-10	L52	Fluid dynamics II Derivation of the governing equation , cont.	AH
Fri	25 Jan	10-12	L52	Fluid dynamics III: Derivation of the governing equation , cont.	AH
Mon	28 Jan	13-15	L52	Fluid dynamics IV: Dimensionless form, fluid phenomena, simplified equation	AH
Wed	30 Jan	08-10	L52	Basic numerics I: Mathematical behavior of hyperbolic, parabolic and elliptic equation. Well-posedness.	JN
Fri	1 Feb	08-10	L51	Basic numerics II: Discretization by finite differences. Analysis of discretized equation; order of accuracy, convergence	JN
Mon	4 Feb	13-15	L52	Basic numerics III: Analysis of discretized equation, cont.	JN
Wed	6 Feb	08-10	Q33	Basic numerics IV: Numerical methods for model equation.	JN
Thu	7 Feb	08-10	L51	Compressible flow I: Introduction to compressible flow. Euler equation, conservative/non-conservative form. Some thermodynamics.	JN
Fri	8 Feb	08-10	L52	Compressible flow II: Scalar conservation laws. Numerical methods for scalar conservation laws.	JN
Mon	11 Feb	13-15	L52	Compressible flow III: System of conservation laws (Euler equation).	JN
Wed	13 Feb	08-10	L52	Compressible flow IV: Numerical methods for systems of conservation laws. Boundary condition. Shock tube.	JN
Thu	14 Feb	08-10	L52	Compressible flow V: Numerical methods for Euler equation. Riemann invariants.	JN
Fri	15 Feb	08-10	L51	Compressible flow VI: Numerical methods for Euler equation, cont. Nozzle flow.	JN
Mon	18 Feb	13-15	L52	Finite 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	20 Feb	08-10	L52	Finite volume and finite difference methods II: Introduction to incompressible flow. Properties of the equation, role of the pressure: artificial compressibility and projection on divergence-free space, Navier-Stokes in integral form.	AH
Fri	22 Feb	08-10	L51	Finite volume and finite difference methods III: Staggered grid/volume formulation + BC. Unsteady equation: projection and MAC method, discrete Poisson pressure eq.	AH
Mon	25 Feb	13-15	L52	Iterative methods, Complex geometries, Coordinate transformation	AH

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Wed	27 Feb	08-10	L52	<b>No lecture</b>	
Fri	29 Feb	08-10	L52	Iterative methods, Complex geometries, Coordinate transformation	AH
Mon	3 Mar	13-15	Q36	Iterative methods, Complex geometries, Coordinate transformation	AH
Tue	4 Mar	08-10	L52	Iterative methods, Complex geometries, Coordinate transformation	AH
Wed	5 Mar	15-17	Q34	High-order finite differences: compact schemes	AH
Thu	13 Mar	14-18	M31, M32, M33	<b>Examination</b>	