

## Computational Fluid Dynamics (SG2212/SG3114), 7.5 ECTS

### Lecturers:

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### Literature:

Relevant books:

- *Computational Fluid Dynamics*, John D. Anderson, Jr., McGraw-Hill, 1995
- *Numerical Computation of Internal & External Flows*, Charles Hirsch, Butterworth-Heinemann, Second Edition, ISBN: 978-0-7506-6594-0.

*Lecture notes on Computational Fluid Dynamics* (D. Henningson)

### Grading:

Exam total of 50p,

Homework (compulsory) 6×2 + project (compulsory) 5 ⇒ max 15p.

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

### Web links:

<https://www.kth.se/social/course/SG2212/>

### Homeworks: (5 of 6 are compulsory)

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|-----------------------|-----------------------|
| •Homework 1, due 27/1 | •Homework 4, due 17/2 |
| •Homework 2, due 3/2  | •Homework 5, due 24/2 |
| •Homework 3, due 10/2 | •Homework 6, due 3/3  |

### Project (compulsory):

Project, due 24/3

**Course plan**

Week 4	Mon	20 Jan	15-17	Q34	Fluid dynamics I: Introduction and outline of the course. Derivation of the governing equation.	AH
	Wed	22 Jan	10-12	Q36	Fluid dynamics II Derivation of the governing equation , cont.	AH
	Fri	24 Jan	10-12	Q33	Fluid dynamics III: Derivation of the governing equation , cont.	AH
Week 5	Mon	27 Jan	15-17	Q34	Basic numerics I: Mathematical behavior of hyperbolic, parabolic and elliptic equation. Well-posedness.	PS
	Wed	29 Jan	10-12	V22	Basic numerics II: Discretization by finite differences. Analysis of discretized equation; order of accuracy, Convergence	PS
	Thu	30 Jan	08-10	Q34	Basic numerics III: Analysis of discretized equation, cont.	PS
	Fri	31 Jan	10-12	Q34	Analysis of discretized equations: Consistency, Convergence and Stability, CFL condition  <b>Homework review:</b> <b>Solution of HW1</b> <b>Description of HW2</b>	PS TK, AN
Week 6	Mon	3 Feb	15-17	Q34	Compressible flow I: Introduction to compressible flow, Euler equation, conservation laws, entropy	PS
	Wed	5 Feb	10-12	V34	Compressible flow II: Numerical methods for conservation laws, Stability, Dispersion, Diffusion	PS
	Fri	7 Feb	10-12	Q36	Compressible flow III: Shock tube, boundary conditions, artificial viscosity  <b>Homework review:</b> <b>Solution of HW2</b> <b>Description of HW3</b>	PS TK, AN
Week 7	Mon	10 Feb	15-17	V34	Compressible flow IV: Systems of conservation laws, Riemann Invariants	PS
	Wed	12 Feb	10-12	Q36	Introduction to incompressible flow. Navier-Stokes in integral form. Finite volume and finite difference methods: Laplace equation on arbitrary grids, equivalence with finite-differences.	AH

	Fri	14 Feb	10-12	Q34	Finite volume and finite difference methods: Cartesian grid and spurious solutions. Staggered grid/volume formulation + BC.  <b>Homework review:</b> <b>Solution of HW3</b> <b>Description of HW4</b>	AH TK,AN
Week 8	Mon	17 Feb	15-17	Q34	Steady incompressible flows: Artificial compressibility	AH
	Wed	19 Feb	10-12	Q34	Projection on divergence-free space, Unsteady incompressible flows: projection method, discrete Poisson pressure eq.	AH
	Thu	20 Feb	08-10	Q34	linear systems: Iterative methods, Gauss-Seidel as smothers for multi-grid	AH
	Fri	21 Feb	10-12	V22	Complex geometries, Coordinate transformation.  <b>Homework review:</b> <b>Solution of HW4</b> <b>Description of HW5</b>	AH TK, AN
Week 9	Wed	26 Feb	10-12	V34	Unstructured Node-Centered FV: consistency and accuracy.	AH
	Thu	27 Feb	10-12	Q33	Upwind schemes, Flux splitting	AH
	Thu	27 Feb	13-15	Q34	High-order compact finite differences.	AH
	Fri	28 Feb	10-12	Q34	<b>Introduction of project</b>  <b>Homework review:</b> <b>Solution of HW5</b> <b>Description of HW6</b>	PS, AH TK, AN
Week 10	Wed	5 Mar	10-12	V34	<b>Project lecture</b>	PS
	Thu	6 Mar	08-10	V34	<b>Project supervision</b>	TK, AN
	Fri	7 Mar	10-12	Q34	<b>Homework review:</b> <b>Solution of HW6</b> <b>Demonstration of project</b>	TK, AN
	Fri	21 Mar	09-13	V01 V22 VSem	<b>Examination</b>	
					<b>Re-exam</b>	