Computational Fluid Dynamics (SG2212/SG3114), 7.5 ECTS

Lecturers:

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Literature:

Relevant books:

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

Lecture notes on Computational Fluid Dynamics (D. Henningson)
Lecture notes on Basic Numerics (K. Gustavsson)

Grading:

Exam total of 50p,

Homework (compulsory) 6×2 + project (compulsory) 5 $\Rightarrow$ max 15p.

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

Web links:

http://www.mech.kth.se/~ardeshir/courses/SG2212.html

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

Homeworks: (5 of 6 are compulsory)

- Homework 1, due 23/1
- Homework 2, due 30/1
- Homework 3, due 6/2
- Homework 4, due 13/2
- Homework 5, due 27/2
- Homework 6, due 5/3

Project (compulsory):

Project, due 19/3

Course plan

Week 3	Mon	16 Jan	13-15	Q31	Fluid dynamics I: Introduction and outline of the course. Derivation of the governing equation.	AH
	Tue	17 Jan	15-17	Q31	Fluid dynamics II Derivation of the governing equation , cont.	AH
	Thu	19 Jan	15-17	Q31	Fluid dynamics III: Derivation of the governing equation , cont.	AH
Week 4	Mon	23 Jan	13-15	Q31	Basic numerics I: Mathematical behavior of hyperbolic, parabolic and elliptic equation. Well-posedness.	PS
	Tue	24 Jan	15-17	L52	Basic numerics II: Discretization by finite differences. Analysis of discretized equation; order of accuracy, Convergence	PS
	Thu	26 Jan	15-17	Q31	Basic numerics III: Analysis of discretized equation, cont. **Homework review:** **Solution of HW1** **Description of HW2**	PS MH, AN
Week 5	Mon	30 Jan	13-15	L52	Analysis of discretized equations: Consistency, Convergence and Stability, CFL condition	PS
	Tue	31 Jan	15-17	L52	Compressible flow I: Introduction to compressible flow, Euler equation, conservation laws, entropy	PS
	Thu	2 Feb	15-17	L52	Compressible flow II: Numerical methods for conservation laws, Stability, Dispersion, Diffusion **Homework review:** **Solution of HW2** **Description of HW3**	PS MH, TM
Week 6	Mon	6 Feb	13-15	E51	Compressible flow III: Shock tube, boundary conditions, artificial viscosity	PS
	Tue	7 Feb	13-15	Q31	Compressible flow IV: Systems of conservation laws, Riemann Invariants	PS
	Thu	9 Feb	10-12	Q31	Introduction to incompressible flow. Navier-Stokes in integral form. Finite volume and finite difference methods: Laplace equation on arbitrary grids, equivalence with finite-differences. **Homework review:** **Solution of HW3** **Description of HW4**	AH MH, AN

Week 7	Mon	13 Feb	13-15	Q33	Finite volume and finite difference methods: Cartesian grid and spurious solutions. Staggered grid/volume formulation + BC.	AH
	Tue	14 Feb	15-17	Q33	Steady incompressible flows: Artificial compressibility	AH
	Thu	16 Feb	13-15	Q31	Projection on divergence-free space, Unsteady incompressible flows: projection method, discrete Poisson pressure eq. **Homework review:** **Solution of HW4**	AH MH, AN
Week 8	Mon	20 Feb	13-15	Q31	linear systems: Iterative methods, Gauss-Seidel as smothers for multi-grid	AH
	Tue	21 Feb	15-17	Q31	Complex geometries, Coordinate transformation.	AH
	Thu	23 Feb	13-15	Q31	Unstructured Node-Centered FV: consistency and accuracy. **Homework review:** **Description of HW5**	AH MH, AN
Week 9	Mon	27 Feb	15-17	Q36	Upwind schemes, Flux splitting	AH
	Wed	29 Feb	08-10	Q33	High-order compact finite differences.	AH
	Fri	2 Mar	10-12	Q31	**Introduction of project** **Homework review:** **Solution of HW5** **Description of HW6**	PS-AH MH, AN
Week 10	Tue	6 Mar	15-17	L52	**Project lecture**	PS
	Wed	7 Mar	08-10	L52	**Project supervision**	MH, AN
	Fri	9 Mar	08-10	L52	**Homework review:** **Solution of HW6** **Demonstration of project**	MH, AN
	Fri	16 Mar	14-18	Q15 Q17 Q21	**Examination**	
	Fri	8 Jun	09-13	E51	**Re-exam**	