

Computational Fluid Dynamics (SG2212/SG3114), 7.5 ECTS

Lecturers:

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Homework corrections will be discussed in the office hours.

Literature:

Relevant books:

- *Computational Fluid Dynamics*, John D. Anderson, Jr., McGraw-Hill, 1995
- *Essential Computational Fluid Dynamics*, Oleg Zikanov, Wiley, 2019.

Lecture notes and *Handouts* on the Canvas page.

Grading:

Exam total max 50p, homeworks + project 10p.

Total points >25 (E), >28 (D), >38 (C), >48 (B), >54 (A).

Exam open for registration: 9. Feb - 23 Feb. 2022. All students need to register!

Re-exam open for registration: 28. Apr – 12. May 2022. All students need to register!

Web links:

Canvas: <https://canvas.kth.se/courses/31845>

All lectures and exercises with Zoom: <https://kth-se.zoom.us/j/69100960780>

Homeworks: (max 3 points, 5 of 6 required for pass, about 75% for pass/points)

- Homework 1, due 26/1
- Homework 2, due 2/2
- Homework 3, due 9/2
- Homework 4, due 16/2
- Homework 5, due 23/2
- Homework 6, due 2/3

Please use Canvas for questions and submission of homeworks!

Project (max 7 points, at least 6 points total required for pass):

Project, due 25/3. **This is the final date for any submission for SG2212/SG3114!**

Course plan

Week 3	Tue	18 Jan	13-15	Zoom	1 Fluid dynamics I: Introduction and outline of the course. Derivation of the governing equation.	AH
	Thu	20 Jan	15-17	Zoom	2 Fluid dynamics II Derivation of the governing equation, cont.	AH
	Fri	21 Jan	10-12	Zoom	3 Fluid dynamics III: Derivation of the governing equation, cont.	AH
Week 4	Mon	24 Jan	15-17	Zoom	4 Basic numerics I: Mathematical behavior of hyperbolic, parabolic and elliptic equation. Well-posedness.	PS
	Tue	25 Jan	13-15	Zoom	5 Basic numerics II: Analysis of discretized equation; order of accuracy, Convergence	PS
	Thu	27 Jan	15-17	Zoom	6 Basic numerics III: Discretization by finite differences and modified wavenumber	PS
	Fri	28 Jan	10-12	Zoom/ E2	7 Basic numerics IV: Analysis of discretized equations: Consistency Homework session 1 and introduction to Matlab	PS LG, FM
Week 5	Mon	31 Jan	15-17	Zoom	8 Basic numeric V: Analysis of discretized equation, cont. Convergence and Stability, CFL condition	PS
	Thu	3 Feb	15-17	Zoom	9 Compressible flow I: Introduction to compressible flow, Euler equation, conservation laws, entropy	PS
	Fri	4 Feb	10-12	Zoom/ E2	10 Compressible flow II: Numerical methods for conservation laws, Stability, Dispersion, Diffusion Homework session 2	PS LG, FM
Week 6	Tue	8 Feb	13-15	Zoom	11 Compressible flow III: Shock tube, boundary conditions, artificial viscosity	PS
	Thu	10 Feb	15-17	Zoom	12 Compressible flow IV: wave-like solutions, analysis in Fourier space	PS
	Fri	11 Feb	10-12	Zoom/ E2	13 Compressible flow V: Systems of conservation laws, Riemann Invariants Homework session 3	PS LG, FM

Week 7	Mon	14 Feb	15-17	Zoom	14 Introduction to incompressible flow. Navier-Stokes in integral form. Finite volume and finite difference methods: Discretization of equations with first and second derivatives on arbitrary grids, equivalence with finite-differences.	AH
	Tue	15 Feb	13-15	Zoom	15 Finite volume and finite difference methods: Cartesian grid and spurious solutions. Staggered grid/volume formulation + BC. Steady incompressible flows: Artificial compressibility	AH
	Thu	17 Feb	15-17	Zoom	16 Projection on divergence-free space, Unsteady incompressible flows: projection method, discrete Poisson pressure equation. Linear systems: Iterative methods, Gauss-Seidel as smoothers for multi-grid	AH
	Fri	18 Feb	10-12	Zoom/ E2	17 Complex geometries, Coordinate transformation. Homework session 4	AH LG, FM
Week 8	Mon	21 Feb	15-17	Zoom	18 Unstructured Node-Centered FV: consistency and accuracy.	AH
	Tue	22 Feb	13-15	Zoom	19 Upwind schemes, Flux splitting	AH
	Wed	23 Feb	10-12	Zoom	20 High-order compact finite differences.	AH
	Fri	25 Feb	10-12	Zoom/ V35	21 Introduction of project Homework session 5	PS LG, FM
Week 9	Tue	1 Mar	13-15	Zoom	22 Project lecture	PS
	Wed	2 Mar	10-12	Zoom	23 Open Foam demonstration	PS LG, FM
	Thu	3 Mar	15-17	Zoom	24 General Questions/additional topics Demonstration of project	PS
	Fri	4 Mar	10-12	Zoom/ E2	25 Homework session 6	LG, FM
Week 11			TBA	Oral	Examination (oral)	PS, AH
Week 23			TBA	Oral	Re-exam (oral)	PS, AH