

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 on the home 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: 6 Feb - 20 Feb 2020. All students need to register!

Re-exam open for registration: 30 Apr - 14 May 2020. All students need to register!

Web links:

Canvas: <https://kth.instructure.com/courses/21925>

All lectures and exercises online via 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 27/1
- Homework 2, due 3/2
- Homework 3, due 10/2
- Homework 4, due 17/2
- Homework 5, due 24/2
- Homework 6, due 3/3

Please use Canvas for questions and submission of homeworks!

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

Project, due 26/3

Course plan

| | | | | | | |
|--------|-----|--------|-------|------|---|--------------|
| Week 3 | Wed | 20 Jan | 10-12 | Zoom | 1 Fluid dynamics I: Introduction and outline of the course. Derivation of the governing equation. | AH |
| | Thu | 21 Jan | 15-17 | Zoom | 2 Fluid dynamics II Derivation of the governing equation, cont. | AH |
| | Fri | 22 Jan | 10-12 | Zoom | 3 Fluid dynamics III: Derivation of the governing equation, cont. | AH |
| Week 4 | Tue | 26 Jan | 15-17 | Zoom | 4 Basic numerics I: Mathematical behavior of hyperbolic, parabolic and elliptic equation. Well-posedness. | PS |
| | Wed | 27 Jan | 08-10 | Zoom | 5 Basic numerics II: Analysis of discretized equation; order of accuracy, Convergence | PS |
| | Thu | 28 Jan | 15-17 | Zoom | 6 Basic numerics III: Discretization by finite differences and modified wavenumber | PS |
| | Fri | 29 Jan | 10-12 | Zoom | 7 Basic numerics IV: Analysis of discretized equations: Consistency Homework session 1 and introduction to Matlab | PS LG, FM |
| Week 5 | Tue | 3 Feb | 13-15 | Zoom | 8 Basic numeric V: Analysis of discretized equation, cont. Convergence and Stability, CFL condition | PS |
| | Thu | 4 Feb | 15-17 | Zoom | 9 Compressible flow I: Introduction to compressible flow, Euler equation, conservation laws, entropy | PS |
| | Fri | 5 Feb | 10-12 | Zoom | 10 Compressible flow II: Numerical methods for conservation laws, Stability, Dispersion, Diffusion Homework session 2 | PS LG, FM |
| Week 6 | Tue | 9 Feb | 13-15 | Zoom | 11 Compressible flow III: Shock tube, boundary conditions, artificial viscosity | PS |
| | Thu | 11 Feb | 15-17 | Zoom | 12 Compressible flow IV: wave-like solutions, analysis in Fourier space | PS |
| | Fri | 12 Feb | 10-12 | Zoom | 13 Compressible flow V: Systems of conservation laws, Riemann Invariants Homework session 3 | PS LG, FM |

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| Week 7 | Tue | 16 Feb | 13-15 | 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 |
| | Wed | 17 Feb | 10-12 | Zoom | 15 Finite volume and finite difference methods: Cartesian grid and spurious solutions. Staggered grid/volume formulation + BC. | AH |
| | Thu | 18 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 | 19 Feb | 10-12 | Zoom | 17 Complex geometries, Coordinate transformation. Homework session 4 | AH LG, FM |
| Week 8 | Tue | 23 Feb | 13-15 | Zoom | 18 Unstructured Node-Centered FV: consistency and accuracy. | AH |
| | Wed | 24 Feb | 10-12 | Zoom | 19 Upwind schemes, Flux splitting | AH |
| | Thu | 25 Feb | 15-17 | Zoom | 20 High-order compact finite differences. | AH |
| | Fri | 26 Feb | 10-12 | Zoom | 21 Introduction of project Homework session 5 | PS LG, FM |
| Week 9 | Tue | 2 Mar | 13-15 | Zoom | 22 Project lecture | PS |
| | Wed | 3 Mar | 10-12 | Zoom | 23 Open Foam demonstration | PS LG, FM |
| | Thu | 4 Mar | 15-17 | Zoom | 24 General Questions/additional topics Demonstration of project | PS |
| | Fri | 5 Mar | 10-12 | Zoom | 25 Homework session 6 | LG, FM |
| | Fri | Around 19 Mar | TBA | Oral | Examination (TBA) | PS, AH |
| | Fri | Around 11 Jun | TBA | Oral | Re-exam (TBA) | PS, AH |

Zoom link: <https://kth-se.zoom.us/j/69100960780>