Time and location

Time:	Tuesday, 14 – 15.30 h
Start date:	April 22, 2025
Location:	HS 59, Bldg. 10.81

Contact

Consultation:	by appointment
Location:	Room 122, Bldg. 10.81
Phone:	0721-608 47245
Email:	`markus.uhlmann@kit.edu`

Aim and scope of the course

- Deepening the basic knowledge of the course "Numerical Fluid Mechanics I"
- We will be working towards the simulation of the Navier-Stokes equations
- Solving a fluid flow simulation project in small teams (optimally: 2 persons)
  - project assignments will be handed out at the beginning of the course;
  - practical realisation of a flow simulation program in Matlab (alternatively: python, C/C++, FORTRAN, ...);
  - analysis, design, coding of the method in independent work and under supervision.
- Presentation of the results.

Supporting material

Please register with the E-learning system ILIAS under the following URL:
`https://ilias.studium.kit.edu/goto.php?target=crs_2645002`
There you will find all the material (including project assignments) for download.

Prerequisites

- Basic fluid mechanics
- Mathematics (PDEs, numerical analysis)
- Successful participation in the course "Numerical Fluid Mechanics I" (or equivalent)
- Computer programming with Matlab
- English language

Exam

The results of the project work will be presented orally (20 minutes) with subsequent discussion.

The work will be graded according to the following criteria:

- **Project work:** 80%. Correctness, completeness and quality of the results.
- **Oral presentation:** 20%. The oral presentation of the results (beamer, slides or blackboard) shall comply with the standards for a scientific-technical presentation in terms of clarity, completeness and structure.

Contents & planning

First session (April 22, 2025): General Introduction
Goals of this course – presentation of the problems – organisational details.

Further sessions (29.4., 6.5., ~~13.5.~~, 20.5., 27.5., 3.6., ~~10.6.~~, 17.6., 24.6., 1.7., 8.7., 15.7., 22.7.):
Joint discussion of your progress – problems/bottlenecks – discussion of possible solutions – monitoring your progress.

Presentation of the results (preliminary date July 29, 2025)[1]**:**
Presentation of the solution by the project teams (short talk, demo of their program); subsequent discussion.

Further resources

- MATLAB Campus license: http://www.scc.kit.edu/produkte/3841.php
- Freely available textbook "Numerical Recipes": http://www.nr.com (alternatively here)

References

[1] C. Hirsch. *Numerical computation of internal and external flows.* Butterworth-Heinemann, 2nd edition, 2007.

[2] C.A.J. Fletcher. *Computational techniques for fluid dynamics.* Springer, 2nd edition, 1991.

[3] R. Peyret and T.D. Taylor. *Computational methods for fluid flow.* Springer, 1983.

[4] R.J. LeVeque. *Finite volume methods for hyperbolic problems.* Cambridge Univ. Press, 2002.

[5] R.J. LeVeque. *Finite difference methods for ordinary and partial differential equations.* Society for Industrial and Applied Mathematics, 2007.

[6] W.H. Press, S.A. Teukolsky, W.H. Vetterling, and B.P. Flannery. *Numerical recipes in Fortran 77.* Cambridge U. Press, second edition, 1986.

[7] P.K. Kundu and I.M. Cohen. *Fluid mechanics.* Academic Press, 2nd edition, 2002.

[1] Please register for the exam by July 25, 2025.