

1 Time and location

	Lecture	Problem session
Time:	Mon 9:45 – 11:15 h	Wed 14:00 – 15:30 h
Location:	kl. HS, Bldg. 10.50	HS 103, Bldg. 10.50
Start date:	October 27, 2025	November 5, 2025

2 Contact

	M. Uhlmann	T. Bzikadze
Consultation:	by appointment	by appointment
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3 Aim and scope of the course

- Introduction to the numerical computation of fluid flow problems
- Techniques for analyzing numerical methods for the basic equation types (precision, stability, efficiency)
- Design of solution methods (finite differences, finite volumes)
- Supervised practical realisation of algorithms in MATLAB (or similar software)

4 Supporting material

In order to access the lecture material, including detailed lecture notes and slides as well as the problem sheets, please register with the e-learning system “ILIAS” under the following URL:

https://ilias.studium.kit.edu/goto.php?target=crs_2771974

5 Prerequisites

- **Basic fluid mechanics:**
 - Advection vs. diffusion processes
 - Practice in manipulating the Navier-Stokes equations
- **Basic mathematical background:**
(the chapter/section data listed in the following refers to the course by M. Neher at KIT)
 - Analysis
 - * Complex numbers (HMI, § 6.2)
 - * Taylor series (HMI, § 15)
 - * Fourier series (HMIII, § 7)
 - Linear algebra:
 - * vectors (HMI, § 3)
 - * matrices and determinants (HMI, § 5)
 - * eigenvalue analysis (HMI, § 6)

- Integral calculus:
 - * Riemann integrals (HMII, § 1-2)
 - * numerical integration (HMII, § 3)
- Differential equations:
 - * ODEs (HMIII, § 1-6,8)
 - * PDEs (HMIII, § 10)
- **Fundamentals of numerical mathematics:**
 - Finite-precision arithmetic, rounding, basic algorithms, ...
- **Basic programming skills:**
 - Previous knowledge of MATLAB or similar numerical/scientific software.

6 Exam

Written exam, duration 90 minutes, no calculator or written notes allowed. Next exam date is:

February 27, 2026.

Please register before the end of the lecture period (February 20, 2026). If not possible online, this must be done by contacting the secretariate ([A. Fels](#), angelika.fels@kit.edu).

7 Contents & Planning

week #	Lecture		date	Problem session		
	topic			date	assignment	
44	L1	General introduction to NFM	27.10.	—	29.10.	—
45	L2	Conservation laws	03.11.	T1	05.11.	E1
46	L3	Equation types	10.11.	T2	12.11.	E2-part1
47	L4		17.11.	T3	19.11.	E2-part2
48	L5	Finite difference method	24.11.	T4	26.11.	E3-part1
49	L6		01.12.	T5	03.12.	E3-part2
50	L7	Finite volume method	08.12.	T6	10.12.	E4-part1
51	L8		15.12.	T7	17.12.	E4-part2
2	—		05.01.	—	07.01.	
3	L9	Numerical stability	12.01.	T8	14.01.	E5
4	L10		19.01.	T9	21.01.	”
5	L11	Temporal integration	26.01.	T10	28.01.	E6
6	L12		02.02.	T11	04.02.	”
7	L13	Linear algebra	09.02.	T12	11.02.	E7
8	L14		16.02.	T13	18.02.	”
9	Exam: February 27, 2026					

8 Other resources

- MATLAB campus license: <https://www.scc.kit.edu/en/products/matlab.php>
- If possible, please **bring your own laptop** to the problem sessions.

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] U.M. Ascher and C. Greif. *A first course on numerical methods*. SIAM, 2011.
- [8] P.K. Kundu and I.M. Cohen. *Fluid mechanics*. Academic Press, 2nd edition, 2002.