1 Time and location

	Lecture	**Problem session**
Time:	Wednesday 11:30–13:00 h	Monday 14–15:30 h
Location:	HS 93, bldg. 10.81	HS 62, bldg. 10.81
Start date:	October 29, 2025	November 10, 2025

2 Contact

	M. Uhlmann	**H. Herlina**
Consultation:	by appointment	by appointment
Phone:	0721-608 47245	0721-608 46668
Email:	`markus.uhlmann@kit.edu`	`herlina@kit.edu`

3 Aim and scope of the course

- Introduction to computational approaches for turbulent flows: DNS, LES, RANS
- Detailed analysis of the Reynolds-averaged (RANS) approach
- Introduction to large-eddy simulation (LES)
- Discussion of subgrid-scale models for LES
- Discussion of applicability and limitations of RANS and LES models

4 Supporting material

Please register with the E-learning system ILIAS under the following URL:
`https://ilias.studium.kit.edu/goto.php?target=crs_2771975`
There you will find the slides as well as accompanying exercises and add. material for download.

5 Prerequisites

- Advanced fluid mechanics
- Mathematics (PDEs, statistics, Fourier analysis)
- Having participated in the course "Fluid mechanics of turbulent flows" (VNr. 6221806)
- Numerical methods & programming skills (e.g. using Matlab)

6 Exam

Oral exam, 45 minutes. Next exam date: **March 2, 2026**. Please register before the end of the lecture period (by **February 20, 2026**). If not possible online, this must be done by contacting the secretariate (A. Fels).

7 Contents & Planning

7.1 Lecture

week #	date	lecture #	topic	
44	29.10.	V1	Introduction	
45	05.11.	V2	DNS – an overview	(DNS)
46	12.11.	V3	Introduction to RANS	(RANS)
47	19.11.	V4	Eddy viscosity models I	(RANS)
48	26.11.	V5	Eddy viscosity models II	(RANS)
49	03.12.	V6	Reynolds stress transport models I	(RANS)
50	10.12.	V7	Reynolds stress transport models II	(RANS)
51	17.12.	V8	Boundary conditions	(RANS)
2	(07.01.)	V9	(buffer date)	(RANS)
3	14.01.	V10	Algebraic stress models	(RANS)
4	21.01.	V11	Introduction to LES	(LES)
5	28.01.	V12	LES equations	(LES)
6	04.02.	V13	Subgrid-scale modelling	(LES)
7	(11.02.)	V14	(buffer date)	(LES)
8	18.02.	V15	Recap	
	March 2, 2026		**oral exams**	

7.2 Problem sessions

week #	date	problem #	topic	
44	~~27.10.~~	–		
45	~~04.11.~~	–		
46	10.11.	E1	Analysis of channel flow data	(DNS)
47	17.11.	E2	Channel flow: algebraic modelling	(RANS)
48	24.11.	E3	Channel flow: one-equation modelling	(RANS)
49	01.12.	E4	Homogeneous shear: k-ε model realizability	(RANS)
50	08.12.	E5	Stagnation point flow: k-ε model realizability	(RANS)
51	15.12.	E6	Homogeneous shear: a priori test of pressure-strain models	(RANS)
2	~~05.01.~~	—		
3	12.01.	E7	Channel flow: a priori test of pressure-strain models	(RANS)
4	19.01.	E8	Channel flow: k-ε model & wall functions	(RANS)
5	26.01.	E9	Complex flows & RANS	(LES)
6	02.02.	E10	Channel flow: filtering	(LES)
7	09.02.	E11	Channel flow: a priori model test	(LES)
8	16.02.	E12	Channel flow: a posteriori model test	(LES)
			(alternatively: Flow around a walking person)	

References

[1] S.B. Pope. *Turbulent flows*. Cambridge University Press, 2000.
[2] P.A. Durbin and P.A. Petterson Reif. *Statistical theory and modeling for turbulent flows*. Wiley, 2001.
[3] D.C. Wilcox. *Turbulence Modeling for CFD*. DCW Industries, second edition, 1998.
[4] J. Fröhlich. *Large Eddy Simulation turbulenter Strömungen*. Teubner, 2006.
[5] W. Rodi, G. Constantinescu, and T. Stoesser. *Large-Eddy Simulation in Hydraulics*. IAHR Monographs. CRC Press, 2013.