

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 23, 2024	November 4, 2024

2 Contact

	M. Uhlmann	H. Herlina
Consultation:	by appointment	by appointment
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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_2489423

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: **February 24, 2025**. Please register before the end of the lecture period (by **February 14, 2025**). If not possible online, this must be done by contacting the secretariate ([A. Fels](#)).

7 Contents & Planning

7.1 Lecture

week #	date	lecture #	topic	
43	23.10.	V1	Introduction	
44	30.10.	V2	DNS – an overview	(DNS)
45	06.11.	V3	Introduction to RANS	(RANS)
46	13.11.	V4	Eddy viscosity models I	(RANS)
47	20.11.	V5	Eddy viscosity models II	(RANS)
48	27.11.	V6	Reynolds stress transport models I	(RANS)
49	04.12.	V7	Reynolds stress transport models II	(RANS)
50	11.12.	V8	Boundary conditions	(RANS)
51	18.12.	V9	Algebraic stress models	(RANS)
2	08.01.	V10	(buffer date)	(RANS)
3	15.01.	V11	Introduction to LES	(LES)
4	22.01.	V12	LES equations	(LES)
5	29.01.	V13	Subgrid-scale modelling	(LES)
6	05.02.	V14	(buffer date)	(LES)
7	12.02.	V15	Recap	
9	February 24, 2025		oral exams	

7.2 Problem sessions

week #	date	problem #	topic	
43	21.10.	–		
44	28.10.	–		
45	04.11.	E1	Analysis of channel flow data	(DNS)
46	11.11.	E2	Channel flow: algebraic modelling	(RANS)
47	18.11.	E3	Channel flow: one-equation modelling	(RANS)
48	25.11.	E4	Homogeneous shear: k - ε model realizability	(RANS)
49	02.12.	E5	Stagnation point flow: k - ε model realizability	(RANS)
50	09.12.	E6	Homogeneous shear: a priori test of pressure-strain models	(RANS)
51	16.12.	E7	Channel flow: a priori test of pressure-strain models	(RANS)
2	06.01.	—		
3	13.01.	E8	Channel flow: k - ε model & wall functions	(RANS)
4	20.01.	E9	Complex flows & RANS	(LES)
5	27.01.	E10	Channel flow: filtering	(LES)
6	03.02.	E11	Channel flow: a priori model test	(LES)
7	10.02.	E12	Channel flow: a posteriori model test (alternatively: Flow around a walking person)	(LES)

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.