Course Catalog

Summer term 2025

KARLSRUHE INSTITUTE FOR TECHNOLOGY

Table Of Contents

1. KIT Department of Mathematics

1.1. Courses and Seminars of the International Program

0163700
4 SWS

Spectral Theory

Lecture (V)
Reichel, Wolfgang

Mon 09:45-11:15 20.30 SR 3.061 from 04/28 until 07/28
Fri 09:45-11:15 20.30 Seminarraum -1.025 (UG) from 04/25 until 08/01

Content

After participation, students understand the concepts of spectrum and resolvent of closed operators on Banach spaces. They will know their basic properties and are able to explain them in simple examples. They can explain and justify the special features of compact operators and the Fredholm Alternative and deduce algebraic identities and norm bounds for operators by means of the Dunford functional calculus and the spectral calculus for self-adjoint operators. This in particular includes spectral projections and spectral mapping theorems. Students are able to apply this general theory to integral and differential equations, and recognize the importance of spectral theoretic methods in Analysis.

Content

- Closed operators on Banach spaces,
- Spectrum and resolvent,
- Compact operators and Fredholm alternative,
- Dunford functional calculus, spectral projections,
- Fourier transform,
- Unbounded self-adjoint operators on Hilbert spaces,
- Spectral theorem,
- Sesquilinear forms and sectorial operators,
- Applications to partial differential equation

Literature

- H.W. Alt: Lineare Funktionalanalysis.
- H. Brezis: Functional Analysis, Sobolev Spaces and Partial Differential Equations.
- J.B. Conway: A Course in Functional Analysis.
- N. Dunford, J.T. Schwartz: Linear Operators, Part I.
- T. Kato: Perturbation Theory of Linear Operators.
- B. Simon: Operator Theory. A Comprehensive Course in Analysis, Part 4.
- A.E. Taylor, D.C. Lay: Introduction to Functional Analysis.
- D. Werner: Funktionalanalysis.

0163710
2 SWS

Tutorial for 0163700 (Spectral Theory)

Practice (Ü)
Reichel, Wolfgang

Wed 15:45-17:15 20.30 SR 2.066 from 04/23 until 07/30

0161150
4 SWS
English

Sobolev spaces

Lecture (V)
Schnaubelt, Roland

Tue 09:45-11:15 20.30 SR 2.067 from 04/22 until 07/29
Wed 11:30-13:00 20.30 SR 2.059 from 04/23 until 07/30

Content

The modern theory of partial differential equations works in L^p spaces to a large extent. One reason is that the energy of systems often involves L^2 norms, and also L^p norms in many nonlinear cases. However, the classical pointwise definition of derivatives does not fit well to L^p spaces. This problem has been solved by introducing weak derivatives and Sobolev spaces, which contain L^p-functions possessing weak derivatives in L^p. This theory has become one of the core parts of analysis and its applications.

In the lecture we discuss these objects in a systematic way, also giving complete proofs. Besides basic properties such as product estimates, we treat the main theorems on density, extension to R^n, embeddings, boundary traces, and duality. Moreover, we study the Helmholtz decomposition which expresses range and kernel of the curl and gradient operators. The theory will be applied to problems from partial differential equations at several points.

The lectures requires knowledge in functional analysis. If necessary, background material on partial differential equations will be briefly introduced.

0161160
2 SWS

Tutorial for 0161150 (Sobolev spaces)
Fri 11:30-13:00 20.30 Seminarraum 0.019 from 04/25 until 08/01

Practice (Ü)
Schnaubelt, Roland

0156970
4 SWS

Scattering Theory
Mon 15:45-17:15 20.30 SR 3.069 from 04/28 until 07/28
Tue 11:30-13:00 20.30 SR 3.069 from 04/22 until 07/29

Lecture (V)
Griesmaier, Roland

Content

The subject of this lecture is **time-harmonic scattering problems** for acoustic, electromagnetic or elastic waves, which can be modeled using the scalar **Helmholtz equation**. To this end, we consider incident waves, which are solutions to the homogeneous Helmholtz equation, and model scattering objects using a contrast in the refractive index that is non-zero only within the scattering object. We also allow a possible source term. The scattering problem now consists of finding a solution to the resulting inhomogeneous Helmholtz equation in unbounded three-dimensional space, so that the difference between this solution and the incident wave -- the scattered field -- satisfies a suitable radiation condition.

We first deal with the solvability of the **direct problem**.

- Here the refractive index, as well as the incident field and the source term are given. The goal is to determine the scattered field. In particular, we investigate the existence and uniqueness of solutions in a suitable **solution space**.

We then consider two inverse problems.

- In the inverse source problem, the incident field is given and the contrast in the refractive index is supposed to be zero. The source term is to be reconstructed from given observations of the scattered field.
- In the inverse scattering problem, on the other hand, no sources are present. Using given incident fields and observations of the associated scattered fields, we would like to reconstruct the refractive index or the support of the scattering object.

0156980
2 SWS

Tutorial for 0156970 (Scattering Theory)
Fri 08:00-09:30 20.30 SR 3.061 from 04/25 until 08/01

Practice (Ü)
Griesmaier, Roland

0160400
4 SWS
English

Topics in Numerical Linear Algebra
Mon 14:00-15:30 20.30 SR 3.061 from 04/28 until 07/28
Fri 11:30-13:00 20.30 SR 3.061 from 04/25 until 08/01

Lecture (V)
Neher, Markus

Content

At the end of the course, students possess informed knowledge of methods and concepts of numerical linear algebra for large matrices. For various applications, they choose and implement the right numerical methods and they are able to assess and establish convergence properties of these methods. Students are able to solve problems in a self-organized and reflective manner, and to present and discuss solutions.

- Direct methods for sparse linear systems
- Krylov subspace methods for large linear systems and eigenvalue problems
- Matrix functions

0160410
2 SWS
English

Tutorial for 0160400 (Topics in Numerical Linear Algebra)
Wed 15:45-17:15 20.30 SR 2.059 from 04/23 until 07/30

Practice (Ü)
Neher, Markus

Content

At the end of the course, students possess informed knowledge of methods and concepts of numerical linear algebra for large matrices. For various applications, they choose and implement the right numerical methods and they are able to assess and establish convergence properties of these methods. Students are able to solve problems in a self-organized and reflective manner, and to present and discuss solutions.

- Direct methods for sparse linear systems
- Krylov subspace methods for large linear systems and eigenvalue problems
- Matrix functions

0165700 **Analytical and Numerical Homogenization** **Lecture (V)**
3 SWS Wed 09:45-11:15 20.30 Seminarraum -1.012 (UG) from 04/23 until 07/30 Maier, Roland

Content

The objective of this lecture is to give an introduction to multiscale problems and (some) analytical and numerical homogenization techniques. Since a lot of research work has been dedicated to the field in recent years, not all aspects can be covered within this lecture. Nevertheless, the goal is to become familiar with general questions and ideas in the field of (elliptic) multiscale problems and corresponding methods. Specifically, we will cover

- a one-dimensional introduction to the overall questions and problems related to multiscale problems and homogenization
- general concepts of convergence
- the Heterogeneous Multiscale Method
- the Localized Orthogonal Decomposition method

Some (basic) knowledge on finite element methods and functional analysis is helpful for the lecture but not required.

0165710 **Tutorial for 0165700 (Analytical and Numerical Homogenization)** **Practice (Ü)**
1 SWS Mon 11:30-13:00 20.30 Seminarraum -1.025 (UG) from 04/28 until 07/28 Maier, Roland

0160800 **Splitting methods for evolution equations** **Lecture (V)**
3 SWS 🗣 On-Site Jahnke, Tobias
English Thu 15:45-17:15 20.30 SR 2.066 from 04/24 until 07/31

Content

Splitting methods are a very popular class of time integrators for solving ordinary or partial differential equations numerically. The underlying idea is to decompose the differential equation into two or more subproblems which can be solved more efficiently than the full problem, and to construct an approximation of the full problem by a suitable composition of the flows of the subproblems.

After a short introduction to splitting methods for ordinary differential equations, the lecture will focus on splitting methods for partial differential equations such as, e.g., linear and nonlinear Schrödinger-type equations and parabolic problems. Special attention will be given to the convergence analysis, in particular to the relation between the order of convergence and the regularity of the data.
This will require some results from semigroup theory, which will be provided in the lecture.

Prerequisites:

Students are expected to be familiar with ordinary differential equations and Runge-Kutta methods (construction, order, stability).

0160810 **Tutorial for 0160800(Splitting Methods for Evolution Equations)** **Practice (Ü)**
1 SWS Wed 08:00-09:30 20.30 SR 3.068 from 04/23 until 07/30 Jahnke, Tobias

0159610 **Adaptive Finite Elemente Methods** **Lecture (V)**
4 SWS Mon 09:45-11:15 20.30 SR 2.059 from 04/28 until 07/28 Dörfler, Willy
Thu 11:30-13:00 20.30 SR 2.058 from 04/24 until 07/31

0159620 **Tutorial for 0159610 (adaptive Finite Elemente Methods)** **Practice (Ü)**
2 SWS Tue 15:45-17:15 20.30 SR 2.066 from 04/22 until 07/29 Dörfler, Willy

0164400
2 SWS
English

Uncertainty Quantification

Lecture (V)
Frank, Martin

Organizational topics

The course will be offered in flipped classroom format. This means that the lectures will be made available as videos; students will also have lecture notes. We meet in presence for the tutorials, and there will also be office hours.

Content

"There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – there are things we do not know we don't know." (Donald Rumsfeld)

In this class, we learn to deal with the known unknowns, a field called Un- certainty Quantification (UQ). We particularly focus on the propagation of uncertainties (e.g. unknown data, unknown initial or boundary conditions) through models (mostly differential equations) and leave other important questions of UQ (especially inference) aside. Given uncertain input, how un- certain is the output? The uncertainties are modeled as random variables, and thus the solutions of the equations become random variables themselves.

Thus we summarize the necessary foundations of probability theory, with a focus on modeling correlated and uncorrelated random vectors. Further- more, we will see that every uncertain parameter becomes a dimension in the problem. We are thus quickly led to high-dimensional problems. Standard numerical methods suffer from the so-called curse of dimensionality, i.e. to reach a certain accuracy one needs excessively many model evaluations. Thus we study the fundamentals of approximation theory.

The first part of the course ("how to do it") gives an overview on techniques that are used. Among these are:

- Sensitivity analysis
- Monte-Carlo methods
- Spectral expansions
- Stochastic Galerkin method
- Collocation methods, sparse grids

The second part of the course ("why to do it like this") deals with the theoretical foundations of these methods. The so-called "curse of dimensionality" leads us to questions from approximation theory. We look back at the very standard numerical algorithms of interpolation and quadrature, and ask how they perform in many dimensions.

Literature

- R.C. Smith: Uncertainty Quantification: Theory, Implementation, and Applications, SIAM, 2014.
- T.J. Sullivan: Introduction to Uncertainty Quantification, Springer-Verlag, 2015.
- D. Xiu: Numerical Methods for Stochastic Computations, Princeton University Press, 2010.
- O.P. Le Maître, O.M. Knio: Spectral Methods for Uncertainty Quantification, Springer-Verlag, 2010.
- R. Ghanem, D. Higdon, H. Owhadi:Handbook of Uncertainty Quantification, Springer-Verlag, 2017.

0164410
1 SWS
English

Tutorial for 0164400 (Uncertainty quantification)

Practice (Ü)
Frank, Martin

Fri 14:00-15:30 20.30 SR 2.058 from 04/25 until 08/01

Organizational topics

The course will be offered in flipped classroom format. This means that the lectures will be made available as videos; students will also have lecture notes. We meet in presence for the tutorials, and there will also be office hours.

0163800
2 SWS

Bayesian Inverse Problems with Connections to Machine Learning
Mon 14:00-15:30 20.30 Seminarraum 0.016 from 04/28 until 07/28

Lecture (V)
Krumscheid, Sebastian

Content

The course offers an introduction to the subject of statistical inversion, where, in its most basic form, the goal is to study how to estimate model parameters from data. We will introduce mathematical concepts and computational tools for systematically treating these inverse problems in a Bayesian framework, including an assessment of how uncertainties affect the solution. In the first part of the course, we will study the Bayesian framework for finite-dimensional inverse problems. While the first part will introduce some machine-learning ideas, the second part will address how machine learning is impacting, and has the potential to impact further on, the subject of inverse problems. In the final part of the course, we will generalize the Bayesian inverse problem theory to a Banach space setting and discuss sampling strategies for accessing the Bayesian posterior.

Topics covered include:
- Bayesian Inverse Problems and Well-Posedness
- The Linear-Gaussian Setting
- Optimization Perspective on Bayesian Inverse Problems
- Gaussian Approximation
- Markov Chain Monte Carlo
- Blending Inverse Problems and Machine-Learning
- Bayesian Inversion in Banach spaces (if time permits)

0163810
1 SWS

Tutorial for 0163800 (Bayesian Inverse Problems with Connections to Machine Learning)
Tue 15:45-17:15 20.30 Seminarraum 0.016 from 04/22 until 07/29

Practice (Ü)
Krumscheid, Sebastian

0159400
4 SWS

Continuous Time Finance
Tue 09:45-11:15 20.30 Seminarraum 0.019 from 04/22 until 07/29
Wed 08:00-09:30 20.30 Seminarraum 0.014 from 04/23 until 07/30

Lecture (V)
Fasen-Hartmann, Vicky

Content

The lecture covers central topics in continuous-time finance. The first part of the course is an introduction to stochastic analysis. First, we introduce Brownian motion and important topics in the theory of martingales. We then develop the stochastic integral and describe its importance in finance. The second part of the course focuses on the analysis of the Black-Scholes model where the asset process is modelled by a geometric Brownian motion. In this market we price and hedge options. We derive the first and second fundamental theorems of asset pricing, which describe the relationships between arbitrage freedom, equivalent martingale measures and completeness. Finally, we study portfolio optimisation problems and term structure models.

Topics:

- Stochastic processes
- Total variation and quadratic variation
- Ito integral
- Black-Scholes model
- Bonds, futures, term structure models

0159410
2 SWS

Tutorial for 0159400 (Continuous Time Finance)
Thu 14:00-15:30 20.30 Seminarraum -1.012 (UG) from 04/24 until 07/31

Practice (Ü)
Fasen-Hartmann, Vicky

0165650
4 SWS
Statistical Learning
Mon 09:45-11:15 20.30 Seminarraum 0.016 from 04/28 until 07/28
Wed 11:30-13:00 20.30 SR 3.068 from 04/23 until 07/30
Lecture (V)
Klar, Bernhard

Content

The term machine learning refers to a toolbox of methods which are able to extract information from a possibly huge amount of data and which have been applied extremely successfully in the last (few) decades. Due to the large datasets that have to be handled, their efficient implementation and application comes with computational and algorithmic challenges. Hence, many important aspects of machine learning are at the heart of computer science. On the other hand the methodological foundation of machine learning builds on mathematical disciplines, in particular, statistics, optimisation and approximation theory. In this lecture we will give a mathematical answer to the question: How and why do machine learning methods work? More precisely, we aim for a rigorous and mathematical analysis of some of these celebrated methods. Our focus is on statistical aspects.

0165660
2 SWS
Tutorial for 0165650 (Statistical Learning)
Fri 08:00-09:30 20.30 SR 2.058 from 04/25 until 08/01
Practice (Ü)
Klar, Bernhard

0161100
2 SWS
English
Time Series Analysis
Wed 09:45-11:15 20.30 SR 2.059 from 04/23 until 07/30
Lecture (V)
Fasen-Hartmann, Vicky

Content

A time series is a sequence of data sequentially observed in time. This course provides an introduction to the theory and practice of statistical time series analysis. The content is as follows:

- Stationary time series
- Trends and seasonality
- Autocorrelation
- Autoregressive models
- ARMA models
- Parameter estimation
- Forecasting
- Spectral density and periodogram

0161110
1 SWS
Tutorial for 0161100 (Time Series Analysis)
Thu 08:00-09:30 20.30 SR 2.058 from 04/24 until 07/31
Practice (Ü)
Fasen-Hartmann, Vicky

0152600
4 SWS
Stochastic Geometry
Tue 11:30-13:00 20.30 SR 2.058 from 04/22 until 07/29
Thu 15:45-17:15 20.30 SR 2.067 from 04/24 until 07/31
Lecture (V)
Hug, Daniel

Content

For some idea what this course is about see

https://www.math.kit.edu/stoch/seite/raeumstoch-lehre/en

Competence Goals:

The students know the fundamental geometric models and characteristics in stochastic geometry, are familiar with properties of Poisson processes of geometric objects, know examples of applications of models of stochastic geometry, know how to work self-organised and self-reflexive.

Content:

- Random Sets
- Geometric Point Processes
- Stationarity and Isotropy
- Germ Grain Models
- Boolean Models
- Foundations of Integral Geometry
- Geometric densities and characteristics
- Random Tessellations

Literature

Lecture Notes will be provided.

0152610
2 SWS
Tutorial for 0152600 (Stochastic Geometry)
Mon 15:45-17:15 20.30 SR 2.066 from 04/28 until 07/28
Practice (Ü)
Hug, Daniel

0178000
2 SWS
English

Forecasting: Theory and Practice II
Lecture (V)
Gneiting, Tilmann
Tue 14:00-15:30 20.30 Seminarraum 0.016 from 04/22 until 07/29

Content

A common desire of all humankind is to make predictions for thefuture. As the future is inherently uncertain, forecasts ought to be probabilistic, i.e., they ought to take the form of probability distributions over future quantities or events. In this class, which is Part I of a two semester series, we will study the probabilistic and statistical foundations of the science of forecasting.

The goal in probabilistic forecasting is to maximize the sharpness of the predictive distributions subject to calibration, based on the information set at hand. Proper scoring rules such as the logarithmic score and the continuous ranked probability score serve to assess calibration and sharpness simultaneously, and relate to information theory and convex analysis. As a special case, consistent scoring functions provide decision-theoretically coherent tools for evaluating point forecasts. Throughout, concepts and methodologies will be illustrated in data examples and case studies.

0178010
1 SWS

Tutorial for 0178010 (Forecasting: Theory and Practice II)
Practice (Ü)
Gneiting, Tilmann
Fri 14:00-15:30 20.30 SR 2.059 from 04/25 until 08/01

0159900
2 SWS

Markov Decision Processes
Lecture (V)
Bäuerle, Nicole
Thu 09:45-11:15 20.30 Seminarraum -1.011 (UG) from 04/24 until 07/31

Content

Problems often arise in applications where it is necessary to intervene in a stochastic, dynamic system in order to control it optimally. Examples are portfolio optimization problems: how do I allocate and reallocate my money across different investments to maximize my expected benefit? Scheduling problems: in which order should I process waiting jobs to maximize production flow? Or stopping problems: when should I sell a stock or when should I stop on games like 17 and 4? The lecture offers an introduction to the optimal control of discrete-time Markovian processes and their solution theory. Important application examples are also covered.

0159910
2 SWS

Tutorial for 0159900 (Markov Decision Processes)
Practice (Ü)
Bäuerle, Nicole
Wed 14:00-15:30 20.30 SR 2.067 from 04/23 until 07/30

0100300
4 SWS
English

Differential Geometry
Lecture (V)
Lytchak, Alexander
Wed 09:45-11:15 20.30 SR 2.058 from 04/23 until 07/30
Thu 09:45-11:15 20.30 SR 2.066 from 04/24 until 07/31

Content

This course is an introduction to modern differential geometry. Differential geometry is the study of geometry of spaces using analytic and linear algebraic methods. After laying down the foundational definitions and basic properties of *smooth manifolds, tangent vectors,* and *Riemannian metrics*, we will develop notions of *linear connections* and *covariant derivatives* allowing us to do differential calculus on these manifolds. We will continue our journey of understanding the shape of these manifolds by developing concepts of *curvature tensors, geodesics, parallel transport* and *Jacobi fields*. We will also cover the celebrated *Bonnet-Myers* and *Cartan-Hadamard theorems* which show us that curvature conditions on a manifold can to some extent dictate the geometry and topology of the manifold.

0100310
2 SWS
English

Tutorial for 0100300 (Differential Geometry)
Practice (Ü)
Lytchak, Alexander
Mon 14:00-15:30 20.30 SR 2.066 from 04/28 until 07/28

0153300
4 SWS
English

Geometric Group Theory
Thu 14:00-15:30 20.30 SR 2.067 from 04/24 until 07/31
Fri 09:45-11:15 20.30 SR 3.068 from 04/25 until 08/01

Lecture (V)
Link, Gabriele

Content

This course will provide an introduction to geometric group theory, which studies the interactions between finitely generated groups and geometric spaces, creating connections between algebra and geometry. While a priori groups may seem like purely algebraic objects, they can naturally arise as symmetries of geometric objects. For instance, the symmetries of a regular n-gon form a group (the dihedral group D_n). In fact, every finitely generated group admits a natural action by isometries on a metric space, known as its Cayley graph. For instance the Cayley graph of the integers is the real line with vertices given by the integer points and the group action defined by translation.

Studying group actions on geometric spaces, allows us to gain insights into ``the geometry of groups". Conversely, knowing that a geometric space admits an interesting group action allows us to obtain a better understanding of the space itself. Over the last decades, these interactions between group theory and geometry have led to an array of fundamental results in both areas. This course will provide an introduction to these interactions and their consequences.

In particular, we will learn about

- finitely generated groups and group presentations
- Cayley graphs and group actions
- quasi-isometries of metric spaces, quasi-isometry invariants and the Theorem of Schwarz-Milnor
- explicit examples of infinite groups and their connections to geometry

Prerequisites are:

Knowledge of the basic concepts on metric and topological spaces, as well as some familiarity with the basic concepts in group theory are recommended.

0153310
2 SWS
English

Tutorial for 0153300 (Geometric Group Theory)
Mon 11:30-13:00 20.30 SR 3.068 from 04/28 until 07/28

Practice (Ü)
Link, Gabriele

0100018
3 SWS
English

Modern Methods in Combinatorics
Tue 08:00-09:30 20.30 SR 3.068 from 04/22 until 07/29

Lecture (V)
Sagdeev, Arsenii

Content

The course is concerned with modern methods in Combinatorics including probabilistic or algebraic ones. Every presented method is illustrated with several applications.

Competence Goal: The students understand and are able to use powerful modern methods in Combinatorics. The probabilistic part includes the following topics: random graphs, linearity of expectation, second moment method, and Lovasz Local Lemma. The algebraic part includes: polynomial methods, spectral methods, and linear algebraic techniques.

The course is designed for advanced undergraduate students, master students, as well as PhD students of mathematics as well as computer science.

0100020
1 SWS
English

Tutorial for 0100018 (Modern Methods in Combinatorics)
Wed 14:00-15:30 20.30 SR 2.058 from 04/23 until 07/30

Practice (Ü)
Liu, Dingyuan
Sagdeev, Arsenii

Content

The course is concerned with modern methods in Combinatorics including probabilistic or algebraic ones. Every presented method is illustrated with several applications.

Competence Goal: The students understand and are able to use powerful modern methods in Combinatorics. The probabilistic part includes the following topics: random graphs, linearity of expectation, second moment method, and Lovasz Local Lemma. The algebraic part includes: polynomial methods, spectral methods, and linear algebraic techniques.

The course is designed for advanced undergraduate students, master students, as well as PhD students of mathematics as well as computer science.

0100022
3 SWS
English

Topics in Algebraic Topology
Thu 11:30-13:00 20.30 Seminarraum -1.009 (UG) from 04/24 until 07/31

Lecture (V)
Kranhold, Florian

Content
This course introduces several algebraic invariants in order to study topological spaces up to deformation, beyond those covered in the lecture Algebraic Topology. This includes singular cohomology, product structures on cohomology, and homotopy groups. Further topics of this course include Poincaré duality, (co-)fibre sequences, and cellular approximation. We assume familiarity with the content of the lecture Algebraic Topology (basic notions of homotopy and category theory, singular homology, CW complexes, cellular homology and homological algebra).

0100025
1 SWS

Tutorial for 0100022 (Topics in Algebraic Topology)
Wed 15:45-17:15 20.30 SR 3.069 from 04/23 until 07/30

Practice (Ü)
Kranhold, Florian

0120700
2 SWS

Seminar (Analysis)
Wed 09:45-11:15 20.30 Seminarraum -1.017 (UG) from 04/23 until 07/30

Seminar (S)
Reichel, Wolfgang

0120750
2 SWS
German/
English

Seminar (Topics in Geometry and Group Theory)
Thu 14:00-15:30 20.30 Seminarraum -1.009 (UG) from 04/24 until 07/31

Seminar (S)
Llosa Isenrich, Claudio

Content
In this seminar we will explore topics in geometry and/or group theory. A detailed description of the topics covered and all relevant organizational information will be published in the seminar announcement later in the winter term 2024/25. Talks can be given in English or German.

0161700
4 SWS
German/
English

Computational Fluid Dynamics and Simulation Lab
Tue 09:45-11:15 20.30 Poolraum -1.031 from 04/22 until 07/29
Fri 09:45-11:15 20.30 Poolraum -1.031 from 04/25 until 08/01

Practical course (P)
Thäter, Gudrun
Krause, Mathias
Simonis, Stephan

Content
The course is held in two parts. The lecture part contains introductions to modeling and simulations, to associated numerical methods, and to associated software and high-performance computer hardware, respectively. The second part is based on supervised group work of the students. Participants work on projects in which modelling, discretization, simulation and evaluation (e.g. visualization) are carried out for specific topics from the catalog. The catalog includes e.g: Diffusion processes, turbulent flows, multiphase flows, reactive flows, particle dynamics, optimal control and optimization under constraints, stabilization methods for advection-dominated transport problems.

At the end of the course, the students are able to jointly model problems beyond their own discipline and simulate them on high-performance computers. They have acquired a critical distance to results and their presentation. They can defend the results of projects in disputes. They have understood the importance of stability, convergence and parallelism of numerical methods from their own experience and are able to evaluate errors in modeling, approximation, computing and presentation.

Basic knowledge of the analysis of boundary value problems and of numerical methods for differential equations is recommended. Knowledge of a programming language is strongly recommened.

Link
https://www.lbrg.kit.edu/page/projsoftpr

0100028
2 SWS

Seminar (Selected Topics on Finite Elements)
Mon 14:00-15:30 20.30 Seminarraum -1.008 (UG) from 04/28 until 07/28

Seminar (S)
Maier, Roland

Content
In this seminar, we cover various different topics in connection with the finite element method. This includes space-time approaches, non-conforming finite elements, modified finite elements, and finite elements for partial differential equations beyond the elliptic setting.

Students that would like to attend the seminar should have some basic knowledge on finite elements (e.g., if they attended the lecture "Finite Element Methods").