Module Handbook
Economathematics M.Sc.

SPO 2016

Summer term 2025

Date: 31/03/2025

KIT DEPARTMENT OF ECONOMICS AND MANAGEMENT / KIT DEPARTMENT OF MATHEMATICS

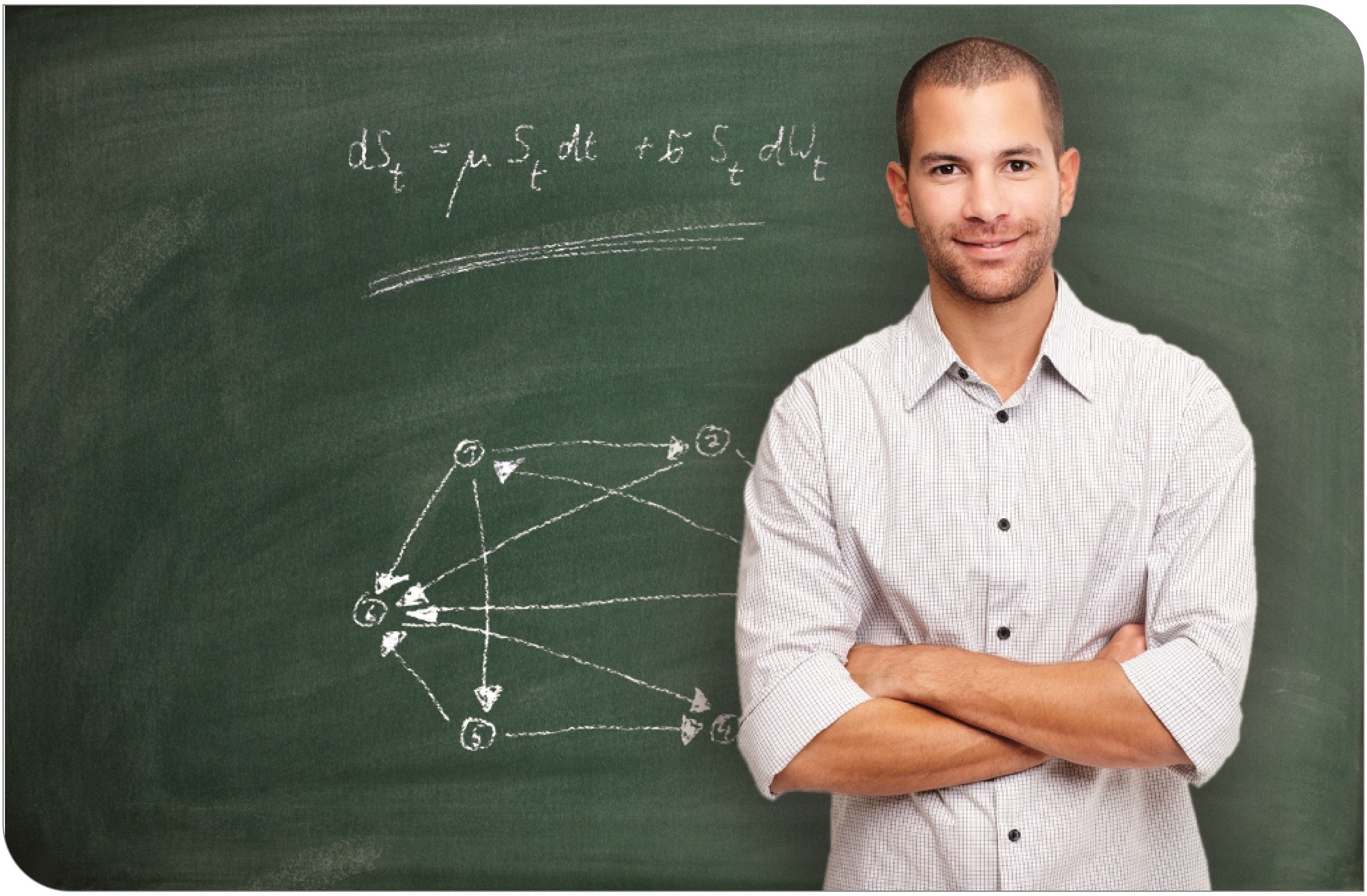

Table Of Contents

1 General information

Welcome to the new module handbook of your study program! We are delighted that you have decided to study at the KIT Department of Economics and Management and wish you a good start into the new semester! In the following we would like to give you a short introduction to the most important terms and rules that are important in connection with the choice of modules, courses and examinations.

1.1 Structural elements

The program exists of several **subjects** (e.g. business administration, economics, operations research). Every subject is split into **modules** and every module itself consists of one or more interrelated **module component exams**. The extent of every module is indicated by credit points (CP), which will be credited after the successful completion of the module. Some of the modules are **obligatory**. According to the interdisciplinary character of the program, a great variety of **individual specialization and deepening possibilities** exists for a large number of modules. This enables the student to customize content and time schedule of the program according to personal needs, interest and job perspective. The **module handbook** describes the modules belonging to the program. It describes particularly:

- the structure of the modules
- the extent (in CP),
- the dependencies of the modules,
- the learning outcomes,
- the assessment and examinations.

The module handbook serves as a necessary orientation and as a helpful guide throughout the studies. The module handbook does not replace the **course catalog**, which provides important information concerning each semester and variable course details (e.g. time and location of the course).

1.2 Begin and completion of a module

Each module and each examination can only be selected once. The decision on the assignment of an examination to a module (if, for example, an examination in several modules is selectable) is made by the student at the moment when he / she is registered for the appropriate examination. A module is completed or passed when the module examination is passed (grade 4.0 or better). For modules in which the module examination is carried out over several partial examinations, the following applies: The module is completed when all necessary module partial examinations have been passed. In the case of modules which offer alternative partial examinations, the module examination is concluded with the examination with which the required total credit points are reached or exceeded. The module grade, however, is combined with the weight of the predefined credit points for the module in the overall grade calculation.

1.3 Module versions

It is not uncommon for modules to be revised due to, for example, new courses or cancelled examinations. As a rule, a new module version is created, which applies to all students who are new to the module. On the other hand, students who have already started the module enjoy confidence and remain in the old module version. These students can complete the module on the same conditions as at the beginning of the module (exceptions are regulated by the examination committee). The date of the student's "`binding declaration"' on the choice of the module in the sense of §5(2) of the Study and Examination Regulation is decisive. This binding declaration is made by registering for the first examination in this module.

In the module handbook, all modules are presented in their current version. The version number is given in the module description. Older module versions can be accessed via the previous module handbooks in the archive at http://www.wiwi.kit.edu/Archiv_MHB.php.

1.4 General and partial examinations

Module examinations can be either taken in a general examination or in partial examinations. If the module examination is offered as a general examination, the entire learning content of the module will be examined in a single examamination. If the module examination is subdivided into partial examinations, the content of each course will be examined in corresponding partial examinations. Registration for examinations can be done online at the campus management portal. The following functions can be accessed on https://campus.studium.kit.edu/:

- Register/unregister for examinations
- Check for examination results
- Create transcript of records

For further and more detailed information, see https://campus.studium.kit.edu/faq.php.

1.5 Types of examinations

Examinations are split into written examinations, oral examinations and alternative exam assessments ("Prüfungsleistungen anderer Art"). Examinations are always graded. Non exam assessments ("Studienleistungen") can be repeated several times and are not graded.

1.6 Repeating examinations

Principally, a failed written exam, oral exam or alternative exam assessment can repeated only once. If the repeat examination (including an eventually provided verbal repeat examination) will be failed as well, the examination claim is lost. A request for a second repetition has to be made in written form to the examination committee two months after loosing the examination claim. For further information see http://www.wiwi.kit.edu/hinweiseZweitwdh.php.

1.7 Examiners

The examination committee has appointed the KIT examiners and lecturers listed in the module handbook for the modules and their courses as examiners for the courses they offer.

1.8 Additional accomplishments

Additional accomplishments are voluntarily taken exams, which have no impact on the overall grade of the student and can take place on the level of single courses or on entire modules. It is also mandatory to declare an additional accomplishment as such at the time of registration for an exam. Additional accomplishments with at most 30 CP may appear additionally in the certificate.

1.9 Further information

For current information about studying at the KIT Department of Economics and Management, please visit our website www.wiwi.kit.edu as well as Instagram, LinkedIn, and YouTube. Please also see current notices and announcements for students at: https://www.wiwi.kit.edu/studium.php.
Information around the legal and official framework of the study program can be found in the respective study and examination regulations of your study program. These are available under the Official Announcements of KIT (http://www.sle.kit.edu/amtlicheBekanntmachungen.php).

More detailed information about the legal and general conditions of the program can be found in the examination regulation of the program (http://www.sle.kit.edu/amtlicheBekanntmachungen.php).

1.10 Contact

If you have any questions about modules or exams with WIWI-ID, please contact the examination office of the KIT Department of Economics and Management:

Ralf Hilser
Anabela Relvas
Telefon +49 721 608-43768
E-Mail: pruefungssekretariat@wiwi.kit.edu

If you have any questions about modules or exams with MATH-ID, please contact at the KIT Department of Mathematics:

Dr. Bernhard Klar
Telefon +49 721 608-42047
E-Mail: Bernhard.Klar@kit.edu

Editorial responsibility:

Dr. André Wiesner
Telefon: +49 721 608-44061
Email: modul@wiwi.kit.edu \

2 Field of study structure

Mandatory	
Master's Thesis	30 CR
Mathematical Methods	36 CR
Finance - Risk Management - Managerial Economics	18 CR
Operations Management - Data Analysis - Informatics	18 CR
Seminar in Economics and Management	3 CR
Mathematical Seminar *This field will not influence the calculated grade of its parent.*	3 CR
Elective Field	12 CR

2.1 Master's Thesis

Credits
30

Mandatory		
M-MATH-102917	Master's Thesis	30 CR

2.2 Mathematical Methods

Credits
36

Stochastics (Election: at least 8 credits)		
M-MATH-102860	Continuous Time Finance	8 CR
M-MATH-102865	Stochastic Geometry	8 CR
M-MATH-102903	Spatial Stochastics	8 CR
M-MATH-102904	Brownian Motion	4 CR
M-MATH-102905	Percolation	5 CR
M-MATH-102906	Generalized Regression Models	4 CR
M-MATH-102907	Markov Decision Processes	5 CR
M-MATH-102908	Stochastic Control	4 CR
M-MATH-102909	Mathematical Statistics	8 CR
M-MATH-102910	Nonparametric Statistics	4 CR
M-MATH-102911	Time Series Analysis	4 CR
M-MATH-102919	Discrete Time Finance	8 CR
M-MATH-102922	Poisson Processes	5 CR
M-MATH-102939	Extreme Value Theory	4 CR
M-MATH-102947	Probability Theory and Combinatorial Optimization	8 CR
M-MATH-102956	Forecasting: Theory and Practice	8 CR
M-MATH-104055	Ruin Theory	4 CR
M-MATH-105101	Introduction to Homogeneous Dynamics	6 CR
M-MATH-105487	Topological Data Analysis	6 CR
M-MATH-105579	Steins Method with Applications in Statistics	4 CR
M-MATH-105649	Fractal Geometry	6 CR
M-MATH-105651	Applications of Topological Data Analysis	4 CR
M-MATH-102864	Convex Geometry	8 CR
M-MATH-105840	Statistical Learning	8 CR
M-MATH-106045	Introduction to Stochastic Differential Equations	4 CR
M-MATH-106052	Random Graphs and Networks	8 CR
M-MATH-106485	Functional Data Analysis	4 CR
Analysis or Applied and Numerical Mathematics, Optimization (Election: at least 8 credits)		
M-MATH-101320	Functional Analysis	8 CR
M-MATH-101768	Spectral Theory	8 CR
M-MATH-102870	Classical Methods for Partial Differential Equations	8 CR
M-MATH-102871	Boundary and Eigenvalue Problems	8 CR
M-MATH-102872	Evolution Equations	8 CR
M-MATH-102874	Integral Equations	8 CR
M-MATH-102878	Complex Analysis	8 CR
M-MATH-102879	Potential Theory	8 CR
M-MATH-102881	Stochastic Differential Equations	8 CR
M-MATH-102883	Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems	8 CR
M-MATH-102885	Maxwell's Equations	8 CR
M-MATH-102890	Inverse Problems	8 CR
M-MATH-102924	Optimization in Banach Spaces	5 CR
M-MATH-102926	Sobolev Spaces	8 CR
M-MATH-102927	Traveling Waves	6 CR
M-MATH-102941	Control Theory	6 CR
M-MATH-103080	Dynamical Systems	8 CR
M-MATH-103259	Bifurcation Theory	5 CR
M-MATH-103539	Nonlinear Analysis	8 CR
M-MATH-102884	Scattering Theory	8 CR
M-MATH-104059	Mathematical Topics in Kinetic Theory	4 CR

M-MATH-104425	Dispersive Equations	6 CR
M-MATH-104435	Selected Topics in Harmonic Analysis	3 CR
M-MATH-101338	Parallel Computing	5 CR
M-MATH-102888	Numerical Methods for Differential Equations	8 CR
M-MATH-102889	Introduction to Scientific Computing	8 CR
M-MATH-102891	Finite Element Methods	8 CR
M-MATH-102892	Numerical Optimisation Methods	8 CR
M-MATH-102894	Numerical Methods in Computational Electrodynamics	6 CR
M-MATH-102895	Wavelets	8 CR
M-MATH-102897	Mathematical Methods in Signal and Image Processing	8 CR
M-MATH-102899	Optimisation and Optimal Control for Differential Equations	4 CR
M-MATH-102900	Adaptive Finite Elemente Methods	8 CR
M-MATH-102901	Numerical Methods in Mathematical Finance	8 CR
M-MATH-102915	Numerical Methods for Hyperbolic Equations	6 CR
M-MATH-102920	Special Topics of Numerical Linear Algebra	8 CR
M-MATH-102921	Geometric Numerical Integration	6 CR
M-MATH-102928	Numerical Methods for Time-Dependent Partial Differential Equations	8 CR
M-MATH-102929	Mathematical Modelling and Simulation in Practise	4 CR
M-MATH-102930	Numerical Methods for Integral Equations	8 CR
M-MATH-102931	Numerical Methods for Maxwell's Equations	6 CR
M-MATH-102932	Numerical Methods in Fluid Mechanics	4 CR
M-MATH-102935	Compressive Sensing	5 CR
M-MATH-102936	Functions of Operators	6 CR
M-MATH-102937	Functions of Matrices	8 CR
M-MATH-106634	Computational Fluid Dynamics and Simulation Lab	4 CR
M-MATH-102943	Introduction into Particulate Flows	3 CR
M-MATH-102955	Advanced Inverse Problems: Nonlinearity and Banach Spaces	5 CR
M-MATH-103260	Mathematical Methods of Imaging	5 CR
M-MATH-103527	Foundations of Continuum Mechanics	4 CR
M-MATH-103700	Exponential Integrators	6 CR
M-MATH-103709	Numerical Linear Algebra for Scientific High Performance Computing	5 CR
M-MATH-103919	Introduction to Kinetic Theory	4 CR
M-MATH-104054	Uncertainty Quantification	4 CR
M-MATH-104058	Numerical Linear Algebra in Image Processing	6 CR
M-MATH-104827	Fourier Analysis and its Applications to PDEs	6 CR
M-MATH-103540	Boundary Element Methods	8 CR
M-MATH-102887	Monotonicity Methods in Analysis	3 CR
M-MATH-105066	Nonlinear Maxwell Equations	8 CR
M-MATH-105101	Introduction to Homogeneous Dynamics	6 CR
M-MATH-105093	Variational Methods	8 CR
M-MATH-105324	Harmonic Analysis	8 CR
M-MATH-105325	Splitting Methods for Evolution Equations	6 CR
M-MATH-105326	Nonlinear Wave Equations	4 CR
M-MATH-105327	Numerical Simulation in Molecular Dynamics	8 CR
M-MATH-105432	Discrete Dynamical Systems	3 CR
M-MATH-105487	Topological Data Analysis	6 CR
M-MATH-105636	Analytical and Numerical Homogenization	6 CR
M-MATH-105650	Introduction to Fluid Dynamics	3 CR
M-MATH-105651	Applications of Topological Data Analysis	4 CR
M-MATH-105764	Numerical Analysis of Helmholtz Problems	3 CR

M-MATH-105837	Introduction to Kinetic Equations	3 CR
M-MATH-105838	Introduction to Microlocal Analysis	3 CR
M-MATH-105897	Selected Methods in Fluids and Kinetic Equations	3 CR
M-MATH-105964	Introduction to Convex Integration	3 CR
M-MATH-105966	Space and Time Discretization of Nonlinear Wave Equations	6 CR
M-MATH-106053	Stochastic Simulation	5 CR
M-MATH-106063	Numerical Complex Analysis	6 CR
M-MATH-106328	Bayesian Inverse Problems with Connections to Machine Learning	4 CR
M-MATH-106401	Introduction to Fluid Mechanics	6 CR
M-MATH-106486	Harmonic Analysis 2	8 CR
M-MATH-106591	Introduction to Dynamical Systems	6 CR
M-MATH-106640	Modelling and Simulation of Lithium-Ion Batteries	4 CR
M-MATH-106664	Scattering Theory for Time-dependent Waves	6 CR
M-MATH-106667	Geometric Variational Problems	8 CR
M-MATH-106666	Minimal Surfaces	3 CR
M-MATH-106663	Semigroup Theory for the Navier-Stokes Equations	6 CR
M-MATH-106696	Regularity for Elliptic Operators	6 CR
M-MATH-106695	Numerical Analysis of Neural Networks	6 CR
M-MATH-106682	Numerical Methods for Oscillatory Differential Equations	8 CR
M-MATH-106822	Advanced Methods in Nonlinear Partial Differential Equations	3 CR
M-MATH-106836	MathSEE Modeling Week *First usage possible from Oct 01, 2025.*	3 CR
Algebra and Geometry (Election: at most 20 credits)		
M-MATH-101315	Algebra	8 CR
M-MATH-101317	Differential Geometry	8 CR
M-MATH-101336	Graph Theory	8 CR
M-MATH-101724	Algebraic Geometry	8 CR
M-MATH-101725	Algebraic Number Theory	8 CR
M-MATH-102864	Convex Geometry	8 CR
M-MATH-102867	Geometric Group Theory	8 CR
M-MATH-102948	Algebraic Topology	8 CR
M-MATH-102949	Introduction to Geometric Measure Theory	6 CR
M-MATH-102950	Combinatorics	8 CR
M-MATH-102957	Extremal Graph Theory	4 CR
M-MATH-102959	Homotopy Theory	8 CR
M-MATH-102865	Stochastic Geometry	8 CR
M-MATH-102866	Geometry of Schemes	8 CR
M-MATH-102912	Global Differential Geometry	8 CR
M-MATH-102953	Algebraic Topology II	8 CR
M-MATH-102954	Group Actions in Riemannian Geometry	5 CR
M-MATH-104261	Lie Groups and Lie Algebras	8 CR
M-MATH-104349	Bott Periodicity	5 CR
M-MATH-105101	Introduction to Homogeneous Dynamics	6 CR
M-MATH-105463	Structural Graph Theory	4 CR
M-MATH-105487	Topological Data Analysis	6 CR
M-MATH-105649	Fractal Geometry	6 CR
M-MATH-105651	Applications of Topological Data Analysis	4 CR
M-MATH-106950	Lie-Algebras	8 CR
M-MATH-105931	Metric Geometry	8 CR
M-MATH-105973	Translation Surfaces	8 CR
M-MATH-106466	Riemann Surfaces	8 CR

M-MATH-106473	Ergodic Theory	8 CR
M-MATH-106632	Curves on Surfaces	3 CR
M-MATH-106776	Complex Geometry	6 CR
M-MATH-106957	Modern Methods in Combinatorics	6 CR
M-MATH-107017	Topics in Algebraic Topology neu	6 CR

2.3 Finance - Risk Management - Managerial Economics

Credits
18

Finance - Risk Management - Managerial Economics (Election: at least 18 credits)		
M-WIWI-105659	Advanced Machine Learning and Data Science	9 CR
M-WIWI-101637	Analytics and Statistics	9 CR
M-WIWI-101504	Collective Decision Making	9 CR
M-WIWI-105032	Data Science for Finance	9 CR
M-WIWI-101647	Data Science: Evidence-based Marketing	9 CR
M-WIWI-106258	Digital Marketing	9 CR
M-WIWI-103720	eEnergy: Markets, Services and Systems	9 CR
M-WIWI-102970	Decision and Game Theory	9 CR
M-WIWI-101505	Experimental Economics	9 CR
M-WIWI-101482	Finance 1	9 CR
M-WIWI-101483	Finance 2	9 CR
M-WIWI-101480	Finance 3	9 CR
M-WIWI-105894	Foundations for Advanced Financial -Quant and -Machine Learning Research	9 CR
M-WIWI-104068	Information Systems in Organizations	9 CR
M-WIWI-101500	Microeconomic Theory	9 CR
M-WIWI-106660	Modeling the Dynamics of Financial Markets	9 CR
M-WIWI-101502	Economic Theory and its Application in Finance	9 CR
M-WIWI-101638	Econometrics and Statistics I	9 CR
M-WIWI-101639	Econometrics and Statistics II	9 CR
M-WIWI-103119	Advanced Topics in Strategy and Management	9 CR

2.4 Operations Management - Data Analysis - Informatics

Credits
18

Operations Management - Data Analysis - Informatics (Election: at least 18 credits)		
M-WIWI-101413	Applications of Operations Research	9 CR
M-WIWI-101414	Methodical Foundations of OR	9 CR
M-WIWI-101452	Energy Economics and Technology	9 CR
M-WIWI-101472	Informatics	9 CR
M-WIWI-101473	Mathematical Programming	9 CR
M-WIWI-102832	Operations Research in Supply Chain Management	9 CR
M-WIWI-102805	Service Operations	9 CR
M-WIWI-103289	Stochastic Optimization	9 CR
M-WIWI-105312	Marketing and Sales Management	9 CR
M-WIWI-101451	Energy Economics and Energy Markets	9 CR

2.5 Seminar in Economics and Management

Credits
3

Seminar in Economics and Management (Election: at least 3 credits)		
M-WIWI-102971	Seminar	3 CR
M-WIWI-102973	Seminar	3 CR

2.6 Mathematical Seminar

Credits
3

Mandatory		
M-MATH-102730	Seminar	3 CR

2.7 Elective Field

Credits
12

Elective Field (Election: at least 12 credits)		
M-MATH-102864	Convex Geometry	8 CR
M-MATH-102866	Geometry of Schemes	8 CR
M-MATH-102872	Evolution Equations	8 CR
M-MATH-102879	Potential Theory	8 CR
M-MATH-102883	Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems	8 CR
M-MATH-102888	Numerical Methods for Differential Equations	8 CR
M-MATH-102890	Inverse Problems	8 CR
M-MATH-102891	Finite Element Methods	8 CR
M-MATH-102894	Numerical Methods in Computational Electrodynamics	6 CR
M-MATH-102904	Brownian Motion	4 CR
M-MATH-102906	Generalized Regression Models	4 CR
M-MATH-102909	Mathematical Statistics	8 CR
M-MATH-102910	Nonparametric Statistics	4 CR
M-MATH-102924	Optimization in Banach Spaces	5 CR
M-MATH-102927	Traveling Waves	6 CR
M-MATH-102931	Numerical Methods for Maxwell's Equations	6 CR
M-MATH-102936	Functions of Operators	6 CR
M-MATH-101315	Algebra	8 CR
M-MATH-101724	Algebraic Geometry	8 CR
M-MATH-101725	Algebraic Number Theory	8 CR
M-MATH-101768	Spectral Theory	8 CR
M-MATH-102867	Geometric Group Theory	8 CR
M-MATH-102874	Integral Equations	8 CR
M-MATH-102899	Optimisation and Optimal Control for Differential Equations	4 CR
M-MATH-102905	Percolation	5 CR
M-MATH-102915	Numerical Methods for Hyperbolic Equations	6 CR
M-MATH-102947	Probability Theory and Combinatorial Optimization	8 CR
M-MATH-102956	Forecasting: Theory and Practice	8 CR
M-MATH-101317	Differential Geometry	8 CR
M-MATH-101320	Functional Analysis	8 CR
M-MATH-101336	Graph Theory	8 CR
M-MATH-101338	Parallel Computing	5 CR
M-MATH-102860	Continuous Time Finance	8 CR
M-MATH-102878	Complex Analysis	8 CR
M-MATH-102885	Maxwell's Equations	8 CR
M-MATH-102889	Introduction to Scientific Computing	8 CR
M-MATH-102892	Numerical Optimisation Methods	8 CR
M-MATH-102930	Numerical Methods for Integral Equations	8 CR
M-MATH-102941	Control Theory	6 CR
M-MATH-102895	Wavelets	8 CR
M-MATH-102897	Mathematical Methods in Signal and Image Processing	8 CR
M-MATH-102901	Numerical Methods in Mathematical Finance	8 CR
M-MATH-102907	Markov Decision Processes	5 CR
M-MATH-102908	Stochastic Control	4 CR
M-MATH-102911	Time Series Analysis	4 CR
M-MATH-102912	Global Differential Geometry	8 CR
M-MATH-102919	Discrete Time Finance	8 CR
M-MATH-102920	Special Topics of Numerical Linear Algebra	8 CR
M-MATH-102922	Poisson Processes	5 CR

M-MATH-102926	Sobolev Spaces	8 CR
M-MATH-102928	Numerical Methods for Time-Dependent Partial Differential Equations	8 CR
M-MATH-102929	Mathematical Modelling and Simulation in Practise	4 CR
M-MATH-102932	Numerical Methods in Fluid Mechanics	4 CR
M-MATH-102935	Compressive Sensing	5 CR
M-MATH-102937	Functions of Matrices	8 CR
M-MATH-102939	Extreme Value Theory	4 CR
M-MATH-102943	Introduction into Particulate Flows	3 CR
M-MATH-102948	Algebraic Topology	8 CR
M-MATH-102949	Introduction to Geometric Measure Theory	6 CR
M-MATH-102954	Group Actions in Riemannian Geometry	5 CR
M-MATH-102959	Homotopy Theory	8 CR
M-MATH-102865	Stochastic Geometry	8 CR
M-MATH-102870	Classical Methods for Partial Differential Equations	8 CR
M-MATH-102871	Boundary and Eigenvalue Problems	8 CR
M-MATH-102881	Stochastic Differential Equations	8 CR
M-MATH-102900	Adaptive Finite Elemente Methods	8 CR
M-MATH-102903	Spatial Stochastics	8 CR
M-MATH-102921	Geometric Numerical Integration	6 CR
M-MATH-106634	Computational Fluid Dynamics and Simulation Lab	4 CR
M-MATH-102950	Combinatorics	8 CR
M-MATH-102953	Algebraic Topology II	8 CR
M-MATH-102955	Advanced Inverse Problems: Nonlinearity and Banach Spaces	5 CR
M-MATH-102957	Extremal Graph Theory	4 CR
M-WIWI-101413	Applications of Operations Research	9 CR
M-WIWI-101414	Methodical Foundations of OR	9 CR
M-WIWI-101452	Energy Economics and Technology	9 CR
M-WIWI-101472	Informatics	9 CR
M-WIWI-101473	Mathematical Programming	9 CR
M-WIWI-101480	Finance 3	9 CR
M-WIWI-101482	Finance 1	9 CR
M-WIWI-101483	Finance 2	9 CR
M-WIWI-101500	Microeconomic Theory	9 CR
M-WIWI-101502	Economic Theory and its Application in Finance	9 CR
M-WIWI-101504	Collective Decision Making	9 CR
M-WIWI-101505	Experimental Economics	9 CR
M-WIWI-101637	Analytics and Statistics	9 CR
M-WIWI-101638	Econometrics and Statistics I	9 CR
M-WIWI-101639	Econometrics and Statistics II	9 CR
M-WIWI-102832	Operations Research in Supply Chain Management	9 CR
M-WIWI-102970	Decision and Game Theory	9 CR
M-WIWI-102971	Seminar	3 CR
M-WIWI-102972	Seminar	3 CR
M-WIWI-102973	Seminar	3 CR
M-WIWI-102974	Seminar	3 CR
M-MATH-103080	Dynamical Systems	8 CR
M-MATH-103259	Bifurcation Theory	5 CR
M-MATH-103260	Mathematical Methods of Imaging	5 CR
M-WIWI-103289	Stochastic Optimization	9 CR
M-WIWI-103119	Advanced Topics in Strategy and Management	9 CR

M-WIWI-103720	eEnergy: Markets, Services and Systems	9 CR
M-MATH-103527	Foundations of Continuum Mechanics	4 CR
M-MATH-103539	Nonlinear Analysis	8 CR
M-MATH-103700	Exponential Integrators	6 CR
M-MATH-103709	Numerical Linear Algebra for Scientific High Performance Computing	5 CR
M-MATH-103919	Introduction to Kinetic Theory	4 CR
M-WIWI-104068	Information Systems in Organizations	9 CR
M-MATH-104054	Uncertainty Quantification	4 CR
M-MATH-104055	Ruin Theory	4 CR
M-MATH-104058	Numerical Linear Algebra in Image Processing	6 CR
M-MATH-104059	Mathematical Topics in Kinetic Theory	4 CR
M-MATH-102884	Scattering Theory	8 CR
M-MATH-104261	Lie Groups and Lie Algebras	8 CR
M-MATH-104349	Bott Periodicity	5 CR
M-MATH-104425	Dispersive Equations	6 CR
M-MATH-104435	Selected Topics in Harmonic Analysis	3 CR
M-MATH-104827	Fourier Analysis and its Applications to PDEs	6 CR
M-MATH-103540	Boundary Element Methods	8 CR
M-MATH-102887	Monotonicity Methods in Analysis	3 CR
M-MATH-105066	Nonlinear Maxwell Equations	8 CR
M-MATH-105101	Introduction to Homogeneous Dynamics	6 CR
M-MATH-105093	Variational Methods	8 CR
M-WIWI-105312	Marketing and Sales Management	9 CR
M-MATH-105324	Harmonic Analysis	8 CR
M-MATH-105325	Splitting Methods for Evolution Equations	6 CR
M-MATH-105326	Nonlinear Wave Equations	4 CR
M-MATH-105327	Numerical Simulation in Molecular Dynamics	8 CR
M-MATH-105432	Discrete Dynamical Systems	3 CR
M-MATH-105463	Structural Graph Theory	4 CR
M-MATH-105487	Topological Data Analysis	6 CR
M-MATH-105579	Steins Method with Applications in Statistics	4 CR
M-MATH-105636	Analytical and Numerical Homogenization	6 CR
M-MATH-105649	Fractal Geometry	6 CR
M-MATH-105650	Introduction to Fluid Dynamics	3 CR
M-MATH-105651	Applications of Topological Data Analysis	4 CR
M-MATH-105764	Numerical Analysis of Helmholtz Problems	3 CR
M-MATH-105837	Introduction to Kinetic Equations	3 CR
M-MATH-105838	Introduction to Microlocal Analysis	3 CR
M-MATH-106950	Lie-Algebras	8 CR
M-MATH-105840	Statistical Learning	8 CR
M-MATH-105897	Selected Methods in Fluids and Kinetic Equations	3 CR
M-MATH-105931	Metric Geometry	8 CR
M-MATH-105964	Introduction to Convex Integration	3 CR
M-MATH-105966	Space and Time Discretization of Nonlinear Wave Equations	6 CR
M-MATH-105973	Translation Surfaces	8 CR
M-MATH-106045	Introduction to Stochastic Differential Equations	4 CR
M-MATH-106052	Random Graphs and Networks	8 CR
M-MATH-106053	Stochastic Simulation	5 CR
M-MATH-106063	Numerical Complex Analysis	6 CR
M-MATH-106328	Bayesian Inverse Problems with Connections to Machine Learning	4 CR

M-MATH-106401	Introduction to Fluid Mechanics	6 CR
M-MATH-106466	Riemann Surfaces	8 CR
M-MATH-106473	Ergodic Theory	8 CR
M-MATH-106485	Functional Data Analysis	4 CR
M-MATH-106486	Harmonic Analysis 2	8 CR
M-MATH-106591	Introduction to Dynamical Systems	6 CR
M-MATH-106632	Curves on Surfaces	3 CR
M-MATH-106640	Modelling and Simulation of Lithium-Ion Batteries	4 CR
M-MATH-106664	Scattering Theory for Time-dependent Waves	6 CR
M-MATH-106667	Geometric Variational Problems	8 CR
M-MATH-106666	Minimal Surfaces	3 CR
M-MATH-106663	Semigroup Theory for the Navier-Stokes Equations	6 CR
M-MATH-106696	Regularity for Elliptic Operators	6 CR
M-MATH-106695	Numerical Analysis of Neural Networks	6 CR
M-MATH-106682	Numerical Methods for Oscillatory Differential Equations	8 CR
M-MATH-106776	Complex Geometry	6 CR
M-MATH-106822	Advanced Methods in Nonlinear Partial Differential Equations	3 CR
M-WIWI-101647	Data Science: Evidence-based Marketing	9 CR
M-MATH-106957	Modern Methods in Combinatorics	6 CR
M-MATH-107017	Topics in Algebraic Topology neu	6 CR
M-MATH-106836	MathSEE Modeling Week *First usage possible from Oct 01, 2025.*	3 CR

3 Modules

M 3.1 Module: Adaptive Finite Elemente Methods [M-MATH-102900]

Responsible: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	2

Mandatory			
T-MATH-105898	Adaptive Finite Element Methods	8 CR	Dörfler

Competence Certificate
oral exam of ca. 30 minutes

Prerequisites
none

Competence Goal
Participants

- know the necessity for using adaptive methods
- are able to explain the basic methods, techniques and algorithms for the treatment of elliptic boundary value problems with adaptive finite element methods
- can describe different approaches for error estimation
- are able to solve simple initial boundary value problems numerically

Content

- necessity of adaptive methods
- residual error estimator
- aspects of implementions
- optimality of adaptive methods
- functional error estimator
- hp-Finite Elements
- adaptivity for time-dependent problems

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research on the course content
- preparation for the module examination

Recommendation
Basic knowledge in finite element methods, in programming and analysis of boundary value problems is strongly recommended. Knowledge in functional analysis is recommended.

M 3.2 Module: Advanced Inverse Problems: Nonlinearity and Banach Spaces [M-MATH-102955]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	5	1

Mandatory			
T-MATH-105927	Advanced Inverse Problems: Nonlinearity and Banach Spaces	5 CR	Rieder

Competence Certificate
Success is assessed in the form of an oral examination lasting approx. 30 minutes.

Prerequisites
none

Competence Goal
Graduates are familiar with regularization methods for nonlinear ill-posed problems in Hilbert and Banach spaces and can discuss the underlying analytical and numerical aspects. They are also able to explain the conceptual differences between regularization methods in
Hilbert and Banach spaces.

Content
Inexact Newton methods in Hilbert spaces,

Approximate Inverse in Banach spaces

Tikhonov regularization with convex penalty

Kaczmarz-Newton methods in Banach spaces

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
Inverse problems, Functional analysis

3.3 Module: Advanced Machine Learning and Data Science [M-WIWI-105659]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	English	4	3

Mandatory			
T-WIWI-111305	Advanced Machine Learning and Data Science	9 CR	Ulrich

Competence Certificate
The assessment is carried out in an alternative form.The final grade is evaluated based on the intermediate presentations during the project, the quality of the implementation, the final written thesis and a final presentation.

Prerequisites
None

Competence Goal
After a successful project, the students can:

- select and apply modern machine learning methods to solve a data science problem;
- organize themselves in a team in a goal-oriented manner and bring an extensive software project in the field of data science and machine learning to success;
- deepen their data science and machine learning skills
- solve a finance problem with the help of data science and machine learning algorithm.

Content
The course is targeted at students with a major in Data Science and/or Machine Learning and/or Quantitative Finance. It offers students the opportunity to develop hands-on knowledge on new developments in the intersection of quantitative financial markets, data science and machine learning. The result of the project should not only be a final thesis, but the implementation of methods or development of an algorithm in machine learning and data science. Typically, problems and data are taken from current research and innovations in the field of quantitative asset and risk management.

Workload
Total effort for 9 credit points: approx. 270 hours are divided into the following parts: Communication:Exchange during the project: 30 h, Final presentation: 10 h; Implementation and thesis: Preparation before development (Problem analysis and solution design): 70 h, Solution implementation: 110 h, Tests and quality assurance: 50 h.

Recommendation
None

3.4 Module: Advanced Methods in Nonlinear Partial Differential Equations [M-MATH-106822]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113691	Advanced Methods in Nonlinear Partial Differential Equations	3 CR	de Rijk, Reichel

Competence Certificate
The module examination takes place in form of an oral exam of about 30 minutes.

Prerequisites
none

Competence Goal
After successful completion of this module students

- know what amplitude or modulation equations are and can explain their significance;
- master several techniques to rigorously justify approximations by amplitude or modulation equations;
- have acquired miscellaneous methods to prove the existence of special solutions to nonlinear partial differential equations;
- can explain what the Ginzburg-Landau formalism is and how it can be employed to prove global existence of solutions.

Content
Nonlinear partial differential equations describing physical phenomena are often complex, making their qualitative and quantitative analysis challenging. Amplitude or modulation equations, such as the Ginzburg-Landau equation, the Korteweg-de Vries equation, and the nonlinear Schrödinger equation, play an important role in capturing the critical dynamics of spatially extended dissipative or conservative physical models. Mathematical theorems demonstrate that these well-understood asymptotic models accurately predict the behavior of the original system on sufficiently long time scales. Examples which can be described in such a way include pattern-forming systems close to their first instability, the long-wave limit of the water wave problem, and highly oscillatory regimes in nonlinear optics.

In the first part of this course, we develop several methods to rigorously justify approximations of complex physical systems by amplitude or modulation equations. Relevant tools include Fourier analysis, energy estimates, semigroup theory, mode filters, and normal form transformations. Often, amplitude or modulation equations admit special solutions, such as Turing patterns, solitary waves, or traveling (modulating) fronts. While approximation results yield solutions of the original system that are close to these special solutions, they are insufficient to conclude that such special solutions exist in the original system as well. In the second part of this course, we focus on techniques, such as Lyapunov-Schmidt reduction, spatial dynamics, and center manifold reduction, to construct these special solutions in the original system.

Module grade calculation
The module grade is the grade of the oral examination.

Workload
Total workload: 90 hours

Attendance: 30 hours

- lectures and examination

Self-studies: 60 hours

- follow-up and deepening of the course content,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The following modules are recommended: Analysis 1-3, Functional Analysis, Evolution Equations

M 3.5 Module: Advanced Topics in Strategy and Management [M-WIWI-103119]

Responsible: Prof. Dr. Hagen Lindstädt
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	2 terms	German	4	1

Compulsory Elective Courses (Election: 9 credits)			
T-WIWI-106188	Workshop Current Topics in Strategy and Management	3 CR	Lindstädt
T-WIWI-106189	Workshop Business Wargaming – Analyzing Strategic Interactions	3 CR	Lindstädt
T-WIWI-106190	Strategy and Management Theory: Developments and “Classics”	3 CR	Lindstädt

Competence Certificate
The control of success takes place in the form of partial examinations (according to §4(2), 1-3 SPO) on the courses of the module, amounting to a total of 9 LP. The performance review is described for each course of this module. The overall grade of the module is formed from the LP-weighted grades of the partial examinations and truncated after the first decimal place.

Prerequisites
None

Competence Goal
Upon completion of the module, students will be able to,

- independently analyze strategic issues in a structured manner using appropriate models and frames of reference from management theory and derive recommendations.
- Convincingly present their position by means of a well thought-out argumentation in structured discussions.
- independently deal with a current, research-oriented issue from strategic management.
- draw his/her own conclusions from the little structured information by incorporating his/her interdisciplinary knowledge and selectively develop the current research results.
- apply and discuss theoretical contents of management theory to real situations by intensively dealing with a variety of practice-relevant case studies.

Content
In terms of content, three focal points will be set. First, strategic issues are discussed and analyzed on the basis of jointly selected case studies. Secondly, the students deal intensively with the topic of business wargaming in a workshop and analyze strategic interactions. Thirdly, topics of strategy and management theory will be elaborated in a written paper.

Annotation
The module is admission restricted. Upon successful admission to a course, the student is guaranteed the opportunity to complete the module. Examinations are offered at least every other semester so that the entire module can be completed in two semesters.

Workload
Total effort for 9 credit points: approx. 270 hours. The exact distribution is done according to the credit points of the courses of the module. The workload for courses with 3 credits is approx. 90h.

M 3.6 Module: Algebra [M-MATH-101315]

Responsible: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	see Annotations	1 term	4	2

Mandatory			
T-MATH-102253	Algebra	8 CR	Kühnlein, Sauer

Competence Certificate
Oral examination of ca. 30 minutes.

Prerequisites
None

Competence Goal
Students are able to

- understand essential concepts from Algebra,
- apply results from Galois theory to concrete situations,
- name basic results concerning discrete valuations and relate them to integral ring extensions.

They are prepared to write a thesis on a topic from algebra.

Content

- algebraic field extensions, Galois theory, roots of unit, applications of Galois theory
- discrete valuations, discrete valuation rings
- Tensor products of modules, integral ring extensions, normalization, noetherian rings, Hilbert's Basis Theorem

Module grade calculation
The grade of the module is the grade of the oral exam.

Annotation
This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

Workload
Total worklaod : 240 hours.

Attendance: 90 h

- lectures and tutorials including the examination

Self studies: 150 h

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research on the course content
- preparation for the module examination

Recommendation
Basic knowledge on groups and rings is benefitial.

M 3.7 Module: Algebraic Geometry [M-MATH-101724]

Responsible: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-103340	Algebraic Geometry	8 CR	Herrlich, Kühnlein

Competence Certificate
The module will be completed by an oral exam of about 30 minutes.

Prerequisites
None

Competence Goal
Participants are able to

- name and discuss basic concepts concerning algebraic varieties
- apply algebraic tools, in particular those from the theory of polynomial rings, to geometric questions
- explain important results from classical algebraic geometry and their application in specific examples
- start to read recent research papers from algebraic geometry and write a thesis in this area.

Content

- Hilbert's Nullstellensatz
- affine and projective varieties
- morphisms and rational maps
- non-singular varieties
- algebraic curves
- Riemann-Roch-Theorem

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total work load:

Attendance: 90 minutes

- lectures, problem classes an examination

Self studies: 150 hours

- follow-up and deepening of the course contents
- work on problem sheets
- literature study and internet research relating to the course contents
- Preparation of the oral exam

Recommendation
The contents of basic courses on algebra and number theory, including basic commutative algebra, should be well-understood.

3.8 Module: Algebraic Number Theory [M-MATH-101725]

Responsible: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-103346	Algebraic Number Theory	8 CR	Herrlich, Kühnlein

Competence Certificate
oral examination of ca. 30 minutes

Prerequisites
none

Competence Goal
Students are able to

- understand basic structures and concepts from algebraic number theory,
- apply abstract concepts to concrete problems,
- read research papers and write a thesis in the field of algebraic number theory.

Content

- Algebraic number fields: rings of integers, Minkowski theory, class-groups and Dirichlet's unit theorem,
- Extensions of number fields: Ramified primes, Hilbert's ramification theory,
- Local fields: Ostrowski's theorem, valuation theory, Hensel's lemma, extensions of local fields,
- analytic methods: Dirichlet series, Dedekind's zeta function, L-series

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The contents of the module "Algebra" are strongly recommended.

M 3.9 Module: Algebraic Topology [M-MATH-102948]

Responsible: Prof. Dr. Roman Sauer
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	German/English	4	1

Mandatory			
T-MATH-105915	Algebraic Topology	8 CR	Krannich, Sauer

Prerequisites
none

Competence Goal
Students

- are able to compute topological invariants of basic examples
- are able to work in a self-organized and reflective manner.

Content

- Basic homotopy-theoretic notions
- Examples of algebraic-topological invariants (e.g. fundamental groups or singular homology)

Annotation
This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

3.10 Module: Algebraic Topology II [M-MATH-102953]

Responsible: Prof. Dr. Roman Sauer
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	5	1

Mandatory			
T-MATH-105926	Algebraic Topology II	8 CR	Krannich, Sauer

Prerequisites
none

M 3.11 Module: Analytical and Numerical Homogenization [M-MATH-105636]

Responsible: TT-Prof. Dr. Roland Maier
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-111272	Analytical and Numerical Homogenization	6 CR	Hochbruck, Maier

Competence Certificate
Oral examination of approximately 30 minutes.

Prerequisites
None.

Competence Goal
The topic of the lecture are numerical multiscale methods presented exemplarily for elliptic problems. Students know the basic analytical results for existence and uniqueness of solutions to multiscale problems and from homogenization theory. In addition, they know methods for the numerical approximation of the multiscale and the homogenized solution. They are able to analyze the convergence of these methods and to assess the advantages and disadvantages of the different approaches.

Content

- Analytical fundamentals (basic results from analysis for elliptic partial differential equations and from homogenization theory)
- Approximation of the homogenized solution(e.g., Heterogeneous Multiscale Method)
- Approximation of the multiscale solution (e.g., Localized Orthogonal Decomposition)

Module grade calculation
The grade of the module is the grade of the oral exam.

Annotation
The course is offered in English. If everybody speaks German, the lecture will be held in German.

Workload
Total workload: 180 h

Attendance: 60 h

- Course including module examination during study.

Self-studies: 120 h

- Deepening the study content by working on the lecture content at home
- Working on exercises
- In-depth study of the course content using suitable literature and Internet research,
- preparation for the module examination during study.

Recommendation
Basic knowledge of ordinary and/or partial differential equations as well as the contents of the module "Numerical Methods for Differential Equations" are strongly recommended. Knowledge of functional analysis is also recommended.

3.12 Module: Analytics and Statistics [M-WIWI-101637]

Responsible: Prof. Dr. Oliver Grothe
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	2 terms	German	4	5

Mandatory			
T-WIWI-103123	Advanced Statistics	4,5 CR	Grothe
Supplementary Courses (Election: between 4,5 and 5 credits)			
T-WIWI-106341	Machine Learning 2 – Advanced Methods	4,5 CR	Zöllner
T-WIWI-111247	Mathematics for High Dimensional Statistics	4,5 CR	Grothe
T-WIWI-103124	Multivariate Statistical Methods	4,5 CR	Grothe
T-WIWI-112109	Topics in Stochastic Optimization	4,5 CR	Rebennack

Competence Certificate
The assessment is carried out as partial written exams (according to Section 4(2), 1 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The examinations are offered every semester. Re-examinations are offered at every ordinary examination date. The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
The course "*Advanced Statistics*" is compulsory.

Competence Goal
A Student

- Deepens the knowledge of descriptive and inferential statistics.
- Deals with simulation methods.
- Learns basic and advanced methods of statistical analysis of multivariate and high-dimensional data.

Content

- Deriving estimates and testing hypotheses
- Stochastic processes
- Multivariate statistics, copulas
- Dependence measures
- Dimension reduction
- High-dimensional methods
- Prediction

Annotation
The planned lectures and courses for the next three years are announced online.

Workload
The total workload for this module is approximately 270 hours.

M 3.13 Module: Applications of Operations Research [M-WIWI-101413]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German	4	9

Compulsory Elective Courses (Election: between 1 and 2 items)			
T-WIWI-102704	Facility Location and Strategic Supply Chain Management	4,5 CR	Nickel
T-WIWI-102714	Tactical and Operational Supply Chain Management	4,5 CR	Nickel
Supplementary Courses (Election: at most 1 item)			
T-WIWI-102726	Global Optimization I	4,5 CR	Stein
T-WIWI-106199	Modeling and OR-Software: Introduction	4,5 CR	Nickel
T-WIWI-106545	Optimization under Uncertainty	4,5 CR	Rebennack

Competence Certificate
The assessment is carried out as partial exams (according to § 4(2), 1 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module.

The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
At least one of the courses *Facility Location and strategic Supply Chain Management* and *Tactical and operational Supply Chain Management* has to be taken.

Competence Goal
The student

- is familiar with basic concepts and terms of Supply Chain Management,
- knows the different areas of Supply Chain Management and their respective optimization problems,
- is acquainted with classical location problem models (in the plane, on networks and discrete) as well as fundamental methods for distribution and transport planning, inventory planning and management,
- is able to model practical problems mathematically and estimate their complexity as well as choose and adapt appropriate solution methods.

Content
Supply Chain Management is concerned with the planning and optimization of the entire, inter-company procurement, production and distribution process for several products taking place between different business partners (suppliers, logistics service providers, dealers). The main goal is to minimize the overall costs while taking into account several constraints including the satisfaction of customer demands.

This module considers several areas of Supply Chain Management. On the one hand, the determination of optimal locations within a supply chain is addressed. Strategic decisions concerning the location of facilities like production plants, distribution centers or warehouses are of high importance for the rentability of supply chains. Thoroughly carried out, location planning tasks allow an efficient flow of materials and lead to lower costs and increased customer service. On the other hand, the planning of material transport in the context of Supply Chain Management represents another focus of this module. By linking transport connections and different facilities, the material source (production plant) is connected with the material sink (customer). For given material flows or shipments, it is considered how to choose the optimal (in terms of minimal costs) distribution and transportation chain from the set of possible logistics chains, which asserts the compliance of delivery times and further constraints.

Furthermore, this module offers the possibility to learn about different aspects of the tactical and operational planning level in Suppy Chain Management, including methods of scheduling as well as different approaches in procurement and distribution logistics. Finally, issues of warehousing and inventory management will be discussed.

Annotation
The planned lectures and courses for the next three years are announced online.

Workload

The total workload of the module is about 240 hours. The workload is proportional to the credit points of the individual courses.

Recommendation

The courses Introduction to Operations Research I and II are helpful.

3.14 Module: Applications of Topological Data Analysis [M-MATH-105651]

Responsible: Dr. Andreas Ott
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-111290	Applications of Topological Data Analysis	4 CR	Ott

Prerequisites
None

M 3.15 Module: Bayesian Inverse Problems with Connections to Machine Learning [M-MATH-106328]

Responsible: TT-Prof. Dr. Sebastian Krumscheid
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MATH-112842	Bayesian Inverse Problems with Connections to Machine Learning	4 CR	Krumscheid

Competence Certificate
oral exam of ca. 30 min

Prerequisites
None

Competence Goal
After completing the module's classes and the exam, students will be familiar with the theory of inverse problems. They will be able to apply the Bayesian framework to a given inverse problem and assess the
well-posedness of the Bayesian posterior. In addition, students will be able to describe the basics of several solution methods for accessing the Bayesian posterior, including approximation and machine-learning techniques, and their limitations. Finally, they will be able to name and discuss essential theoretical concepts for Bayesian inversion in Banach spaces and describe the suitable sampling-based solution techniques. In particular, the course prepares students to write a thesis in the field of Uncertainty Quantification.

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

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
total workload: 120 hours

Recommendation
The contents of the modules 'M-MATH-101321 - Introduction to Stochastics', 'M-MATH-103214 – Numerical Mathematics 1+2', and 'M-MATH-106053 — Stochastic Simulation' are recommended.

M 3.16 Module: Bifurcation Theory [M-MATH-103259]

Responsible: Dr. Rainer Mandel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-106487	Bifurcation Theory	5 CR	Mandel

Prerequisites
None

Annotation
Course is held in English

M 3.17 Module: Bott Periodicity [M-MATH-104349]

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-108905	Bott Periodicity	5 CR	Tuschmann

Prerequisites
None

3.18 Module: Boundary and Eigenvalue Problems [M-MATH-102871]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each summer term	1 term	4	1

Mandatory			
T-MATH-105833	Boundary and Eigenvalue Problems	8 CR	Frey, Hundertmark, Lamm, Plum, Reichel, Schnaubelt

Competence Certificate
The module will be completed by an oral exam (approx. 30 min).

Prerequisites
None

Competence Goal
Graduates will be able to

- assess the significance of boundary value and eigenvalue problems within mathematics and/or physics and illustrate them using examples,
- describe qualitative properties of solutions,
- prove the existence of solutions to boundary value problems using functional analysis methods,
- make statements about the existence of eigenvalues and eigenfunctions of elliptic differential operators and describe their properties.

Content

- Examples of boundary and eigenvalue problems
- Maximum principles for 2nd order equations
- Function spaces, e.g. Sobolev spaces
- Weak formulation of 2nd order linear elliptic equations
- Existence and regularity theory for elliptic equations
- Eigenvalue theory for weakly formulated elliptic eigenvalue problems

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

M 3.19 Module: Boundary Element Methods [M-MATH-103540]

Responsible: PD Dr. Tilo Arens
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-109851	Boundary Element Methods	8 CR	Arens

Competence Certificate
The examination is carried out by an oral examination (approx. 30 minutes).

Prerequisites
None

Competence Goal
Students are able to apply the analytic foundations of defining potentials and boundary operators, such as distributions, Sobolev spaces on boundaries of Lipschitz domains and trace operators to specific problems. They understand the definition of potentials, boundary operators and important mathematical statements about them. They are able to formulate boundary integral equations for concrete elliptic boundary value problems and to comprehend the proofs for their solvability.

Students are able to name and describe classes of boundary elements. They are familiar with the use of various boundary elements for numerically solving boundary integral equations by Galerkin methods. They can explain results on convergence of such methods. The students can describe techniques for improving practical handling of boundary element methods such as matrix compression schemes and preconditioning.

Content

- Sobolev spaces
- function spaces on Lipschitz boundaries
- boundary value problems for elliptic partial differential equations
- potentials and boundary operators
- boundary integral equations
- boundary elements
- Galerkin boundary element methods
- preconditioning
- matrix compression

Module grade calculation
The module grade is the grade of the oral examination.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- increased understanding of module content by wrapping up lectures at home
- work on exercises
- increased understanding of module content by self study of literature and internet research
- preparing for the examination

Recommendation
We recommend attendance of the module "Numerical Methods for Integral Equations".

M 3.20 Module: Brownian Motion [M-MATH-102904]

Responsible: Prof. Dr. Nicole Bäuerle
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105868	Brownian Motion	4 CR	Bäuerle, Fasen-Hartmann, Last

Competence Certificate
The module will be completed by an oral exam (about 20 min).

Prerequisites
none

Competence Goal
At the end of the course, students

- can name, explain and justify properties of the Brownian motion,
- can use the Brownian motion to model stochastic phenomenon,
- can use specific probabilistic techniques,
- are able to work in a self-organized and reflective manner.

Content

- Existence and construction of Brownian motion,
- path properties of Brownian motion,
- strong Markov property of Brownian motion with applications,
- Skorokhod representation theorems with Brownian motion.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: zz hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course 'Probability Theory' is strongly recommended.

M 3.21 Module: Classical Methods for Partial Differential Equations [M-MATH-102870]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each winter term	1 term	4	1

Mandatory			
T-MATH-105832	Classical Methods for Partial Differential Equations	8 CR	Frey, Hundertmark, Lamm, Plum, Reichel, Schnaubelt

M 3.22 Module: Collective Decision Making [M-WIWI-101504]

Responsible: Prof. Dr. Clemens Puppe
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	English	4	4

Compulsory Elective Courses (Election:)			
T-WIWI-102740	Public Management	4,5 CR	Wigger
T-WIWI-102859	Social Choice Theory	4,5 CR	Puppe

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2), 1 or 2 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module seperately.

The overall grade of the the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None

Competence Goal
Students

- are able to model and assess problems in public economics and to analyze them with respect to positive and normative aspects,
- understand individual incentives and social outcomes of different institutional designs,
- are familiar with the functioning and design of democratic elections and can analyze them with respect to their individual incentives.

Content
The focus of the module is on mechanisms for public decision making including voting and the aggregation of preferences and judgements.

Workload
Total workload for 9 credit points: approx. 270 hours

The exact distribution is based on the credit points of the courses in the module.

3.23 Module: Combinatorics [M-MATH-102950]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	English	4	4

Mandatory			
T-MATH-105916	Combinatorics	8 CR	Aksenovich

Competence Certificate
The final grade is given based on the written final exam (2h).

By successfully working on the problem sets, a bonus can be obtained. To obtain the bonus, one has to achieve 50% of the points on the solutions of the exercise sheets 1-6 and also of the exercise sheets 7-12. If the grade in the final written exam is between 4,0 and 1,3, then the bonus improves the grade by one step (0,3 or 0,4).

Prerequisites
none

Competence Goal
The students understand, describe, and use fundamental notions and techniques in combinatorics. They can analyze, structure, and formally describe typical combinatorial questions. The students can use the results and methods such as inclusion-exclusion, generating functions, Young tableaux, as well as the developed proof ideas, in solving combinatorial problems. In particular, they can analyze the existence and the number of ordered and unordered arrangements of a given size. The students understand and critically use the combinatorial methods. Moreover, the students can communicate using English technical terminology.

Content
The course is an introduction into combinatorics. Starting with counting problems and bijections, classical methods such as inclusion-exclusion principle and generating functions are discussed. Further topics include Catalan families, permutations, Young tableaux, partial orders, and combinatorial designs.

Module grade calculation
The grade of the module ist the grade of the written exam.

Annotation

- Course is held in English
- This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

Workload
Total workload: 240 hours

Attendance time: 90 hours

- Course including module examination during the course of study

Self-study: 150 hours

- Deepening the study content by working on the lecture content at home
- Completion of exercises
- In-depth study of the course content using suitable literature and internet research
- Preparation for the module examination during the course of study

Recommendation
Knowledge of the modules Linear Algebra 1 and 2 and Analysis 1 and 2 is recommended.

3.24 Module: Complex Analysis [M-MATH-102878]

Responsible: PD Dr. Gerd Herzog
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	5	1

Mandatory			
T-MATH-105849	Complex Analysis	8 CR	Herzog, Plum, Reichel, Schnaubelt, Tolksdorf

Competence Certificate
The module will be completed by an oral exam (about 30 min).

Prerequisites
None

Competence Goal
At the end of the course, students can

- explain the basic concepts and results of the theory of infinite products and apply them in examples within the framework of Weierstrass's theorems
- reproduce the Mittag-Leffler theorem and derive conclusions from it
- explain Riemann's mapping theorem and are able to describe what Montel's theorem is and how this theorem is included in the proof of Riemann's theorem
- name the most important properties of class S of simple functions and formulate the (proven) Bieberbach conjecture
- can explain the basic concepts of the theory of harmonic functions and apply them in examples
- explain the Schwarz reflection principle.
- describe properties of regular and singular points in power series and discuss them with examples.

Content

- infinite products
- Mittag-Leffler's theorem
- Montel's theorem
- Riemann's mapping theorem
- conformal mappings
- univalent (schlicht) functions
- automorphisms of some domains
- harmonic functions
- Schwarz reflection principle
- regular and singular points of power series

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
Basics of complex analysis, for example from the “Analysis 4” module, are recommended.

M 3.25 Module: Complex Geometry [M-MATH-106776]

Responsible: Jun.-Prof. Dr. Claudio Llosa Isenrich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113614	Complex Geometry	6 CR	Llosa Isenrich

Competence Certificate
The module will be completed by an oral exam (of ca. 30 min).

Prerequisites
None

Competence Goal
Graduates

- can understand the structure of complex geometry and apply its results to specific problems;
- are able to explain important results on compact Kähler manifolds and their topology, relate them to each other and apply them to examples;
- can sketch proofs of important results from the lecture;
- can work in a self-organized and reflective manner.

Content

- Introduction to complex analysis in several variables
- Complex manifolds, vector bundles and forms
- Introduction to Kähler manifolds and important examples
- The Kähler identities and their consequences
- Dolbeaut cohomology and the Hodge decomposition theorem

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 hours

- lectures and examination

Self-studies: 120 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
Knowledge of complex analysis (e.g. "Analysis 4") and differential geometry is strongly recommended. The same applies to the contents of the modules "Elementary Geometry" and "Introduction to Algebra and Number Theory".

M 3.26 Module: Compressive Sensing [M-MATH-102935]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105894	Compressive Sensing	5 CR	Rieder

Competence Certificate
Success is assessed in the form of an oral examination lasting approx. 30 minutes.

Competence Goal
Graduates can explain the ideas of compressive sensing and can name areas of application. They can apply and compare the basic algorithms and analyze their convergence behavior.

Content

- What is compressive sensing and where is it used?
- Sparse solutions of underdetermined linear systems of equations
- Basic algorithms
- Restricted isometry property
- Sparse solutions of underdetermined linear systems of equations with random matrices

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course "Introduction to stochastics" is recommended.

M 3.27 Module: Computational Fluid Dynamics and Simulation Lab [M-MATH-106634]

Responsible: PD Dr. Mathias Krause
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	German/English	4	2

Mandatory			
T-MATH-113373	Computational Fluid Dynamics and Simulation Lab	4 CR	Frank, Krause, Simonis, Thäter

Competence Certificate
For their final project, students prepare a written report, usually 10-15 pages long, which is graded.

Prerequisites
none

Competence Goal
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.

Content
Lecture part: Introduction to modeling and simulations, introduction to associated numerical methods, introduction to associated software and high-performance computer hardware

Own group work: Working on 1-2 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.

Module grade calculation
The module grade is the grade of the final project.

Workload
Total workload: 120 hours

Attendance: 60 hours

- lectures and examination

Self-studies: 60 hours

- follow-up and deepening of the course content,
- work on projects and report,
- literature study and internet research relating to the course content

Recommendation
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.

M 3.28 Module: Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems [M-MATH-102883]

Responsible: Prof. Dr. Michael Plum

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105854	Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems	8 CR	Plum

M 3.29 Module: Continuous Time Finance [M-MATH-102860]

Responsible: Prof. Dr. Nicole Bäuerle
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each summer term	1 term	4	1

Mandatory			
T-MATH-105930	Continuous Time Finance	8 CR	Bäuerle, Fasen-Hartmann, Trabs

Competence Certificate
oral examination of ca. 30 min.

Prerequisites
The module cannot be completed together with "Stochastic Calculus and Finance [T-WIWI-103129]".

Competence Goal
Students are able to

- understand, describe and use fundamental notions and techniques of modern continuous time finance,
- use specific probabilistic techniques,
- analyze mathematically economical questions in option pricing and optimization

Content

- Stochastic processes and filtrations
  - Martingales in continuous time
  - Stopping times
  - Quadratic variation
- Stochastic Ito-Integral w.r.t. continuous semimartingales
- Ito-calculus
  - Ito-Doeblin formula
  - Stochastic exponentials
  - Girsanov theorem
  - Martingale representation
- Black-Scholes financial market
  - Arbitrage and equivalent martingale measures
  - Options and no-arbitrage prices
  - market completeness
- Portfolio optimization
- Bonds, forwards and interest rate models

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation

The content of the module „Probability theory“ is strongly recommended. The module „Discrete time finance“ is recommended.

3.30 Module: Control Theory [M-MATH-102941]

Responsible: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-105909	Control Theory	6 CR	Schnaubelt

Competence Certificate
The module will be completed by an oral exam (ca. 20 min).

Prerequisites
none

Competence Goal
Students can explain the central concepts of the treatment of controlled linear ordinary differential equations (controllability, observability, stabilizability and discoverability) and the associated characterizations and apply them in examples. They are able to describe the basic features of the theory of transfer functions and realization theory. They can discuss the solution of the quadratic optimal control problem and apply it to feedback synthesis. They can describe the basic concepts of control theory including the associated criteria also for non-linear systems and apply them to examples.

Content

- controllabilty and observabilty of systems of linear ordinary differential equations
- stabilizability and detectability
- transfer functions
- realization theory,
- quadratic optimal control, feedback synthesis
- nonlinear controll theory: basic concepts, criteria via linearization, Lie brackets and Lyapunov functions

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The contents of the modules Analysis 1-2 und Lineare Algebra 1-2 are strongly recommended. Further knowledge of ordinary differential equations (as in Analysis 4) is useful.

Literature
J. Zabczyk, Mathematical Control Theory. An Introduction.

M 3.31 Module: Convex Geometry [M-MATH-102864]

Responsible: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105831	Convex Geometry	8 CR	Hug

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
None

Competence Goal
The students

- know fundamental combinatorial, geometric and analytic properties of convex sets and convex functions and apply these to related problems,
- are familiar with fundamental geometric and analytic inequalities for functionals of convex sets and their applications to geometric extremal problems and can present central ideas and techniques of proofs,
- know selected integral formulas for convex sets and the required results on invariant measures.
- know how to work self-organized and self-reflexive.

Content

1. Convex Sets
   1.1. Combinatorial Properties
   1.2. Support and Separation Properties
   1.3. Extremal Representations
2. Convex Functions
   2.1. Basic Properties
   2.2. Regularity
   2.3. Support Function
3. Brunn-Minkowski Theory
   3.1. Hausdorff Metric
   3.2. Volume and Surface Area
   3.3. Mixed Volumes
   3.4. Geometric Inequalities
   3.5. Surface Area Measures
   3.6. Projection Functions
4. Integralgeometric Formulas
   4.1. Invariant Measures
   4.2. Projection and Section Formula
   4.3 Kinematic Formula

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research related to the course content
- preparation for the module exam.

Literature
D. Hug, W. Weil: Lectures on Convex Geometry. Graduate Texts in Mathematics, Vol. 286, Springer, Cham, 2020.

M 3.32 Module: Curves on Surfaces [M-MATH-106632]

Responsible: Dr. Elia Fioravanti
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113364	Curves on Surfaces	3 CR	Fioravanti

Competence Certificate
The module will be completed by an oral exam (of ca. 20 - 30 min).

Prerequisites
None

Competence Goal
At the end of the course, students

- have a deeper understanding of the topology and geometry of surfaces, as well as of the structure of their homeomorphisms;
- are able to work independently and critically;
- are prepared to read recent research articles and work on a thesis on mapping class groups and related topics.

Content

- curves on surfaces up to homotopy and isotopy,
- mapping class groups of surfaces,
- Nielsen-Thurston classification of homeomorphisms of surfaces,
- Teichmüller space.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 90 hours

Attendance: 30 hours

- lectures and examination

Self-studies: 60 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the courses 'Introduction into Geometry and Topology' and 'Elementary Geometry' are recommended. The courses 'Hyperbolic Geometry' and 'Algebraic Topology' can faciliate a deeper understanding of the course contents.

3.33 Module: Data Science for Finance [M-WIWI-105032]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-WIWI-102878	Computational Risk and Asset Management	4,5 CR	Ulrich
T-WIWI-110213	Python for Computational Risk and Asset Management	4,5 CR	Ulrich

Competence Certificate
The module examination takes the form of an alternative exam assessment.
The alternative exam assessment consists of a Python-based "Takehome Exam". At the end of the third week of January, the student is given a "Takehome Exam" which he processes and sends back independently within 4 hours using Python. Precise instructions will be announced at the beginning of the course. The alternative exam assessment can be repeated a maximum of once. A timely repeat option takes place at the end of the third week in March of the same year. More detailed instructions will be given at the beginning of the course.

Competence Goal
The aim of the module is to use data science, machine learning and financial market theories to generate better investment, risk and asset management decisions. The student gets to know the characteristics of different asset classes in an application-oriented manner using real financial market data. We use Python and web scraping techniques to extract, visualize and examine patterns of publicly available financial market data. Interesting and non-public financial market data such as (option and futures data on shares and interest) are provided. Financial market theories are also discussed to improve data analysis through theoretical knowledge. Students get to know stock, interest rate, futures and options markets through the "data science glasses". Through "finance theory glasses" students understand how patterns can be communicated and interpreted using finance theory. Python is the link through which we bring data science and modern financial market modeling together.

Content
The course covers several topics, among them:

- Pattern detection in price and return data in equity, interest rate, futures and option markets
- Quantitative Portfolio Strategies
- Modeling Return Densities using tools from financial econometrics, data science and machine learning
- Valuation of equity, fixed-income, futures and options in a coherent framework to possibly exploit arbitrage opportunities
- Neural networks and Natural Language Processing

Workload
The total workload for this module is 270 hours (9 credit points).The total number of hours resulting from income from studying online video, answering quizzes, studying Ipython notebooks, active and interactive "Python Data Sessions" and reading literature you have heard.

Recommendation
Basic knowledge of capital markt theory.

M 3.34 Module: Data Science: Evidence-based Marketing [M-WIWI-101647]

Responsible: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	2 terms	English	4	5

Compulsory Elective Courses (Election: 9 credits)			
T-WIWI-103139	Marketing Analytics	4,5 CR	Klarmann
T-WIWI-107720	Market Research	4,5 CR	Klarmann

Competence Certificate
The assessment is carried out as partial exams (according to Section 4 (2), 1-3 SPO) of the courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module separately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
Keine.

Competence Goal
Students

- possess advanced knowledge of relevant market research contents
- know many different qualitative and quantitative methods for measuring customer behavior, preparation of strategic decisions, making causal deductions, usage of social media data and sales forecasting
- possess the statistical skills required for working in marketing research

Content
This module provides in-depth knowledge of relevant quantitative and qualitative methods used in market research.Students can attend the following courses:

- The course “Market Research” provides contents of practical relevance for measuring customer attitudes and customer behavior. The participants learn using statistical methods for strategic decision-making in marketing. Students who are interested in writing their master thesis at the Marketing & Sales Research Group are required to take this course.
- The course "Marketing Analytics“ is based on "Market Research“ and teaches advanced statistical methods for analyzing relevant marketing and market research questions. Please note that a successful completion of "Market Research" is a prerequisite for the completion of "Marketing Analytics".

Workload
The total workload for this module is approximately 270 hours.

Recommendation
None

M 3.35 Module: Decision and Game Theory [M-WIWI-102970]

Responsible: Prof. Dr. Clemens Puppe
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each winter term	1 term	German	4	1

Wahlpflichtangebot (Election: 9 credits)			
T-WIWI-102613	Auction Theory	4,5 CR	Ehrhart
T-WIWI-102614	Experimental Economics	4,5 CR	Weinhardt
T-WIWI-102861	Advanced Game Theory	4,5 CR	Ehrhart, Puppe, Reiß

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2), 1 or 2 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None

Competence Goal
The student learns the basics of individual and strategic decisions on an advanced and formal level.

He learns to analyze economic problems through abstract and method-based thinking and to design solution strategies. In the tutorials, the concepts and results of the lecture will be applied in case studies.

Content
See German version.

Workload
The total workload for this module is approximately 270 hours. For further information see German version.

M 3.36 Module: Differential Geometry [M-MATH-101317]

Responsible: Prof. Dr. Wilderich Tuschmann
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	see Annotations	1 term	4	1

Mandatory			
T-MATH-102275	Differential Geometry	8 CR	Lytchak, Tuschmann

Prerequisites
None

Annotation
This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

M 3.37 Module: Digital Marketing [M-WIWI-106258]

Responsible: Prof. Dr. Ann-Kristin Kupfer
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	2 terms	English	4	2

Mandatory			
T-WIWI-112693	Digital Marketing	4,5 CR	Kupfer
Supplementary Courses (Election: 4,5 credits)			
T-WIWI-106981	Digital Marketing and Sales in B2B	1,5 CR	Klarmann, Konhäuser
T-WIWI-114174	Economic Decision Making	4,5 CR	Scheibehenne
T-WIWI-107720	Market Research	4,5 CR	Klarmann
T-WIWI-112711	Media Management	4,5 CR	Kupfer
T-WIWI-111848	Online Concepts for Karlsruhe City Retailers	3 CR	Klarmann

Competence Certificate
The assessment is carried out as partial exams of the core course and further single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module separately.

The overall grade of the module is the average of the grades for each course, weighted by the credits and truncated after the first decimal.

Prerequisites
None

Competence Goal
Students

- have an advanced knowledge about central marketing contents
- have a fundamental understanding of the marketing instruments
- know current fundamental principles and latest trends in the field of digital marketing
- know and understand several strategic concepts and how to implement them
- are able to implement their extensive marketing knowledge in a practical context
- are able to critically discuss and question theoretical concepts and current practices in marketing
- have theoretical knowledge that is fundamental for writing a master thesis in the field of marketing
- have gained insight into scientific research that prepares them to independently write a master's thesis
- have the theoretical knowledge and skills necessary to work in or collaborate with the marketing department of a company

Content
The aim of this module is to deepen central marketing contents in different areas.

Workload
Total effort for 9 credit points: approx. 270 hours.
The exact distribution is done according to the credit points of the courses of the module.

3.38 Module: Discrete Dynamical Systems [M-MATH-105432]

Responsible: PD Dr. Gerd Herzog
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-110952	Discrete Dynamical Systems	3 CR	Herzog

Competence Certificate
The module will be completed by an oral exam (about 20 min).

Prerequisites
None

Competence Goal
At the end of the course, students can

- name, discuss and apply fundamental statements of the theory of discrete dynamic systems,
- explain the meaning of dynamic systems using examples,
- describe and use specific techniques of topological dynamics.

Content

1. Discrete dynamical systems
2. Chaotic dynamical systems
3. Non-expansive mappings
4. The Fürstenberg-Weiss theorem
5. Cellular automata
6. (Weakly) mixing dynamical systems
7. Dynamics of linear operators

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 90 hours

Attendance: 30 hours

- lectures, problem classes, and examination

Self-studies: 60 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
Basics of complex analysis (e.g. from Analysis 4) and functional analysis are recommended.

3.39 Module: Discrete Time Finance [M-MATH-102919]

Responsible: Prof. Dr. Nicole Bäuerle
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each winter term	1 term	4	1

Mandatory			
T-MATH-105839	Discrete Time Finance	8 CR	Bäuerle, Fasen-Hartmann, Trabs

Competence Certificate
Written exam of 2h.

Prerequisites
none

Competence Goal
Students are able to

- understand, describe and use fundamental notions and techniques of modern discrete time finance,
- use specific probabilistic techniques,
- analyze mathematically economical questions in discrete option pricing and optimization,
- work self-organized and in a reflective manner.

Content

- Finite financial markets
- The Cox-Ross-Rubinstein-model
- Limit to Black-Scholes
- Characterizing no-arbitrage
- Characterizing completeness
- Incomplete markets
- American options
- Exotic options
- Portfolio optimization
- Preferences and stochastic dominance
- Mean-Variance portfolios
- Risk measures

Module grade calculation
The grade of the module is the grade of the written exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The content of the module „Probability theory“ is strongly recommended.

3.40 Module: Dispersive Equations [M-MATH-104425]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-109001	Dispersive Equations	6 CR	Reichel

Competence Certificate
The module will be completed by an oral exam (ca. 20 min).

Prerequisites
None

Competence Goal
Graduates will be able to
- recognize the essential properties of dispersive partial differential equations and explain them using examples.
- name the particular difficulties of dispersive equations.
- use techniques to describe the short- and long-term behavior of solutions using the nonlinear Schrödinger equation as an example.
- analyze the stability of solitary waves.
- understand the concept of conservation variables and explain them for specific examples.

Content
- Strichartz estimates, Sobolev embeddings and conservation laws
- Well-posedness results
- Long-term behavior of solutions (virial and Morawetz identities)
- orbital stability of solitary waves (variational description and concentration compactness)
- Energy conservation (invariant transmission coefficients)

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the course 'Functional Analysis' are recommended.

M 3.41 Module: Dynamical Systems [M-MATH-103080]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-106114	Dynamical Systems	8 CR	Reichel

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
none

Competence Goal
Graduates will be able to

- explain the significance of dynamical systems using examples,
- relate the concepts of a discrete-time and continuous-time dynamical system to each other,
- describe important methods for analyzing dynamical systems and use them to analyze the asymptotic behavior of solutions near equilibria for different dynamical systems,
- describe the behavior of invariant sets under discretization.

Content

- Examples of finite- and infinite-dimensional dynamical systems
- Fixed points, periodic orbits, limit sets
- Invariant sets
- Attractors
- Upper and lower continuity of attractors
- Stable and unstable manifolds
- Center manifolds

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The module 'Functional Analysis' is recommended.

M 3.42 Module: Econometrics and Statistics I [M-WIWI-101638]

Responsible: Prof. Dr. Melanie Schienle
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	6

Mandatory			
T-WIWI-111388	Applied Econometrics	4,5 CR	Krüger
Supplementary Courses (Election: between 4,5 and 5 credits)			
T-WIWI-103064	Financial Econometrics	4,5 CR	Schienle
T-WIWI-103126	Non- and Semiparametrics	4,5 CR	Schienle
T-WIWI-103127	Panel Data	4,5 CR	Heller
T-WIWI-110868	Predictive Modeling	4,5 CR	Krüger
T-WIWI-111387	Probabilistic Time Series Forecasting Challenge	4,5 CR	Krüger
T-WIWI-103065	Statistical Modeling of Generalized Regression Models	4,5 CR	Heller
T-WIWI-110939	Financial Econometrics II	4,5 CR	Schienle

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2), 1-3 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The examinations are offered every semester. Re-examinations are offered at every ordinary examination date. The assessment procedures are described for each course of the module separately.
The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
The course 'Applied Econometrics' [2520020] is compulsory and must be completed if it has not already been successfully completed in one of the modules 'Economics of Innovation and Growth' or 'Economics in a Connected World'. If the course 'Applied Econometrics' has already been completed in another module, the module cannot be chosen by the student. In this case, please contact the Examinations Office of the WIWI-Department, which will adjust the elective requirements in the module.

Competence Goal
The student shows an in depth understanding of advanced Econometric techniques suitable for different types of data.He/She is able to apply his/her theoretical knowledge to real world problems with the help of statistical software and to evaluate performance of different approaches based on statistical criteria.

Content
The courses of this module offer students a broad range of advanced Econometric techniques for state-of-the art data analysis.

Workload
The total workload for this module is approximately 270 hours.

M 3.43 Module: Econometrics and Statistics II [M-WIWI-101639]

Responsible: Prof. Dr. Melanie Schienle
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German	4	6

Election notes

++

This module will not count towards the degree until the module "Econometrics and Statistics I" has also been successfully completed. If the module "Econometrics and Statistics I" is booked out to the additional examinations, the "Econometrics and Statistics II" module loses its curricular validity/valuation for the degree.

++

Compulsory Elective Courses (Election: at least 1 item)			
T-WIWI-103064	Financial Econometrics	4,5 CR	Schienle
T-WIWI-110939	Financial Econometrics II	4,5 CR	Schienle
T-WIWI-103126	Non- and Semiparametrics	4,5 CR	Schienle
T-WIWI-103127	Panel Data	4,5 CR	Heller
T-WIWI-110868	Predictive Modeling	4,5 CR	Krüger
T-WIWI-111387	Probabilistic Time Series Forecasting Challenge	4,5 CR	Krüger
T-WIWI-103065	Statistical Modeling of Generalized Regression Models	4,5 CR	Heller
Additional Lectures (Election: at most 1 item)			
T-WIWI-103124	Multivariate Statistical Methods	4,5 CR	Grothe
T-WIWI-103128	Portfolio and Asset Liability Management	4,5 CR	Safarian
T-WIWI-103123	Advanced Statistics	4,5 CR	Grothe
T-WIWI-103129	Stochastic Calculus and Finance	4,5 CR	Safarian

Competence Certificate

The assessment is carried out as partial exams (according to Section 4(2), 1-3 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The examinations are offered every semester. Re-examinations are offered at every ordinary examination date. The assessment procedures are described for each course of the module separately.
The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites

This module can only be passed if the module *"Econometrics and Statistics I"* has been finished successfully before.

At least one course must be chosen from the compulsory elective programme.

Competence Goal

The student shows an in depth understanding of advanced Econometric techniques suitable for different types of data. He/She is able to apply his/her theoretical knowledge to real world problems with the help of statistical software and to evaluate performance of different approaches based on statistical criteria.

Content

This modula builds on prerequisites acquired in Module *"Econometrics and Statistics I"*. The courses of this module offer students a broad range of advanced Econometric techniques for state-of-the art data analysis.

Workload

Total workload for 9 credit points: approx. 270 hours. The allocation is based on the credit points of the courses in the module. The workload for courses with 4.5 credits is approx. 135 hours. The total number of hours per course is calculated from the time required to attend the lectures and exercises, as well as the examination times and the time required to achieve the learning objectives of the module for an average student for an average performance.

M 3.44 Module: Economic Theory and its Application in Finance [M-WIWI-101502]

Responsible: Prof. Dr. Kay Mitusch
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	English	4	6

Compulsory Elective Courses (Election: 1 item)			
T-WIWI-102609	Advanced Topics in Economic Theory	4,5 CR	Brumm, Mitusch
T-WIWI-102861	Advanced Game Theory	4,5 CR	Ehrhart, Puppe, Reiß
Supplementary Courses (Election:)			
T-WIWI-113469	Advanced Corporate Finance	4,5 CR	Ruckes
T-WIWI-102647	Asset Pricing	4,5 CR	Ruckes, Uhrig-Homburg
T-WIWI-109050	Corporate Risk Management	4,5 CR	Ruckes
T-WIWI-102623	Financial Intermediation	4,5 CR	Ruckes

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2), 1 or 2 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The exams are offered at the beginning of the recess period about the subject matter of the latest held lecture. Re-examinations are offered at every ordinary examination date. The assessment procedures are described for each course of the module separately. The overall grade for the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
One of the courses T-WIWI-102861 "Advanced Game Theory" and T-WIWI-102609 "Advanced Topics in Economic Theory" is compulsary.

Competence Goal
The students

- have learnt the methods of formal economic modeling, particularly of General Equilibrium Theory and contract theory
- will be able to apply these methods to the topics in Finance, specifically the areas of financial markets and institutions and corporate finance
- have gained many useful insights into the relationship between firms and investors and the functioning of financial markets

Content
The mandatory course "Advanced Topics in Economic Theory" is devoted in equal parts to General Equilibrium Theory and to contract theory. The course "Asset Pricing" will apply techniques of General Equilibrium Theory to valuation of financial assets. The courses "Corporate Financial Policy" and "Finanzintermediation" will apply the techniques of contract theory to issues of corporate finance and financial institutions.

Workload
Total workload for 9 credit points: approx. 270 hours

The exact distribution is based on the credit points of the courses in the module.

3.45 Module: eEnergy: Markets, Services and Systems [M-WIWI-103720]

Responsible: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German	4	3

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-107501	Energy Market Engineering	4,5 CR	Weinhardt
T-WIWI-107503	Energy Networks and Regulation	4,5 CR	Weinhardt
T-WIWI-107504	Smart Grid Applications	4,5 CR	Weinhardt
T-WIWI-113726	Special Topics in Information Systems	4,5 CR	Weinhardt

Competence Certificate
The assessment is carried out as partial exams (according to Section 4 (2), 1-3 SPO) of single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module separately. The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None.

Competence Goal
The student

- is aware of design options for energy and especially electricity markets and can derive implications for the market results from the market design,
- knows about current trends regarding the Smart Grid and understands affiliated modelling aproaches,
- can evaluate business models of electricity grids according to the regulation regime
- is prepared for scientific contributions in the field of energy system analysis.

Content
The module conveys scientific and practical knowledge to analyse energy markets and according business models. To do so the scientific discussion on energy market designs is evaluated and analysed. Different energy market models are presented and their design implications are evaluated. Furthermore, the electricity system is analysed with regards to being a network industry and resulting regulation and business models are discussed. Besides these traditional areas of energy economics we will look at methods and models of digitalisation in the energy sector.

Annotation
The lecture Smart Grid Applications will be available starting in the winter term 2018/19.

Workload
The total workload for this module is approx. 270 hours (9 CP). The allocation is based on the credit points of the courses in the module. The workload for courses with 4.5 CP is approx. 135 hours.

The total number of hours per course results from the time required to attend the lectures and exercises, as well as the examination times and the time required to achieve the qualification objectives of the module for an average student for an average performance.

3.46 Module: Energy Economics and Energy Markets [M-WIWI-101451]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: Operations Management - Data Analysis - Informatics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	8

Mandatory			
T-WIWI-107043	Liberalised Power Markets	5,5 CR	Fichtner
Supplementary Courses (Election:)			
T-WIWI-107501	Energy Market Engineering	4,5 CR	Weinhardt
T-WIWI-112151	Energy Trading and Risk Management	3,5 CR	N.N.
T-WIWI-108016	Simulation Game in Energy Economics	3,5 CR	Genoese
T-WIWI-107446	Quantitative Methods in Energy Economics	3,5 CR	Plötz
T-WIWI-102712	Regulation Theory and Practice	4,5 CR	Mitusch
T-WIWI-113935	Social Dimensions of Energy Transitions	3,5 CR	Fichtner

Competence Certificate
The assessment is carried out as partial written exams (according to Section 4(2), 1 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The examinations take place every semester. Re-examinations are offered at every ordinary examination date.The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
The lecture Liberalised Power Markets has to be examined.

Competence Goal
The student

- gains detailed knowledge about the new requirements of liberalised energy markets,
- describes the planning tasks on the different energy markets,
- knows solution approaches to respective planning tasks.

Content
Liberalised Power Markets: The European liberalisation process, energy markets, pricing, market failure, investment incentives, market power
Energy Trade and Risk Management: trade centres, trade products, market mechanisms, position and risk management
Simulation Game in Energy Economics: Simulation of the German electricity system

Workload
The total workload for this module is approx. 270 hours (9 credits). The allocation is based on the credit points of the courses in the module. The workload for courses with 3.5 credits is approx. 105 hours, for courses with 5.5 credits approx. 165 hours.
The total number of hours per course is calculated from the time required to attend the lectures and exercises, as well as the examination times and the time required for an average student to achieve the learning objectives of the module for an average performance.

Recommendation
The courses are conceived in a way that they can be attended independently from each other. Therefore, it is possible to start the module in winter and summer term.

M 3.47 Module: Energy Economics and Technology [M-WIWI-101452]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	5

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-102793	Efficient Energy Systems and Electric Mobility	3,5 CR	Jochem
T-WIWI-102650	Energy and Environment	3,5 CR	Karl
T-WIWI-113073	Machine Learning and Optimization in Energy Systems	3,5 CR	Fichtner
T-WIWI-107464	Smart Energy Infrastructure	5,5 CR	Ardone, Pustisek
T-WIWI-102695	Heat Economy	3,5 CR	Fichtner

Competence Certificate
The assessment is carried out as partial written exams (according to Section 4(2), 1 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The examinations take place every semester. Re-examinations are offered at every ordinary examination date.The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None

Competence Goal
The student

- gains detailed knowledge about present and future energy supply technologies (focus on final energy carriers electricity and heat),
- knows the techno-economic characteristics of plants for energy provision, for energy transport as well as for energy distribution and demand,
- is able to assess the environmental impact of these technologies.

Content
Heat Economy: district heating, heating technologies, reduction of heat demand, statutory provisions
Energy Systems Analysis: Interdependencies in energy economics, energy systems modelling approaches in energy economics
Energy and Environment: emission factors, emission reduction measures, environmental impact
Efficient Energy Systems and Electric Mobility: concepts and current trends in energy efficiency, Overview of and economical, ecological and social impacts through electric mobility

Workload
The total workload for this module is approx. 270 hours (9 credits). The allocation is based on the credit points of the courses in the module. The workload for courses with 3,5 credits is approx. 105 hours, and for courses with 5,5 credits approx. 165 hours.

The total number of hours per course is calculated from the time required to attend the lectures and exercises, as well as the examination times and the time required for an average student to achieve the learning objectives of the module for an average performance.

3.48 Module: Ergodic Theory [M-MATH-106473]

Responsible: Dr. Gabriele Link
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-113086	Ergodic Theory	8 CR	Link

Competence Certificate
Oral examination of ca. 20-30 minutes.

Prerequisites
None

Competence Goal
Students

- know important examples of dynamical systems,
- can state and discuss substantial concepts of ergodic theory,
- can state important results on qualitative properties of dynamical systems and relate them,
- are prepared to read recent research articles and write a bachelor or master thesis in the field of ergodic theory.

Content

- Elementary examples of dynamical systems such as Bernoulli systems and billiards
- Poincare rekurrence and ergodic theorems
- mixing, weak mixing, equidistribution
- entropy
- advanced topic(s) (as for example hyperbolic dynamics, symbolic dynamics and coding, Furstenberg correspondence principle or unitary representations of SL(2,R))

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
Some basic knowledge of measure theory, topology, geometry, group theory and functional analysis is recommended.

M 3.49 Module: Evolution Equations [M-MATH-102872]

Responsible: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	German/English	4	1

Mandatory			
T-MATH-105844	Evolution Equations	8 CR	Frey, Kunstmann, Schnaubelt

Competence Certificate
Oral examination of ca. 30 minutes.

Prerequisites
none

Competence Goal
The students

- can explain the basics of the theory of strongly continuous operator semigroups and their generators, in particular the theorems on generation and wellposedness, and they can apply it to examples.
- can also describe and use the solution and regularity theory of inhomogeneous Cauchy problems.
- are able to construct analytic semigroups and to characterize their generators. Using these results and perturbations theorems, they can solve partial differential equations.
- are able to explain main aspects of approximation theory of evolution equations.
- can discuss the core statements of stability and spectral theory of operator semigroups and discuss examples by means of them.
- have mastered the important techniques for proofs in evolution equations and are able to, at least, sketch the complicated proofs.

Content

- strongly continuous operator semigroups and their generators,
- generation results and wellposedness,
- inhomogeneous Cauchy problems,
- analytic semigroups,
- perturbation and approximation theory,
- stability and spectral theory of operator semigroups,
- applications to partial differential equations

Module grade calculation
The grade of the module is the grade of the oral exam.

Annotation
Regular cycle: every 2nd year. The module "Nonlinear Evolution Equations" is based on "Evolution Equations"

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The module “Functional Analysis” is strongly recommended.

Literature
K.-J. Engel und R. Nagel, One-Parameter Semigroups for Linear Evolution Equations.

M 3.50 Module: Experimental Economics [M-WIWI-101505]

Responsible: Prof. Dr. Johannes Philipp Reiß
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	2 terms	German/English	4	5

Compulsory Elective Courses (Election: 2 items)			
T-WIWI-102614	Experimental Economics	4,5 CR	Weinhardt
T-WIWI-105781	Incentives in Organizations	4,5 CR	Nieken
T-WIWI-102862	Predictive Mechanism and Market Design	4,5 CR	Reiß
T-WIWI-102863	Topics in Experimental Economics	4,5 CR	Reiß

Competence Certificate
The assessment is carried out as partial exams (according to Section 4 (2), 1-3 SPO) of the core course and further single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module separately.
The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None.

Competence Goal
Students

- are acquainted with the methods of Experimental Economics along with its strengths and weaknesses;
- understand how theory-guided research in Experimental Economics interacts with the development of theory;
- are provided with foundations in data analysis;
- design an economic experiment and analyze its outcome.

Content
The module Experimental Economics offers an introduction into the methods and topics of Experimental Economics. It also fosters and extends knowledge in theory-guided experimental economics and its interaction with theory development. Throughout the module, readings of selected papers are required.

Annotation
The course "Predictive Mechanism and Market Design" is offered every second winter semester, e.g. WS2013 / 14, WS2015 / 16, ...

Workload
Total workload for 9 credit points: approx. 270 hours

The exact distribution is based on the credit points of the courses in the module.

Recommendation
Basic knowledge in mathematics, statistics, and game theory is assumed.

3.51 Module: Exponential Integrators [M-MATH-103700]

Responsible: Prof. Dr. Marlis Hochbruck
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-107475	Exponential Integrators	6 CR	Hochbruck, Jahnke

Competence Certificate
Oral exam of approximately 20 minutes.

Prerequisites
None.

Competence Goal
Graduates will be able to name key concepts for the construction and analysis of exponential integrators and implement them efficiently.

Content
In this class we consider the construction, analysis, implementation and application of exponential integrators. The focus will be on two types of stiff problems.

The first one is characterized by a Jacobian that possesses eigenvalues with large negative real parts. Parabolic partial differential equations and their spatial discretization are typical examples. The second class consists of highly oscillatory problems with purely imaginary eigenvalues of large modulus.

Apart from motivating the construction of exponential integrators for various classes of problems, our main intention in this class is to present the mathematics behind these methods. We will derive error bounds that are independent of stiffness or highest frequencies in the system.

Since the implementation of exponential integrators requires the evaluation of the product of a matrix function with a vector, we will briefly discuss some possible approaches as well.

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 180 h

Attendance: 60 h

- Course including module examination during study.

Self-studies: 120 h

- Deepening the study content by working on the lecture content at home
- Working on exercises
- In-depth study of the course content using suitable literature and Internet research,
- preparation for the module examination during study.

Recommendation
Basic knowledge of ordinary and/or partial differential equations as well as the contents of the module "Numerical Methods for Differential Equations" are strongly recommended. Knowledge of functional analysis is also recommended.

M 3.52 Module: Extremal Graph Theory [M-MATH-102957]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Irregular	1 term	English	4	2

Mandatory			
T-MATH-105931	Extremal Graph Theory	4 CR	Aksenovich

Competence Certificate
The final grade is given based on an oral exam (approx. 30 min.).

Competence Goal
The students understand, describe, and use fundamental notions and techniques in extremal graph theory. They can analyze, structure, and formally describe typical combinatorial questions. The students understand and use Szemeredi's regularity lemma and Szemeredi's theorem, can use probabilistic techniques, such as dependent random choice and multistep random colorings, know the best bounds for the extremal numbers of complete graphs, cycles, complete bipartite graphs, and bipartite graphs with bounded maximum degree. They understand and can use the Ramsey theorem for graphs and hypergraphs, as well as stepping-up techniques for bounding Ramsey numbers. Moreover, the students know and understand the behavior of Ramsey numbers for graphs with bounded maximum degree. The students can communicate using English technical terminology.

Content
The course is concerned with advanced topics in graph theory. It focuses on the areas of extremal functions, regularity, and Ramsey theory for graphs and hypergraphs. Further topics include Turán's theorem, Erdös-Stone theorem, Szemerédi's lemma, graph colorings and probabilistic techniques.

Annotation
Course is held in English

Recommendation
Basic knowledge of linear algebra, analysis and graph theory is recommended.

M 3.53 Module: Extreme Value Theory [M-MATH-102939]

Responsible: Prof. Dr. Vicky Fasen-Hartmann
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	2

Mandatory			
T-MATH-105908	Extreme Value Theory	4 CR	Fasen-Hartmann

Competence Certificate
The module will be completed by an oral exam (approx. 20 min).

Prerequisites
None

Competence Goal
Students are able to

- name, explain, motivate and apply statistical methods for estimating risk measures,
- model and quantify extreme events,
- apply specific probabilistic techniques of extreme value theory,
  - master proof techniques,
- work in a self-organised and reflective manner.

Content

- Theorem of Fisher and Tippett's
- Generalised extreme value and Pareto distribution (GED and GPD)
- Domain of attractions of generalised extreme value distributions
- Theorem of Pickands-Balkema-de Haan
- Estimation of risk measures
- Hill estimator
- Block maxima method
- POT method

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 hours

- lectures and problem classes including the examination.

Self studies: 75 hours

- follow-up and deepening of the course content
- work on problem sheets
- literature and internet research on the course content
- preparation for the module examination

Recommendation
The content of the module "Probability theory" is recommended.

M 3.54 Module: Finance 1 [M-WIWI-101482]

Responsible: Prof. Dr. Martin Ruckes
Prof. Dr. Marliese Uhrig-Homburg

Organisation: KIT Department of Economics and Management

Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	1

Compulsory Elective Courses (Election: 9 credits)			
T-WIWI-102643	Derivatives	4,5 CR	Uhrig-Homburg
T-WIWI-102621	Valuation	4,5 CR	Ruckes
T-WIWI-102647	Asset Pricing	4,5 CR	Ruckes, Uhrig-Homburg

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2), 1 or 2 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None

Competence Goal
The student

- has core skills in economics and methodology in the field of finance
- assesses corporate investment projects from a financial perspective
- is able to make appropriate investment decisions on financial markets

Content
The courses of this module equip the students with core skills in economics and methodology in the field of modern finance. Securities which are traded on financial and derivative markets are presented, and frequently applied trading strategies are discussed. A further focus of this module is on the assessment of both profits and risks in security portfolios and corporate investment projects from a financial perspective.

Workload
The total workload for this module is approx. 270 hours (9 credits). The distribution is based on the credit points of the courses in the module. The workload for courses with 4.5 credits is approx. 135 hours.

The total number of hours per course is calculated from the time required to attend the lectures and exercises, as well as the examination times and the time required for an average student to achieve the learning objectives of the module for an average performance.

3.55 Module: Finance 2 [M-WIWI-101483]

Responsible: Prof. Dr. Martin Ruckes
Prof. Dr. Marliese Uhrig-Homburg

Organisation: KIT Department of Economics and Management

Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	10

Election notes

++

This module will not count towards the degree until the module *Finance 1* has also been successfully completed. If the module Finance 1 is booked out to the additional examinations, the *Finance 2* module loses its curricular validity/valuation for the degree.

++

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-113469	Advanced Corporate Finance	4,5 CR	Ruckes
T-WIWI-110513	Advanced Empirical Asset Pricing	4,5 CR	Thimme
T-WIWI-102647	Asset Pricing	4,5 CR	Ruckes, Uhrig-Homburg
T-WIWI-110995	Bond Markets	4,5 CR	Uhrig-Homburg
T-WIWI-110997	Bond Markets - Models & Derivatives	3 CR	Uhrig-Homburg
T-WIWI-110996	Bond Markets - Tools & Applications	1,5 CR	Uhrig-Homburg
T-WIWI-109050	Corporate Risk Management	4,5 CR	Ruckes
T-WIWI-102643	Derivatives	4,5 CR	Uhrig-Homburg
T-WIWI-110797	eFinance: Information Systems for Securities Trading	4,5 CR	Weinhardt
T-WIWI-102900	Financial Analysis	4,5 CR	Luedecke
T-WIWI-102623	Financial Intermediation	4,5 CR	Ruckes
T-WIWI-102646	International Finance	3 CR	Uhrig-Homburg
T-WIWI-102621	Valuation	4,5 CR	Ruckes

Competence Certificate

The assessment is carried out as partial exams (according to Section 4(2), 1 or 2 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites

It is only possible to choose this module in combination with the module *Finance 1*. The module is passed only after the final partial exam of *Finance 1* is additionally passed.

Competence Goal

The student is in a position to discuss, analyze and provide answers to advanced economic and methodological issues in the field of modern finance.

Content

The module Finance 2 is based on the module Finance 1. The courses of this module equip the students with advanced skills in economics and methodology in the field of modern finance on a broad basis.

Annotation

The courses *eFinance: Information Engineering and Management for Securities Trading* [2540454] and *Financial Analysis* [2530205] can be chosen from summer term 2015 on.

Workload
The total workload for this module is approximately 270 hours. For further information see German version.

3.56 Module: Finance 3 [M-WIWI-101480]

Responsible: Prof. Dr. Martin Ruckes
Prof. Dr. Marliese Uhrig-Homburg

Organisation: KIT Department of Economics and Management

Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	10

Election notes

++

This module will not count towards the degree until the modules *Finance 1* and *Finance 2* have also been successfully completed. If the modules *Finance 1* and/or *Finance 2* are booked out to the additional examinations, the *Finance 3* module loses its curricular validity/valuation for the degree.

++

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-113469	Advanced Corporate Finance	4,5 CR	Ruckes
T-WIWI-110513	Advanced Empirical Asset Pricing	4,5 CR	Thimme
T-WIWI-102647	Asset Pricing	4,5 CR	Ruckes, Uhrig-Homburg
T-WIWI-110995	Bond Markets	4,5 CR	Uhrig-Homburg
T-WIWI-110997	Bond Markets - Models & Derivatives	3 CR	Uhrig-Homburg
T-WIWI-110996	Bond Markets - Tools & Applications	1,5 CR	Uhrig-Homburg
T-WIWI-109050	Corporate Risk Management	4,5 CR	Ruckes
T-WIWI-102643	Derivatives	4,5 CR	Uhrig-Homburg
T-WIWI-110797	eFinance: Information Systems for Securities Trading	4,5 CR	Weinhardt
T-WIWI-102900	Financial Analysis	4,5 CR	Luedecke
T-WIWI-102623	Financial Intermediation	4,5 CR	Ruckes
T-WIWI-102646	International Finance	3 CR	Uhrig-Homburg
T-WIWI-102621	Valuation	4,5 CR	Ruckes
T-WIWI-110933	Web App Programming for Finance	4,5 CR	Thimme

Competence Certificate

The assessment is carried out as partial exams (according to Section 4(2), 1 or 2 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites

It is only possible to choose this module in combination with the module *Finance 1*and *Finance 2*. The module is passed only after the final partial exams of *Finance 1 and Finance 2* are additionally passed.

Competence Goal

The student is in a position to discuss, analyze and provide answers to advanced economic and methodological issues in the field of modern finance.

Content

The courses of this module equip the students with advanced skills in economics and methodology in the field of modern finance on a broad basis.

Workload

The total workload for this module is approximately 270 hours. For further information see German version.

M 3.57 Module: Finite Element Methods [M-MATH-102891]

Responsible: Prof. Dr. Willy Dörfler
Prof. Dr. Christian Wieners

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each winter term	1 term	4	1

Mandatory			
T-MATH-105857	Finite Element Methods	8 CR	Dörfler, Hochbruck, Jahnke, Maier, Rieder, Wieners

M 3.58 Module: Forecasting: Theory and Practice [M-MATH-102956]

Responsible: Prof. Dr. Tilmann Gneiting
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	2 terms	English	4	2

Mandatory			
T-MATH-105928	Forecasting: Theory and Practice	8 CR	Gneiting

Prerequisites
None

Annotation

- Regular cycle: every 2nd year, starting winter semester 16/17
- Course is held in English

M 3.59 Module: Foundations for Advanced Financial -Quant and -Machine Learning Research [M-WIWI-105894]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	see Annotations	1 term	English	4	1

Mandatory			
T-WIWI-111846	Fundamentals for Financial -Quant and -Machine Learning Research	9 CR	Ulrich

Competence Certificate
The module examination is an alternative exam assessment with a maximum score of 100 points to be achieved. These points are distributed over 4 worksheets to be submitted during the semester. The worksheets cover the respective material of the module and are handed out, worked on and assessed in lecture weeks 3 (10 points), 6 (20 points), 9 (30 points) and 12 (40 points).

The module-wide exam (all 4 worksheets) must be taken in the same semester.

The worksheets are a mixture of analytical tasks and programming tasks with financial data.

Competence Goal
This MSc module teaches students fundamental stats and analytics concepts, as well necessary financial economic intuition, necessary to identify, design and execute interesting research questions in quant finance and financial machine learning.
Topics include: Maximum Likelihood learning of arma-garch models, expectation maximization learning applied to stochastic volatility and valuation models, Kalman filter techniques to learn latent states, estimation of affine jump diffusion models with options and higher-order moments, stochastic calculus, dynamic modeling of asset markets (bond, equity, options), equilibrium determination of risk premiums, risk premiums for higher moment risk, risk decomposition (fundamental vs idiosyncratic), option-implied return distributions, mixture-density-networks and neural nets.

Content
Learning Objectives: Skills and understanding of how to successfully set-up, execute and interpret financial data driven research with the following methods: MLE, Kalman Filter, Expectation Maximization, Option Pricing, dynamic asset pricing theory, backward-looking historical return densities, forward-looking options-implied return densities, mixture-density-network, neural networks. Programming is not taught in this course, yet, some graded and non-graded exercises might make heavy use of software based data analysis. See the course's pre-requisites and comments in the modul handbook.

Annotation

- Strongly recommended to have good knowledge in financial econometrics (MLE, OLS, GLS, ARMA-GARCH), mathematics (differential equations, difference equations and optimization), investments (CAPM, factor models), asset pricing (SDF, SDF pricing), derivatives (Black-Scholes, risk-neutral pricing), and programming of statistical concepts (Java or R or Python or Matlab or C or ...)
- Strongly recommended to have a strong interest for interdisciplinary research work in statistics, programming, applied math and financial economics.
- Students lacking the prior knowledge might find the resources of the Chair helpful: www.youtube.com/c/cram-kit.

Workload
The total workload for this course is approximately 270 hours. This is for a student with the appropriate prior knowledge in financial econometrics, finance, mathematics and programming. Students without programming experience of statistical concepts will need to invest extra time. Students who have struggled in math- or programming- or finance- oriented classes, will find this course very challenging. Please check the pre-requisites and comments in the module handbook.

M 3.60 Module: Foundations of Continuum Mechanics [M-MATH-103527]

Responsible: Prof. Dr. Christian Wieners
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Once	1 term	4	2

Election notes
by interest of international students the course will be in English

Mandatory			
T-MATH-107044	Foundations of Continuum Mechanics	4 CR	Wieners

Competence Certificate
Oral exam of approx. 20 minutes.

Prerequisites
none

Competence Goal
Graduates can

- explain the basic concepts in continuum mechanics
- distinguish different models in continuum mechanics and analyze their properties
- applying methods and principles in mathematical modelling for solids and fluids

Content

- kinematic foundations
- balance relations for static problems, Cauchy theorem
- elastic materials
- hyperelastic materials
- balance relations for dynamic probleme, Reynolds theorem
- Newtonian Fluids
- Non-Newtonian Fluids

Module grade calculation
the grade points are the grade points of the oral exam

Workload
in presence: 45 hours

- lecture, exercises, including exam

own study time: 75 hours

- deeper learning of the lecture content by repeating the content at home
- solving the exercises
- deeper learning by reading literature and internet
- preparation of the exam

Recommendation
optimization theory

3.61 Module: Fourier Analysis and its Applications to PDEs [M-MATH-104827]

Responsible: TT-Prof. Dr. Xian Liao
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	3

Mandatory			
T-MATH-109850	Fourier Analysis and its Applications to PDEs	6 CR	Liao

Prerequisites
None

M 3.62 Module: Fractal Geometry [M-MATH-105649]

Responsible: PD Dr. Steffen Winter
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	German/English	4	2

Mandatory			
T-MATH-111296	Fractal Geometry	6 CR	Winter

Competence Certificate
The module will be completed with an oral exam (20 - 30 min).

Prerequisites
None

Competence Goal
Students

- can name and explain important terms and concepts of fractal geometry;
- know important results of dimension theory and can apply them to examples;
- have the ability to use specific methods for the analysis of fractal structures;
- are able to construct fractals and random fractals with certain prescribed properties;
- master important proof techniques in fractal geometry and are able to at least sketch the more difficult proofs;
- are able to work self-organized and in a reflective manner;
- are prepared, to write a thesis in the field of fractal geometry.

Content

- iterated function systems and self-similar sets
- chaos game algorithm
- random fractals
- fractal dimension theory
- Hausdorff measure and dimension
- packing measure and dimension
- Minkowski contents
- methods of computing dimension
- self-similar measures and multifractals
- dimension of measures

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The contents of the courses Analysis 3 (measure theory) and Probability theory are recommended.

M 3.63 Module: Functional Analysis [M-MATH-101320]

Responsible: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each winter term	1 term	4	2

Mandatory			
T-MATH-102255	Functional Analysis	8 CR	Frey, Herzog, Hundertmark, Lamm, Liao, Reichel, Schnaubelt, Tolksdorf

Competence Certificate
Written examination of 120 minutes.

Prerequisites
None

Competence Goal
The students can

- explain basic topological concepts such as compactness in the framework of metric spaces, and are able to apply these in examples.
- describe the structure of Hilbert spaces and can use them in applications.
- explain the principle of uniform boundedness, the open mapping theorem and the Hahn-Banach theorem, and are able to derive conclusions from them.
- describe the concepts of dual Banach spaces, in particular weak convergence, reflexivity and the Banach-Alaoglu theorem. They can discuss these concepts in examples.
- explain the spectral theorem for compact self-adjoint operators.
- come up with a proof for simple functional analytic statements.

Content

- Metric spaces (basic topological concepts, compactness),
- Hilbert spaces, Orthonormal bases, Sobolev spaces,
- Continuous linear operators on Banach spaces (principle of uniform boundedness, open mapping theorem),
- Dual spaces and representations, Hahn-Banach theorem, Banach-Alaoglu theorem, weak convergence, reflexivity,
- Spectral theorem for compact self-adjoint operators.

Module grade calculation
The grade of the module is the grade of the written exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

M 3.64 Module: Functional Data Analysis [M-MATH-106485]

Responsible: Dr. rer. nat. Bruno Ebner
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Irregular	1 term	English	4	2

Mandatory			
T-MATH-113102	Functional Data Analysis	4 CR	Ebner, Klar, Trabs

Competence Certificate
Oral examination of ca. 25 minutes.

Prerequisites
None

Competence Goal
The aim of the course is to give an introduction to weak convergence concepts in metric spaces and to highlight some statistical applications.

After successful participation students can

- model random elements in metric spaces,
- explain the concept of weak convergence in metric spaces and are familiar with structural problems in this context,
- apply limit laws for functionals of the empirical distribution function,
- model the normal distribution for random elements in Hilbert spaces,
- derive limit distributions of L2 type goodness-of-fit statistics,
- apply goodness-of-fit tests to functional data.

Content

- Theorem of Glivenko-Cantelli,
- weak convergence in metric spaces,
- Theorem of Prokhorov,
- Gaussian Processes,
- Donsker's Theorem,
- functional central limit theorem,
- empirical processes,
- random elements in separable Hilbert spaces,
- Goodness-of-fit tests.

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 h

- lectures and examination

Self studies: 75 h

- follow-up and deepening of the course content,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The contents of the modules "Probability Theory" and "Mathematical Statistics" are strongly recommended.

M 3.65 Module: Functions of Matrices [M-MATH-102937]

Responsible: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105906	Functions of Matrices	8 CR	Grimm

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
none

Competence Goal
The students know the basic definitions and properties of matrix functions. They can evaluate methods for approximating matrix functions in terms of convergence and efficiency, independently solve exercises, present their own solutions and implement the methods discussed.

Content

- Definition of functions of matrices
- Approximations to functions of matrices for large sparse matrices
- Krylov subspace methods and rational Krylov subspace methods
- Application to the numerical solution of partial differential equations

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The courses Numerical Analysis 1 and 2 are strongly recommended.

3.66 Module: Functions of Operators [M-MATH-102936]

Responsible: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105905	Functions of Operators	6 CR	

Competence Certificate
The module will be completed by an oral exam (ca. 20 min).

Prerequisites
None

Competence Goal
The students have basic knowledge of the approximation of functions of operators. They can examine the methods for convergence properties and efficiency. In the context of semigroups, they can analyze the procedures discussed, independently select the appropriate procedures and justify their choice.

Content

- Definition of functions of operators
- Strongly continuous and analytic semigroups
- Rational approximations to functions of operators with fixed poles
- Rational Krylov subspace method for the approximation of functions of operators
- Applications in the numerical analysis of semigroups

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The courses Numerical Analysis 1 and 2, and Functional Analysis are strongly recommended.

3.67 Module: Generalized Regression Models [M-MATH-102906]

Responsible: PD Dr. Bernhard Klar
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	2

Mandatory			
T-MATH-105870	Generalized Regression Models	4 CR	Ebner, Fasen-Hartmann, Klar, Trabs

Competence Certificate
The module will be completed by an oral exam (ca. 20 min).

Prerequisites
None

Competence Goal
At the end of the course, students will

- be familiar with the most important regression models and their properties,
- be able to evaluate and interpret the results obtained using these models,
- be able to use the models to analyze more complex data sets.

Content
This course covers basic models of statistics that allow us to capture relationships between variables. Topics include

- Linear regression models:
  Model diagnostics
  Multicollinearity
  Variable selection
  Generalized least squares
- Nonlinear regression models:
  Parameter estimation
  Asymptotic normality of maximum likelihood estimators
- Regression models for count data
- Generalized linear models:
  Parameter estimation
  Model diagnostics
  Overdispersion and quasi-likelihood

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: 75 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the course "Statistics" are strongly recommended.

3.68 Module: Geometric Group Theory [M-MATH-102867]

Responsible: Prof. Dr. Roman Sauer
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	see Annotations	1 term	4	1

Mandatory			
T-MATH-105842	Geometric Group Theory	8 CR	Herrlich, Link, Llosa Isenrich, Sauer, Tuschmann

Annotation
This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

M 3.69 Module: Geometric Numerical Integration [M-MATH-102921]

Responsible: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105919	Geometric Numerical Integration	6 CR	Hochbruck, Jahnke

Competence Certificate
The module will be completed by an oral exam (about 20 min).

Prerequisites
none

Competence Goal
After attending the course, students understand the central properties of finite-dimensional Hamilton systems (energy conservation, symplectic flow, first integrals etc.). They know important classes of geometric time integrators such as, e.g., symplectic (partitioned) Runge-Kutta methods, splitting methods, SHAKE and RATTLE. They are not only able to implement these methods and apply them to practice-oriented problems, but also to analyze and explain the observed long-time behavior (e.g. approximative energy conservation over long times).

Content

- Newtonian equation of motion, Lagrange equations, Hamilton systems
- Properties of Hamilton systems: symplectic flow, energy conservation, other conserved quantities
- Symplectic numerical methods: symplectic Euler method, Störmer-Verlet method, symplectic (partitioned) Runge-Kutta methods
- Construction of symplectic methods, for example by composition and splitting
- Backward error analysis and energy conservation over long time intervals
- Mechanical systems with constraints

Module grade calculation
The module grade is the grade of the oral exam.

Annotation
The module is offered about every two years

Workload
Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
Familiarity with ordinary differential equations and Runge-Kutta methods (construction, order, stability, etc.) are strongly recommended. The course "Numerical methods for differential equations" provides an excellent basis. Moreover, programming skills in MATLAB are strongly recommended.

M 3.70 Module: Geometric Variational Problems [M-MATH-106667]

Responsible: Prof. Dr. Tobias Lamm
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-113418	Geometric Variational Problems	8 CR	Lamm

Competence Certificate
oral exam of ca. 30 min

Prerequisites
none

Competence Goal
The students

- can name basic results in the theory of geometric variational problems and relate them to each other;
- are prepared to write a thesis in the field of geometric analysis.

Content

- Harmonic maps
- Willmore surfaces
- Regularity theory
- Hardy and BMO spaces

Module grade calculation
The module grade is the grade of the oral examination.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The modules *Classical Methods for Partial Differential Equations* and *Functional Analysis* are recommended.

M 3.71 Module: Geometry of Schemes [M-MATH-102866]

Responsible: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	5	1

Mandatory			
T-MATH-105841	Geometry of Schemes	8 CR	Herrlich, Kühnlein

Competence Certificate
The modules is completed by an oral exam of about 30 minutes

Prerequisites
None

Competence Goal
At the end of the module, participants are able to

- relate the notion of algebraic schemes with that of algebraic varieties
- name and discuss basic properties of schemes
- deal with sheaves on schemes and investigate their properties
- start to read recent research papers in algebraic geometry and write a thesis in this field.

Content

- Sheaves of modules
- affine schemes
- varieties and schemes
- morphisms between schemes
- coherent and quasicoherent sheaves
- cohomology of sheaves

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total work load. 240 hours

Attendance: 90 hours

- lectures, problem classes and examination

Self studies: 150 hours

- follow-up and deepening of the course content
- work on problem sheets
- literature studies and internet research relating to the course content
- preparation for the module examination

Recommendation
The modules "Algebra" and "Algebraic Geometry" are strongly recommended.

M 3.72 Module: Global Differential Geometry [M-MATH-102912]

Responsible: Prof. Dr. Wilderich Tuschmann
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	5	1

Mandatory			
T-MATH-105885	Global Differential Geometry	8 CR	Tuschmann

Prerequisites
none

3.73 Module: Graph Theory [M-MATH-101336]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	English	4	3

Mandatory			
T-MATH-102273	Graph Theory	8 CR	Aksenovich

Competence Certificate
The final grade is given based on the written final exam (3h).

By successfully working on the problem sets, a bonus can be obtained. To obtain the bonus, one has to achieve 50% of the points on the solutions of the exercise sheets 1-6 and also of the exercise sheets 7-12. If the grade in the final written exam is between 4,0 and 1,3, then the bonus improves the grade by one step (0,3 or 0,4).

Prerequisites
None

Competence Goal
The students understand, describe and use fundamental notions and techniques in graph theory. They can represent the appropriate mathematical questions in terms of graphs and use the results such as Menger's theorem, Kuratowski's theorem, Turan's theorem, as well as the developed proof ideas, to solve these problems. The students can analyze graphs in terms of their characteristics such as connectivity, planarity, and chromatic number. They are well positioned to understand graph theoretic methods and use them critically. Moreover, the students can communicate using English technical terminology.

Content
The course Graph Theory treats the fundamental properties of graphs, starting with basic ones introduced by Euler and including the modern results obtained in the last decade. The following topics are covered: structure of trees, paths, cycles and walks in graphs, minors, unavoidable subgraphs in dense graphs, planar graphs, graph coloring, Ramsey theory, and regularity in graphs.

Annotation

- Course is held in English
- This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

3.74 Module: Group Actions in Riemannian Geometry [M-MATH-102954]

Responsible: Prof. Dr. Wilderich Tuschmann
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	5	1

Mandatory			
T-MATH-105925	Group Actions in Riemannian Geometry	5 CR	Tuschmann

Prerequisites
none

M 3.75 Module: Harmonic Analysis [M-MATH-105324]

Responsible: Prof. Dr. Dorothee Frey
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	2

Mandatory			
T-MATH-111289	Harmonic Analysis	8 CR	Frey, Kunstmann, Schnaubelt, Tolksdorf

Content

- Fourier series
- Fourier transform on L1 and L2
- Tempered distributions and their Fourier transform
- Explizit solutions of the Heat-, Schrödinger- and Wave equation in Rn
- the Hilbert transform
- the interpolation theorem of Marcinkiewicz
- Singular integral operators
- the Fourier multiplier theorem of Mihlin

M 3.76 Module: Harmonic Analysis 2 [M-MATH-106486]

Responsible: Prof. Dr. Dorothee Frey
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-113103	Harmonic Analysis 2	8 CR	Frey, Kunstmann, Tolksdorf

Competence Certificate
Oral examination of ca. 30 minutes.

Prerequisites
None

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The following modules are strongly recommended: "Harmonic Analysis", "Functional Analysis".

M 3.77 Module: Homotopy Theory [M-MATH-102959]

Responsible: Prof. Dr. Roman Sauer
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-105933	Homotopy Theory	8 CR	Sauer

3.78 Module: Informatics [M-WIWI-101472]

Responsible: Dr.-Ing. Tobias Käfer
Prof. Dr. Sanja Lazarova-Molnar
Prof. Dr. Andreas Oberweis
Prof. Dr. Harald Sack
Prof. Dr. Ali Sunyaev
Prof. Dr. Alexey Vinel
Prof. Dr. Melanie Volkamer
Prof. Dr.-Ing. Johann Marius Zöllner

Organisation: KIT Department of Economics and Management

Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	20

Compulsory Elective Area (Election:)			
T-WIWI-110339	Applied Informatics – Principles of Internet Computing: Foundations for Emerging Technologies and Future Services	4,5 CR	Sunyaev
T-WIWI-102680	Computational Economics	4,5 CR	Shukla
T-WIWI-112690	Cooperative Autonomous Vehicles	4,5 CR	Vinel
T-WIWI-113363	Collective Perception in Autonomous Driving	4,5 CR	Vinel
T-WIWI-109248	Critical Information Infrastructures	4,5 CR	Sunyaev
T-WIWI-109246	Digital Health	4,5 CR	Sunyaev
T-WIWI-102661	Database Systems and XML	4,5 CR	Oberweis
T-WIWI-110346	Supplement Enterprise Information Systems	4,5 CR	Oberweis
T-WIWI-110372	Supplement Software- and Systemsengineering	4,5 CR	Oberweis
T-WIWI-113059	Human Factors in Autonomous Driving	4,5 CR	Vinel
T-WIWI-109270	Human Factors in Security and Privacy	4,5 CR	Volkamer
T-WIWI-106423	Information Service Engineering	4,5 CR	Sack
T-WIWI-113968	Management of IT-Projects	4,5 CR	Alpers
T-WIWI-102666	Knowledge Discovery	4,5 CR	Käfer
T-WIWI-106340	Machine Learning 1 - Basic Methods	4,5 CR	Zöllner
T-WIWI-106341	Machine Learning 2 – Advanced Methods	4,5 CR	Zöllner
T-WIWI-112685	Modeling and Simulation	4,5 CR	Lazarova-Molnar
T-WIWI-102697	Business Process Modelling	4,5 CR	Oberweis
T-WIWI-102679	Nature-Inspired Optimization Methods	4,5 CR	Shukla
T-WIWI-109799	Process Mining	4,5 CR	Oberweis
T-WIWI-110848	Semantic Web Technologies	4,5 CR	Käfer
T-WIWI-102895	Software Quality Management	4,5 CR	Oberweis
Seminars and Advanced Labs (Election: between 0 and 1 items)			
T-WIWI-110144	Emerging Trends in Digital Health	4,5 CR	Sunyaev
T-WIWI-110143	Emerging Trends in Internet Technologies	4,5 CR	Sunyaev
T-WIWI-109249	Sociotechnical Information Systems Development	4,5 CR	Sunyaev
T-WIWI-111126	Advanced Lab Blockchain Hackathon (Master)	4,5 CR	Sunyaev
T-WIWI-111125	Advanced Lab Sociotechnical Information Systems Development (Master)	4,5 CR	Sunyaev
T-WIWI-110548	Advanced Lab Informatics (Master)	4,5 CR	Professorenschaft des Instituts AIFB
T-WIWI-112914	Advanced Lab Realization of Innovative Services (Master)	4,5 CR	Oberweis
T-WIWI-108439	Advanced Lab Security, Usability and Society	4,5 CR	Volkamer

T-WIWI-109985	Project Lab Cognitive Automobiles and Robots	5 CR	Zöllner
T-WIWI-109983	Project Lab Machine Learning	5 CR	Zöllner
T-WIWI-113026	Trustworthy Emerging Technologies	4,5 CR	Sunyaev

Competence Certificate
The assessment is carried out as partial exams of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. For passing the module exam in every singled partial exam the respective minimum requirements has to be achieved.

The examinations are offered every semester. Re-examinations are offered at every ordinary examination date. The assessment procedures are described for each course of the module separately.

When every singled examination is passed, the overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
It is only allowed to choose one lab.

Competence Goal
The student

- has the ability to master methods and tools in a complex discipline and to demonstrate innovativeness regarding the methods used,
- knows the principles and methods in the context of their application in practice,
- is able to grasp and apply the rapid developments in the field of computer science, which are encountered in work life, quickly and correctly, based on a fundamental understanding of the concepts and methods of computer science,
- is capable of finding and defending arguments for solving problems.

Content
The thematic focus will be based on the choice of courses in the areas of Applied Technical Cognitive Systems, Business Information Systems, Critical Information Infrastructures, Information Service Engineering, Security - Usability - Society or Web Science.

Workload
The total workload for this module is approximately 270 hours. The total number of hours per course is calculated from the time required to attend the lectures and exercises, as well as the examination times and the time required for an average student to achieve the learning objectives of the module.

M 3.79 Module: Information Systems in Organizations [M-WIWI-104068]

Responsible: Prof. Dr. Alexander Mädche
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	2 terms	English	4	5

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-105777	Business Intelligence Systems	4,5 CR	Mädche
T-WIWI-113465	Designing Interactive Systems: Human-AI Interaction	4,5 CR	Mädche
T-WIWI-114210	(Gen)AI-based Automation in Organizations	4,5 CR	Mädche
T-WIWI-113459	Practical Seminar: Human-Centered Systems	4,5 CR	Mädche

Competence Certificate
The assessment is carried out as partial exams (according to Section 4 (2), 1-3 SPO) of the core course and further single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module separately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None

Competence Goal
The student

- has a comprehensive understanding of conceptual and theoretical foundations of informations systems in organizations
- is aware of the most important classes of information systems used in organizations:. process-centric, information-centric and people-centric information systems.
- knows the most important activities required to execute in the pre-implementation, implementation and post-implementation phase of information systems in organizations in order to create business value
- has a deep understanding of key capabilities of business intelligence systems and/or interactive information systems used in organizations

Content
During the last decades we witnessed a growing importance of Information Technology (IT) in the business world along with faster and faster innovation cycles. IT has become core for businesses from an operational company-internal and external customer perspective. Today, companies have to rethink their way of doing business, from an internal as well as an external digitalization perspective.

This module focuses on the internal digitalization perspective. The contents of the module abstract from the technical implementation details and focus on foundational concepts, theories, practices and methods for information systems in organizations. The students get the necessary knowledge to guide the successful digitalization of organizations. Each lecture in the module is accompanied with a capstone project that is carried out in cooperation with an industry partner.

Annotation
New module starting summer term 2018.

Workload
The total workload for this module is approximately 270 hours.

M 3.80 Module: Integral Equations [M-MATH-102874]

Responsible: PD Dr. Frank Hettlich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105834	Integral Equations	8 CR	Arens, Griesmaier, Hettlich

Competence Certificate
The module will be completed by an oral exam (~30min.).

Prerequisites
none

Competence Goal
The students can clarify integral equations and can show existence and uniqueness of solutions by perturbation theory and by Fredholm theory. Ideas of proofs for Fredholm theory and perturbation theory especially in case of convolution equations can be described and explained. Furthermore, the students can formulate classical boundary value problems for ordinary differential equations and from potential theory in terms of integral equations.

Content

- Riesz and Fredholm theory
- Fredholm and Volterra integral equations
- Applications in potential theory
- convolution equation

Module grade calculation
The module grade is the the grade of the oral exam

Workload
Total workload: 240h

Attendance: 90h

- Lecture, problem class, examination

Self studies: 150h

- follow-up and deepening of the course content
- work on problem sheets
- literature studies and internet research related to the course content
- preparation of the module examination

M 3.81 Module: Introduction into Particulate Flows [M-MATH-102943]

Responsible: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
3	Grade to a tenth	Once	1 term	4	1

Mandatory			
T-MATH-105911	Introduction into Particulate Flows	3 CR	Dörfler

Prerequisites
none

M 3.82 Module: Introduction to Convex Integration [M-MATH-105964]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-112119	Introduction to Convex Integration	3 CR	Zillinger

Competence Certificate
The module will be completed with an oral exam (approx. 30 min).

Prerequisites
none

Competence Goal
The main aim of this lecture is to introduce students to convex integration as a tool to construct solutions to partial differential equations.
In particular, they will be able to

- discuss the structure of convex integration algorithms,
- state major theorems and their relation,
- discuss regularity of convex integration solutions and uniqueness,
- discuss building blocks of constructions and their properties.

Content
This lecture provides an introduction to the methods of convex integration and its applications:

- for isometric immersions,
- for the m-well problem in elasticity,
- for equations of fluid dynamics and
- higher regularity of convex integration solutions.

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 90 hours

Attendance: 30 h

- lectures and examination

Self studies: 60 h

- follow-up and deepening of the course content,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The modules "Classical Methods for Partial Differential Equations" and "Functional Analysis" are recommended.

3.83 Module: Introduction to Dynamical Systems [M-MATH-106591]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-113263	Introduction to Dynamical Systems	6 CR	de Rijk, Reichel

Competence Certificate
The module will be completed with an oral exam of about 30 minutes.

Prerequisites
None

Competence Goal
After successful completion of this module students

- can explain the significance of dynamical systems and give several examples;
- have acquired miscellaneous tools to prove the existence of special solutions and to analyze the local dynamics around them;
- master several techniques to describe global dynamics in certain classes of dynamical systems;
- identify various bifurcations and explain how these change the dynamics of the system;
- outline the main steps in establishing chaotic behavior.

Content

- Flows
- Abstract dynamical systems
- Lyapunov functions
- Invariant sets
- Limit sets and attractors
- Hartman-Grobman theorem
- Local (un)stable manifold theorem
- Poincaré-Bendixson theorem
- Periodic orbits and Floquet theory
- Exponential dichotomies
- Melnikov functions
- Lin's method
- Hamiltonian dynamics
- Liénard systems
- Bifurcations
- Chaotic dynamics
- (Introduction to) Fenichel theory
- Center manifolds
- Dynamical systems associated with semilinear evolution equations

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The following modules are strongly recommended: Analysis 1-2 and Linear Algebra 1-2. The module Analysis 4 is recommended.

M 3.84 Module: Introduction to Fluid Dynamics [M-MATH-105650]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
3	Grade to a tenth	Irregular	1 term	4	2

Mandatory			
T-MATH-111297	Introduction to Fluid Dynamics	3 CR	Reichel

Competence Certificate
The module will be completed by an oral exam (approx. 30 min).

Prerequisites
None

Competence Goal
The main aim of this lecture is to introduce students to mathematical fluid dynamics. In particular, by the end of the course students will be able to

- discuss and explain the various formulations of the Euler equations and when these formulations are equivalent,
- state major theorems and their relation,
- discuss weak formulations, existence and uniqueness results.

Content
Mathematical description and analysis of fluid dynamics:

- physical motivation of the incompressible Euler and Navier-Stokes equations,
- Vorticity-Stream formulation and Eulerian and Lagrangian coordinates,
- Local existence theory and energy methods,
- Weak solutions and the Beale-Kato-Majda criterion.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 90 hours

Attendance: 30 hours

- lectures, problem classes, and examination

Self-studies: 60 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the courses "Classical Methods for Partial Differential Equations" or "Boundary and Eigenvalue Problems" are recommended.

M 3.85 Module: Introduction to Fluid Mechanics [M-MATH-106401]

Responsible: TT-Prof. Dr. Xian Liao
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-112927	Introduction to Fluid Mechanics	6 CR	Liao

Competence Certificate
The module examination takes the form of an oral examination of approx. 25 minutes.

Prerequisites
None

Competence Goal
Graduates can

- recognize the essential formulations of the partial differential equations in fluid mechanics and explain them using examples,
- use techniques to describe the weak and strong solutions for the Euler and Navier-Stokes equations, and show the existence, uniqueness and regularity results,
- name the special difficulties in the three-dimensional case,
- understand the concept of stratification and explain it using concrete examples.

Content

- Derivation of models, modeling
- Euler equations, Navier-Stokes equations
- Biot-Savart law, Leray-Hopf decomposition
- Wellposedness results
- Regularity results

Module grade calculation
The module grade is the grade of the oral exam.

Workload
total work load: 180 hours

Recommendation
The module *Functional Analysis* is strongly recommended.

M 3.86 Module: Introduction to Geometric Measure Theory [M-MATH-102949]

Responsible: PD Dr. Steffen Winter
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105918	Introduction to Geometric Measure Theory	6 CR	Winter

Prerequisites
none

3.87 Module: Introduction to Homogeneous Dynamics [M-MATH-105101]

Responsible: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-110323	Introduction to Homogeneous Dynamics	6 CR	Hartnick

Prerequisites
None

3.88 Module: Introduction to Kinetic Equations [M-MATH-105837]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	English	4	2

Mandatory			
T-MATH-111721	Introduction to Kinetic Equations	3 CR	Zillinger

Competence Certificate
oral examination of approx. 30 minutes

Prerequisites
none

Competence Goal
The main aim of this lecture is to introduce students to the theory of kinetic transport equations. In particular, by the end of the course students will be able to

- discuss properties of the free transport, Boltzmann and Vlasov-Poisson equations,
- state major theorems and their relation,
- discuss notions of solutions and their properties,
- discuss the effects of phase mixing and challenges of nonlinear equations.

Content
Mathematical description and analysis of kinetic transport equations:

- the free transport, Boltzmann and Vlasov-Poisson equations,
- linear theory, phase mixing and Landau damping,
- equilibrium solutions and stability,
- nonlinear results and methods,
- renormalized solutions.

Module grade calculation
The module grade is the grade of the final oral exam.

Workload
Totel workload: 90 h

Attendance: 30 h

- lectures and examination

Self studies: 60 h

- follow-up and deepening of the course content,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The contents of the course "Classical Methods for Partial Differential Equations" are recommended.

M 3.89 Module: Introduction to Kinetic Theory [M-MATH-103919]

Responsible: Prof. Dr. Martin Frank
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MATH-108013	Introduction to Kinetic Theory	4 CR	Frank

Prerequisites
None

Competence Goal
After successfully taking part in the module's classes and exams, students have gained knowledge and abilities as described in the "Inhalt" section. Specifically, Students know common means of mesoscopic and macroscopic description of particle systems. Furthermore, students are able to describe the basics of multiscale methods, such as the asypmtotic analysis and the method of moments. Students are able to apply numerical methods to solve engineering problems related to particle systems. They can name the assumptions that are needed to be made in the process. Students can judge whether specific models are applicable to the specific problem and discuss their results with specialists and colleagues.

Content

- From Newton's equations to Boltzmann's equation
- Rigorous derivation of the linear Boltzmann equation
- Properties of kinetic equations (existence & uniqueness, H theorem)
- The diffusion limit
- From Boltzmann to Euler & Navier-Stokes
- Method of Moments
- Closure techniques
- Selected numerical methods

Recommendation
Partial Differential Equations, Functional Analysis

M 3.90 Module: Introduction to Microlocal Analysis [M-MATH-105838]

Responsible: TT-Prof. Dr. Xian Liao
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-111722	Introduction to Microlocal Analysis	3 CR	Liao

Competence Certificate
oral examination of circa 30 minutes

Prerequisites
none

Competence Goal

- Students will become familiar with the notions of Fourier multipliers and pseudo-differential operators
- Students can state major theorems and their relation
- Students will understand the structure of the propagation of singularities by introducing the wave front set and apply them to the domain of partial differential equations, control theory, etc.

Content

1. Pseudo-differential operators
2. Symbolic calculus
3. Wavefront set
4. Propagation of singularities
5. Microlocal defective measure

Module grade calculation
The module grade is the grade of the final oral exam.

Workload
Totel workload: 90 h

Attendance: 30 h

- lectures and examination

Self studies: 60 h

- follow-up and deepening of the course content,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The following courses should be studied beforehand: "Classical Methods for Partial Differential Equations" und "Functional Analysis".

M 3.91 Module: Introduction to Scientific Computing [M-MATH-102889]

Responsible: Prof. Dr. Willy Dörfler
Prof. Dr. Tobias Jahnke

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each summer term	1 term	4	3

Mandatory			
T-MATH-105837	Introduction to Scientific Computing	8 CR	Dörfler, Hochbruck, Jahnke, Rieder, Wieners
T-MATH-114059	Project Lab Scientific Computing	0 CR	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

Competence Certificate
The module will be completed by an oral exam (about 30 min).

Requirement for exam: Successful Hands-on tutorial

Prerequisites
None

Competence Goal
At the end of the course, students

- are able to develop the interlinking of all aspects of scientific computing using simple examples: from modeling and algorithmic implementation to stability and error analysis.
- can explain concepts of modeling with differential equations
- are able to implement simple application examples algorithmically, evaluate the code and present and discuss the results.

Content

- Numerical methods for initial value problems, boundary value problems, and initial boundary value problems
- Modelling with differential equations
- Algorithmic realization of applications
- Presentation of results of scientific computations

Module grade calculation
The module grade is the grade of the oral exam.

Annotation
3 SWS lecture plus 3 SWS hands-on training

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets and coding,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation

It is strongly recommended that participants have completed the modules "Numerische Mathematik 1 und 2" as well as "Programmieren: Einstieg in die Informatik und algorithmische Mathematik".

M 3.92 Module: Introduction to Stochastic Differential Equations [M-MATH-106045]

Responsible: Prof. Dr. Mathias Trabs
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-112234	Introduction to Stochastic Differential Equations	4 CR	Janák, Trabs

Competence Certificate
The module will be completed with an oral exam (approx. 30 min).

Prerequisites
none

Competence Goal
The students will

- know fundamental examples for linear and non-linear stochastic differential equations,
- be able to apply basic solution concepts for stochastic differential equations,
- know fundamental theorems of stochastic calculus and will be able to apply these to stochastic differential equations.

Content

1. Introduction and recapitulation of stochastic integration, Itô's formula, Lévy Theorem
2. Burkholder-Davis-Gundy inequality
3. Existence and uniqueness of solutions of stochastic differential equations
4. Explicit solutions of linear stochastic differential equations
5. Change of the time scale of Brownian motion
6. Representation of continuous time martingales
7. Brownian martingales
8. Local and global solutions of stochastic differential equations
9. Girsanov Theorem

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: 75 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the course "Probability Theory" are strongly recommended. The contents of the course "Continuous Time Finance" are recommended.

3.93 Module: Inverse Problems [M-MATH-102890]

Responsible: Prof. Dr. Roland Griesmaier
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each winter term	1 term	4	1

Mandatory			
T-MATH-105835	Inverse Problems	8 CR	Arens, Griesmaier, Hettlich, Rieder

Competence Certificate
The module will be completed by an oral exam (approx. 30 min).

Prerequisites
None

Competence Goal
At the end of the course, students are able to distinguish well-posed from ill-posed problems. They acquire a systematic knowledge of the theory of linear inverse problems and their regularization in Hilbert spaces and can provide proof ideas. They are able to analyze regularization methods such as, e.g., Tikhonov regularization and assess their convergence properties.

Content

- Compact operator equations
- Ill-posed problems
- Regularization
- Tikhonov regularization
- Iterative regularization
- Examples for ill-posed problems

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course "Functional Analysis" or "Integral Equations" is recommended as a prerequisite.

M 3.94 Module: Lie Groups and Lie Algebras [M-MATH-104261]

Responsible: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	German	4	1

Mandatory			
T-MATH-108799	Lie Groups and Lie Algebras	8 CR	Hartnick

Annotation
This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

3.95 Module: Lie-Algebras [M-MATH-106950]

Responsible: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	German	4	1

Mandatory			
T-MATH-113907	Lie-Algebras	8 CR	Hartnick

Annotation
This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

M 3.96 Module: Marketing and Sales Management [M-WIWI-105312]

Responsible: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Economics and Management
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each summer term	1 term	English	4	9

Compulsory Elective Courses (Election:)			
T-WIWI-112693	Digital Marketing	4,5 CR	Kupfer
T-WIWI-106981	Digital Marketing and Sales in B2B	1,5 CR	Klarmann, Konhäuser
T-WIWI-114174	Economic Decision Making	4,5 CR	Scheibehenne
T-WIWI-110985	International Business Development and Sales	6 CR	Casenave , Klarmann, Terzidis
T-WIWI-107720	Market Research	4,5 CR	Klarmann
T-WIWI-111848	Online Concepts for Karlsruhe City Retailers	3 CR	Klarmann
T-WIWI-102883	Pricing	4,5 CR	Klarmann

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2) of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. For passing the module exam in every singled partial exam the respective minimum requirements has to be achieved.

When every singled examination is passed, the overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
The course "Market Research" is obligatory.

Competence Goal
Students

- have an advanced knowledge about central marketing contents
- have a fundamental understanding of the marketing instruments
- know and understand several strategic concepts and how to implement them
- are able to implement their extensive marketing knowledge in a practical context
- know several qualitative and quantitative approaches to prepare decisions in Marketing
- have the theoretical knowledge to write a master thesis in Marketing
- have the theoretical knowledge to work in/together with the Marketing department

Content
The aim of this module is to deepen central marketing contents in different areas.

Workload
The total workload for this module is approximately 270 hours.

3.97 Module: Markov Decision Processes [M-MATH-102907]

Responsible: Prof. Dr. Nicole Bäuerle
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105921	Markov Decision Processes	5 CR	Bäuerle

Competence Certificate
The module will be completed by an oral exam (about 20 min).

Prerequisites
none

Competence Goal
At the end of the course, students

- can name the mathematical foundations of Markov Decision Processes and apply solution algorithm,
- can formulate stochastic, dynamic optimization problems as Markov Decision Processes,
- are able to work in a self-organized and reflective manner.

Content

- MDPs with finite time horizon
  - Bellman equation
  - Problems with structure
  - Applications
- MDPs with infinite time horizon
  - contracting MDPs
  - positive MDPs
  - Howards policy improvement
  - Solution by linear programs
- Stopping problems
  - finite and infinite time horizon
  - One-step-look-ahead rule

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course 'Probability theory' is strongly recommended and 'Markov chains' is recommended.

M 3.98 Module: Master's Thesis [M-MATH-102917]

Responsible: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: Master's Thesis

Credits	Grading scale	Recurrence	Duration	Level	Version
30	Grade to a tenth	Each term	1 term	4	1

Mandatory			
T-MATH-105878	Master's Thesis	30 CR	Kühnlein

Competence Certificate
The Master's Thesis is graded according to the regulations from §14 (7) of Studien- und Prüfungsordnung. The handling time is six months. On submission of the Master's Thesis, according to §14 (5) the students have to confirm, that the thesis has been written independently without using undisclosed sources and tools, that passages which have been copied literally or in content have clearly been marked as such, and that the by-laws to implement scientific integrity at KIT in the recent version have been taken into account. If this confirmation is not contained, the thesis gets rejected. In case of a wrong confirmation, the thesis is graded with "not sufficient" (5.0). The thesis may be written in English.

If the thesis is planned to be written outside the KIT-departments of Mathematics or Economics and Management, the approval by the examination board is required.

Further details are regulated by §14 of Studien- und Prüfungsordnung.

Prerequisites
For admission to the module Master's Thesis it is required that the student has successfully accomplished module examinations of at least 70 credit points.

Competence Goal
The students are able to work on a given topic independently and in a limited time, using scientific methods from the state of the art. They master the necessary scientific methods and techniques, modify them if necessary and develop them further if required. Alternative approaches are compared critically. In their thesis, the students write up their results clearly structured and in a way adequate to academic standards.

Content
Following §14 SPO the thesis should demonstrate that the students are able to work on a given topic from their course of studies independently and in a bounded time, using scientific methods from the state of the art. The students should have the opportunity to make suggestions for their topic. If the student petitions, in exceptional cases the head of the examination board takes care that the student receives a topic for a master thesis within four weeks. In that case, the topic is given by the head of the examination board. Further details are regulated by §14 of Studien- und Prüfungsordnung.

Workload
Total work load: 900 hours

Attendance: 0 hours

Self studies: 900 hours

M 3.99 Module: Mathematical Methods in Signal and Image Processing [M-MATH-102897]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105862	Mathematical Methods in Signal and Image Processing	8 CR	Rieder

Competence Certificate
Success is assessed in the form of an oral examination lasting approx. 30 minutes.

Prerequisites
none

Competence Goal
Graduates know the essential mathematical tools of signal and image processing and their properties. They are able to apply these tools appropriately and to scrutinize and evaluate the results obtained.

Content

- Digital and analog systems
- Integral Fourier transform
- Sampling and resolution
- Discrete and fast Fourier transform
- Non-uniform sampling
- Anisotropic diffusion filters
- Variational methods

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course "Functional analysis" is recommended.

3.100 Module: Mathematical Methods of Imaging [M-MATH-103260]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-106488	Mathematical Methods of Imaging	5 CR	Rieder

Competence Certificate
Success is assessed in the form of an oral examination lasting approx. 30 minutes.

Prerequisites
None

Competence Goal
Graduates become familiar with some imaging methods and are able to discuss and analyze the underlying mathematical aspects. In particular, they will be able to explain the functional-analytical properties of the imaging operators. They can implement the corresponding reconstruction algorithms and they can explain and evaluate the artifacts that appear. They are able to apply the techniques they have learned to related problems.

Content

- Variants of tomography (X-ray, impedance, seismic, etc.)
- Properties of (generalized) Radon transforms
- Microlocal analysis/Pseudodifferential operators
- Ill-Posedness and regularization
- Reconstruction algorithms

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total work load: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course „Functional Analysis“ is recommended.

M 3.101 Module: Mathematical Modelling and Simulation in Practise [M-MATH-102929]

Responsible: PD Dr. Gudrun Thäter
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Irregular	1 term	English	4	2

Mandatory			
T-MATH-105889	Mathematical Modelling and Simulation in Practise	4 CR	Thäter

Competence Certificate
The module will be completed by an oral exam (ca. 20 min).

Prerequisites
None

Competence Goal
The general aim of this lecture course is threefold:

1) to interconnect different mathematical fields,
2) to connect mathematics and real life problems,
3) to learn to be critical and to ask relevant questions.

At the end of the course, students can

- work Project-orientated,
- link knowledge from different fields,
- develop typical modelling approaches on their own.

Content
Mathematical thinking (as modelling) and mathematical techniques (as tools) meet application problems such as:

- Differential equations
- Population models
- Traffic flow
- Game theory
- Chaos
- Mechanics and fluids

Module grade calculation
The module grade is the grade of the oral exam.

Annotation
The lecture is always in English.

To earn the credits you have to attend the lecture, finish the work on one project during the term in a group of 2-3 persons and pass the exam. The topic of the project is up to the choice of each group.

Workload
Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination
- Project presentations

Self-studies: 75 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination,
- work on the project

Recommendation
Some basic knowledge of numerical mathematics is recommended.

Literature
Hans-Joachim Bungartz e.a.: Modeling and Simulation: An Application-Oriented Introduction, Springer, 2013

M 3.102 Module: Mathematical Programming [M-WIWI-101473]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	8

Compulsory Elective Courses (Election: at most 2 items)			
T-WIWI-102719	Mixed Integer Programming I	4,5 CR	Stein
T-WIWI-102726	Global Optimization I	4,5 CR	Stein
T-WIWI-103638	Global Optimization I and II	9 CR	Stein
T-WIWI-102856	Convex Analysis	4,5 CR	Stein
T-WIWI-111587	Multicriteria Optimization	4,5 CR	Stein
T-WIWI-102724	Nonlinear Optimization I	4,5 CR	Stein
T-WIWI-103637	Nonlinear Optimization I and II	9 CR	Stein
T-WIWI-102855	Parametric Optimization	4,5 CR	Stein
Supplementary Courses (Election: at most 2 items)			
T-WIWI-106548	Advanced Stochastic Optimization	4,5 CR	Rebennack
T-WIWI-102720	Mixed Integer Programming II	4,5 CR	Stein
T-WIWI-102727	Global Optimization II	4,5 CR	Stein
T-WIWI-102723	Graph Theory and Advanced Location Models	4,5 CR	Nickel
T-WIWI-106549	Large-scale Optimization	4,5 CR	Rebennack
T-WIWI-111247	Mathematics for High Dimensional Statistics	4,5 CR	Grothe
T-WIWI-103124	Multivariate Statistical Methods	4,5 CR	Grothe
T-WIWI-102725	Nonlinear Optimization II	4,5 CR	Stein
T-WIWI-102715	Operations Research in Supply Chain Management	4,5 CR	Nickel
T-WIWI-112109	Topics in Stochastic Optimization	4,5 CR	Rebennack

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2), 1 or 2 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
At least one of the courses "Mixed Integer Programming I", "Multicriteria Optimization", "Convex Analysis", "Parametric Optimization", "Nonlinear Optimization I" and "Global Optimization I" has to be taken.

If the module is taken as an elective, no compulsory courses need to be taken. If you take the module in the compulsory elective area and only want to complete courses from the supplementary offer, please contact the examination office of the KIT Department of
Economics and Management.

Competence Goal
The student

- names and describes basic notions for advanced optimization methods, in particular from continuous and mixed integer programming,
- knows the indispensable methods and models for quantitative analysis,
- models and classifies optimization problems and chooses the appropriate solution methods to solve also challenging optimization problems independently and, if necessary, with the aid of a computer,
- validates, illustrates and interprets the obtained solutions,
- identifies drawbacks of the solution methods and, if necessary, is able to makes suggestions to adapt them to practical problems.

Content
The modul focuses on theoretical foundations as well as solution algorithms for optimization problems with continuous and mixed integer decision variables.

Annotation
The lectures are partly offered irregularly. The curriculum of the next three years is available online (www.ior.kit.edu).

For the lectures of Prof. Stein a grade of 30 % of the exercise course has to be fulfilled. The description of the particular lectures is more detailed.

Workload
The total workload for this module is approximately 270 hours.

3.103 Module: Mathematical Statistics [M-MATH-102909]

Responsible: PD Dr. Bernhard Klar
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each winter term	1 term	4	2

Mandatory			
T-MATH-105872	Mathematical Statistics	8 CR	Ebner, Fasen-Hartmann, Klar, Trabs

Competence Certificate
The module will be completed by an oral exam (approx. 30 min).

Prerequisites
none

Competence Goal
By the end of the course, students will

- know the basic concepts of mathematical statistics,
- be able to apply them independently to simple problems and examples,
- know specific probabilistic techniques and be able to use them for the mathematical analysis of estimation and test procedures,
- know the asymptotic behavior of maximum likelihood estimators and the generalized likelihood ratio for parametric test problems.

Content
The course covers basic concepts of mathematical statistics, in particular the finite optimality theory of estimators and tests, and the asymptotic behavior of estimators and test statistics. Topics are:

- Optimal and best linear unbiased estimators,
- Cramér-Rao bound in exponential families,
- sufficiency, completeness and the Lehmann-Scheffé theorem,
- the multivariate normal distribution,
- convergence in distribution and multivariate central limit theorem,
- Glivenko-Cantelli theorem,
- limit theorems for U-statistics,
- asymptotic estimation theory (maximum likelihood estimator),
- asymptotic relative efficiency of estimators,
- Neyman-Pearson tests and optimal unbiased tests,
- asymptotic tests in parametric models (likelihood ratio tests).

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the courses "Probability theory" and "Statistics" are strongly recommended.

M 3.104 Module: Mathematical Topics in Kinetic Theory [M-MATH-104059]

Responsible: Prof. Dr. Dirk Hundertmark
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-108403	Mathematical Topics in Kinetic Theory	4 CR	Hundertmark

Prerequisites
None

Competence Goal
The students are familiar with the basic questions in kinetic theory and methodical approaches to their solutions. With the acquired knowledge they are able to understand the required analytical methods and are able to apply them to the basic equations in kinetic theory.

Content

- Boltzmann equation: Cauchy problem and properties of solutions
- entropy and H theorem
- equilibrium and convergence to equilibrium
- other models of kinetic theory

3.105 Module: MathSEE Modeling Week [M-MATH-106836]

Responsible: TT-Prof. Dr. Sebastian Krumscheid
PD Dr. Stefan Kühnlein

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization) (Usage from 10/1/2025)
Elective Field (Usage from 10/1/2025)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MATH-113711	MathSEE Modeling Week	3 CR	Krumscheid, Kühnlein

Competence Certificate
The performance review takes the form of a presentation on the results of the respective project together with a final report.

Prerequisites
none

Competence Goal
Graduates

- gain practical experience in interdisciplinary collaboration,
- can apply basic concepts from uncertainty quantification and mathematical modeling,
- can combine scientific software from different research areas to solve complex problems, and
- have experience in scaling them on clusters.

Content
Students work in teams on tasks in mathematical modeling, uncertainty quantification, and high-performance computing. Through cooperation between these teams, they solve complex scientific problems ranging from accessible tasks to current research topics, depending on their level of knowledge. Short lectures provide an introduction to all topics, and material is provided to allow independent familiarisation with advanced methods and their implementation in scientific software. A universal interface for simulation software facilitates collaboration between teams.

Module grade calculation
The module grade is the grade for presentation and final report.

Workload
Total work load: 90 hours

Attendance: 30 hours

Self studies: 60 hours

- preparation of the scientific content of the talk
- preparation of a didactical concept for the talk
- preparation of the presentation (blackboard, beamer, etc.)
- creating a hand-out
- final report

M 3.106 Module: Maxwell's Equations [M-MATH-102885]

Responsible: PD Dr. Frank Hettlich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105856	Maxwell's Equations	8 CR	Arens, Griesmaier, Hettlich

Competence Certificate
The module will be completed by an oral exam (~30min.).

Prerequisites
none

Competence Goal
The students can explain mathematical questions from the theory of Maxwell's equations. They can formulate and prove the main theorems on properties and existence of solutions, can apply these to specific cases, and can compare results with simpler differential equations (like the Helmholtz equation).

Content
Specific examples of solutions to Maxwell's equations, properties of solutions (e.g. representation theorems), specific cases like E-mode and H-mode, corresponding boundary value problems.

Module grade calculation
The module grade is the grade of the oral exam

Workload
Total workload: 240h

Attendace: 90h

- lecture, problem class, examination

Self-studies: 150h

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research related to the course content
- preparation of the course content

Recommendation
Desirable is basic knowledge from functional analysis

3.107 Module: Methodical Foundations of OR [M-WIWI-101414]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
9	Grade to a tenth	Each term	1 term	4	10

Compulsory Elective Courses (Election: at least 1 item as well as between 4,5 and 9 credits)			
T-WIWI-102726	Global Optimization I	4,5 CR	Stein
T-WIWI-103638	Global Optimization I and II	9 CR	Stein
T-WIWI-102724	Nonlinear Optimization I	4,5 CR	Stein
T-WIWI-103637	Nonlinear Optimization I and II	9 CR	Stein
Supplementary Courses (Election:)			
T-WIWI-106546	Introduction to Stochastic Optimization	4,5 CR	Rebennack
T-WIWI-102727	Global Optimization II	4,5 CR	Stein
T-WIWI-102725	Nonlinear Optimization II	4,5 CR	Stein
T-WIWI-102704	Facility Location and Strategic Supply Chain Management	4,5 CR	Nickel

Competence Certificate
The assessment is carried out as partial written exams (according to Section 4(2), 1 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
At least one of the courses *Nonlinear Optimization I* and *Global Optimization I* has to be examined.

Competence Goal
The student

- names and describes basic notions for optimization methods, in particular from nonlinear and from global optimization,
- knows the indispensable methods and models for quantitative analysis,
- models and classifies optimization problems and chooses the appropriate solution methods to solve also challenging optimization problems independently and, if necessary, with the aid of a computer,
- validates, illustrates and interprets the obtained solutions.

Content
The modul focuses on theoretical foundations as well as solution algorithms for optimization problems with continuous decision variables. The lectures on nonlinear programming deal with local solution concepts, whereas the lectures on global optimization treat approaches for global solutions.

Annotation
The planned lectures and courses for the next three years are announced online (http://www.ior.kit.edu).

Workload
The total workload for this module is approx. 270 hours (9 credits). The allocation is based on the credit points of the courses in the module.

The total number of hours per course results from the time required to attend the lectures and exercises, as well as the examination times and the time required to achieve the learning objectives of the module for an average student for an average performance.

Recommendation
The courses Introduction to Operations Research I and II are helpful.

3.108 Module: Metric Geometry [M-MATH-105931]

Responsible: Prof. Dr. Alexander Lytchak
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	German	4	1

Mandatory			
T-MATH-111933	Metric Geometry	8 CR	Lytchak, Nepechiy

Competence Certificate
oral examination of circa 20 minutes

Prerequisites
None

Module grade calculation
The module grade is the grade of the final oral exam.

Annotation
This course is one of the nine core courses in the subject area Algebra and Geometry, from which at least six courses are offered within every two years (at least four different ones).

3.109 Module: Microeconomic Theory [M-WIWI-101500]

Responsible: Prof. Dr. Clemens Puppe
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	English	4	4

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-102609	Advanced Topics in Economic Theory	4,5 CR	Brumm, Mitusch
T-WIWI-102861	Advanced Game Theory	4,5 CR	Ehrhart, Puppe, Reiß
T-WIWI-102613	Auction Theory	4,5 CR	Ehrhart
T-WIWI-105781	Incentives in Organizations	4,5 CR	Nieken
T-WIWI-113264	Matching Theory	4,5 CR	Puppe
T-WIWI-102859	Social Choice Theory	4,5 CR	Puppe

Competence Certificate
The assessment is carried out as partial exams (according to Section 4(2), 1 or 2 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module seperately.

The overall grade of the the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
None

Competence Goal
Students

- are able to model practical microoeconomic problems mathematically and to analyze them with respect to positive and normative questions,
- understand individual incentives and social outcomes of different institutional designs.

Here is an example of a positive question: what firm decisions does a specific regulatory policy result in under imperfect competition? An example of a normative question would be: which voting rule has appealing properties?

Content
The module teaches advanced concepts and content in microeconomic theory. Thematically, it offers a formally rigorous treatment of game theory and exemplary applications, such as strategic interaction on markets and non-/cooperative bargaining ("Advanced Game Theory"), as well as specialized courses dedicated to auctions ("Auktionstheorie") and incentive systems in organizations ("Incentives in Organizations"). Moreover, it offers the opportunity to delve deeper into the mathematical theory of voting and collective decision making, i.e. the systematic aggregation of preferences and judgments ("Social Choice Theory").

Workload
Total workload for 9 credit points: approx. 270 hours

The exact distribution is based on the credit points of the courses in the module.

3.110 Module: Minimal Surfaces [M-MATH-106666]

Responsible: Dr. Peter Lewintan
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-113417	Minimal Surfaces	3 CR	Lewintan

Competence Certificate
The module will be completed by an oral exam (about 30 min).

Prerequisites
None

Competence Goal
Graduates

- are able to mathematically understand and solve a practical problem;
- can explain important results of the theory of minimal surfaces and apply them to examples;
- are prepared to write a thesis in the field of the theory of minimal surfaces or the calculus of variations.

Content
Minimal surfaces are critical points of the area functional and locally minimize its area. They can also be described by having zero mean curvature. In this course we consider two dimensional minimal surfaces in R^3 and discuss their properties. We will use arguments from differential geometry, the calculus of variations, the theory of partial differential equations and functions of a complex variable. Our goal is to prove the classical Plateau's problem.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 90 hours

Attendance: 30 hours

- lectures, problem classes, and examination

Self-studies: 60 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course "Classical Methods for Partial Differential Equations" is recommended.

3.111 Module: Modeling the Dynamics of Financial Markets [M-WIWI-106660]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: Finance - Risk Management - Managerial Economics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-WIWI-113414	Modeling the Dynamics of Financial Markets	9 CR	Ulrich

Competence Certificate
The module examination takes the form of a one-hour written comprehensive examination on the courses "Dynamic Capital Market Theory", "Essentials for Dynamic Financial Machine Learning" and "Exercises, Python, Research Frontier in Dynamic Capital Markets".

Competence Goal
Dynamic Capital Market Theory:

Professional competence:

- Understanding of the principles of Dynamic Asset Pricing Theory
- Mastery of concepts such as stochastic calculus and dynamic modeling in discrete and continuous time
- Application of dynamic programming theory to portfolio and investment decisions
- Knowledge of pricing bonds, stocks, futures and options markets.

Interdisciplinary skills:

- Develop analytical skills for working on and solving complex problems in finance
- Ability to apply theoretical models to real financial market scenarios.

Essentials for Dynamic Financial Machine Learning:

Professional Competence:

- Competencies in Multivariate Time Series Modeling and Dynamic Volatility Modeling.
- Skills in dealing with big financial data.
- Knowledge in the estimation of risk premia and the application of Kalman Filtering.

Interdisciplinary skills:

- Analytical skills in applying machine learning algorithms to dynamic financial market data.
- Development of problem-solving skills through the practical application of Python in financial data analysis.

Content

Dynamic Capital Market Theory:

The course "Dynamic Capital Market Theory" offers an introduction to the modeling of dynamic capital markets. Portfolio holdings and asset prices move dynamically across time and states. This course teaches basic financial economic thinking to help understand why this is the case and how to optimally act in such environments.
Next to the asset pricing focus, the second focus of the course is on optimal portfolio choice (robo advisory). For that, this course develops the theory of dynamic programming in discrete and continuous time and applies it to solve portfolio choice and corporate investment decisions. These concepts are key for financial engineering and the machine learning branch of Reinforcement Learning.

Students obtain proficiency in the following topics:

- Dynamic Valuation and Optimal Dynamic Asset Allocation
- Dynamic modeling in discrete time and continuous time
- Stochastic Calculus
- Markov Decision Processes and Dynamic Programming in discrete time and continuous time
- Pricing of bonds, equity, futures and options

Lectures (2 SWS) develop all concepts on the whiteboard.

Essentials for Dynamic Financial Machine Learning:

The course "Essentials for Dynamic Financial Machine Learning" teaches students to work with financial data, algorithms and statistical concepts.
Students are exposed to algorithms to learn key quantities of dynamic capital markets, such as time-varying risk premia, time-varying volatility and unobserved realizations of random states. The course covers the following concepts:

- Multivariate time series modeling
- Dynamic volatility modeling
- Handling big financial data
- Estimating risk premia
- Kalman Filtering

Weekly lectures (2 SWS) develop all algorithmic material on the whiteboard.

Exercises, Python, Research Frontier in Dynamic Capital Markets:

This course provides hands-on experience in implementing concepts from dynamic capital market theory and financial machine learning using Python. Students will develop practical skills in coding and data analysis that complement the theoretical knowledge gained in the companion courses. The course covers:

- Introduction to Python for financial applications Data manipulation and visualization with pandas and matplotlib.
- Implementing dynamic portfolio optimization algorithms.
- Coding stochastic processes and simulations.
- Building and testing time series models.
- Applying machine learning techniques to financial data.
- Developing Reinforcement Learning algorithms for trading strategies.
- Implementing and backtesting option pricing models.
- Creating interactive financial dashboards

Weekly computer lab sessions (2 SWS) will guide students through coding exercises and problem sets that directly relate to topics covered in "Dynamic Capital Market Theory" and "Essentials for Dynamic Financial Machine Learning". Students will work on individual and group projects, applying their programming skills to real-world financial problems and current research questions in dynamic capital markets.
This course forms an integral part of the module, complementing the theoretical components with practical implementation skills essential for modern quantitative finance.

Workload

Total workload for 9 credit points: approx. 270 hours. The exact distribution is based on the credit points of the courses in the module:

- Dynamic Capital Market Theory: 3 CP
- Essentials for Dynamic Financial Machine Learning: 3 CP
- Exercises, Python, Research Frontier in Dynamic Capital Markets: 3 CP

The total number of hours per course is determined by the amount of time spent attending the lectures and tutorials, as well as the exam times and the time required to achieve the module's learning objectives for an average student for an average performance.

Recommendation
Recommendation: Knowledge in the fields of Advanced Statistics, Deep Learning, Financial Economics, Differential Equations, Optimization.

Learning type
The module consists of two weekly lectures and respective tutorials:

1. **Dynamic Capital Market Theory** and
2. **Essentials for Dynamic Financial Machine Learning**.
3. **Exercises, Python, Research Frontier in Dynamic Capital Markets**

M 3.112 Module: Modelling and Simulation of Lithium-Ion Batteries [M-MATH-106640]

Responsible: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113382	Modelling and Simulation of Lithium-Ion Batteries	4 CR	Dörfler

Competence Certificate
oral exam of ca. 20 minutes

Prerequisites
None

Competence Goal
Participants know about the modelling and physical basics that lead to the model equations. They can explain (at least for simplified problems) their well-posedness. They are able to analyze stability and convergence of the presented methods.

Content

- Derivation of the model equations,
- Existence for simplified model problems,
- Discretization of the initial boundary value problems with fiite elements,
- Nonlinear diffusion equations, Cahn-Hilliard equation, linear elasticity and contact problems,
- Stability and convergence of the discrete models,
- Applications

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 h

- lectures, problem classes and examination

Self studies: 75 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
Basic knowledge in the numerical treatment of differential equations, such as boundary value problems or initial value problems is strongly recommended.

3.113 Module: Modern Methods in Combinatorics [M-MATH-106957]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113911	Modern Methods in Combinatorics	6 CR	Aksenovich

Competence Certificate
The module examination takes the form of an oral examination (approx. 30 min).

Prerequisites
None

Competence Goal
The students understand and are able to use powerful modern methods in Combinatorics.

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

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.

Module grade calculation
The module grade is the grade of the oral examination.

Workload
Total workload: 180 hours

Attendance time: 60 hours

- Course including module examination during the course of study

Self-study: 120 hours

- Deepening the study content by working on the lecture content at home
- completion of exercises
- In-depth study of the course content using suitable literature and internet research
- Preparation for the module examination during the course of study

Recommendation
Some knowledge of linear algebra and probability theory is strongly recommended. The courses *Graph Theory* and *Combinatorics* are recommended but not required.

M 3.114 Module: Monotonicity Methods in Analysis [M-MATH-102887]

Responsible: PD Dr. Gerd Herzog
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
3	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105877	Monotonicity Methods in Analysis	3 CR	Herzog

Competence Certificate
The module will be completed by an oral exam (about 20 min).

Prerequisites
None

Competence Goal
At the end of the course, students can

- name, discuss and apply basic techniques of the order-theoretical methods of analysis,
- apply specific order theory techniques to fixed point problems and differential equations.

Content

- Fixed point theorems in ordered sets and ordered metric spaces.
- Ordered Banach spaces.
- Quasimonotone increasing functions.
- Differential equations and differential inequalities in ordered Banach spaces.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 90 hours

Attendance: 30 hours

- lectures, problem classes, and examination

Self-studies: 60 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course "Functional Analysis" is recommended.

M 3.115 Module: Nonlinear Analysis [M-MATH-103539]

Responsible: Prof. Dr. Tobias Lamm
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-107065	Nonlinear Analysis	8 CR	Lamm

Prerequisites
None

3.116 Module: Nonlinear Maxwell Equations [M-MATH-105066]

Responsible: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-110283	Nonlinear Maxwell Equations	8 CR	Schnaubelt

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
none

Competence Goal
Students can explain some basic types of nonlinear Maxwell equations and the physical significance of the variables that occur. They are able to prove and discuss local wellposedness theorems in the whole space using energy methods. They can derive Strichartz inequalities for linear Maxwell equations. With their help, they can show improved wellposedness results.

Content

- Maxwell equations with nonlinear material laws
- local wellposedness theory in the whole space using linearisation, apriori estimates and regularisation
- Strichartz inequalities and improved wellposedness theory

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The contents of the module "Functional Analysis" are strongly recommended.

3.117 Module: Nonlinear Wave Equations [M-MATH-105326]

Responsible: Prof. Dr. Wolfgang Reichel
Prof. Dr. Roland Schnaubelt

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-110806	Nonlinear Wave Equations	4 CR	Reichel, Schnaubelt

Competence Certificate
The module will be completed by an oral exam (ca. 20 min).

Prerequisites
None

Competence Goal
Graduates will be able to

- name important properties of nonlinear wave equations,
- describe essential difficulties in the analysis of the initial value problem,
- analyze the short- and long-term behavior of solutions of semilinear wave equations using modern techniques.

Content
The aim of the course is an introduction to methods for analyzing nonlinear wave equations. The aim is to get to know the basics of various important techniques and to apply them to simple models. The following topics will be covered:

- Symmetries and conservation laws
- Fourier transformation, Sobolev spaces
- Energy estimates
- Strichartz estimates
- Local and global well-posedness results
- Vector field methods
- Longtime behavior

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 h

- lectures, problem classes and examination

Self studies: 75 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The contents of the module "Functional Analysis" are strongly recommended.

3.118 Module: Nonparametric Statistics [M-MATH-102910]

Responsible: PD Dr. Bernhard Klar
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	2

Mandatory			
T-MATH-105873	Nonparametric Statistics	4 CR	Ebner, Fasen-Hartmann, Klar, Trabs

Competence Certificate
The module will be completed with an oral exam (ca. 20 min).

Prerequisites
None

Competence Goal
By the end of the course, students will be able to

- explain nonparametric statistical tests based on location problems and distinguish them from parametric methods,
- name and explain nonparametric estimation methods for nonparametric regression and density estimation,
- know and apply optimality criteria for the statistical methods covered.

Content

- Introduction to nonparametric models
- Nonparametric tests, especially rank statistics
- Nonparametric density and regression estimation
- Dependence measures or optimal convergence rates

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 h

- lectures, problem classes and examination

Self studies: 75 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The contents of the module 'Probability Theory' are strongly recommended. The module 'Mathematical Statistics' is recommended.

M 3.119 Module: Numerical Analysis of Helmholtz Problems [M-MATH-105764]

Responsible: TT-Prof. Dr. Barbara Verfürth
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	German	4	2

Mandatory			
T-MATH-111514	Numerical Analysis of Helmholtz Problems	3 CR	Verfürth

Competence Certificate
oral examination of circa 30 minutes

Prerequisites
none

Module grade calculation
The module grade is the grade of the final oral exam.

3.120 Module: Numerical Analysis of Neural Networks [M-MATH-106695]

Responsible: TT-Prof. Dr. Roland Maier
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-113470	Numerical Analysis of Neural Networks	6 CR	Maier

Competence Certificate
The module will be completed by an oral exam (about 30 min).

Prerequisites
None.

Competence Goal
The goal of the lecture is to provide a mathematical foundation of neural networks from the perspective of numerical analysis. Students know basic definitions and terminology as well as classical approximation results for neural networks. They are familiar with numerical methods for the efficient training of neural networks and can analyze them. Moreover, students can apply the concepts to popular applications (such as physics-informed neural networks, Deep Ritz method, etc.).

Content

- Neural networks
- Approximation results
- Connections to finite element methods
- Numerical methods for the efficient learning
- Datasets

Module grade calculation
The grade of the module is the grade of the oral exam.

Annotation
The course is offered in English. If everybody speaks German, the lecture will be held in German.

Workload
Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
Basic knowledge of ordinary and/or partial differential equations as well as the contents of the module "Numerical Methods for Differential Equations" are recommended. Basic knowledge of functional analysis and finite element methods is helpful, but not required.

3.121 Module: Numerical Complex Analysis [M-MATH-106063]

Responsible: Prof. Dr. Marlis Hochbruck
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-112280	Numerical Complex Analysis	6 CR	Hochbruck

Competence Certificate
Oral exam of approximately 20 minutes.

Prerequisites
None.

Competence Goal
Graduates

- can apply techniques and concepts from complex analysis in numerical analysis,
- are prepared to write a thesis in numerical analysis.

Content
In this lecture we consider numerical methods for problems in complex analysis and complex analysis techniques to analyze numerical methods. It provides the chance to rediscover theorems known from the complex analysis lecture in applications.

The following topics are planned

- Calculations with power series: formal Newton's method and FFT,
- control systems and convolution quadrature (Cauchy integral formula, Laplace transform, argument principle),
- rational approximation to the exponential: order stars (maximum principle, argument principle),
- convergence of iterative methods for linear systems of equations an approximation of the matrix exponential operator (conformal mappings, Cauchy integral formula),
- numerical conformal mapping.

Module grade calculation
The module grade ist the grade of the oral exam.

Workload
Total workload: 180 h

Attendance: 60 h

- lectures, problem classes, and examination

Self-studies: 120 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination.

Recommendation
Basic knowledge of complex analysis is highly recommended.

Literature
Lecture notes with references.

M 3.122 Module: Numerical Linear Algebra for Scientific High Performance Computing [M-MATH-103709]

Responsible: Prof. Dr. Hartwig Anzt
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Irregular	1 term	English	4	2

Mandatory			
T-MATH-107497	Numerical Linear Algebra for Scientific High Performance Computing	5 CR	Anzt

Prerequisites
None

M 3.123 Module: Numerical Linear Algebra in Image Processing [M-MATH-104058]

Responsible: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-108402	Numerical Linear Algebra in Image Processing	6 CR	Grimm

Competence Certificate
The module will be completed by an oral exam (ca. 20 min).

Prerequisites
None

Competence Goal
Graduates can name essential concepts of image processing using numerical linear algebra methods and implement them efficiently.

Content

- Linear models of optical devices
- Point spread function and discrete convolution
- Structured matrices and fast transformations
- Large, ill-conditioned linear systems of equations
- Krylov subspace methods, preconditioning
- Several applications

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

M 3.124 Module: Numerical Methods for Differential Equations [M-MATH-102888]

Responsible: Prof. Dr. Willy Dörfler
Prof. Dr. Tobias Jahnke

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each winter term	1 term	4	1

Mandatory			
T-MATH-105836	Numerical Methods for Differential Equations	8 CR	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

Competence Certificate
Success is assessed in form of an oral or written examination. This will be determined by the lecturer at the beginning of the course.

Prerequisites
None

Competence Goal
At the end of the course, students

- know important examples of numerical methods for ordinary differential equations as well as the underlying construction principles
- are able to analyze the properties of these methods (in particular their stability, convergence and complexity)
- are able to analyze basic numerical methods for linear partial differential equations
- can explain concepts of modelling with differential equations

Content

- Numerical methods for initial value problems (Runge-Kutta methods, multistep methods, order, stability, stiff problems)
- Numerical methods for boundary value problems (finite difference methods for second-order elliptic equations)
- Numerical methods for initial boundary value problems (finite difference methods for parabolic equations and hyperbolic equations)

Module grade calculation
The module grade is the grade of the oral or written exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
It is highly recommended that participants have completed the modules "Numerische Mathematik 1 und 2" as well as "Programmieren: Einstieg in die Informatik und algorithmische Mathematik".

3.125 Module: Numerical Methods for Hyperbolic Equations [M-MATH-102915]

Responsible: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105900	Numerical Methods for Hyperbolic Equations	6 CR	Dörfler

Prerequisites
none

Competence Goal
.

M 3.126 Module: Numerical Methods for Integral Equations [M-MATH-102930]

Responsible: PD Dr. Tilo Arens
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	5	1

Mandatory			
T-MATH-105901	Numerical Methods for Integral Equations	8 CR	Arens, Hettlich

Competence Certificate
The module examination is carried out by one oral examination (approx. 30 minutes).

By successfully participating in the problem classes by correctly completing 60% of the programming exercise assignments, students will obtain a bonus to the grade of the oral examination. This bonus amounts to an improvement of the grade to the next marking step (a decrease by 0.3 or 0.4, respectively), if the original grade is between 4.0 and 1.3.

Prerequisites
None

Competence Goal
Students are able to name and describe basic methods for numerically solving linear integral equations of the second kind, such as the Nyström method, collocation method and Galerkin method, as well as their underlying principles such as interpolation and numerical integration. They are able to apply these methods for numerically solving integral equations and to implement concrete examples on a computer. Students are able to state convergence results concerning these methods and have mastered the application of methods of proof for such results. They can independently derive corresponding results for simple variations of these methods and perform the analysis of the convergence behavior for specific applications.

Content

- Boundary integral operators
- Interpolation and quadrature formulae
- Nyström methods
- Projection methods and boundary element methods

Module grade calculation
The grade of the module is the grade of the oral examination, modified by the bonus from the problem class assignments.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- increased understanding of module content by wrapping up lectures at home
- work on exercises
- increased understanding of module content by self study of literature and internet research
- preparing for the examination

Recommendation
Numerical Analysis I

Integral Equations

3.127 Module: Numerical Methods for Maxwell's Equations [M-MATH-102931]

Responsible: Prof. Dr. Marlis Hochbruck
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105920	Numerical Methods for Maxwell's Equations	6 CR	Hochbruck, Jahnke

Competence Certificate
Oral examination of approximately 20 minutes.

Prerequisites
None.

Competence Goal
The students can interpret the terms arising in the time-dependent Maxwell equations physically and prove the existence and uniqueness of the solution under appropriate assumptions. They know numerical methods and techniques to approximate these solutions and they are able to perform an error analysis. From the practical point of view they are able to evaluate advantages and disadvantages of different methods.

Content
Maxwell equations are a set of vector valued partial differential equations that are fundamental for the propagation of electromagnetic waves in media. In this lecture we start to derive Maxwell equations in integral- and differential form, discuss examples of material laws, boundary conditions, and study the well-posedness in suitable function spaces. For the numerical solution of Maxwell equations, we employ finite element methods for the spatial discretization. Our emphasis is on discontinuous Galerkin methods. Favorable methods for time discretization are splitting methods, (locally) implicit schemes, and exponential integrators. We construct and analyse these methods and discuss their efficient implementation.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 180 h

Attendance: 60 h

- lectures, problem classes, and examination

Self-studies: 120 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination.

Recommendation
Basic knowledge of ordinary and/or partial differential equations is recommended.

The module "Numerical Methods for Differential Equations" is strongly recommended.

Learning type
Lecture and tutorial with the active contribution of the students; problem sheets every 2 weeks.

Literature
Lecture notes with many references will be provided.

M 3.128 Module: Numerical Methods for Oscillatory Differential Equations [M-MATH-106682]

Responsible: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	German/English	4	1

Mandatory			
T-MATH-113437	Numerical Methods for Oscillatory Differential Equations	8 CR	Jahnke

Competence Certificate
The module will be completed by an oral exam (about 30 min).

Prerequisites
none

Competence Goal
The central topic of the lecture are numerical time-integrators for highly oscillatory ordinary and partial differential equations.

After participation, students

- know selected classes of ordinary and partial differential equations with oscillatory solutions and can explain the reason for the oscillatons.
- can explain why time-integration of such problems with traditional methods is usually inefficient.
- know different techniques which can be used to construct more efficient methods for selected problems.
- can explain error bounds for such integrators and know the ideas, techniques and assumptions used in the error analysis.

Content

- Oscillatory ordinary and partial differential equations: examples and applications
- Construction of time integrators
- Oscillations and resonances
- Error analysis
- Space discretization by Fourier collocation methods

Module grade calculation
The grade of the module is the grade of the oral exam.

Annotation
The module will be offered about every second summer semester.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
Participants are expected to be familiar with numerical methods for ordinary differential equations (e.g. Runge-Kutta methods) and with concepts required for their analysis (stability, order, local and global error, etc.).

3.129 Module: Numerical Methods for Time-Dependent Partial Differential Equations [M-MATH-102928]

Responsible: Prof. Dr. Marlis Hochbruck
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	5	1

Mandatory			
T-MATH-105899	Numerical Methods for Time-Dependent Partial Differential Equations	8 CR	Hochbruck, Jahnke

Competence Certificate
Success is assessed in form of an oral examination lasting approx. 25 minutes.

Prerequisites
None.

Competence Goal
Students can analyze numerical methods for abstract evolution equations. They can understand current research results and master various techniques for proving stability and error estimates of time integration methods. They can independently solve exercises, and present and discuss solutions.

Content

- Time integration methods for linear, semilinear, and quasilinear evolution equations and their semi-discretization in place, in particular, implicit Runge-Kutta and multistep methods,
- rigorous error estimates and stability proofs.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 h

Attendance: 90 h

- lectures, problem classes, and examination

Self-studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination.

Recommendation
Numerical methods for differential equations, finite element methods, functional analysis.

3.130 Module: Numerical Methods in Computational Electrodynamics [M-MATH-102894]

Responsible: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105860	Numerical Methods in Computational Electrodynamics	6 CR	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

Prerequisites
none

3.131 Module: Numerical Methods in Fluid Mechanics [M-MATH-102932]

Responsible: Prof. Dr. Willy Dörfler
PD Dr. Gudrun Thäter

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-MATH-105902	Numerical Methods in Fluid Mechanics	4 CR	Dörfler, Thäter

Competence Certificate
Oral exam of about 20 minutes.

Prerequisites
None

Competence Goal
Participants know about the modelling and physical basics that lead to the model equations. They know how to discretize fluidmechanical problems with the finite element method and know especiallly how to treat the incompressibility condition. They are able to analyze stability and convergence of the presented methods.

Content

- Modelling and derivation of the Navier-Stokes equations
- Mathematical and physical representation of energy and stress
- Lax-Milgram theorem, Céa lemma and saddle point theory
- Analytical and numerical treatment of the potential and Stokes flow
- Stability and convergence of the discrete models
- Numerical treatment of the stationary nonlinear equation
- Numerical treatment of the instationary problems
- Applications

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 h

- lectures, problem classes and examination.

Self studies: 75 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination.

Recommendation
Basic knowledge in the numerical treatment of differential equations, such as boundary value problems or initial value problems is strongly recommended. Knowledge in functional analysis is recommended.

3.132 Module: Numerical Methods in Mathematical Finance [M-MATH-102901]

Responsible: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	German/English	4	1

Mandatory			
T-MATH-105865	Numerical Methods in Mathematical Finance	8 CR	Jahnke

Competence Certificate
oral exam of ca. 30 minutes

Prerequisites
none

Competence Goal
The lecture concentrates on option pricing with numerical methods.

After participation, students

- know how to model the price dynamics of different types of options by stochastic or partial differential equations, and to evaluate the differences between these models.
- know, in particular, the assumptions on which these models are based, which enables them to discuss and question the meaningfulness and reliability of the models.
- know different methods for solving stochastic and partial differential equations numerically, and for solving high-dimensional integration problems.
- are able to implement and apply these methods to different types of options, and to analyze their stability and convergence.

Content

- Options, arbitrage and other basic concepts,
- Black-Scholes equation und Black-Scholes formulas,
- Numerical methods for stochastic differential equations,
- (Multilevel) Monte Carlo methods,
- (Quasi-)Monte Carlo integration,
- Numerical methods for Black-Scholes equations,
- Numerical methods for American options

Module grade calculation
The grade of the module is the grade of the oral exam.

Annotation
The module is offered every second winter term.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
Familiarity with stochastic differential equations, the Ito integral, and the Ito formula is strongly recommended. MATLAB skills are strongly recommended for the programming exercises.

3.133 Module: Numerical Optimisation Methods [M-MATH-102892]

Responsible: Prof. Dr. Christian Wieners
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105858	Numerical Optimisation Methods	8 CR	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

M 3.134 Module: Numerical Simulation in Molecular Dynamics [M-MATH-105327]

Responsible: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-110807	Numerical Simulation in Molecular Dynamics	8 CR	Grimm

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
None

Competence Goal
Graduates know the basic concepts for implementing numerical simulations in molecular dynamics on serial and parallel computer architectures. They can name the numerical results and procedures required for simulation in molecular dynamics, apply them to specific problems and implement them.

Content

- Linked-cell method for short-range potentials
- Parallel programming with MPI
- Various potentials and molecules
- Time integration methods
- Aspects of numerical geometric integration
- Methods for the simulation of long-range potentials

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-study: 150 hours

- follow-up and deepening of course content,
- work on problem sheets,
- literature study and internet research relating to the course content
- preparation for the module examination

Recommendation
The module M-MATH-102888 (Numerical Methods for Differential Equations) and some programming skills in C (or C++) are recommended.

3.135 Module: Operations Research in Supply Chain Management [M-WIWI-102832]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	2 terms	German/English	4	9

Election notes
At least one of the courses "Operations Research in Supply Chain Management", "Graph Theory and Advanced Location Models", "Modeling and OR-Software: Advanced Topics" and"Special Topics of Stochastic Optimization (elective)" has to be taken.
Students who choose the module in the field "compulsory elective modules" may select any two courses of the module.

Compulsory Elective Courses (Election: between 1 and 2 items)			
T-WIWI-102723	Graph Theory and Advanced Location Models	4,5 CR	Nickel
T-WIWI-106200	Modeling and OR-Software: Advanced Topics	4,5 CR	Nickel
T-WIWI-102715	Operations Research in Supply Chain Management	4,5 CR	Nickel
Supplementary Courses (Election: at most 1 item)			
T-MACH-112213	Applied material flow simulation	4,5 CR	Baumann
T-WIWI-106546	Introduction to Stochastic Optimization	4,5 CR	Rebennack
T-WIWI-102718	Discrete-Event Simulation in Production and Logistics	4,5 CR	Spieckermann
T-WIWI-102719	Mixed Integer Programming I	4,5 CR	Stein
T-WIWI-102720	Mixed Integer Programming II	4,5 CR	Stein
T-WIWI-106549	Large-scale Optimization	4,5 CR	Rebennack
T-WIWI-111587	Multicriteria Optimization	4,5 CR	Stein
T-WIWI-112109	Topics in Stochastic Optimization	4,5 CR	Rebennack

Competence Certificate
The assessment is carried out as partial exams (according to § 4(2), 1 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module.

The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
At least one of the three courses "Operations Research in Supply Chain Management", "Graph Theory and Advanced Location Models" and "Modeling and OR Software: Advanced Topics" is mandatory.

If the module is taken as an elective, no compulsory courses need to be taken. If you take the module in the compulsory elective area and only want to complete courses from the supplementary offer, please contact the examination office of the KIT Department of
Economics and Management.

Competence Goal
The student

- is familiar with basic concepts and terms of Supply Chain Management,
- knows the different areas of SCM and their respective optimization problems,
- is acquainted with classical location problem models (in planes, in networks and discrete) as well as fundamental methods for distribution and transport planning, inventory planning and management,
- is able to model practical problems mathematically and estimate their complexity as well as choose and adapt appropriate solution methods.

Content

Supply Chain Management is concerned with the planning and optimization of the entire, inter-company procurement, production and distribution process for several products taking place between different business partners (suppliers, logistics service providers, dealers). The main goal is to minimize the overall costs while taking into account several constraints including the satisfaction of customer demands.

This module considers several areas of SCM. On the one hand, the determination of optimal locations within a supply chain is addressed. Strategic decisions concerning the location of facilities as production plants, distribution centers or warehouses are of high importance for the rentability of Supply Chains. Thoroughly carried out, location planning tasks allow an efficient flow of materials and lead to lower costs and increased customer service. On the other hand, the planning of material transport in the context of supply chain management represents another focus of this module. By linking transport connections and different facilities, the material source (production plant) is connected with the material sink (customer). For given material flows or shipments, it is considered how to choose the optimal (in terms of minimal costs) distribution and transportation chain from the set of possible logistics chains, which asserts the compliance of delivery times and further constraints. Furthermore, this module offers the possibility to learn about different aspects of the tactical and operational planning level in Suppy Chain Mangement, including methods of scheduling as well as different approaches in procurement and distribution logistics. Finally, issues of warehousing and inventory management will be discussed.

Annotation

Some lectures and courses are offered irregularly.

The planned lectures and courses for the next three years are announced online.

Workload

Total effort for 9 credits: ca. 270 hours

- Presence time: 84 hours
- Preparation/Wrap-up: 112 hours
- Examination and examination preparation: 74 hours

Recommendation

Basic knowledge as conveyed in the module *Introduction to Operations Research* is assumed.

M 3.136 Module: Optimisation and Optimal Control for Differential Equations [M-MATH-102899]

Responsible: Prof. Dr. Christian Wieners
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105864	Optimisation and Optimal Control for Differential Equations	4 CR	

Prerequisites
none

3.137 Module: Optimization in Banach Spaces [M-MATH-102924]

Responsible: Prof. Dr. Roland Griesmaier
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	4	2

Mandatory			
T-MATH-105893	Optimization in Banach Spaces	5 CR	Griesmaier, Hettlich

Competence Certificate
The module will be completed by an oral exam (approx. 30 min).

Prerequisites
none

Competence Goal
The students can transfer properties from finite dimensional optimization problems to infinite dimensional cases. Furthermore, they can apply these results to problems from approximation theory, calculus of variation and optimal control. The students know about the main theorems and their proofs and can explain conclusions with the help of examples.

Content
Basics from Functional Analysis (in particular separation theorems, properties of convex functions and generalized derivatives), duality theory of convex problems, differentiable optimization problems (Lagrange multiplier), sufficient optimality conditions, existence results, applications in approximation theory, calculus of variation, and optimal control theory.

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 150 hours

Attendance: 60 hours

- lecture including course related examinations

Self-studies: 90 hours

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research relating to the course content
- preparation for the module examination

Recommendation
Some basic knowledge of finite dimensional optimization theory and functional analysis is desirable.

M 3.138 Module: Parallel Computing [M-MATH-101338]

Responsible: PD Dr. Mathias Krause
Prof. Dr. Christian Wieners

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-102271	Parallel Computing	5 CR	Krause, Wieners

Prerequisites
None

3.139 Module: Percolation [M-MATH-102905]

Responsible: Prof. Dr. Günter Last
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	4	2

Mandatory			
T-MATH-105869	Percolation	5 CR	Hug, Last, Winter

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
none

Competence Goal
The students

- are acquainted with basic models of discrete and continuum percolation,
- acquire the skills needed to use specific probabilistic and graph-theoretical methods for the analysis of these models,
- know how to work self-organised and self-reflexive.

Content

- Bond and site percolation on graphs
- Infinite clusters and critical probabilities
- Asymptotics of cluster sizes
- Uniqueness of the infinite cluster
- Continuous percolation

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the module *Probability Theory* are recommended.

M 3.140 Module: Poisson Processes [M-MATH-102922]

Responsible: Prof. Dr. Günter Last
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
5	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105922	Poisson Processes	5 CR	Fasen-Hartmann, Hug, Last, Nestmann, Winter

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
none

Competence Goal
The students know about important properties of the Poisson process. The focus is on probabilistic methods and results which are independent of the specific phase space. The students understand the central role of the Poisson process as a specific point process and as a random measure.

Content

- The Poisson process as particular point process
- Multivariate Mecke equation
- Superpositions, markings and thinnings
- Characterizations of the Poisson process
- Stationary Poisson and point processes
- Balanced allocations and the Gale-Shapley algorithm
- Compound Poisson processes
- Wiener-Ito integrals
- Fock space representation

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the module *Probability Theory* are recommended.

M 3.141 Module: Potential Theory [M-MATH-102879]

Responsible: Prof. Dr. Roland Griesmaier
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105850	Potential Theory	8 CR	Arens, Griesmaier, Hettlich, Reichel

Competence Certificate
The module will be completed by an oral exam (30 min).

Prerequisites
None

Competence Goal
Students can explain basic properties of harmonic functions and prove existence and uniqueness of solutions to boundary value problems for the Laplace equation in interior and exterior domains using integral equation techniques. They master representation theorems and are able to apply single- and double layer potentials to solver boundary value problems.

Content

- Properties of harmonic functions
- Existence and uniqueness of boundary value problems for the Laplace equation
- Fundamental solutions and Green's functions
- Single- and double layer potentials
- Integral equations

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research relating to the course content
- preparation for the module examination

M 3.142 Module: Probability Theory and Combinatorial Optimization [M-MATH-102947]

Responsible: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105923	Probability Theory and Combinatorial Optimization	8 CR	Hug, Last

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
none

Competence Goal
The students

- know basic problems of combinatorial optimization as discussed in the lectures and are able to explain them,
- know typical methods for the probabilistic analysis of algorithms and combinatorial optimization problems and are able to use them for the solution of specific optimization problems,
- are familiar with the essential techniques of proof and are able to explain them,
- know how to work in a self-organized and self-reflexive manner.

Content
This course is devoted to the analysis of algorithms and combinatorial optimization problems in a probabilistic framework. A natural setting for the investigation of such problems is often provided by a (geometric) graph. For a given system (graph), the average or most likely behavior of an objective function of the system will be studied. In addition to asymptotic results, which describe a system as its size increases, quantitative laws for systems of fixed size will be described. Among the specific problems to be explored are

- the long-common-subsequence problem,
- packing problems,
- the Euclidean traveling salesperson problem,
- minimal Euclidean matching,
- minimal Euclidean spanning tree.

For the analysis of problems of this type, several techniques and concepts have been developed and will be introduced and applied in this course. Some of these are

- concentration inequalities and concentration of measure,
- subadditivity and superadditivity,
- martingale methods,
- isoperimetry,
- entropy.

Module grade calculation
The modul grade is the grade of the oral exam.

Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research related to the course content
- preparation for the module exam.

Recommendation

It is recommended to have taken the module `Probability Theory' from the Bachelor program beforehand.

M 3.143 Module: Random Graphs and Networks [M-MATH-106052]

Responsible: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-112241	Random Graphs and Networks	8 CR	Hug

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
none

Competence Goal
Students

- know the basic models of random graphs and their properties,
- are familiar with probabilistic techniques for the investigation of random graphs,
- are able to work in a self-organized and reflexive manner.

Content
In the course, models of random graphs and networks are presented and methods will be developed which allow to state and prove results about the structure of such models.

In particular, the following models are treated:

- Erdös--Renyi graphs
- Configuration models
- Preferential-Attachment graphs
- Generalized inhomogeneous random graphs
- Geometric random graphs

and the following methods are addressed:

- Branching processes
- Coupling arguments
- Probabilistic bounds
- Martingales
- Local convergence of random graphs

Module grade calculation
The grade of the module is the grade of the oral exam.

Annotation
can not be completed together with M-MATH-102951 - Random Graphs

Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research related to the course content
- preparation for the module exam.

Recommendation

The contents of the module 'Probability Theory' are strongly recommended.

M 3.144 Module: Regularity for Elliptic Operators [M-MATH-106696]

Responsible: apl. Prof. Dr. Peer Kunstmann
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113472	Regularity for Elliptic Operators	6 CR	Kunstmann

Competence Certificate
The module will be completed by an oral exam (about 30 min).

Prerequisites
none

Competence Goal
The students

- can explain methods for definition of elliptic operators,
- can name results on spectral properties in L^q and relate them,
- can explain the relevance of heat kernel estimates and sketch corresponding methods of proof,
- can sketch the construction of the H^\infty calculus and name classes of elliptic operators for which it is bounded,
- can explain the concept of L^p maximal regularity and its relation to other parts of the theory and can name exmaples,
- have mastered the important techniques of proofs for regulariy properties of elliptic operators,
- are able to start a master thesis in the field.

Content

- elliptic operators in divergence and non-divergence form
- elliptic operators on domains with boundary conditions
- heat kernel estimates for elliptic operators
- spectrum of elliptic operators in Lebesgue spaces L^q
- maximal L^p regularity for the parabolic problem
- H^\infty functional calculus for elliptic operators
- L^q theory for parabolic boundary value problems

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The modules “Functional Analysis” and "Spectral Theory" are strongly recommended.

M 3.145 Module: Riemann Surfaces [M-MATH-106466]

Responsible: Prof. Dr. Frank Herrlich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-113081	Riemann Surfaces	8 CR	Herrlich

Competence Certificate
Oral examination of ca. 30 minutes.

Prerequisites
None

Competence Goal
Students know

- essential structural properties of Riemann surfaces,
- topological, analytic and algebraic methods for the investigation of Riemann surfaces, and are able to apply them.

Content

- Definition of Riemann surfaces
- holomorphic and meromorphic functions on Riemann surfaces
- Compact Riemann surfaces
- The Riemann-Roch theorem
- Uniformization, Fuchsian groups and hyperbolic metric
- Classification of compact Riemann surfaces

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
Some knowledge of complex analysis (e.g. *"Analysis 4"*) is strongly recommended as well as the modules *"Elementary Geometry"* and "*Introduction to Algebra and Number Theory*".

M 3.146 Module: Ruin Theory [M-MATH-104055]

Responsible: Prof. Dr. Vicky Fasen-Hartmann
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-108400	Ruin Theory	4 CR	Fasen-Hartmann

Competence Certificate
The module will be completed by an oral exam (approx. 20 min).

Prerequisites
None

Competence Goal
Students are able to

- name and discuss key concepts and results of ruin theory with applications in actuarial mathematics and can apply them to examples,
- apply specific probabilistic methods to analyse risk processes,
- master proof techniques,
- work in a self-orientated and reflective manner.

Content

- renewal theory
- classical risk process of Cramér and Lundberg
- asymptotic behaviour of the probability of ruin probability if the Lundberg constant exists (losses with light tailed distributions)
- subexponential distributions
- asymptotic behaviour of the probability of ruin if the losses are subexponentially distributed (losses with heavy tailed distributions)
- approximation of the ruin probability
- integrated risk processes
- portfolio of risk processes

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 hours

- lectures and problem classes including the examination

Self studies: 75 hours

- follow-up and deepening of the course content
- work on problem sheets
- literature and internet research on the course content
- preparation for the module examination

Recommendation
The content of the module "Probability Theory" is recommended.

M 3.147 Module: Scattering Theory [M-MATH-102884]

Responsible: PD Dr. Frank Hettlich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105855	Scattering Theory	8 CR	Arens, Griesmaier, Hettlich

Competence Certificate
The module will be completed by an oral exam (~30min.)

Prerequisites
none

Competence Goal
The students can prove and apply basic properties of solutions of the Helmholtz equation in the interior and in the exterior of a domain. They know about the representation theorems for such solutions. Students can explain the existence theory of corresponding boundary value problems by integral equations and/or variational formulations including appropriate proofs. Furthermore, the students can show and apply the dependence of a scattered field on the scattering object and the wave number as well as the relationship with its far field pattern.

Content

- Helmholtz equation and elementary soultions
- Greens representation theorems
- Existence and uniqueness of scattering problems
- Radiation condition and far field pattern

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240h

Attendance: 90h

- lecture, problem class, examination

Self-studies: 150h

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research related to the course content
- preparation for the module exam

Recommendation
One of the following modules should already be covered: functional analysis or integral equations

3.148 Module: Scattering Theory for Time-dependent Waves [M-MATH-106664]

Responsible: Prof. Dr. Roland Griesmaier
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-113416	Scattering Theory for Time-dependent Waves	6 CR	Griesmaier

Competence Certificate
The module will be completed with an oral exam of about 30 minutes.

Prerequisites
None

Competence Goal
The students can prove and apply basic properties of solutions of the wave equation in interior or exterior domains. They know about representation theorems for such solutions and can apply the Fourier-Laplace-transform to analyze causal solutions. Students master the existence and uniqueness theory of associated boundary value problems using integral equations and retarded single and double layer potentials including proofs. Furthermore, the students can apply these results to scattering problems and explain the depence of scattered waves on the scattering object as well as the relationship with its far field pattern.

Content

- Wave equations and elementary solutions
- Representation theorems
- Fourier-Laplace-transform
- Boundary element formulations of boundary value problems for the wave equation
- Existence and uniqueness of solutions to interior and exterior boundary value problems
- Scattering problems and far field patterns

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 h

Self studies: 120 h

Recommendation
The modules *Functional Analysis* and/or *Integral Equations* are recommended.

3.149 Module: Selected Methods in Fluids and Kinetic Equations [M-MATH-105897]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-111853	Selected Methods in Fluids and Kinetic Equations	3 CR	

Competence Certificate
The module will be completed with an oral exam (approx. 30 min).

Prerequisites
none

Competence Goal
The main aim of this lecture is to introduce students to tools and techniques developed in recent years to analyze the evolution of fluids and kinetic equations.
The students will learn how to use these techniques and how to apply them to families of equations.

Content
In this lecture we discuss selected techniques and tools that have lead to significant progress in the analysis of fluids and kinetic eqautions.
These, for instance, include:
- energy methods and local well-posedness results (e.g. fixed point results, Osgood lemma)
- Newton iteration
- Cauchy-Kowalewskaya and ghost energy approaches

No prior knowledge of fluids or kinetic equations is required.

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 90 hours

Attendance: 30 h

- lectures and examination

Self studies: 60 h

- follow-up and deepening of the course content,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The modules "Classical Methods for Partial Differential Equations" and "Functional Analysis" are recommended.

M 3.150 Module: Selected Topics in Harmonic Analysis [M-MATH-104435]

Responsible: Prof. Dr. Dirk Hundertmark
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
3	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-109065	Selected Topics in Harmonic Analysis	3 CR	Hundertmark

Prerequisites
None

Competence Goal
The students are familiar with the concepts of singular integral operators and weighted estimates in Harmonic Analysis. They know the relations between the BMO space and the Muckenhoupt weights and also how to use dyadic analysis operators to obtain estimates for Calderon-Zygmund operators.

Content
- Calderon-Zygmund and Singular Integral operators
- BMO space and Muckenhoupt weights
- Reverse Holder Inequality and Factorisation of Ap weights
- Extrapolation Theory and weighted norm inequalities for singular integral operators

3.151 Module: Semigroup Theory for the Navier-Stokes Equations [M-MATH-106663]

Responsible: Dr. rer. nat. Patrick Tolksdorf
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113415	Semigroup Theory for the Navier-Stokes Equations	6 CR	Tolksdorf

Competence Certificate
The module will be completed with an oral exam of about 30 minutes.

Prerequisites
None

Competence Goal
After a successful participation of the course, students are familiar with essential concepts of semigroup theory, such as analytic semigroups and fractional powers of sectorial operators. They are able to apply these concepts to the Stokes operator and derive basic regularity properties of solutions to the Stokes equations. Furthermore, they can use these concepts to construct solutions to the Navier-Stokes equations in critical spaces through an iteration scheme.

Content
Content from abstract semigroup theory:

- Sectorial operators
- Analytic semigroups
- Fractional powers

Content from fluid mechanics:

- Helmholtz decomposition
- Bogovskii operator
- Stokes operator
- Mapping properties of the Stokes semigroup
- Solvability of the Navier-Stokes equations in critical spaces

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The following modules are strongly recommended: *Functional Analysis* and *Classical Methods for Partial Differential Equations.*

3.152 Module: Seminar [M-WIWI-102973]

Responsible: Prof. Dr. Hagen Lindstädt
Prof. Dr. Oliver Stein

Organisation: KIT Department of Economics and Management

Part of: Seminar in Economics and Management
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each term	1 term	German	4	1

Wahlpflichtangebot (Election: 3 credits)			
T-WIWI-103479	Seminar in Informatics A (Master)	3 CR	Professorenschaft des Instituts AIFB
T-WIWI-103481	Seminar in Operations Research A (Master)	3 CR	Nickel, Rebennack, Stein

Competence Certificate
The modul examination consists of one seminar (according to §4 (3), 3 of the examintaion regulation). A detailed description of the assessment is given in the specific course characerization.

The final mark for the module is the mark of the seminar.

Prerequisites
None.

Competence Goal
The students are in a position to independently handle current, research-based tasks according to scientific criteria.

• They are able to research, analyze, abstract and critically review the information.

• They can draw own conclusions using their interdisciplinary knowledge from the less structured information and selectively develop current research results.

• They can logically and systematically present the obtained results both orally and in written form in accordance with scientific guidelines (structuring, technical terminology, referencing). They can argue and defend the results professionally in the discussion.

Content
Competences which are gained in the seminar module especially prepare the student for composing the final thesis. Within the term paper and the presentation the student exercises himself in scientific working techniques supported by the supervisor.

Beside advancing skills in techniques of scientific working there are gained integrative key qualifications as well. A detailled description o these qualifications is given in the section "Key Qualifications" of the module handbook.

Furthermore, the module also includes additional key qualifications provided by the KQ-courses.

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required. The available places are listed on the internet: https://portal.wiwi.kit.edu.

Recommendation
None.

M 3.153 Module: Seminar [M-WIWI-102971]

Responsible: Prof. Dr. Hagen Lindstädt
Prof. Dr. Oliver Stein

Organisation: KIT Department of Economics and Management

Part of: Seminar in Economics and Management
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each term	1 term	German	4	1

Wahlpflichtangebot (Election: 3 credits)			
T-WIWI-103474	Seminar in Business Administration A (Master)	3 CR	Professorenschaft des Fachbereichs Betriebswirtschaftslehre
T-WIWI-103478	Seminar in Economics A (Master)	3 CR	Professorenschaft des Fachbereichs Volkswirtschaftslehre
T-WIWI-103483	Seminar in Statistics A (Master)	3 CR	Grothe, Schienle

Competence Certificate
The modul examination consists of one seminar (according to §4 (3), 3 of the examintaion regulation). A detailed description of the assessment is given in the specific course characerization.

The final mark for the module is the mark of the seminar.

Prerequisites
None.

Competence Goal
The students are in a position to independently handle current, research-based tasks according to scientific criteria.

• They are able to research, analyze, abstract and critically review the information.

• They can draw own conclusions using their interdisciplinary knowledge from the less structured information and selectively develop current research results.

• They can logically and systematically present the obtained results both orally and in written form in accordance with scientific guidelines (structuring, technical terminology, referencing). They can argue and defend the results professionally in the discussion.

Content
Competences which are gained in the seminar module especially prepare the student for composing the final thesis. Within the term paper and the presentation the student exercises himself in scientific working techniques supported by the supervisor.

Beside advancing skills in techniques of scientific working there are gained integrative key qualifications as well. A detailled description o these qualifications is given in the section “Key Qualifications” of the module handbook.

Furthermore, the module also includes additional key qualifications provided by the KQ-courses.

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required. The available places are listed on the internet: https://portal.wiwi.kit.edu.

Recommendation
None.

M 3.154 Module: Seminar [M-MATH-102730]

Responsible: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: Mathematical Seminar

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	pass/fail	Each term	1 term	German/English	4	3

Elective Seminar (Election: 1 item)			
T-MATH-105686	Seminar Mathematics	3 CR	Kühnlein

Competence Certificate
The control of success (pass/fail) is based on a seminar talk lasting at least 45 minutes.

Prerequisites
None

Competence Goal
At the end of the module, participants should

- have analyzed a specific problem in a mathematical area
- be able to discuss subject-specific problems in the given context and present as well as defend them, using suitable media
- have summarized the most relevant results of their topic
- have communicative, organizational and didactic skills in complex problem analyses at their disposal. They can use techniques of scientific work.

Content
The specific content is based on the seminar topics being offered.

Module grade calculation
Omitted, as ungraded (pass/fail)

Workload
Total work load: 90 hours

Attendance: 30 hours

Self studies: 60 hours

- Preparation of the scientific content of the talk
- Preparation of a didactical concept for the talk
- Preparation of the presentation (blackboard, beamer, etc.)
- getting practice for the talk, creating a hand-out

M 3.155 Module: Seminar [M-WIWI-102972]

Responsible: Prof. Dr. Hagen Lindstädt
Prof. Dr. Oliver Stein

Organisation: KIT Department of Economics and Management

Part of: Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each term	1 term	German/English	4	1

Wahlplfichtangebot (Election: 1 item)			
T-WIWI-103476	Seminar in Business Administration B (Master)	3 CR	Professorenschaft des Fachbereichs Betriebswirtschaftslehre
T-WIWI-103477	Seminar in Economics B (Master)	3 CR	Professorenschaft des Fachbereichs Volkswirtschaftslehre
T-WIWI-103484	Seminar in Statistics B (Master)	3 CR	Grothe, Schienle

Competence Certificate
The modul examination consists of one seminar (according to §4 (3), 3 of the examintaion regulation). A detailed description of the assessment is given in the specific course characerization.

The final mark for the module is the mark of the seminar

Prerequisites
None.

Competence Goal

- The students are in a position to independently handle current, research-based tasks according to scientific criteria.
- They are able to research, analyze, abstract and critically review the information.
- They can draw own conclusions using their interdisciplinary knowledge from the less structured information and selectively develop current research results.
- They can logically and systematically present the obtained results both orally and in written form in accordance with scientific guidelines (structuring, technical terminology, referencing). They can argue and defend the results professionally in the discussion.

Content
Competences which are gained in the seminar module especially prepare the student for composing the final thesis. Within the term paper and the presentation the student exercises himself in scientific working techniques supported by the supervisor.

Beside advancing skills in techniques of scientific working there are gained integrative key qualifications as well.

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
he total workload for this module is approximately 90 hours.

M 3.156 Module: Seminar [M-WIWI-102974]

Responsible: Prof. Dr. Hagen Lindstädt
Prof. Dr. Oliver Stein

Organisation: KIT Department of Economics and Management

Part of: Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Each term	1 term	German/English	4	1

Wahlplfichtangebot (Election: 1 item)			
T-WIWI-103480	Seminar in Informatics B (Master)	3 CR	Professorenschaft des Instituts AIFB
T-WIWI-103482	Seminar in Operations Research B (Master)	3 CR	Nickel, Rebennack, Stein

Competence Certificate
The modul examination consists of one seminar (according to §4 (3), 3 of the examintaion regulation). A detailed description of the assessment is given in the specific course characerization.

The final mark for the module is the mark of the seminar

Prerequisites
None.

Competence Goal

- The students are in a position to independently handle current, research-based tasks according to scientific criteria.
- They are able to research, analyze, abstract and critically review the information.
- They can draw own conclusions using their interdisciplinary knowledge from the less structured information and selectively develop current research results.
- They can logically and systematically present the obtained results both orally and in written form in accordance with scientific guidelines (structuring, technical terminology, referencing). They can argue and defend the results professionally in the discussion.

Content
Competences which are gained in the seminar module especially prepare the student for composing the final thesis. Within the term paper and the presentation the student exercises himself in scientific working techniques supported by the supervisor.

Beside advancing skills in techniques of scientific working there are gained integrative key qualifications as well.

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
he total workload for this module is approximately 90 hours.

3.157 Module: Service Operations [M-WIWI-102805]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: Operations Management - Data Analysis - Informatics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	8

Election notes
At least one of the fourcourses Operations Research in Supply Chain Management, Operations Research in Health Care Management, Practical seminar: Health Care Management orDiscrete-Event Simulation in Production and Logistics has to be assigned.
Students who choose the module in the field "compulsory elective modules" may select any two courses of the module.

Compulsory Elective Courses (Election: at most 2 items)			
T-WIWI-102718	Discrete-Event Simulation in Production and Logistics	4,5 CR	Spieckermann
T-WIWI-102884	Operations Research in Health Care Management	4,5 CR	Nickel
T-WIWI-102715	Operations Research in Supply Chain Management	4,5 CR	Nickel
T-WIWI-102716	Practical Seminar: Health Care Management (with Case Studies)	4,5 CR	Nickel
Supplementary Courses (Election: at most 1 item)			
T-MACH-112213	Applied material flow simulation	4,5 CR	Baumann
T-WIWI-110971	Demand-Driven Supply Chain Planning	4,5 CR	Heckmann
T-WIWI-114109	Service Operations and Cyber Security	4,5 CR	Mohr

Competence Certificate
The assessment is carried out as partial exams (according to Section 4 (2), 1-3 SPO), whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module separately. The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
At least one of the four courses "Operations Research in Supply Chain Management", "Operations Research in Health Care Management", "Practical seminar: Health Care Management" or "Discrete-Event Simulation in Production and Logistics" has to be assigned.

If the module is taken as an elective, no compulsory courses need to be taken. If you take the module in the compulsory elective area and only want to complete courses from the supplementary offer, please contact the examination office of the KIT Department of
Economics and Management.

Competence Goal
Students

- knows the theoretical bases and the key components of Business Intelligence systems,
- acquires the basic skills to make use of business intelligence and analytics software in the service context
- are introduced into various application scenarios of analytics in the service context
- are able to distinguish different analytics methods and apply them in context
- learn how to apply analytics software in the service context
- are trained for the structured compilation and solution of practice relevant problems with the help of commercial business intelligence software packages as well as analytics methods and tools

Content

The importance of services in modern economies is most evident – nearly 70% of gross value added are achieved in the tertiary sector and a growing number of industrial enterprises add customer specific services to their material goods or transform their business models fundamentally. The growing availability of data “Big Data” and their intelligent processing by applying analytic methods and business intelligence systems plays a key role.

It is the goal of the module to give students a comprehensive overview on the subject Business Intelligence & Analytics focusing on service issues. Various scenarios illustrate how the methods and systems introduced help to improve existing services or create innovative data-based services.

Annotation

This module is part of the KSRI teaching profile “Digital Service Systems”. Further information on a service-specific profiling is available under www.ksri.kit.edu/teaching.

Workload

Total workload for 9 credit points: approx. 270 hours. The allocation is based on the credit points of the courses in the module.

Recommendation

The course Practical Seminar Health Care should be combined with the course OR in Health Care Management.

3.158 Module: Sobolev Spaces [M-MATH-102926]

Responsible: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German/English	4	2

Mandatory			
T-MATH-105896	Sobolev Spaces	8 CR	Schnaubelt

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
None

Competence Goal
Students can explain the significance of Sobolev spaces for partial differential equations and apply the theory to examples. They are able to reproduce and prove the basic properties of the spaces and to describe the central methods. They can discuss the central theorems and their significance and describe the main ideas of the proofs.

Content
Definition of Sobolev spaces for functions on Lipschitz domains; density and extension results; product, composition and interpolation estimates; embeddings including compactness, traces, duality; Helmholtz decomposition in R^3; simple applications to partial differential equations.

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The module "Functional Analysis" is strongly recommended.

3.159 Module: Space and Time Discretization of Nonlinear Wave Equations [M-MATH-105966]

Responsible: Dr. rer. nat. Benjamin Dörich
Prof. Dr. Marlis Hochbruck

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-112120	Space and Time Discretization of Nonlinear Wave Equations	6 CR	Hochbruck

Competence Certificate
Oral exam of approximately 20 minutes.

Prerequisites
None.

Competence Goal
Graduates

- can name and discuss essential concepts of error analysis of space and time discretizations for nonlinear wave equations,
- are prepared to write a thesis in the field of numerics of partial differential equations.

Content
The topic of the lecture is a unified error analysis of the space and time discretization of nonlinear wave-like equations. For this purpose, evolution equations with monotone operators on Hilbert spaces and different types of space discretization are considered, e.g. finite elements, discontinuous Galerkin methods or spectral methods, and, in particular, non-conformal discretizations.

After the analysis of the space discretization errors, this is combined with time integration methods such as the Crank-Nicolson and an implicit-explicit method.

The abstract analysis is illustrated with concrete examples.

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 180 h

Attendance: 60 h

- lectures, problem classes, and examination

Self-studies: 120 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination.

Recommendation
Basic knowledge of partial differential equations and the contents of the modules M-MATH-102888 - Numerische Methoden für Differentialgleichungen and M-MATH-102891 - Finite Elemente Methoden are strongly recommended. Knowledge of functional analysis is also recommended.

3.160 Module: Spatial Stochastics [M-MATH-102903]

Responsible: Prof. Dr. Günter Last
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each winter term	1 term	4	1

Mandatory			
T-MATH-105867	Spatial Stochastics	8 CR	Hug, Last, Winter

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
none

Competence Goal
The students are familiar with some basic spatial stochastic processes. They do not only understand how to deal with general properties of distributions, but also know how to describe and apply specific models (Poisson process, Gaussian random fields). They know how to work self-organised and self-reflexive.

Content

- Random sets
- Point processes
- Random measures
- Palm distributions
- Random fields
- Gaussian fields
- Spectral theory of random fields
- Spatial ergodic theorem

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the module *Probability Theory* are recommended.

3.161 Module: Special Topics of Numerical Linear Algebra [M-MATH-102920]

Responsible: Prof. Dr. Marlis Hochbruck
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	see Annotations	1 term	English	4	1

Mandatory			
T-MATH-105891	Special Topics of Numerical Linear Algebra	8 CR	Grimm, Hochbruck, Neher

Competence Certificate
Oral exam of approximately 30 minutes.

Prerequisites
None.

Competence Goal
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.

Content

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

Module grade calculation
The module grade is the grade of the oral exam.

Annotation
Bi-yearly course.

Workload
Total workload: 240 h

Attendance: 90 h

- lectures, problem classes, and examination

Self-studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination.

Recommendation
Numerical analysis 1 and 2.

3.162 Module: Spectral Theory [M-MATH-101768]

Responsible: Prof. Dr. Dorothee Frey
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each summer term	1 term	German	5	1

Mandatory			
T-MATH-103414	Spectral Theory - Exam	8 CR	Frey, Herzog, Kunstmann, Schnaubelt, Tolksdorf

Competence Certificate
Oral examination of approx. 30 minutes.

Prerequisites
none

Competence Goal
After participation, students

- understand the concepts of spectrum and resolvent of closed operators on Banach spaces.
- know their basic properties and are able to explain them in simple examples.
- can explain and justify the special features of compact operators and the Fredholm Alternative.
- can 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.
- 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 equations.

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research on the course content,
- preparation for the module examination

Recommendation
The module „Functional Analysis“ is strongly recommended.

M 3.163 Module: Splitting Methods for Evolution Equations [M-MATH-105325]

Responsible: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-110805	Splitting Methods for Evolution Equations	6 CR	Jahnke

Competence Certificate
The module will be completed by an oral exam (about 30 min).

Prerequisites
None

Competence Goal
After attending the course, students can explain the concept and the advantages of splitting methods. They know important examples of such methods and typical problem classes to which these methods can be applied. They can explain the relation between classical order and accuracy, and they know the (classical) order conditions of such methods. Students can reproduce and explain error estimates for splitting methods for linear and nonlinear evolution equations, and to explain the essential steps of the proof as well as the relevance of the made assumptions.

Content

- Concept and advantages of splitting methods
- Splitting methods for ordinary differential equations
- Baker-Campbell-Hausdorff formula and order conditions
- Tools from operator theory
- Splitting methods for linear evolution equations (Schrödinger equation, parabolic problems)
- Splitting methods for nonlinear evolution equations (nonlinear Schrödinger equation, Gross-Pitaevskii equation, Korteweg-de Vries equation)

Module grade calculation
The module grade is the grade of the oral exam.

Annotation
The module will be offered about every second summer semester.

Workload
Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
Familiarity with ordinary differential equations and Runge-Kutta methods (construction, order, stability) is strongly recommended.

M 3.164 Module: Statistical Learning [M-MATH-105840]

Responsible: Prof. Dr. Mathias Trabs
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each summer term	1 term	4	1

Mandatory			
T-MATH-111726	Statistical Learning	8 CR	Trabs

Competence Certificate
The module will be completed with an oral exam (approx. 30 min).

Prerequisites
none

Competence Goal
At the end of the course, students

- know the fundamental principles and problems of machine learning and can relate learning methods to these,
- are able to explain how selected machine learning methods work and can apply these,
- are able to derive and to discuss a statistical analysis of selected learning methods,
- are able to independently develop and apply new learning methods.

Content
The course aims for a rigorous and mathematical analysis of some popular machine learning methods with a focus is on statistical aspects. Topics are:

- Regression
  - Empirical risk minimization
  - Lasso
  - Regression trees and Random forests
- Classification
  - Bayes classifier
  - model based classifiers (e.g. logistic regression, discriminant analysis)
  - model-free classifiers (e.g. k nearest neighbors, support vector machines)
- Neural networks
  - training
  - approximation properties
  - statistical analysis
- Unsupervised learning
  - principle component analysis
  - clustering
  - generative models

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation

The modules "Probability Theory" and "Statistics" (M-MATH-103220) are recommended.

3.165 Module: Steins Method with Applications in Statistics [M-MATH-105579]

Responsible: Dr. rer. nat. Bruno Ebner
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-111187	Steins Method with Applications in Statistics	4 CR	Ebner, Hug

Prerequisites
None

M 3.166 Module: Stochastic Control [M-MATH-102908]

Responsible: Prof. Dr. Nicole Bäuerle
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105871	Stochastic Control	4 CR	Bäuerle

Competence Certificate
The module will be completed by an oral exam (about 20 min).

Prerequisites
none

Competence Goal
At the end of the course, students

- can name the mathematical foundations of stochastic control and and are able to apply solution techniques,
- can formulate continuous-time dynamic stochastic optimization problems as stochastic control problems,
- are able to work in a self-organized and reflective manner,

Content

- Verification techniques, Hamilton-Jacobi-Bellman equation
- Viscosity solution
- Singular control
- Feynman-Kac representations
- Applications from finance and insurance

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: 75 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course 'Probably Theory' is strongly recommended. The courses 'Brownian motion' and 'Continuous time finance' are recommended.

M 3.167 Module: Stochastic Differential Equations [M-MATH-102881]

Responsible: Prof. Dr. Dorothee Frey
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	5	1

Mandatory			
T-MATH-105852	Stochastic Differential Equations	8 CR	Frey, Schnaubelt

Content

- Brownian motion
- Martingales and Martingal inequalities
- Stochastic integrals and Ito's formula
- Existence and uniqueness of solutions for systems of stochastic differential equations
- Perturbation and stability results
- Application to equations in financial mathematics, physics and engineering
- Connection with diffusion equations and potential theory

M 3.168 Module: Stochastic Geometry [M-MATH-102865]

Responsible: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Each summer term	1 term	5	1

Mandatory			
T-MATH-105840	Stochastic Geometry	8 CR	Hug, Last, Winter

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Prerequisites
None

Competence Goal
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

Module grade calculation
The modul grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content
- work on problem sheets
- literature study and internet research related to the course content
- preparation for the module exam.

Recommendation
It is recommended to have taken the module 'Spatial Stochastics' beforehand.

3.169 Module: Stochastic Optimization [M-WIWI-103289]

Responsible: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Economics and Management
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	11

Compulsory Elective Courses (Election: between 1 and 2 items)			
T-WIWI-106546	Introduction to Stochastic Optimization	4,5 CR	Rebennack
T-WIWI-106548	Advanced Stochastic Optimization	4,5 CR	Rebennack
T-WIWI-106549	Large-scale Optimization	4,5 CR	Rebennack
Supplementary Courses (Election: at most 1 item)			
T-WIWI-102723	Graph Theory and Advanced Location Models	4,5 CR	Nickel
T-WIWI-102719	Mixed Integer Programming I	4,5 CR	Stein
T-WIWI-102720	Mixed Integer Programming II	4,5 CR	Stein
T-WIWI-111247	Mathematics for High Dimensional Statistics	4,5 CR	Grothe
T-WIWI-111587	Multicriteria Optimization	4,5 CR	Stein
T-WIWI-103124	Multivariate Statistical Methods	4,5 CR	Grothe
T-WIWI-102715	Operations Research in Supply Chain Management	4,5 CR	Nickel
T-WIWI-106545	Optimization under Uncertainty	4,5 CR	Rebennack
T-WIWI-112109	Topics in Stochastic Optimization	4,5 CR	Rebennack

Competence Certificate
The assessment is carried out as partial exams (according to § 4(2), 1 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module.

The assessment procedures are described for each course of the module seperately.

The overall grade of the module is the average of the grades for each course weighted by the credits and truncated after the first decimal.

Prerequisites
At least one of the courses "Advanced Stochastic Optimization", "Large-scale Optimization" or "Introduction to Stochastic Optimization" has to be taken.

If the module is taken as an elective, no compulsory courses need to be taken. If you take the module in the compulsory elective area and only want to complete courses from the supplementary offer, please contact the examination office of the KIT Department of
Economics and Management.

Competence Goal
The student

- names and describes basic notions for advanced stochastic optimization methods, in particular, ways to algorithmically exploit the special model structures,
- knows the indispensable methods and models for quantitative analysis of stochastic optimization problems,
- models and classifies stochastic optimization problems and chooses the appropriate solution methods to solve also challenging stochastic optimization problems independently and, if necessary, with the aid of a computer,
- validates, illustrates and interprets the obtained solutions,
- identifies drawbacks of the solution methods and, if necessary, is able to makes suggestions to adapt them to practical problems.

Content
The module focuses on the modeling as well as the imparting of theoretical principles and solution methods for optimization problems with special structure, which occur for example in the stochastic optimization.

Annotation

The courses are sometimes offered irregularly. The curriculum, planned for three years in advance, can be found on the Internet at http://sop.ior.kit.edu/28.php.

Workload

The total workload for this module is approximately 270 hours (9 credits). The allocation is made according to the credit points of the courses of the module. The total number of hours per course is determined by the amount of time spent attending the lectures and exercises, as well as the exam times and the time required to achieve the module's learning objectives for an average student for an average performance.

Recommendation

It is recommended to listen to the lecture "Introduction to Stochastic Optimization" before the lecture "Advanced Stochastic Optimization" is visited.

M 3.170 Module: Stochastic Simulation [M-MATH-106053]

Responsible: TT-Prof. Dr. Sebastian Krumscheid
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Each winter term	1 term	English	4	1

Mandatory			
T-MATH-112242	Stochastic Simulation	5 CR	Krumscheid

Competence Certificate
oral exam of ca. 30 min

Prerequisites
None

Competence Goal
After successfully taking part in the module's classes and the exam, students will be acquainted with sampling-based computational tools used to analyze systems with uncertainty arising in engineering,
physics, chemistry, and economics. Specifically, by the end of this course, students will be able to analyze the convergence of sampling algorithms and implement the discussed sampling methods for different
stochastic processes as computer codes. Understanding the advantages and disadvantages of different sampling-based methods, the students can, in particular, choose appropriate stochastic simulation
techniques and propose efficient sampling methods for a specific stochastic problem. In particular, they can name and discuss essential theoretical concepts, and understand the structure of the sampling-based computational methods. Finally, the course prepares students to write a thesis in the field of Uncertainty Quantification.

Content
The course covers mathematical concepts and computational tools used to analyze systems with uncertainty arising across various application domains. First, we will address stochastic modelling strategies to represent uncertainty in such systems. Then we will discuss sampling-based methods to assess uncertain system outputs via stochastic simulation techniques. The focus of this course will be on
the theoretical foundations of the discussed techniques, as well as their methodological realization as efficient computational tools. Topics covered include:

- Random variable generation
- Simulation of random processes
- Simulation of Gaussian random fields
- Monte Carlo method; output analysis
- Variance reduction techniques
- Rare event simulations
- Quasi Monte Carlo methods
- Markov Chain Monte Carlo methods (Metropolis-Hasting, Gibbs sampler)

Module grade calculation
The grade of the module is the grade of the oral exam.

Workload
total workload: 150 hours

Recommendation
The contents of the modules 'M-MATH-101321 - Introduction to Stochastics' and 'M-MATH-103214 – Numerical Mathematics 1+2' are recommended.

3.171 Module: Structural Graph Theory [M-MATH-105463]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-111004	Structural Graph Theory	4 CR	Aksenovich

Prerequisites
None

Competence Goal
After successful completion of the course, the participants should be able to present and analyse main results in Structural Graph Theory. They should be able to establish connections between graph minors and other graph parameters, give examples, and apply fundamental results to related problems.

Content
The purpose of this course is to provide an introduction to some of the central results and methods of structural graph theory. Our main point of emphasis will be on graph minor theory and the concepts devised in Robertson and Seymour's intricate proof of the Graph Minor Theorem: in every infinite set of graphs there are two graphs such that one is a minor of the other.

Our second point of emphasis (time permitting) will be on Hadwiger's conjecture: that every graph with chromatic number at least r has a K_r minor. We shall survey what is known about this conjecture, including some very recent progress.

Recommendation
A solid background in the fundamentals of graph theory.

3.172 Module: Time Series Analysis [M-MATH-102911]

Responsible: PD Dr. Bernhard Klar
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Each summer term	1 term	4	2

Mandatory			
T-MATH-105874	Time Series Analysis	4 CR	Ebner, Fasen-Hartmann, Gneiting, Klar, Trabs

Competence Certificate
The module will be completed by an oral exam (ca. 20 min).

Prerequisites
None

Competence Goal
At the end of the course, students will

- know and understand the standard models of time series analysis,
- know exemplary statistical methods for model selection and model validation,
- independently apply models and methods from the lecture to real and simulated data,
- know specific mathematical techniques and be able to use them to analyze time series models.

Content
The lecture covers the basic concepts of classical time series analysis:

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

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: 75 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the course "Probability Theory" are strongly recommended. The contents of the course "Statistics" are recommended.

3.173 Module: Topics in Algebraic Topology [M-MATH-107017]

Responsible: TT-Prof. Dr. Manuel Krannich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-MATH-114063	Topics in Algebraic Topology	6 CR	Krannich

Competence Certificate
The module examination takes the form of a written exam (120 min).

Prerequisites
none

Competence Goal
Students

- are able to calculate the discussed topological invariants in concrete examples;
- have mastered advanced techniques of algebraic topology;
- are able to work in a self-organized and reflective manner.

Content

- Examples of advanced invariants of algebraic topology (e.g. cohomology rings, higher homotopy groups)
- applications to the topology of manifolds (e.g. Poincaré duality)
- advanced homotopy theoretical concepts (e.g. fibrations and cofibrations, homotopy fibres)

Module grade calculation
The module grade is the grade of the written examination.

Workload
Total workload: 180 hours

Attendance time: 60 hours

- Course including module examination during the course of study

Self-study: 120 hours

- Deepening the study content by working on the lecture content at home
- completion of exercises
- In-depth study of the course content using suitable literature and internet research
- Preparation for the module examination during the course of study

Recommendation
The contents of the modules "Elementary Geometry" and "Algebraic Topology" are recommended.

M 3.174 Module: Topological Data Analysis [M-MATH-105487]

Responsible: Prof. Dr. Tobias Hartnick
Prof. Dr. Roman Sauer

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Stochastics)
Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
6	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-111031	Topological Data Analysis	6 CR	Hartnick, Sauer

3.175 Module: Translation Surfaces [M-MATH-105973]

Responsible: Prof. Dr. Frank Herrlich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-MATH-112128	Translation Surfaces	8 CR	Herrlich

Competence Certificate
The module will be completed by an oral exam of about 30 min.

Prerequisites
None

Competence Goal
At the end of the module, participants are able to

- name and discuss basic concepts to study translation surfaces,
- describe and use in examples essential methods for the classification of translation surfaces,
- read recent research papers on translation surfaces and write a thesis in this field.

Content

- Chararcterization of finite translation surfaces
- Riemann surfaces and algebraic curves
- Moduli space of Riemann surfaces
- Classification of translation surfaces
- Strata and the action of SL(2,R)
- Period coordinates

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
Basic knowledge in surface topology and complex analysis is strongly recommended. The module "Algebraic Geometry" is also recommended.

3.176 Module: Traveling Waves [M-MATH-102927]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	2

Mandatory			
T-MATH-105897	Traveling Waves	6 CR	de Rijk, Reichel

Competence Certificate
The module examination takes place in form of an oral exam of about 30 minutes. Please see under "Modulnote" for more information about the bonus regulation.

Prerequisites
none

Competence Goal
After successful completion of this module students:

- can explain the significance of traveling waves and their dynamic stability;
- know basic methods to study the existence of traveling waves;
- outline the main steps in a stability analysis and address potential complications;
- have acquired several mathematical tools to compute or approximate the spectrum;
- master several techniques to derive (in)stability of the wave from spectral information;
- understand how spectrum and stability might depend on the class of perturbations.

Content
Traveling waves are solutions to nonlinear partial differential equations (PDEs) that propagate over time with a fixed speed without changing their profiles. These special solutions arise in many applied problems where they model, for instance, water waves, nerve impulses in axons or light in optical fibers. Therefore, their existence and the naturally associated question of their dynamic stability is of interest, because only those waves which are stable can be observed in practice.

The first step in the stability analysis is to linearize the underlying PDE about the wave and compute the associated spectrum, which is in general a nontrivial task. To approximate spectra associated with various waves, such as fronts, pulses and periodic wave trains, we introduce the following tools:

- Sturm-Liouville theory
- exponential dichotomies
- Fredholm theory
- the Evans function
- parity arguments
- essential spectrum, point spectrum and absolute spectrum
- exponential weights

The next step is to derive useful bounds on the linear solution operator, or semigroup, based on the spectral information. A complicating factor is that any non-constant traveling wave possesses spectrum up to the imaginary axis. For various dissipative PDEs, such as reaction-diffusion systems, we employ the bounds on the linear solution operator to close a nonlinear argument via iterative estimates on the Duhamel formula. For traveling waves in Hamiltonian PDEs, such as the NLS or KdV equation, we describe a different route towards stability based on the variational arguments of Grillakis, Shatah and Strauss.

Module grade calculation
After passing the oral exam at the end of the semester, the final grade is min(0.7X + 0.3Y, X), where X is the grade for the oral exam and Y is the grade obtained by voluntarily working out and presenting a model problem during one of the exercise classes.

Workload
Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The following background is strongly reommended: Analysis 1-4.

Literature
Kapitula, Todd; Promislow, Keith. Spectral and dynamical stability of nonlinear waves. Applied Mathematical Sciences, 185. Springer, New York, 2013.

3.177 Module: Uncertainty Quantification [M-MATH-104054]

Responsible: Prof. Dr. Martin Frank
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
4	Grade to a tenth	Each summer term	1 term	4	1

Mandatory			
T-MATH-108399	Uncertainty Quantification	4 CR	Frank

Prerequisites
None

Competence Goal
After successfully taking part in the module's classes and exams, students have gained knowledge and abilities as described in the "Inhalt" section.

Specifically, students know several parametrization methods for uncertainties. Furthermore, students are able to describe the basics of several solution methods (stochastic collocation, stochastic Galerkin, Monte-Carlo). Students can explain the so-called curse of dimensionality.

Students are able to apply numerical methods to solve engineering problems formulated as algebraic or differential equations with uncertainties. They can name the advantages and disadvantages of each method. Students can judge whether specific methods are applicable to the specific problem and discuss their results with specialists and colleagues. Finally, students are able to implement the above methods in computer codes.

Content
In this class, we learn to propagate uncertain input parameters through differential equation models, a field called Uncertainty Quantification (UQ). Given uncertain input (parameter values, initial or boundary conditions), how uncertain is the output? 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.

Recommendation
Numerical methods for differential equations

3.178 Module: Variational Methods [M-MATH-105093]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-110302	Variational Methods	8 CR	Reichel

Competence Certificate
The module will be completed by an oral exam (ca. 30 min).

Competence Goal
Graduates will be able to

- assess the significance of variational problems in relation to their applications in the natural sciences, engineering or geometry and illustrate them using examples,
- formulate variational problems independently,
- recognize the specific difficulties within the calculus of variations,
- analyze and solve concrete, prototypical problems,
- use techniques to prove the existence of solutions to certain classes of variational problems and calculate these solutions in special cases.

Content

- one-dimensional variational problems
- Euler-Lagrange equation
- necessary and sufficient criteria
- multidimensional variational problems
- direct methods of the calculus of variations
- existence of critical points of functionals

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The contents of the courses Functional Analysis, Classical Methods for Partial Differential Equations, or Boundary and Eigenvalue problems are recommended.

3.179 Module: Wavelets [M-MATH-102895]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading scale	Recurrence	Duration	Level	Version
8	Grade to a tenth	Irregular	1 term	4	1

Mandatory			
T-MATH-105838	Wavelets	8 CR	Rieder

Competence Certificate
Success is assessed in the form of an oral examination lasting approx. 30 minutes.

Prerequisites
none

Competence Goal
Graduates are able

- to name, discuss and analyze the functional-analytical principles of continuous and discrete wavelet transforms,
- to apply the wavelet transform as an analysis tool in signal and image processing and evaluate the results obtained,
- to explain design aspects for wavelet systems.

Content

- Short-time Fourier transform
- Integral wavelet transform
- Wavelet frames
- Wavelet basis
- Fast wavelet transform
- Construction of orthogonal and bi-orthogonal wavelet systems
- Applications in signal and image processing

Module grade calculation
The module grade is the grade of the oral exam.

Workload
Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

- follow-up and deepening of the course content,
- work on problem sheets,
- literature study and internet research relating to the course content,
- preparation for the module examination

Recommendation
The course "Functional analysis" is recommended.

4 Courses

T 4.1 Course: (Gen)AI-based Automation in Organizations [T-WIWI-114210]

Responsible: Prof. Dr. Alexander Mädche
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-104068 - Information Systems in Organizations

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2500015	(Gen)AI-based Automation in Organizations	3 SWS	Lecture / Blended	Mädche, Benke

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Alternative exam assessment. It consists of a one-hour exam and the implementation of a capstone project.

The final grade is made up of 60% of the exam grade and 40% of the capstone project grade.

Details on the structure of the assessment will be announced during the lecture.

Workload
135 hours

Below you will find excerpts from events related to this course:

V (Gen)AI-based Automation in Organizations — **Lecture (V)**, **Blended (On-Site/Online)**
2500015, SS 2025, 3 SWS, Language: English, Open in study portal

Content

4.2 Content

The advent of generative artificial intelligence (GenAI) has received great attention in business and society due to its capabilities of content creation or decision making. Individuals started rapidly to use the capabilities of tools like ChatGPT and Google Gemini for text and image generation, personal recommendations, or decision support. At the same time, organizations are challenged to leverage GenAI but also AI technology in general within their business models, processes, and information systems. (Gen)AI technologies enable executing cognitive tasks which in the past were carried out manually by organizations' employees. Ultimately, this leads to an increase of automation in organizations. For example, organizations can automate the creation of customer service responses, contract document reviewing in legal departments, application screening in human resources, or fraud detection in financial transactions.

This digital transformation process to higher levels of automation must be managed by organizations. While the goal is to free up capacity of employees from simple repetitive tasks for more complex ones, improce efficiency and extend innovation capabilities, organizations also must consider social and ethical aspects when implementing automation. Thus, a (Gen)AI integration strategy that benefits organizations must consider many facets, e.g., strategic objectives, business model adaptation, governance and risk management, implementation project portfolio management, and change management.
Summarizing, this course will teach concepts to support organizations and their employees to increase the level of automation leveraging (Gen)AI technologies under consideration of an economic and social perspective.

This course consists of the following major building blocks:

- Introduction to (Gen)AI concepts and technology.
- Overview of history and key concepts of automation in organizations.
- Organizational perspective on integrating (Gen)AI.
- Individual perspective on integrating (Gen)AI capabilities.
- Challenges and countermeasures to secure the integration of (Gen)AI capabilities into organizations from a socio-economic perspective.

The course is complemented with quizzes for knowledge recapture and hands-on activities in which the students apply the lecture content and implement the integration of (generative) AI capabilities in organizational processes and structures based on real-world case studies to increase organizational automation.

4.3 Learning goals

As a result of attending this program, students will be able to:

- describe key concepts of (Gen)AI technologies enabling the increase of automation in organizations.
- understand the historical evolution and describe core concepts of automation to drive organizational efficiency and innovation.
- articulate (Gen)AI integration principles for effectively implementing automation in organizations.
- explore and prototype (Gen)AI-based applications to streamline individual tasks and workflows in the context of organizational automation.
- analyze best practices for addressing challenges to ensure adoption of (Gen)AI capabilities for organizational automation from a socio-economic perspective..

4.4 Prerequisites

No specific prerequisites are required for the lecture.

T 4.5 Course: Adaptive Finite Element Methods [T-MATH-105898]

Responsible: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: M-MATH-102900 - Adaptive Finite Elemente Methods

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

Events					
ST 2025	0159610	Adaptive Finite Elemente Methods	4 SWS	Lecture	Dörfler
ST 2025	0159620	Tutorial for 0159610 (adaptive Finite Elemente Methods)	2 SWS	Practice	Dörfler

Competence Certificate
oral exam of ca. 30 minutes

Prerequisites
none

Recommendation
Basic knowledge of finite element methods, a programming language and the analysis of boundary value problems is strongly recommended. Knowledge of functional analysis is recommended.

Workload
240 hours

Below you will find excerpts from events related to this course:

V Adaptive Finite Elemente Methods

0159610, SS 2025, 4 SWS, Open in study portal

Lecture (V)

Content
The Finite Element Method is the method of choice for the solution of elliptic boundary value problems. In computing these approximations we follow two aims: We need a computable error bound to judge the quality of an approximation, and we want to reduce the amount of work to obtain an approximation of a prescribed tolerance. The first aim is a must since numerical simulations without information about their accuracy may be not reliable. This has been seen by some failures in the past, see information about the Sleipner accident. The second aim may be achieved by constructing local (e.g.\ in space) error indicators and perform local refinement where large errors are indicated. We show for a model problem how to construct convergent local refinement algorithms and show that the algorithm has optimal complexity.

T 4.6 Course: Advanced Corporate Finance [T-WIWI-113469]

Responsible: Prof. Dr. Martin Ruckes
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2
M-WIWI-101502 - Economic Theory and its Application in Finance

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2530214	Advanced Corporate Finance	2 SWS	Lecture / 🗣	Ruckes
Exams					
WT 24/25	7900058	Advanced Corporate Finance			Ruckes
ST 2025	7900317	Advanced Corporate Finance			Ruckes

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of this course is a written examination (following §4(2), 1 SPO) of 60 mins.

The exam is offered each semester.

Below you will find excerpts from events related to this course:

V Advanced Corporate Finance

2530214, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
The course covers the foundational principles of advanced topics of corporate finance, such as corporate governance, executive compensation, strategy & finance, mergers & acquisitions (M&A), and sustainable finance. Additionally, the course explores the respective institutional aspects within these areas of corporate finance. The approach is holistic, including both theoretical-conceptional aspects (e.g., moral hazard and the influence of asymmetric information) and empirical insights (e.g., the effects of financial decisions on firm value). Throughout, the course will emphasize both fundamental and current research findings.

Learning outcomes:

Upon successful completion of the course, students will possess profound knowledge and skills in advanced areas of corporate finance. These areas include topics such as corporate governance, executive compensation, strategy and finance, mergers and acquisitions (M&A), as well as key aspects of sustainable finance. Participants of this course will be able to describe and analyze the theoretical and conceptual foundations of the effects of information asymmetries and moral hazard on corporate financing behavior and assess their impact in corporate practice. Furthermore, upon completion of the course, participants will be familiar with the fundamental institutional elements in these areas and be able to discuss and solve advanced problems in corporate finance from both a theoretical and an empirical perspective. Moreover, students will acquire an advanced understanding of the central scientific findings in these topic areas, which will enable them to critically apply them in scientific and practical contexts.

Literature
Verschiedene Literaturquellen, u.a. Brealey/Myers/Allen/Edmans: Principles of Corporate Finance; Thomson/Conyon: Corporate Governance: Mechanisms and Systems; Larcker/Tayan: Corporate Governance Matters. Weitere Literatur wird in der Lehrveranstaltung bekannt gegeben.

Various source of literature, among others Brealey/Myers/Allen/Edmans: Principles of Corporate Finance; Thomson/Conyon: Corporate Governance: Mechanisms and Systems; Larcker/Tayan: Corporate Governance Matters. Additional reading materials will be introduced during the course.

T 4.7 Course: Advanced Empirical Asset Pricing [T-WIWI-110513]

Responsible: TT-Prof. Dr. Julian Thimme
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Exams			
WT 24/25	7900319	Advanced Empirical Asset Pricing	Thimme
ST 2025	7900321	Advanced Empirical Asset Pricing	Thimme

Competence Certificate
The success control takes place in form of a written examination (60 min) during the semester break. If the number of participants is low, an oral examination may also be offered. The examination is offered every semester and can be repeated at any regular examination date.

A bonus can be acquired by submitting exercise solutions to 80% of the assigned exercise tasks. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

Recommendation
We strongly recommend knowledge of the basic topics in investments (bachelor course), which will be necessary to be able to follow the course. In addition, prior participation in the Asset Pricing Master course is strongly recommended.

Annotation
New course from winter semester 2019/2020.

Workload
135 hours

T 4.8 Course: Advanced Game Theory [T-WIWI-102861]

Responsible: Prof. Dr. Karl-Martin Ehrhart
Prof. Dr. Clemens Puppe
Prof. Dr. Johannes Philipp Reiß

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-101500 - Microeconomic Theory
M-WIWI-101502 - Economic Theory and its Application in Finance
M-WIWI-102970 - Decision and Game Theory

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2500037	Advanced Game Theory	2 SWS	Lecture / 🗣	Puppe, Ammann
WT 24/25	2500038	Übung zu Advanced Game Theory	1 SWS	Practice / 🗣	Puppe, Ammann
Exams					
WT 24/25	7900013	Advanced Game Theory			Puppe
ST 2025	7900126	Advanced Game Theory			Puppe

Legend: 🖥 Online, ♲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes) (following §4(2), 1 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Prerequisites
None

Recommendation
Basic knowledge of mathematics and statistics is assumed.

Below you will find excerpts from events related to this course:

V Advanced Game Theory

2500037, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
The course “Advanced Game Theory” deals with the formulation and solution concepts of games. A game is defined as a formal representation of a situation in which a number of individuals interact in a setting of strategic interdependence.

The first part of the course builds upon the topics of the bachelor’s course “Introduction to Game Theory”. In particular, in contrast to the bachelor’s lecture, the course introduces a rigorous mathematical treatment of simultaneous move and dynamic games (noncooperative games) as well as their solution concepts.

The second part of the course deals with the topics of evolutionary and cooperative game theory. Both the models as well as the solution concepts of evolutionary stable strategies, the core, and the Shapley value are introduced.

The third part of the course embeds the topic of game theory in the more general context of mechanism design and concludes with the introduction of voting games and their solution concepts.

Learning objectives:
The student should learn

- to name and define the models and solution concepts of a variety of games in both mathematical-formal and precise verbal form.
- to solve games of different types and difficulties with the appropriate solution concepts.
- to prove and reason about simple statements on games and their solution concepts.
- to model strategic interdependencies in the real world as games in a formal mathematical way.

Workload:
Total workload for 4.5 credit points: approx. 135 hours
Attendance: 30 hours
Self-study: 105 hours

Literature

- Mas-Colell, A., Whinston, M. D. and Green, J. R. 1995. *Microeconomic Theory*. Oxford University Press.
- Osborne, M. J. and Rubinstein, A. 1998. *A Course in Game Theory*. 5. print. MIT Press.
- Myerson, R. B. 1997. *Game Theory: Analysis of Conflict*. Harvard University Press.

T 4.9 Course: Advanced Inverse Problems: Nonlinearity and Banach Spaces [T-MATH-105927]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-102955 - Advanced Inverse Problems: Nonlinearity and Banach Spaces

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

Prerequisites
none

T 4.10 Course: Advanced Lab Blockchain Hackathon (Master) [T-WIWI-111126]

Responsible: Prof. Dr. Ali Sunyaev
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Competence Certificate
The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

Prerequisites
None

Workload
135 hours

T 4.11 Course: Advanced Lab Informatics (Master) [T-WIWI-110548]

Responsible: Professorenschaft des Instituts AIFB
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Events					
WT 24/25	2512101	Seminar: Digital Twins with Lego: Hands-on Workshop in Data-driven Simulation (Master)	2 SWS	Seminar / On-Site	Lazarova-Molnar, Götz, Khodadadi
WT 24/25	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course / Blended	Toussaint, Schiefer, Schüler
WT 24/25	2512314	Practical Course Linked Data and the Semantic Web (Master)	3 SWS	Practical course / On-Site	Käfer, Braun
WT 24/25	2512401	Practical Course Sociotechnical Information Systems Development (Master)	3 SWS	Practical course / Online	Sunyaev, Leiser
WT 24/25	2512501	Practical Course Cognitive automobiles and robots (Master)	3 SWS	Practical course / Blended	Zöllner, Daaboul
WT 24/25	2512600	Project lab Information Service Engineering (Master)	3 SWS	Practical course / Blended	Sack
ST 2025	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course / On-Site	Schiefer, Toussaint, Ullrich
ST 2025	2512207	Smart Living Lab – IoT for Everyday (Master)	3 SWS	Practical course / On-Site	Oberweis, Rybinski
ST 2025	2512500	Project Lab Machine Learning	3 SWS	Practical course / Blended	Daaboul, Zöllner, Schneider
ST 2025	2512555	Praktikum Security, Usability and Society (Master)	3 SWS	Practical course / Blended	Volkamer, Strufe, Berens, Mossano, Hennig, Veit, Länge
ST 2025	2512600	Project lab Telling Data Stories with Semantic Technologies and Generative AI (Master)	3 SWS	Practical course / Blended	Sack, Tietz
Exams					
WT 24/25	7900046	Advanced Lab Security (Master)			Volkamer
WT 24/25	7900102	Advanced Lab Information Service Engineering (Master)			Sack
WT 24/25	7900107	Advanced Lab Cognitive Automobile and Robots (Master)			Zöllner
WT 24/25	7900143	Advanced Lab Development of Sociotechnical Information Systems (Master)			Sunyaev
WT 24/25	7900218	Advanced Lab Linked Data and the Semantic Web (Master)			Käfer
WT 24/25	7900306	Advanced Lab Realization of Innovative Services (Master)			Oberweis
WT 24/25	7900307	Advanced Lab Security, Usability and Society (Master)			Volkamer

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Competence Certificate
The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

Prerequisites
None

Annotation
The title of this course is a generic one. Specific titles and the topics of offered seminars will be announced before the start of a semester in the internet at https://portal.wiwi.kit.edu.

Workload
135 hours

Below you will find excerpts from events related to this course:

V	**Lab Realisation of innovative services (Master)** 2512205, WS 24/25, 3 SWS, Language: German, Open in study portal	**Practical course (P)** **Blended (On-Site/Online)**

Content
As part of the lab, the participants should work together in small groups to realize innovative services (mainly for students).

Organizational issues
Informationen zu Themen und die Anmeldung erfolgt vor Praktikumsbeginn im Wiwi-Portal
https://portal.wiwi.kit.edu/ys

V	**Practical Course Linked Data and the Semantic Web (Master)** 2512314, WS 24/25, 3 SWS, Language: German/English, Open in study portal	**Practical course (P)** **On-Site**

Content
Linked Data is a way of publishing data on the web in a machine-understandable fashion. The aim of this practical seminar is to build applications and devise algorithms that consume, provide, or analyse Linked Data.

The Linked Data principles are a set of practices for data publishing on the web. Linked Data builds on the web architecture and uses HTTP for data access, and RDF for describing data, thus aiming towards web-scale data integration. There is a vast amount of data available published according to those principles: recently, 4.5 billion facts have been counted with information about various domains, including music, movies, geography, natural sciences. Linked Data is also used to make web-pages machine-understandable, corresponding annotations are considered by the big search engine providers. On a smaller scale, devices on the Internet of Things can also be accessed using Linked Data which makes the unified processing of device data and data from the web easy.

In this practical seminar, students will build prototypical applications and devise algorithms that consume, provide, or analyse Linked Data. Those applications and algorithms can also extend existing applications ranging from databases to mobile apps.

For the seminar, programming skills or knowledge about web development tools/technologies are highly recommended. Basic knowledge of RDF and SPARQL are also recommended, but may be acquired during the seminar. Students will work in groups. Seminar meetings will take place as 'Block-Seminar'.

Topics of interest include, but are not limited to:

- Travel Security
- Geo data
- Linked News
- Social Media

The exact dates and information for registration will be announced at the event page.

V	**Practical Course Cognitive automobiles and robots (Master)** 2512501, WS 24/25, 3 SWS, Language: German/English, Open in study portal	**Practical course (P)** **Blended (On-Site/Online)**

Content
The lab is intended as a practical supplement to courses such as "Machine Learning 1/2".
Scientific topics, mostly in the area of autonomous driving and robotics, will be addressed in joint work with ML/KI methods. The goal of the internship is for participants to design, develop, and evaluate ML Software system.

In addition to the scientific goals, such as the study and application of methods, the aspects of project-specific teamwork in research (from specification to presentation of results) are also worked on in this internship.

The individual projects require the analysis of the set task, selection of appropriate methods, specification and implementation and evaluation of the solution approach. Finally, the selected solution is to be documented and presented in a short lecture.

Learning Objectives:

- Students will be able to practically apply theoretical knowledge from lectures on machine learning to a selected area of current research.
- Students will be proficient in analyzing and solving thematic problems.
- Students will be able to evaluate, document, and present their concepts and results.

Recommendations:

- Theoretical knowledge of machine learning and/or AI.
- Python knowledge
- Initial experience with deep learning frameworks such as PyTorch/Jax/Tensorflow may be beneficial.

Workload:

The workload of 5 credit points consists of practical implementation of the selected solution, as well as time for literature research and planning/specification of the selected solution. In addition, a short report and presentation of the work performed will be prepared.

Organizational issues
Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

V	**Project lab Information Service Engineering (Master)** 2512600, WS 24/25, 3 SWS, Language: English, Open in study portal	**Practical course (P)** **Blended (On-Site/Online)**

Content
The ISE project lab is based on the summer semester lecture "Information Service Engineering". Goal of the course is to work on a given research problem in small groups (3-4 students) related to the ISE lecture topics, i.e. Natural Language Processing, Knowledge Graphs, and Machine Learning. The solution of the given research problem requires the development of a software implementation.

The project will be worked on in teams of 3-4 students each, guided by a tutor from the teaching staff.

Required coursework includes:

- Mid term presentation (5-10 min)
- Final presentation (10-15 min)
- Course report (c. 16 pages)
- Participation and contribution of the students during the course
- Software development and delivery

Notes:

The ISE project lab can also be credited as a **seminar** (if necessary).

The project will be worked on in teams of 3-4 students each, guided by a tutor from the teaching staff.

Participation will be restricted to 16 students.

Participation in the lecture "Information Service Engineering" (summer semester) is required. There are video recordings on our youtube channel.

ISE Tutor Team:

- Dr. Genet Asefa Gesese
- Dr. Shufan Jiang
- Dr. Anna Jacysyzn
- M. Sc. Ebrahim Norouzi
- M. Sc. Sarah Rebecca Ondraszek
- B. Sc. Tabea Tietz

WS 2024/25 Tasks List:

- Generating Competency Questionss from ontologies using LLMs
- Ontology Verbalization and Categorization via LLMs
- Towards the Automated Extraction of Patterns from Ontologies with Large Language Models
- Leveraging Large Language Models for Artwork Recognition from Historical Texts
- Identification of mathematical definitions from Scientific Papers
- The Chronicles of Culture Knowledge Graphs: Creating Data Stories with Generative AI

Literature
ISE video channel on youtube: https://www.youtube.com/channel/UCjkkhNSNuXrJpMYZoeSBw6Q/

V **Lab Realisation of innovative services (Master)**
2512205, SS 2025, 3 SWS, Language: German, Open in study portal

Practical course (P)
On-Site

Content
As part of the lab, the participants should work together in small groups to realize innovative services (mainly for students).

Organizational issues
Informationen zu Themen und die Anmeldung erfolgt vor Praktikumsbeginn im Wiwi-Portal
https://portal.wiwi.kit.edu/ys

V **Smart Living Lab – IoT for Everyday (Master)**
2512207, SS 2025, 3 SWS, Language: German, Open in study portal

Practical course (P)
On-Site

Content
As part of the lab, various topics on everyday automation are offered. During the lab, the participants will gain an insight into problem-solving oriented project work and work on a project together in small groups.

In case of questions, please contact fabian.rybinski@kit.edu.

Organizational issues
Informationen zu Themen und die Anmeldung erfolgt vor Praktikumsbeginn im Wiwi-Portal
https://portal.wiwi.kit.edu/ys

Bei Fragen bitte an fabian.rybinski@kit.edu wenden.

V

Project Lab Machine Learning

2512500, SS 2025, 3 SWS, Language: German/English, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content
The lab is intended as a practical supplement to lectures such as "Machine Learning". The theoretical basics are applied in the lab course. The aim of the lab course is that the participants work together to design, develop and evaluate a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

In addition to the scientific objectives involved in the investigation and application of the methods, aspects of project-specific teamwork in research (from specification to presentation of the results) are also developed in this practical course.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and implementation and evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

Learning objectives:

- Students can practically apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles.
- Students master the analysis and solution of corresponding problems in a team.
- Students can evaluate, document and present their concepts and results.

Recommendations:

Attendance of the lecture machine learning, C/C++ knowledge, Python knowledge

Workload:

The workload of 5 credit points consists of the time spent in the lab for practical implementation of the selected solution, as well as the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

Organizational issues
Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

V

Praktikum Security, Usability and Society (Master)

2512555, SS 2025, 3 SWS, Language: English, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content
In the lab-course “Security, Usability and Society”, students deal with practical and interdisciplinary topics from the field of IT security and privacy at the cutting edge of society. In addition to the programming of data-saving apps, the development or implementation of user studies can also be possible tasks in this course.

The course can be credited towards the KASTEL certificate. Further information about the KASTEL certificate can be found on the SECUSO website: https://secuso.aifb.kit.edu/Studium_und_Lehre.php

Prerequisites:

The internship is aimed at Bachelor's and Master's students from the Industrial Engineering and Management, Business Informatics and Computer Science degree programs as well as related degree programs.

Organization:

There are two mandatory attendance dates: The kick-off is scheduled for the first week of the lectures, and the final presentations will take place in the second to last week of lectures. Additional dates will be arranged individually with the supervisors. All in-person lectures will be held in English. The main components of the course is the work on the respective topic, a final presentation and a final report. After consultation with the supervisor, all components can be either completed in German or English.

If you have any questions about the course or the registration, please contact contact@secuso.org.

Registration:

The topics for the course as well as the registration is organized via the WiWi-Portal. To reserve a place and choose a topic, students register for the course in the WiWi-Portal. A description of the current topics as well as important dates and deadlines can also be found there.

Please note that the number of topics is limited and topics are allocated in the order of registration.

V

Project lab Telling Data Stories with Semantic Technologies and Generative AI (Master)

2512600, SS 2025, 3 SWS, Language: English, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content

Large Knowledge Graphs are often overwhelming for non-technical users due to their complexity, making it difficult to understand the structures and contents in a clear and intuitive way. Data Stories are designed to help users explore data; they simplify the complex relationships within Knowledge Graphs, reveal "hidden" connections and patterns between entities, and provide narrative summaries that highlight the most relevant aspects of large datasets. This makes it easier for non-technical users to intuitively explore and interpret graph data, helping them discover insights they weren't specifically searching for.

In this course, we aim to conceptualize and implement methods for creating Data Stories from large and complex Knowledge Graphs. This includes the creation of engaging visualizations and the use of generative AI to bridge the gap between data creators and users. Domain experts will share their insights into the data and help evaluate the effectiveness of the Data Stories.

In this course you have the chance to combine creativity and practical implementation tasks to develop solutions for real-world projects and problems.

T 4.12 Course: Advanced Lab Realization of Innovative Services (Master) [T-WIWI-112914]

Responsible: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Events					
WT 24/25	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course / Blended	Toussaint, Schiefer, Schüler
ST 2025	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course / On-Site	Schiefer, Toussaint, Ullrich
Exams					
WT 24/25	7900218	Advanced Lab Linked Data and the Semantic Web (Master)			Käfer
WT 24/25	7900306	Advanced Lab Realization of Innovative Services (Master)			Oberweis

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

Annotation
As part of the lab, the participants should work together in small groups to produce innovative services (mainly for students).

Further information can be found on the ILIAS page of the lab.

Workload
135 hours

Below you will find excerpts from events related to this course:

V Lab Realisation of innovative services (Master)
2512205, WS 24/25, 3 SWS, Language: German, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content
As part of the lab, the participants should work together in small groups to realize innovative services (mainly for students).

Organizational issues
Informationen zu Themen und die Anmeldung erfolgt vor Praktikumsbeginn im Wiwi-Portal
https://portal.wiwi.kit.edu/ys

V Lab Realisation of innovative services (Master)
2512205, SS 2025, 3 SWS, Language: German, Open in study portal

Practical course (P)
On-Site

Content
As part of the lab, the participants should work together in small groups to realize innovative services (mainly for students).

Organizational issues
Informationen zu Themen und die Anmeldung erfolgt vor Praktikumsbeginn im Wiwi-Portal
https://portal.wiwi.kit.edu/ys

T 4.13 Course: Advanced Lab Security, Usability and Society [T-WIWI-108439]

Responsible: Prof. Dr. Melanie Volkamer
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	see Annotations	2

Events					
WT 24/25	2512554	Praktikum Security, Usability and Society (Bachelor)	3 SWS	Practical course / Blended	Volkamer, Strufe, Berens, Morisco, Fallahi, Ballreich, Hennig, Länge, Mossano
WT 24/25	2512555	Praktikum Security, Usability and Society (Master)	3 SWS	Practical course / Blended	Volkamer, Strufe, Berens, Fallahi, Morisco, Ballreich, Hennig, Länge, Mossano
ST 2025	2512554	Practical lab Security, Usability and Society (Bachelor)	3 SWS	Practical course / Blended	Volkamer, Strufe, Berens, Mossano, Hennig, Veit, Länge, Fallahi
ST 2025	2512555	Praktikum Security, Usability and Society (Master)	3 SWS	Practical course / Blended	Volkamer, Strufe, Berens, Mossano, Hennig, Veit, Länge
Exams					
WT 24/25	7900116	Advanced Lab Security, Usability and Society (Bachelor)			Volkamer
WT 24/25	7900307	Advanced Lab Security, Usability and Society (Master)			Volkamer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The alternative exam assessment consists of:

- a practical work
- a presentation and possibly
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

Prerequisites
None

Recommendation
Knowledge from the lecture "Information Security" is recommended.

Annotation
The course will not be offered in the summer semester 2023.

Workload
135 hours

Below you will find excerpts from events related to this course:

V Praktikum Security, Usability and Society (Bachelor)

2512554, WS 24/25, 3 SWS, Language: German/English, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content

English:

The Praktikum Security, Usability and Society will cover topics both of usable security and privacy programming, and how to conduct user studies. To reserve a place, please, register on the WiWi portal and send an email with your chosen topic, plus a back-up one, to mattia.mossano@kit.edu . Topics are assigned first-come-first-served until all of them are filled. Topics in italics have already been assigned.

Application deadline 25.10.2024
Assignment 30.10.2024
Confirmation deadline 03.11.2024

Important dates:

Kick-off: 23.10.2024, 09:00 AM CET in Big Blue Button - Link and Kronenplatz 5.20, 3A-11.1

Report & code feedback deadline: 26.01.2025, 23:59 CET
Feedback on Report & code: 10.02.2025, 23:59 CET
Final report + code deadline: 17.02.2025, 23:59 CET

Presentation draft deadline: 23.02.2025, 23:59 CET
Feedback on presentation draft: 28.02.2025, 23:59 CET
Final presentation deadline: 07.03.2025, 23:59 CET

Presentation day: 11.03.2025, 09:00 CET

Topics:

Privacy Friendly Apps

In this area, students complete an app (or an extension of an app) among our Privacy-Friendly Apps. Please click the following link to know more about them: https://secuso.aifb.kit.edu/english/105.php . Students are provided with a point list of goals, containing both basic features mandatory to pass the course and more advanced ones that heighten the final grade.

Title: NoPhish App Rework
Number of students: 2 Ba/Ma
Description: The NoPhish app was one of the first measures from the NoPhish concept. The app has been around for a long time and has not been updated since then. Accordingly, the task of the project is to make the app functional for the current Android version. The app is also to be optimized so that updates, e.g. new chapters, can be added easily.

Designing Security User studies

These topics are related to how to set up and conduct user studies of various types. Online studies, interviews and lab studies are possible. At the end of the semester, the students present a report / paper and a talk in which they present their methodologies and the results of small pre-studies.

Title: IT-Security and Privacy Studies in the health sector
Number of students: 1 Ba/Ma
Description: Cyberattacks in the healthcare sector are on the rise and medical facilities are increasingly becoming the target of hacker attacks. This often affects sensitive patient data or, in the event of a cyberattack, patient care. The German Federal Office for Information Security (BSI) reports that "[t]he security situation of the IT infrastructure of medical practices in Germany [...] has hardly been studied to date." The aim of the work is to find out which scientific studies already exist in the field of IT security and privacy and which best practices can be derived from these studies, e.g. on the subject of recruitment, study design or consideration of special needs.

Title: Understanding Privacy and Security Risk Awareness Among Sports Science Students at KIT
Number of students: 1 Ba/Ma
Description: Privacy and Security Awareness in Data Handling: The key issue is that many sports science students may not fully understand the privacy and security risks involved in handling sensitive data. As students increasingly deal with personal and research-related information, gaps in their awareness of data protection, such as risks of data breaches or misuse, can lead to significant vulnerabilities. The aim of the task is to design a survey that assesses their current understanding of these risks, helping to identify areas where further education or guidance is needed.

Run Usable Security Studies and Results Analysis

These topics are related to run and analyze the results of user-studies. Online studies, interviews and lab studies are all possible, depending on the topic. At the end of the semester, the students present a report / paper with the analyses conducted and a talk in which they present the results.

Title: Visualization of Eye Gaze Patterns during Authentication Tasks
Number of students: 1 Ba/Ma
Description: In this project, students will analyze and visualize eye gaze data collected during two specific authentication tasks: the Dot Task and the Slider Task. The primary objective is to represent subjects' eye movements visually, enhancing the understanding of gaze patterns during the authentication process. *Dot Task Visualization:* For the Dot Task, participants were instructed to focus on a sequence of dots displayed on a screen. The dataset includes the positions of these dots and the corresponding gaze locations of the subjects. The student's task is to create a dynamic visualization that not only represents these positions accurately but also illustrates the sequence in which the dots were focused on by the subjects. *Slider Task Visualization:* The Slider Task involved presenting participants with a series of images, for which both the images' locations on the screen and the subjects' gaze locations are recorded. The challenge is to develop a heatmap visualization based on this data, effectively demonstrating the concentration and dispersion of gaze points across different images.

Title: Compare BSI Phishing Game with the NoPhish Game
Number of students: 1 Ba
Description: The NoPhish app, one of the first implementations of the NoPhish concept, is a form of serious game. The BSI has also developed a game in the field of phishing. Both "games" use different approaches to impart knowledge from the same context. The aim is to evaluate the two games in terms of similarities and differences.

Title: Chatbots for Literature Reviews
Number of students: 1 Ba
Description: Chatbots are becoming increasingly popular and are already being used in various areas. But in what form can these bots be used for science? The variety of chatbots also raises the question of whether there are chatbots that are better suited to a scientific context. The aim is to identify a selection of chatbots and evaluate them in terms of their effectiveness for future literature research. To this end, the results of the chatbots will be compared with the ACM database in order to check their effectiveness for finding literature for a specific period of time.

Title: Phishing Advice from Organizations (English Only)
Number of students: 1 Ba/Ma
Description: Many companies distribute information on how to recognize phishing via various channels such as e-mails, e.g. Amazon or Telekom. The question arises as to how helpful these tips are in reality. Are they too specific to the context of the company or so abstractly formulated that they are of no real help to users? The aim of the work is to collect various hints and then compare them with the hints of the NoPhish concept in order to find differences and similarities between the hints and the concept.

Title: How do website owners become aware that their website was hacked?
Number of students: 1 Ba/Ma
Description: We identified website owners that were affected by a hack on their website and sent them a notification. During the course of the notification process, we also identified several websites who seemingly remediated the hack before our notification. We now wanted to find out, how those website owners got aware of the hack. If they were notified by a third party, we would also like to know how and by whom they were notified and what their feelings were with respect to the notification.

Title: Cognitive Walkthrough for applying, installing, and using an S/MIME certificate at KIT
Number of students: 1-2 Ba/Ma
Description: The main application of S/MIME is the encryption and signing of e-mail messages. The KIT offers all members the opportunity to have S/MIME certificates issued and has recently started using a new process of the European research network GÉANT for this purpose. The aim of this work is to carry out a cognitive walkthrough with members of the KIT to apply for, set up and use S/MIME certificates and to identify problem areas and obstacles.

Title: Anti-phishing information presented in medias and anti-phishing channels (English only)
Number of students: 1 Ba
Description: Several different channels exists to disseminate information about phishing, be it recent major campaigns or more specific recommendations. Some of these are through social networks accounts, others are specific webpages created "ad hoc" by certain organizations (e.g., Action Fraud in the UK, the BSI). The goal of this topic is to conduct a media review of several channels, collect the data, and compare it with results from a previous iteration of this same topic.

This event counts towards the KASTEL certificate. Further information on how to obtain the certificate can be found on the SECUSO website https://secuso.aifb.kit.edu/Studium_und_Lehre.php) .

V	**Praktikum Security, Usability and Society (Master)** 2512555, WS 24/25, 3 SWS, Language: German/English, Open in study portal	**Practical course (P)** **Blended (On-Site/Online)**

Content

English:

The Praktikum Security, Usability and Society will cover topics both of usable security and privacy programming, and how to conduct user studies. To reserve a place, please, register on the WiWi portal and send an email with your chosen topic, plus a back-up one, to mattia.mossano@kit.edu . Topics are assigned first-come-first-served until all of them are filled. Topics in italics have been already assigned.

Application deadline 25.10.2024
Assignment 30.10.2024
Confirmation deadline 03.11.2024

Important dates:

Kick-off: 23.10.2024, 09:00 AM CET in Big Blue Button - Link and Kronenplatz 5.20, 3A-11.1

Report & code feedback deadline: 26.01.2025, 23:59 CET
Feedback on Report & code: 10.02.2025, 23:59 CET
Final report + code deadline: 17.02.2025, 23:59 CET

Presentation draft deadline: 23.02.2025, 23:59 CET
Feedback on presentation draft: 28.02.2025, 23:59 CET
Final presentation deadline: 07.03.2025, 23:59 CET

Presentation day: 11.03.2025, 09:00 CET

Topics:

Privacy Friendly Apps

In this area, students complete an app (or an extension of an app) among our Privacy-Friendly Apps. Please click the following link to know more about them: https://secuso.aifb.kit.edu/english/105.php . Students are provided with a point list of goals, containing both basic features mandatory to pass the course and more advanced ones that heighten the final grade.

Title: NoPhish App Rework
Number of students: 2 Ba/Ma
Description: The NoPhish app was one of the first measures from the NoPhish concept. The app has been around for a long time and has not been updated since then. Accordingly, the task of the project is to make the app functional for the current Android version. The app is also to be optimized so that updates, e.g. new chapters, can be added easily.

Designing Security User studies

These topics are related to how to set up and conduct user studies of various types. Online studies, interviews and lab studies are possible. At the end of the semester, the students present a report / paper and a talk in which they present their methodologies and the results of small pre-studies.

Title: Usability of Password Managers in Virtual Reality
Number of students: 2 Ma
Description: The pre-dominant form of authentication in Virtual Reality (VR) are passwords. Passwords create a burden for users in the VR environment because of special input methods and the virtual keyboard [Stephenson, S. et al (2022). SoK: Authentication in Augmented and Virtual Reality]. Password Managers (PMs) can support the user with handling this problem [Mayer, P. et al. (2022). Why Users (Don't) Use Password Managers at a Large Educational Institution]. They offer auto-filling features, store credentials in an overview or generate complex and secure passwords. Especially in the VR context, where typing a password is slow and complex, PMs can be beneficial. We want to explore the different PMs in VR and test the usability to find challenges and possible solutions.

Title: IT-Security and Privacy Studies in the health sector
Number of students: 1 Ba/Ma
Description: Cyberattacks in the healthcare sector are on the rise and medical facilities are increasingly becoming the target of hacker attacks. This often affects sensitive patient data or, in the event of a cyberattack, patient care. The German Federal Office for Information Security (BSI) reports that “[t]he security situation of the IT infrastructure of medical practices in Germany [...] has hardly been studied to date.” The aim of the work is to find out which scientific studies already exist in the field of IT security and privacy and which best practices can be derived from these studies, e.g. on the subject of recruitment, study design or consideration of special needs.

Title: Understanding Privacy and Security Risk Awareness Among Sports Science Students at KIT
Number of students: 1 Ba/Ma
Description: Privacy and Security Awareness in Data Handling: The key issue is that many sports science students may not fully understand the privacy and security risks involved in handling sensitive data. As students increasingly deal with personal and research-related information, gaps in their awareness of data protection, such as risks of data breaches or misuse, can lead to significant vulnerabilities. The aim of the task is to design a survey that assesses their current understanding of these risks, helping to identify areas where further education or guidance is needed.

Run Usable Security Studies and Results Analysis

These topics are related to run and analyze the results of user-studies. Online studies, interviews and lab studies are all possible, depending on the topic. At the end of the semester, the students present a report / paper with the analyses conducted and a talk in which they present the results.

Title: Visualization of Eye Gaze Patterns during Authentication Tasks
Number of students: 1 Ba/Ma
Description: In this project, students will analyze and visualize eye gaze data collected during two specific authentication tasks: the Dot Task and the Slider Task. The primary objective is to represent subjects' eye movements visually, enhancing the understanding of gaze patterns during the authentication process. *Dot Task Visualization:* For the Dot Task, participants were instructed to focus on a sequence of dots displayed on a screen. The dataset includes the positions of these dots and the corresponding gaze locations of the subjects. The student's task is to create a dynamic visualization that not only represents these positions accurately but also illustrates the sequence in which the dots were focused on by the subjects. *Slider Task Visualization:* The Slider Task involved presenting participants with a series of images, for which both the images' locations on the screen and the subjects' gaze locations are recorded. The challenge is to develop a heatmap visualization based on this data, effectively demonstrating the concentration and dispersion of gaze points across different images.

Title: Phishing Advice from Organizations (English Only)
Number of students: 1 Ba/Ma
Description: Many companies distribute information on how to recognize phishing via various channels such as e-mails, e.g. Amazon or Telekom. The question arises as to how helpful these tips are in reality. Are they too specific to the context of the company or so abstractly formulated that they are of no real help to users? The aim of the work is to collect various hints and then compare them with the hints of the NoPhish concept in order to find differences and similarities between the hints and the concept.

Title: How do website owners become aware that their website was hacked?
Number of students: 1 Ba/Ma
Description: We identified website owners that were affected by a hack on their website and sent them a notification. During the course of the notification process, we also identified several websites who seemingly remediated the hack before our notification. We now wanted to find out, how those website owners got aware of the hack. If they were notified by a third party, we would also like to know how and by whom they were notified and what their feelings were with respect to the notification.

Title: Cognitive Walkthrough for applying, installing, and using an S/MIME certificate at KIT
Number of students: 1-2 Ba/Ma
Description: The main application of S/MIME is the encryption and signing of e-mail messages. The KIT offers all members the opportunity to have S/MIME certificates issued and has recently started using a new process of the European research network GÉANT for this purpose. The aim of this work is to carry out a cognitive walkthrough with members of the KIT to apply for, set up and use S/MIME certificates and to identify problem areas and obstacles.

This event counts towards the KASTEL certificate. Further information on how to obtain the certificate can be found on the SECUSO website https://secuso.aifb.kit.edu/Studium_und_Lehre.php) .

V Practical lab Security, Usability and Society (Bachelor)

2512554, SS 2025, 3 SWS, Language: English, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content

In the lab-course “Security, Usability and Society”, students deal with practical and interdisciplinary topics from the field of IT security and privacy at the cutting edge of society. In addition to the programming of data-saving apps, the development or implementation of user studies can also be possible tasks in this course.

The course can be credited towards the KASTEL certificate. Further information about the KASTEL certificate can be found on the SECUSO website: https://secuso.aifb.kit.edu/Studium_und_Lehre.php

Prerequisites:

The internship is aimed at Bachelor's and Master's students from the Industrial Engineering and Management, Business Informatics and Computer Science degree programs as well as related degree programs.

Organization:

There are two mandatory attendance dates: The kick-off is scheduled for the first week of the lectures, and the final presentations will take place in the second to last week of lectures. Additional dates will be arranged individually with the supervisors. All in-person lectures will be held in English. The main components of the course is the work on the respective topic, a final presentation and a final report. After consultation with the supervisor, all components can be either completed in German or English.

If you have any questions about the course or the registration, please contact contact@secuso.org.

Registration:

The topics for the course as well as the registration is organized via the WiWi-Portal. To reserve a place and choose a topic, students register for the course in the WiWi-Portal. A description of the current topics as well as important dates and deadlines can also be found there.

Please note that the number of topics is limited and topics are allocated in the order of registration.

V **Praktikum Security, Usability and Society (Master)**
2512555, SS 2025, 3 SWS, Language: English, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content
In the lab-course “Security, Usability and Society”, students deal with practical and interdisciplinary topics from the field of IT security and privacy at the cutting edge of society. In addition to the programming of data-saving apps, the development or implementation of user studies can also be possible tasks in this course.

The course can be credited towards the KASTEL certificate. Further information about the KASTEL certificate can be found on the SECUSO website: https://secuso.aifb.kit.edu/Studium_und_Lehre.php

Prerequisites:

The internship is aimed at Bachelor's and Master's students from the Industrial Engineering and Management, Business Informatics and Computer Science degree programs as well as related degree programs.

Organization:

There are two mandatory attendance dates: The kick-off is scheduled for the first week of the lectures, and the final presentations will take place in the second to last week of lectures. Additional dates will be arranged individually with the supervisors. All in-person lectures will be held in English. The main components of the course is the work on the respective topic, a final presentation and a final report. After consultation with the supervisor, all components can be either completed in German or English.

If you have any questions about the course or the registration, please contact contact@secuso.org.

Registration:

The topics for the course as well as the registration is organized via the WiWi-Portal. To reserve a place and choose a topic, students register for the course in the WiWi-Portal. A description of the current topics as well as important dates and deadlines can also be found there.

Please note that the number of topics is limited and topics are allocated in the order of registration.

T 4.14 Course: Advanced Lab Sociotechnical Information Systems Development (Master) [T-WIWI-111125]

Responsible: Prof. Dr. Ali Sunyaev
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Events					
WT 24/25	2512401	Practical Course Sociotechnical Information Systems Development (Master)	3 SWS	Practical course /	Sunyaev, Leiser
Exams					
WT 24/25	7900143	Advanced Lab Development of Sociotechnical Information Systems (Master)			Sunyaev

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

Prerequisites
None

Workload
135 hours

T 4.15 Course: Advanced Machine Learning and Data Science [T-WIWI-111305]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105659 - Advanced Machine Learning and Data Science

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	9	Grade to a third	Each term	5

Exams			
WT 24/25	7900291	Advanced Machine Learning and Data Science	Ulrich

Competence Certificate
The assessment is carried out in form of a written thesis based on the course "Advanced Machine Learning and Data Science".

Annotation
The course is targeted to students with a major in Data Science and/or Machine Learning. It offers students the opportunity to develop hands-on knowledge on new developments in data science and machine learning. Please apply via the link: https://portal.wiwi.kit.edu/forms/form/fbv-ulrich-msc-project.

Workload
270 hours

T 4.16 Course: Advanced Methods in Nonlinear Partial Differential Equations [T-MATH-113691]

Responsible: Dr. Björn de Rijk
Prof. Dr. Wolfgang Reichel

Organisation: KIT Department of Mathematics

Part of: M-MATH-106822 - Advanced Methods in Nonlinear Partial Differential Equations

Type	Credits	Grading scale	Version
Oral examination	3	Grade to a third	1

Exams			
WT 24/25	7700105	Advanced Methods in Nonlinear Partial Differential Equations	de Rijk

Competence Certificate
The module examination takes place in form of an oral exam of about 30 minutes.

Prerequisites
none

Recommendation
The following modules are recommended: Analysis 1-3, Functional Analysis, Evolution Equations.

Workload
90 hours

T 4.17 Course: Advanced Statistics [T-WIWI-103123]

Responsible: Prof. Dr. Oliver Grothe
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101637 - Analytics and Statistics
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2550552	Advanced Statistical Techniques, Including Multivariate and Simulation Methods	2 SWS	Lecture / 🗣	Grothe
WT 24/25	2550553	Exercises and Computer Labs in Advanced Statistical Techniques	2 SWS	Practice / 🗣	Kaplan
Exams					
WT 24/25	7900289	Advanced Statistical Techniques, Including Multivariate and Simulation Methods			Grothe
ST 2025	7900253	Advanced Statistical Techniques, Including Multivariate and Simulation Methods			Grothe

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation. The exam is offered every semester. Re-examinations are offered only for repeaters.

Prerequisites
None

Workload
135 hours

Below you will find excerpts from events related to this course:

V Advanced Statistical Techniques, Including Multivariate and Simulation Methods

Lecture (V)
On-Site

2550552, WS 24/25, 2 SWS, Language: English, Open in study portal

Literature
Skript zur Vorlesung

T 4.18 Course: Advanced Stochastic Optimization [T-WIWI-106548]

Responsible: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	Irregular	2

Events					
WT 24/25	2500089	Advanced Stochastic Optimization	2 SWS	Lecture / 🖥	Rebennack
WT 24/25	2550468	Übung zu Advanced Stochastic Optimization	1 SWS	Practice / ⚙	Rebennack
Exams					
WT 24/25	7900025	Advanced Stochastic Optimization			Rebennack
ST 2025	7900034	Advanced Stochastic Optimization			Rebennack

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of an oral exam (20 minutes). The exam is offered every semester.

Prerequisites
None.

Recommendation
It is recommended to attend the lecture "Introduction to Stochastic Optimization" before attending the lecture "Advanced Stochastic Optimization".

Annotation
Lectures and tutorials are offered irregularly.

Workload
135 hours

T 4.19 Course: Advanced Topics in Economic Theory [T-WIWI-102609]

Responsible: Prof. Dr. Johannes Brumm
Prof. Dr. Kay Mitusch

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-101500 - Microeconomic Theory
M-WIWI-101502 - Economic Theory and its Application in Finance

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Events					
ST 2025	2520527	Advanced Topics in Economic Theory	2 SWS	Lecture / 🗣	Mitusch, Brumm
ST 2025	2520528	Übung zu Advanced Topics in Economic Theory	1 SWS	Practice / 🗣	Pegorari, Corbo, Mitusch, Brumm

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60min) (following §4(2), 1 of the examination regulation) at the end of the lecture period or at the beginning of the following semester.

Prerequisites
None

Recommendation
This course is designed for advanced Master students with a strong interest in economic theory and mathematical models. Bachelor students who would like to participate are free to do so, but should be aware that the level is much more advanced than in other courses of their curriculum.

Below you will find excerpts from events related to this course:

V Advanced Topics in Economic Theory
2520527, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Literature
Die Veranstaltung wird in englischer Sprache angeboten:

The course is based on the excellent textbook "Microeconomic Theory" (Chapters 1-5, 10, 13-20) by A.Mas-Colell, M.D.Whinston, and J.R.Green.

T 4.20 Course: Algebra [T-MATH-102253]

Responsible: PD Dr. Stefan Kühnlein
Prof. Dr. Roman Sauer

Organisation: KIT Department of Mathematics

Part of: M-MATH-101315 - Algebra

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

Events					
WT 24/25	0102200	Algebra	4 SWS	Lecture / 🗣	Sauer
WT 24/25	0102210	Tutorial for 0102200 (Algebra)	2 SWS	Practice / 🗣	Sauer
Exams					
WT 24/25	7700138	Algebra			Sauer
WT 24/25	7700141	Algebra			Sauer
ST 2025	7700066	Algebra			Sauer

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 4.21 Course: Algebraic Geometry [T-MATH-103340]

Responsible: Prof. Dr. Frank Herrlich
PD Dr. Stefan Kühnlein

Organisation: KIT Department of Mathematics

Part of: M-MATH-101724 - Algebraic Geometry

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T 4.22 Course: Algebraic Number Theory [T-MATH-103346]

Responsible:	Prof. Dr. Frank Herrlich PD Dr. Stefan Kühnlein
Organisation:	KIT Department of Mathematics
Part of:	M-MATH-101725 - Algebraic Number Theory

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Competence Certificate
oral examination of ca. 30 minutes

Prerequisites
none

Workload
240 hours

T 4.23 Course: Algebraic Topology [T-MATH-105915]

Responsible: TT-Prof. Dr. Manuel Krannich
Prof. Dr. Roman Sauer

Organisation: KIT Department of Mathematics

Part of: M-MATH-102948 - Algebraic Topology

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	1

Exams			
WT 24/25	7700131	Algebraic Topology	Krannich
ST 2025	7700134	Algebraic Topology	Krannich

Prerequisites
none

T 4.24 Course: Algebraic Topology II [T-MATH-105926]

Responsible: TT-Prof. Dr. Manuel Krannich
Prof. Dr. Roman Sauer

Organisation: KIT Department of Mathematics

Part of: M-MATH-102953 - Algebraic Topology II

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Irregular	1

Prerequisites
none

T 4.25 Course: Analytical and Numerical Homogenization [T-MATH-111272]

Responsible: Prof. Dr. Marlis Hochbruck
TT-Prof. Dr. Roland Maier

Organisation: KIT Department of Mathematics

Part of: M-MATH-105636 - Analytical and Numerical Homogenization

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Events					
ST 2025	0165700	Analytical and Numerical Homogenization	3 SWS	Lecture	Maier

Prerequisites
none

Below you will find excerpts from events related to this course:

V Analytical and Numerical Homogenization — **Lecture (V)**
0165700, SS 2025, 3 SWS, Open in study portal

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.

T 4.26 Course: Applications of Topological Data Analysis [T-MATH-111290]

Responsible: Dr. Andreas Ott
Organisation: KIT Department of Mathematics
Part of: M-MATH-105651 - Applications of Topological Data Analysis

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Prerequisites
none

T 4.27 Course: Applied Econometrics [T-WIWI-111388]

Responsible: Prof. Dr. Fabian Krüger
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101638 - Econometrics and Statistics I

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2520020	Applied Econometrics	2 SWS	Lecture / 🗣	Krüger, Eberl
WT 24/25	2520021	Tutorial in Applied Econometrics	2 SWS	Practice / 🗣	Eberl, Krüger
Exams					
WT 24/25	7900251	Applied Econometrics			Krüger
ST 2025	7900007	Applied Econometrics			Krüger

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of this course is a written examination (90 min).

Prerequisites
None

Below you will find excerpts from events related to this course:

V Applied Econometrics
2520020, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
The course starts with a concise review of core econometric topics (in particular, the linear regression model). It then presents methods for causal inference: The potential outcomes approach, methods for analyzing randomized controlled trials, and methods for analyzing observational data (e.g., regression discontinuity). Empirical examples and R code are used to illustrate the methodological concepts.

Learning goals

Students understand the properties of various econometric estimators and research designs, and can implement econometric estimators using R software.

Workload

The total workload for this course (4.5 credit points) is approximately 135 hours.

Literature
The following book is the main reference for the course:

Ding, P. (2024). A First Course in Causal Inference. Routledge.

Further literature will be announced in class.

T 4.28 Course: Applied Informatics – Principles of Internet Computing: Foundations for Emerging Technologies and Future Services [T-WIWI-110339]

Responsible: Prof. Dr. Ali Sunyaev
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	see Annotations	2

Events					
ST 2025	2511032	Applied Informatics - Internet Computing	2 SWS	Lecture / 🗣	Lins, Kannengießer, Schmidt-Kraepelin, Sturm, Thiebes
ST 2025	2511033	Übungen zu Angewandte Informatik - Internet Computing	1 SWS	Practice /	Lins, Kannengießer, Schmidt-Kraepelin, Sturm, Thiebes, Guse, Rank
Exams					
WT 24/25	79AIFB_AI-IC_B4	Applied Informatics – Principles of Internet Computing: Foundations for Emerging Technologies and Future Services			Sunyaev
ST 2025	79AIFB_AI2	Applied Informatics - Internet Computing (Registration until 16.09.2025)			Sunyaev

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

Competence Certificate
The examination will be offered for the last time in the summer semester 2025 for first-time students. The last examination opportunity (only for repeaters) is in the winter semester 2025/2026. The lecture"Applied Computer Science - Internet Computing" (Prof. Dr. A. Sunyaev) will be replaced by the new lecture "Applied Computer Science - Cybersecurity" (Prof. Dr. M. Volkamer).

Success is assessed in the form of a written examination (60 minutes) in accordance with §4(2),1 SPO.

Successful completion of the exercises is recommended for the written exam, which is offered at the end of the winter semester and at the end of the summer semester.

A grade bonus can be earned for successful participation in the exercises by submitting correct solutions to 50% of the exercises set. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

Prerequisites
None

Annotation
The lecture "Applied Computer Science - Internet Computing" (Prof. Dr. A. Sunyaev) will be held for the last time in the summer semester 2025 and will then be replaced by the new lecture "Applied Computer Science - Cyber Security" (Prof. Dr. M. Volkamer).

Workload
135 hours

Below you will find excerpts from events related to this course:

V Applied Informatics - Internet Computing
2511032, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content

The lecture Applied Computer Science - Internet Computing provides insights into fundamental concepts and future technologies of distributed systems and Internet computing. Students should be able to select, design and apply the presented concepts and technologies. The course first introduces basic concepts of distributed systems (e.g. design of architectures for distributed systems, internet architectures, web services, middleware).

In the second part of the course, emerging technologies of Internet computing will be examined in depth. These include, among others:

- Cloud Computing
- Edge & Fog Computing
- Internet of Things
- Blockchain
- Artificial Intelligence

Learning objectives:

The student learns about basic concepts and emerging technologies of distributed systems and internet computing. Practical topics will be deepened in lab classes.

Recommendations:

Knowledge of content of the module [WI1INFO].

Workload:

The total workload for this course is approximately 135-150 hours.

Literature

Wird in der Vorlesung bekannt gegeben

T 4.29 Course: Applied material flow simulation [T-MACH-112213]

Responsible: Dr.-Ing. Marion Baumann
Organisation: KIT Department of Mechanical Engineering

Part of: M-WIWI-102805 - Service Operations
M-WIWI-102832 - Operations Research in Supply Chain Management

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2117054	Applied material flow simulation	3 SWS	Lecture / Practice (/ 🗣	Baumann
Exams					
WT 24/25	76-T-MACH-112213	Applied material flow simulation			Baumann, Furmans
WT 24/25	76-T-MACH-112214	Applied material flow simulation			Baumann, Furmans

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of an oral exam (20 min.) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

Prerequisites
None

Recommendation

- Basic statistical knowledge and understanding
- Knowledge of a common programming language (Java, Python, ...)
- Recommended course: T-WIWI-102718 - Discrete Event Simulation in Production and Logistics

Workload
135 hours

Below you will find excerpts from events related to this course:

V Applied material flow simulation

2117054, WS 24/25, 3 SWS, Language: German, Open in study portal

Lecture / Practice (VÜ)
On-Site

Content
Learning Content:

- Methods of modeling a simulation such as:
    - Discrete-event simulation
    - Agent based simulation
- Design of a simulation model of a material flow system
- Data exchange in simulation models
- Verification and validation of simulation models
- Execution of simulation studies
- Statistical evaluation and parameter study

This is an application-oriented course in which the course contents are applied and deepened using the Anylogic software.

Learning Goals:
Students are able to:

- select the appropriate simulation modeling method depending on a modeling objective and build a suitable simulation model for material flow systems,
- extend a simulation model in a meaningful way with data import and export,
- verify and validate a simulation model,
- conduct a simulation study efficiently and with meaningful results, and
- design and conduct a parameter study and statistically analyze and evaluate the results.

Requirements:

- Basic knowledge of the Java programming language

Recommendations:

- Basic statistical skills
- Recommended course: T-WIWI-102718 - Discrete Event Simulation in Production and Logistics

Workload for 4,5 ECTS (135 h):

- regular attendance: 21 hours
  self-study: 114 hours

Organizational issues

- **Im Wintersemester 2024/2025 ist die Veranstaltung auf maximal 30 Teilnehmer beschränkt.**
- **Die Anmeldung ist durch Beitritt zum ILIAS-Kurs und Ausfüllen des Anmeldungsformulars (erforderliche Felder beim Beitritt zum ILIAS-Kurs) möglich.**
- **Die Anmeldung ist vom 01.09.2024 bis zum 30.09.2024 möglich.**

Literature
Borshev, A. (2022): The Big Book of Simulation Modeling - Multimethod Modeling with AnyLogic 8, https://www.anylogic.de/resources/books/big-book-of-simulation-modeling/.

Grigoryev, I. (2021): AnyLogic8 in Three Days, 5. Aufl., https://www.anylogic.de/resources/books/free-simulation-book-and-modeling-tutorials/.

Gutenschwager, K. et. al. (2017): Simulation in Produktion und Logistik, Springer Vieweg, Berlin.

VDI (2014): Simulation von Logistik-, Materialfluss- und Produktionssystemen - Grundlagen. VDI Richtlinie 3633, Blatt 1, VDI-Verlag, Düsseldorf.

VDI (2016): Simulation von Logistik-, Materialfluss- und Produktionssystemen - Simulation und Optimierung. VDI Richtlinie 3633, Blatt 12, VDI-Verlag, Düsseldorf

T 4.30 Course: Asset Pricing [T-WIWI-102647]

Responsible: Prof. Dr. Martin Ruckes
Prof. Dr. Marliese Uhrig-Homburg

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-101480 - Finance 3
M-WIWI-101482 - Finance 1
M-WIWI-101483 - Finance 2
M-WIWI-101502 - Economic Theory and its Application in Finance

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2025	2530555	Asset Pricing	2 SWS	Lecture / 🗣	Uhrig-Homburg, Müller
ST 2025	2530556	Asset Pricing	1 SWS	Practice / 🗣	Böll, Uhrig-Homburg, Müller
Exams					
WT 24/25	7900056	Asset Pricing			Uhrig-Homburg
ST 2025	7900110	Asset Pricing			Uhrig-Homburg, Thimme

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Depending on further pandemic developments, the examination will be offered either as a 60-minute written examination or as an open-book examination (alternative exam assessment).

A bonus can be earned by correctly solving at least 50% of the posed bonus exercises. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

Prerequisites
None

Recommendation
We strongly recommend knowledge of the basic topics in investments (bachelor course), which will be necessary to be able to follow the course.

Below you will find excerpts from events related to this course:

V Asset Pricing
2530556, SS 2025, 1 SWS, Language: German, Open in study portal

Practice (Ü)
On-Site

T 4.31 Course: Auction Theory [T-WIWI-102613]

Responsible: Prof. Dr. Karl-Martin Ehrhart
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101500 - Microeconomic Theory
M-WIWI-102970 - Decision and Game Theory

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2520408	Auction Theory	2 SWS	Lecture	Ehrhart
WT 24/25	2520409	Auction Theory Exercise	1 SWS	Practice	Ehrhart
Exams					
WT 24/25	7900028	Auction Theory			Ehrhart
ST 2025	7900255	Auction Theory			Ehrhart

Competence Certificate
The assessment of this course is a written examination (following §4(2), 1 SPO) of 60 mins.

The exam is offered each semester.

Prerequisites
None

Below you will find excerpts from events related to this course:

V Auction Theory
Lecture (V)
2520408, WS 24/25, 2 SWS, Open in study portal

Literature

- Ehrhart , K.-M. und S. Seifert: Auktionstheorie, Skript zur Vorlesung, KIT, 2011
- Krishna, V.: Auction Theory, Academic Press, Second Edition, 2010
- Milgrom, P.: Putting Auction Theory to Work, Cambridge University Press, 2004
- Ausubel, L.M. und P. Cramton: Demand Reduction and Inefficiency in Multi-Unit Auctions, University of Maryland, 1999

T 4.32 Course: Bayesian Inverse Problems with Connections to Machine Learning [T-MATH-112842]

Responsible: TT-Prof. Dr. Sebastian Krumscheid
Organisation: KIT Department of Mathematics
Part of: M-MATH-106328 - Bayesian Inverse Problems with Connections to Machine Learning

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each summer term	1 terms	1

Competence Certificate
oral exam of ca. 30 min

Prerequisites
none

Workload
120 hours

T 4.33 Course: Bifurcation Theory [T-MATH-106487]

Responsible: Dr. Rainer Mandel
Organisation: KIT Department of Mathematics
Part of: M-MATH-103259 - Bifurcation Theory

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

Prerequisites
None

T 4.34 Course: Bond Markets [T-WIWI-110995]

Responsible: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2530560	Bond Markets	3 SWS	Lecture / Practice (/ 🗣	Uhrig-Homburg, Molnar
Exams					
WT 24/25	7900311	Bond Markets			Uhrig-Homburg
ST 2025	7900280	Bond Markets			Uhrig-Homburg

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate

The assessment consists of a written exam (75min.)

A bonus can be earned by correctly solving at least 50% of the posed bonus exercises. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one level (0.3 or 0.4). The examination is offered in each semester and can be repeated at any regular examination date.

Depending on further pandemic developments, the examination will be offered as an open-book examination (alternative exam assessment).

Annotation

This course will be held in English.

Workload

135 hours

Below you will find excerpts from events related to this course:

V Bond Markets

2530560, WS 24/25, 3 SWS, Language: English, Open in study portal

Lecture / Practice (VÜ)
On-Site

Content

The lecture "Bond Markets" deals with the national and international bond markets, which are an important source of financing for companies, as well as for the public sector. After an overview of the most important bond markets, different yield definitions are discussed. Based on this, the concept of the yield curve is presented. In addition, the theoretical and empirical relationships between ratings, default probabilities and spreads are analyzed. The focus will then be on questions regarding the valuation, measurement, management and control of credit risks.

The total workload for this course is approximately 135 hours (4.5 credits).

The assessment consists of a written exam (75min.) (according to §4(2), 1 SPO). A bonus can be earned by correctly solving at least 50% of the posed bonus exercices. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one level (0.3 or 0.4). The examination is offered in each semester and can be repeated at any regular examination date.

Students deepen their knowledge of national and international bond markets. They gain knowledge of the traded instruments and their key figures for describing default risk such as ratings, default probabilities or credit spreads.

Organizational issues

Die Veranstaltung wird freitags in der ersten Semesterhälfte am Campus B (Geb. 09.21) im Raum 124 angeboten. Die Klausur findet am 08.01.25 statt.

T 4.35 Course: Bond Markets - Models & Derivatives [T-WIWI-110997]

Responsible: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2530565	Bond Markets - Models & Derivatives	2 SWS	Block / 🗣	Grauer, Uhrig-Homburg
Exams					
WT 24/25	7900318	Bond Markets - Models & Derivatives			Uhrig-Homburg

Legend: Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of success consists in equal parts of a written thesis and an oral exam including a discussion of one's own work. The main examination is offered once a year, re-examinations every semester.

Recommendation
Knowledge of "Bond Markets" and "Derivatives" courses is very helpful.

Annotation
This course will be held in English.

Workload
90 hours

Below you will find excerpts from events related to this course:

V Bond Markets - Models & Derivatives
2530565, WS 24/25, 2 SWS, Language: English, Open in study portal

Block (B)
On-Site

Content

- **Competence Certificate:** The assessment of success consists in equal parts of a written thesis and an oral exam (according to §4(2), 3 SPO) including a discussion of one's own work. The main examination is offered once a year, re-examinations every semester.
- **Competence Goal:** Students deepen their knowledge of national and international bond markets. They are able to apply the knowledge they have gained about traded instruments and common valuation models for pricing derivative financial instruments.
- **Prerequisites:**
- **Content:** The lecture "Bond Markets – Models & Derivatives" deepens the content of the lecture "Bond Markets". The modelling of the dynamics of yield curves and the management of credit risks forms the theoretical foundation for the valuation of interest rate and credit derivatives to be discussed. In this course, students deal intensively with selected topics and acquire the relevant knowledge on their own.
- **Recommendation:** Knowledge of "Bond Markets" and "Derivatives" courses is very helpful.
- **Workload:** The total workload for this course is approximately 90 hours (3.0 credits).

Organizational issues
Die Veranstaltung mit Seminarcharakter und dem Ziel, ein selbstgewähltes Themenfeld in Form einer schriftlichen Ausarbeitung eigenständig zu erarbeiten, findet in der 2. Semesterhälfte statt.

4.36 Course: Bond Markets - Tools & Applications [T-WIWI-110996]

Responsible: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	1,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2530562	Bond Markets - Tools & Applications	1 SWS	Block / 🗣	Uhrig-Homburg, Grauer
Exams					
WT 24/25	7900317	Bond Markets - Tools & Applications			Uhrig-Homburg
ST 2025	7900283	Bond Markets - Tools & Applications			Uhrig-Homburg

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of an empirical case study with written elaboration and presentation. The main examination is offered once a year, re-examinations every semester.

Recommendation
Knowledge of the "Bond Markets" course is very helpful.

Annotation
This course will be held in English.

Workload
45 hours

Below you will find excerpts from events related to this course:

Bond Markets - Tools & Applications
2530562, WS 24/25, 1 SWS, Language: English, Open in study portal

Block (B)
On-Site

Content

- **Competence Certificate:** The assessment consists of an empirical case study with written elaboration and presentation (according to $4(2), 3 SPO). The main examination is offered once a year, re-examinations every semester.
- **Competence Goal:** The students apply various methods in practice within the framework of a project-related case study. They are able to deal with empirical data and analyze them in a targeted manner.
- **Content:** The course "Bond Markets – Tools & Applications" includes a hands-on project in the field of national and international bond markets. Using empirical datasets, the students have to apply practical methods in order to analyze the data in a targeted manner.
- **Recommendation:** Knowledge of the "Bond Markets" course is very helpful.
- **Workload:** The total workload for this course is approximately 45 hours (1.5 credits).

Organizational issues
Die Veranstaltung findet in der ersten Semesterhälfte statt und beinhaltet eine eigenständige Projektarbeit im Umgang mit realen Bond Daten. Die Erfolgskontrolle erfolgt anhand einer schriftlichen Ausarbeitung und einer kurzen Präsentation.

T 4.37 Course: Bott Periodicity [T-MATH-108905]

Responsible: Prof. Dr. Wilderich Tuschmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-104349 - Bott Periodicity

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

Prerequisites
none

T 4.38 Course: Boundary and Eigenvalue Problems [T-MATH-105833]

Responsible: Prof. Dr. Dorothee Frey
Prof. Dr. Dirk Hundertmark
Prof. Dr. Tobias Lamm
Prof. Dr. Michael Plum
Prof. Dr. Wolfgang Reichel
Prof. Dr. Roland Schnaubelt

Organisation: KIT Department of Mathematics

Part of: M-MATH-102871 - Boundary and Eigenvalue Problems

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2025	0157500	Boundary and Eigenvalue Problems	4 SWS	Lecture	Liao
ST 2025	0157510	Tutorial for 0157500 (Boundary and Eigenvalue Problems)	2 SWS	Practice	Liao

Below you will find excerpts from events related to this course:

V Boundary and Eigenvalue Problems

0157500, SS 2025, 4 SWS, Open in study portal

Lecture (V)

Content
We consider boundary value and eigenvalue problems within mathematics and physics, describe qualitative properties of solutions, prove the existence of solutions to boundary value problems using functional analytical methods and will work in more general function spaces, e.g. Sobolev spaces. Further contents are the weak formulation of 2nd order linear elliptic equations, existence and regularity theory of elliptic equations, as well as, eigenvalue theory for weakly formulated elliptic eigenvalue problems.

T 4.39 Course: Boundary Element Methods [T-MATH-109851]

Responsible: PD Dr. Tilo Arens
Organisation: KIT Department of Mathematics
Part of: M-MATH-103540 - Boundary Element Methods

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Prerequisites
none

T 4.40 Course: Brownian Motion [T-MATH-105868]

Responsible: Prof. Dr. Nicole Bäuerle
Prof. Dr. Vicky Fasen-Hartmann
Prof. Dr. Günter Last

Organisation: KIT Department of Mathematics

Part of: M-MATH-102904 - Brownian Motion

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Prerequisites
none

Workload
120 hours

T 4.41 Course: Business Intelligence Systems [T-WIWI-105777]

Responsible: Prof. Dr. Alexander Mädche
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-104068 - Information Systems in Organizations

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2540422	Business Intelligence Systems	3 SWS	Lecture /	Mädche
Exams					
WT 24/25	7900224	Business Intelligence Systems			Mädche

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Alternative exam assessment. The assessment consists of a one-hour exam and the implementation of a Capstone project. Details will be announced at the beginning of the course.

Prerequisites
None

Recommendation
Basic knowledge on database systems is helpful.

Below you will find excerpts from events related to this course:

V **Business Intelligence Systems**
2540422, WS 24/25, 3 SWS, Language: English, Open in study portal

Lecture (V)
Blended (On-Site/Online)

Content

In most modern enterprises, Business Intelligence & Analytics (BI&A) Systems represent a core enabler of decision-making in that they supply up-to-date and accurate information about all relevant aspects of a company's planning and operations: from stock levels to sales volumes, from process cycle times to key indicators of corporate performance. Modern BI&A systems leverage beyond reporting and dashboards also advanced analytical functions. Thus, today, they also play a major role in enabling data-driven products and services. This course aims to introduce theoretical foundations, concepts, tools, and current practice of BI&A Systems from a managerial and technical perspective.

The course is complemented by an engineering capstone project, where students work in a team with real-world use cases and data in order to create a prototypical Business intelligence & Analytics system using state-of-the-art technologies (e.g., scikit-learn in Python or Microsoft Power BI).

Learning objectives

- Understand the theoretical foundations of key Business Intelligence & Analytics concepts supporting decision-making
- Explore key capabilities of state-of-the-art Business Intelligence & Analytics Systems
- Learn how to successfully implement and run Business Intelligence & Analytics Systems from multiple perspectives, e.g. architecture, data management, consumption, analytics
- Get hands-on experience by working with Business Intelligence & Analytics Systems with real-world use cases and data

Prerequisites

This course is limited to 50 places. The capacity limitation is due to the format of the accompanying engineering capstone project. Strong analytical abilities and profound skills in SQL and Python are required. Students have to apply with their CVs and transcripts of records via the WiWi-Portal. The first lecture will present all organizational details and the underlying registration process for the lecture and the capstone project. The teaching language is English.

Die Erfolgskontrolle erfolgt in Form einer Prüfungsleistung anderer Art (Form) nach § 4 Abs. 2 Nr. 3 SPO. Die Leistungskontrolle erfolgt in Form einer einstündigen Klausur und durch Durchführung eines Capstone Projektes. Details zur Ausgestaltung der Erfolgskontrolle werden im Rahmen der Vorlesung bekannt gegeben.

Literature

- Turban, E., Aronson, J., Liang T.-P., Sharda, R. 2008. "Decision Support and Business Intelligence Systems".
- Watson, H. J. 2014. "Tutorial: Big Data Analytics: Concepts, Technologies, and Applications," Communications of the Association for Information Systems (34), p. 24.
- Arnott, D., and Pervan, G. 2014. "A critical analysis of decision support systems research revisited: The rise of design science," Journal of Information Technology (29:4), Nature Publishing Group, pp. 269–293 (doi: 10.1057/jit.2014.16) .
- Carlo, V. (2009). "Business intelligence: data mining and optimization for decision making". Editorial John Wiley and Sons, 308-317.
- Chen, H., Chiang, R. H. L, and Storey, V. C. 2012. „Business Intelligence and Analytics: From Big Data to Big Impact," MIS Quarterly (36:4), pp. 1165-1188.
- Davenport, T. 2014. Big Data @ Work, Boston, MA: Harvard Business Review.
- Economist Intelligence Unit. 2015 "Big data evolution: Forging new corporate capabilities for the long term"
- Power, D. J. 2008. "Decision Support Systems: A Historical Overview," Handbook on Decision Support Systems, pp. 121–140 (doi: 10.1007/978-3-540-48713-5_7) .
- Sharma, R., Mithras, S., and Kankanhalli, A. 2014. „Transforming decision-making processes: a research agenda for understanding the impact of business analytics on organisations," European Journal of Information Systems (23:4), pp. 433-441.
- Silver, M. S. 1991. "Decisional Guidance for Computer-Based Decision Support," MIS Quarterly (15:1), pp. 105-122.

Further literature will be made available in the lecture.

T 4.42 Course: Business Process Modelling [T-WIWI-102697]

Responsible: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2511210	Business Process Modelling	2 SWS	Lecture / 🗣	Oberweis
WT 24/25	2511211	Exercise Business Process Modelling	1 SWS	Practice / 🗣	Oberweis, Schüler
Exams					
WT 24/25	79AIFB_MvG_C2	Business Process Modelling			Oberweis
ST 2025	79AIFB_MvG_B4	Business Process Modelling (Registration until 21.07.2025)			Oberweis

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation in the first week after lecture period.

Prerequisites
None

Below you will find excerpts from events related to this course:

V Business Process Modelling
2511210, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
The proper modeling of relevant aspects of business processes is essential for an efficient and effective design and implementation of processes. This lecture presents different classes of modeling languages and discusses the respective advantages and disadvantages of using actual application scenarios. For that simulative and analytical methods for process analysis are introduced. In the accompanying exercise the use of process modeling tools is practiced.

Learning objectives:

Students

- describe goals of business process modeling and aplly different modeling languages,
- choose the appropriate modeling language according to a given context,
- use suitable tools for modeling business processes,
- apply methods for analysing and assessing process modells to evaluate specific quality characteristics of the process model.

Recommendations:

Knowledge of course Applied Informatics I - Modelling is expected.

Workload:

- Lecture 30h
- Exercise 15h
- Preparation of lecture 24h
- Preparation of exercises 25h
- Exam preparation 40h
- Exam 1h

Literature

- M. Weske: Business Process Management: Concepts, Languages, Architectures. Springer 2012.
- F. Schönthaler, G.Vossen, A. Oberweis, T. Karl: Business Processes for Business Communities: Modeling Languages, Methods, Tools. Springer 2012.

Weitere Literatur wird in der Vorlesung bekannt gegeben.

T 4.43 Course: Classical Methods for Partial Differential Equations [T-MATH-105832]

Responsible: Prof. Dr. Dorothee Frey
Prof. Dr. Dirk Hundertmark
Prof. Dr. Tobias Lamm
Prof. Dr. Michael Plum
Prof. Dr. Wolfgang Reichel
Prof. Dr. Roland Schnaubelt

Organisation: KIT Department of Mathematics

Part of: M-MATH-102870 - Classical Methods for Partial Differential Equations

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	1

Events					
WT 24/25	0105300	Classical Methods for Partial Differential Equations	4 SWS	Lecture	Zillinger
WT 24/25	0105310	Tutorial for 0105300 (Classical Methods for Partial Differential Equations)	2 SWS	Practice	Zillinger
Exams					
WT 24/25	7700045	Classical Methods for Partial Differential Equations			Reichel, Lamm, Hundertmark, Lewintan, Zillinger

T 4.44 Course: Collective Perception in Autonomous Driving [T-WIWI-113363]

Responsible: Prof. Dr. Alexey Vinel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2511456	Collective Perception in Autonomous Driving	2 SWS	Lecture / Blended	Bied, Zhao , Vinel
ST 2025	2511457	Exercise Collective Perception in Autonomous Driving	1 SWS	Practice / Blended	Flores Comeca, Arockiasamy, Zhao , Bied
Exams					
WT 24/25	79AIFB_CPAD_B3	Collective Perception in Autonomous Driving			Vinel
ST 2025	79AIFB_CPAD_C3	Collective Perception in Autonomous Driving (Registration until 21.07.2025)			Vinel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The default assessment of this course is a written examination (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

Prerequisites
None.

Workload
135 hours

T 4.45 Course: Combinatorics [T-MATH-105916]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-102950 - Combinatorics

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	3

Exams			
WT 24/25	7700086	Combinatorics	Aksenovich

Prerequisites
none

T 4.46 Course: Complex Analysis [T-MATH-105849]

Responsible: PD Dr. Gerd Herzog
Prof. Dr. Michael Plum
Prof. Dr. Wolfgang Reichel
Prof. Dr. Roland Schnaubelt
Dr. rer. nat. Patrick Tolksdorf

Organisation: KIT Department of Mathematics

Part of: M-MATH-102878 - Complex Analysis

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

4.47 Course: Complex Geometry [T-MATH-113614]

Responsible: Jun.-Prof. Dr. Claudio Llosa Isenrich
Organisation: KIT Department of Mathematics
Part of: M-MATH-106776 - Complex Geometry

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Exams			
WT 24/25	7700144	Complex Geometry	Llosa Isenrich

Competence Certificate
oral exam (ca. 30 min)

Prerequisites
none

Workload
180 hours

4.48 Course: Compressive Sensing [T-MATH-105894]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-102935 - Compressive Sensing

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

T 4.49 Course: Computational Economics [T-WIWI-102680]

Responsible: Prof. Dr. Pradyumn Kumar Shukla
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	see Annotations	3

Events					
WT 24/25	2590458	Computational Economics	2 SWS	Lecture /	Shukla
WT 24/25	2590459	Excercises to Computational Economics	1 SWS	Practice /	Shukla
Exams					
WT 24/25	79AIFB_CE_B1	Computational Economics			Shukla
ST 2025	79AIFB_CE_C6	Computational Economics (Registration until 21.07.2025)			Shukla

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Please note: the lecture will not take place in the winter semester 2023/2024. Also an exam cannot be offered.

Prerequisites
None

Annotation
The lecture is currently suspended. An exam cannot be offered.

Below you will find excerpts from events related to this course:

V Computational Economics

2590458, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
Blended (On-Site/Online)

Content
Examining complex economic problems with classic analytical methods usually requires making numerous simplifying assumptions, for example that agents behave rationally or homogeneously. Recently, widespread availability of computing power gave rise to a new field in economic research that allows the modeling of heterogeneity and forms of bounded rationality: Computational Economics. Within this new discipline, computer based simulation models are used for analyzing complex economic systems. In short, an artificial world is created which captures all relevant aspects of the problem under consideration. Given all exogenous and endogenous factors, the modelled economy evolves over time and different scenarios can be analyzed. Thus, the model can serve as a virtual testbed for hypothesis verification and falsification.

Learning objectives:

The student

- understands the methods of Computational Economics and applies them on practical issues,
- evaluates agent models considering bounded rational behaviour and learning algorithms,
- analyses agent models based on mathematical basics,
- knows the benefits and disadvantages of the different models and how to use them,
- examines and argues the results of a simulation with adequate statistical methods,
- is able to support the chosen solutions with arguments and can explain them.

Literature

- R. Axelrod: "Advancing the art of simulation in social sciences". R. Conte u.a., Simulating Social Phenomena, Springer, S. 21-40, 1997.
- R. Axtel: "Why agents? On the varied motivations for agent computing in the social sciences". CSED Working Paper No. 17, The Brookings Institution, 2000.
- K. Judd: "Numerical Methods in Economics". MIT Press, 1998, Kapitel 6-7.
- A. M. Law and W. D. Kelton: "Simulation Modeling and Analysis", McGraw-Hill, 2000.
- R. Sargent: "Simulation model verification and validation". Winter Simulation Conference, 1991.
- L. Tesfation: "Notes on Learning", Technical Report, 2004.
- L. Tesfatsion: "Agent-based computational economics". ISU Technical Report, 2003.

Weiterführende Literatur:

- Amman, H., Kendrick, D., Rust, J.: "Handbook of Computational Economics". Volume 1, Elsevier North-Holland, 1996.
- Tesfatsion, L., Judd, K.L.: "Handbook of Computational Economics". Volume 2: Agent-Based Computational Economics, Elsevier North-Holland, 2006.
- Marimon, R., Scott, A.: "Computational Methods for the Study of Dynamic Economies". Oxford University Press, 1999.
- Gilbert, N., Troitzsch, K.: "Simulation for the Social Scientist". Open University Press, 1999.

T 4.50 Course: Computational Fluid Dynamics and Simulation Lab [T-MATH-113373]

Responsible: Prof. Dr. Martin Frank
PD Dr. Mathias Krause
Dr. Stephan Simonis
PD Dr. Gudrun Thäter

Organisation: KIT Department of Mathematics

Part of: M-MATH-106634 - Computational Fluid Dynamics and Simulation Lab

Type	Credits	Grading scale	Version
Examination of another type	4	Grade to a third	1

Events					
ST 2025	0161700	Computational Fluid Dynamics and Simulation Lab	4 SWS	Practical course	Thäter, Krause, Simonis

Prerequisites
none

Workload
120 hours

Below you will find excerpts from events related to this course:

V Computational Fluid Dynamics and Simulation Lab

0161700, SS 2025, 4 SWS, Language: German/English, Open in study portal

Practical course (P)

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 recommended.

T 4.51 Course: Computational Risk and Asset Management [T-WIWI-102878]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105032 - Data Science for Finance

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Irregular	5

Competence Certificate
The module examination takes the form of an alternative exam assessment.
The alternative exam assessment consists of a Python-based "Takehome Exam". At the end of the third week of January, the student is given a "Takehome Exam" which he processes and sends back independently within 4 hours using Python. Precise instructions will be announced at the beginning of the course. The alternative exam assessment can be repeated a maximum of once. A timely repeat option takes place at the end of the third week in March of the same year. More detailed instructions will be given at the beginning of the course.

Prerequisites
None.

Recommendation
Basic knowledge of capital markt theory.

Workload
135 hours

T 4.52 Course: Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems [T-MATH-105854]

Responsible: Prof. Dr. Michael Plum
Organisation: KIT Department of Mathematics
Part of: M-MATH-102883 - Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T 4.53 Course: Continuous Time Finance [T-MATH-105930]

Responsible: Prof. Dr. Nicole Bäuerle
Prof. Dr. Vicky Fasen-Hartmann
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: M-MATH-102860 - Continuous Time Finance

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2025	0159400	Continuous Time Finance	4 SWS	Lecture	Fasen-Hartmann
ST 2025	0159410	Tutorial for 0159400 (Continuous Time Finance)	2 SWS	Practice	Fasen-Hartmann
Exams					
ST 2025	7700110	Continuous Time Finance			Fasen-Hartmann
ST 2025	7700112	Continuous Time Finance			Fasen-Hartmann

Competence Certificate
oral exam of ca. 30 minutes

Prerequisites
none

Workload
240 hours

Below you will find excerpts from events related to this course:

V Continuous Time Finance

0159400, SS 2025, 4 SWS, Open in study portal

Lecture (V)

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

T 4.54 Course: Control Theory [T-MATH-105909]

Responsible: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: M-MATH-102941 - Control Theory

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

Prerequisites
none

T 4.55 Course: Convex Analysis [T-WIWI-102856]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Events					
ST 2025	2550120	Convex Analysis	2 SWS	Lecture / 🗣	Stein
ST 2025	2550121	Exercises Convex Analysis	2 SWS	Practice / 🗣	Stein, Schwarze
Exams					
ST 2025	7900208_SS2025_HK	Convex Analysis			Stein

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

Prerequisites
None

Recommendation
It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Annotation
The lecture is offered irregularly. The curriculum of the next three years is available online (www.ior.kit.edu).

Below you will find excerpts from events related to this course:

V Convex Analysis
2550120, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
Convex Analysis deals with properties of convex functions and convex sets, amongst others with respect to the minimization of convex functions over convex sets. That the involved functions are not necessarily assumed to be differentiable allows a number a applications which are not covered by techniques from smooth optimization, e.g. approximation problems with respect to the Manhattan or maximum norms, classification problems or the theory of statistical estimates. The lecture develops along another, geometrically intuitive example, where a nonsmooth obstacle set is to be described by a single smooth convex constraint such that minimal and maximal distances to the obstacle can be computed. The lecture is structured as follows:

- Introduction to entropic smoothing and convexity
- Global error bounds
- Smoothness properties of convex functions
- The convex subdifferential
- Global Lipschitz continuity
- Descent directions and stationarity conditions

Remark:

Prior to the attendance of this lecture, it is strongly recommend to acquire basic knowledge on optimization problems in one of the lectures "Global Optimization I and II" and "Nonlinear Optimization I and II".

Learning objectives:

The student

- knows and understands the fundamentals of convex analysis,
- is able to choose, design and apply modern techniques of convex analysis in practice.

Literature

- J. Borwein, A. Lewis, Convex Analysis and Nonlinear Optimization: Theory and Examples (2 ed.), Springer, 2006
- S. Boyd, L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004
- O. Güler, Foundations of Optimization, Springer, 2010
- J.-B. Hiriart-Urruty, C. Lemarechal, Fundamentals of Convex Analysis, Springer, 2001
- B. Mordukhovich, N.M. Nam, An Easy Path to Convex Analysis and Applications, Morgan & Claypool Publishers, 2014
- R.T. Rockafellar, Convex Analysis, Princeton University Press, 1970
- R.T. Rockafellar, R.J.B. Wets, Variational Analysis, Springer, Berlin, 1998

T 4.56 Course: Convex Geometry [T-MATH-105831]

Responsible: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: M-MATH-102864 - Convex Geometry

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T 4.57 Course: Cooperative Autonomous Vehicles [T-WIWI-112690]

Responsible: Prof. Dr. Alexey Vinel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2511450	Cooperative Autonomous Vehicles	2 SWS	Lecture /	Vinel
ST 2025	2511451	Exercise Cooperative Autonomous Vehicles	1 SWS	Practice /	Vinel
Exams					
WT 24/25	79AIFB_CAV_A3	Cooperative Autonomous Vehicles			Vinel
ST 2025	79AIFB_CAV_B5	Cooperative Autonomous Vehicles (Registration until 21.07.2025)			Vinel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The default assessment of this course is a written examination (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

Prerequisites
None.

Workload
135 hours

T 4.58 Course: Corporate Risk Management [T-WIWI-109050]

Responsible: Prof. Dr. Martin Ruckes
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2
M-WIWI-101502 - Economic Theory and its Application in Finance

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Competence Certificate
The assessment consists of a written exam (60 min.) according to § 4 paragraph 2 Nr. 1 of the examination regulation. If there are only a small number of participants registered for the exam, we reserve the right to hold an oral examination instead of a written one.
Please note that the exam is only offered in the semester of the lecture as well as in the following semester.

Prerequisites
None

Recommendation
None

Annotation
The course will be held again in the summer term 2023 at the earliest. Please pay attention to the announcements on our website.

Workload
135 hours

T 4.59 Course: Critical Information Infrastructures [T-WIWI-109248]

Responsible: Prof. Dr. Ali Sunyaev
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	4

Competence Certificate
The alternative exam assessment consists of

- the preparation of a written elaboration as well as
- an oral examination as part of a presentation of the work.

Details of the grades will be announced at the beginning of the course.

The examination is only offered to first-time students in the winter semester, but can be repeated in the following summer semester.

Prerequisites
None.

Annotation
New lecture from winter semester 2018/2019.

Workload
150 hours

T 4.60 Course: Curves on Surfaces [T-MATH-113364]

Responsible: Dr. Elia Fioravanti
Organisation: KIT Department of Mathematics
Part of: M-MATH-106632 - Curves on Surfaces

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Irregular	1

Exams			
WT 24/25	7700147	Curves on Surfaces	Fioravanti

Competence Certificate
oral exam (ca. 20-30 min)

Prerequisites
none

Workload
90 hours

4.61 Course: Database Systems and XML [T-WIWI-102661]

Responsible: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	see Annotations	2

Events					
WT 24/25	2511202	Database Systems and XML	2 SWS	Lecture / 🗣	Oberweis
WT 24/25	2511203	Exercises Database Systems and XML	1 SWS	Practice / 🗣	Oberweis, Fritsch
Exams					
WT 24/25	79AIFB_DBX_A4	Database Systems and XML			Oberweis
ST 2025	79AIFB_DBX_A3	Database Systems and XML (Registration until 21.07.2025)			Oberweis

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The examination will be offered for the last time in the winter semester 2025/2026 for first-time students. The last examination opportunity (only for repeaters) is in the summer semester 2026. The assessment takes the form of a written examination (60 minutes) (in accordance with SPO § 4(2)).

Prerequisites
None

Annotation
The lecture will be held for the last time in the winter semester 2024/25.

Below you will find excerpts from events related to this course:

V Database Systems and XML
2511202, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
Databases are a proven technology for managing large amounts of data. The oldest database model, the hierarchical model, was replaced by different models such as the relational or the object-oriented data model. The hierarchical model became particularly more important with the emergence of the extensible Markup Language XML. XML is a data format for structured, semi-structured, and unstructured data. In order to store XML documents consistently and reliably, databases or extensions of existing data base systems are required. Among other things, this lecture covers the data model of XML, concepts of XML query languages, aspects of storage of XML documents, and XML-oriented database systems.

Organisational Note:

We are in the process of transitioning the course "Datenbanksysteme und XML" to English. This semester, the **lecture will be held in German** and the **exercise sessions in English**. We will provide the German exercise materials from last semester as supplementary resources. In the exam, you can give answers in both English and German.

Learning objectives:

Students

- know the basics of XML and generate XML documents,
- are able to use XML database systems and to formulate queries to XML documents,
- know to assess the use of XML in operational practice in different application contexts.

Workload:

- Lecture 30h
- Exercise 15h
- Preparation of lecture 24h
- Preparation of exercises 25h
- Exam preparation 40h
- Exam 1h

Organizational issues
Liebe Studierende,

wir sind dabei, die Veranstaltung "Datenbanksysteme und XML" auf Englisch umzustellen. In diesem Semester findet die **Vorlesung auf deutsch** statt und die **Übung auf englisch**. Wir werden die deutschen Übungsunterlagen aus dem letzten Semester ergänzend zur Verfügung stellen. In der Klausur können sowohl englische als auch deutsche Antworten gegeben werden.

Viele Grüße
DBXML-Team

Dear Students,

We are in the process of transitioning the course "Datenbanksysteme und XML" to English. This semester, the **lecture will be held in German** and the **exercise sessions in English**. We will provide the German exercise materials from last semester as supplementary resources. In the exam, you can give answers in both English and German.

Best regards,
DBXML Team

Literature

- M. Klettke, H. Meyer: XML & Datenbanken: Konzepte, Sprachen und Systeme. dpunkt.verlag 2003
- H. Schöning: XML und Datenbanken: Konzepte und Systeme. Carl Hanser Verlag 2003
- W. Kazakos, A. Schmidt, P. Tomchyk: Datenbanken und XML. Springer-Verlag 2002
- R. Elmasri, S. B. Navathe: Grundlagen der Datenbanksysteme. 2009
- G. Vossen: Datenbankmodelle, Datenbanksprachen und Datenbankmanagementsysteme. Oldenbourg 2008

Weitere Literatur wird in der Vorlesung bekannt gegeben.

V **Exercises Database Systems and XML**
2511203, WS 24/25, 1 SWS, Language: German/English, Open in study portal

Practice (Ü)
On-Site

Content
Organisational note:

We are in the process of transitioning the course "Datenbanksysteme und XML" to English. This semester, the **lecture will be held in German** and the **exercise sessions in English**. We will provide the German exercise materials from last semester as supplementary resources. In the exam, you can give answers in both English and German.

Organizational issues
Liebe Studierende,

wir sind dabei, die Veranstaltung "Datenbanksysteme und XML" auf Englisch umzustellen. In diesem Semester findet die **Vorlesung auf deutsch** statt und die **Übung auf englisch**. Wir werden die deutschen Übungsunterlagen aus dem letzten Semester ergänzend zur Verfügung stellen. In der Klausur können sowohl englische als auch deutsche Antworten gegeben werden.

Viele Grüße
DBXML-Team

Dear Students,

We are in the process of transitioning the course "Datenbanksysteme und XML" to English. This semester, the **lecture will be held in German** and the **exercise sessions in English**. We will provide the German exercise materials from last semester as supplementary resources. In the exam, you can give answers in both English and German.

Best regards,
DBXML Team

T 4.62 Course: Demand-Driven Supply Chain Planning [T-WIWI-110971]

Responsible: Dr. Iris Heckmann
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102805 - Service Operations

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2550510	Demand-Driven Supply Chain Planning		Lecture / 🗣	Heckmann
Exams					
WT 24/25	7900031	Demand-Driven Supply Chain Planning			Heckmann
WT 24/25	7900373	Demand-Driven Supply Chain Planning			Heckmann

Legend: 🖥 Online, ⯐ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam.

Annotation
Due to capacity restrictions, registration before course start is required. For further information see the webpage of the course. The course is planned to be held every winter term. The planned lectures and courses for the next three years are announced online.

Workload
135 hours

T 4.63 Course: Derivatives [T-WIWI-102643]

Responsible: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101482 - Finance 1
M-WIWI-101483 - Finance 2

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2530550	Derivatives	2 SWS	Lecture / 🗣	Uhrig-Homburg, Thimme
ST 2025	2530551	Übung zu Derivate	1 SWS	Practice / 🗣	Dinger, Uhrig-Homburg, Thimme
Exams					
WT 24/25	7900051	Derivatives			Uhrig-Homburg
ST 2025	7900111	Derivatives			Uhrig-Homburg

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Depending on further pandemic developments, the examination will be offered either as a 60-minute written examination or as an open-book examination (alternative exam assessment).

A bonus can be earned by correctly solving at least 50% of the posed bonus exercises. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

Prerequisites
None

Recommendation
None

Below you will find excerpts from events related to this course:

V Derivatives

2530550, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Literature

- Hull (2012): Options, Futures, & Other Derivatives, Prentice Hall, 8th Edition

Weiterführende Literatur:

Cox/Rubinstein (1985): Option Markets, Prentice Hall

T 4.64 Course: Designing Interactive Systems: Human-AI Interaction [T-WIWI-113465]

Responsible: Prof. Dr. Alexander Mädche
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-104068 - Information Systems in Organizations

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2540558	Designing Interactive Systems: Human-AI Interaction	3 SWS	Lecture / Blended	Mädche, Seitz

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Alternative exam assessment. The assessment consists of a one-hour exam and the implementation of a Capstone project. Details will be announced at the beginning of the course.

Annotation
The course is held in english.

Workload
135 hours

Below you will find excerpts from events related to this course:

V Designing Interactive Systems: Human-AI Interaction

2540558, SS 2025, 3 SWS, Language: English, Open in study portal

Lecture (V)
Blended (On-Site/Online)

Content
Description

Computers have evolved from batch processors towards highly interactive systems. With the rapid progress in the field of artificial intelligence, computers can now learn and adapt to their environment, simulate human intelligence processes as well as support or even take over tasks from humans. This offers great possibilities, but at the same time raises new challenges for the successful design of interactive systems.

The aim of this course is to introduce advanced concepts and theories as well as current practice of designing interactive systems. A specific focus is set on designing AI-based interactive systems for individuals and groups at work ranging from personal productivity assistants to AI-augmented virtual collaboration.

The course is complemented with hands-on exercises and a design capstone project in cooperation with an industry partner. In the project, students in a team effort apply state-of-the-art design methods & techniques and create an interactive system design prototype with a specific focus on human-AI interaction.

Learning objectives

- Explain what interactive systems are and how they can be conceptualized
- Describe the unique characteristics of human-AI interaction and their impact on designing interactive systems
- Understand the human-centered design process and know how to apply corresponding methods and tools
- Understand the concepts and theoretical foundations that guide the design of interactive systems
- Know key concepts, design principles and design methods for contemporary interactive systems focusing on on human-AI interaction
- Get hands-on experience by applying lecture content in a design capstone project

Prerequisites

No specific prerequisites are required for the lecture

Literature

Die Vorlesung basiert zu einem großen Teil auf

· Benyon, D. (2014). Designing interactive systems: A comprehensive guide to HCI, UX and interaction design (3. ed.). Harlow: Pearson.

Weiterführende Literatur wird in der Vorlesung bereitgestellt.

T 4.65 Course: Differential Geometry [T-MATH-102275]

Responsible: Prof. Dr. Alexander Lytchak
Prof. Dr. Wilderich Tuschmann

Organisation: KIT Department of Mathematics

Part of: M-MATH-101317 - Differential Geometry

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	1

Events					
ST 2025	0100300	Differential Geometry	4 SWS	Lecture	Lytchak
ST 2025	0100310	Tutorial for 0100300 (Differential Geometry)	2 SWS	Practice	Lytchak

Below you will find excerpts from events related to this course:

V Differential Geometry

0100300, SS 2025, 4 SWS, Language: English, Open in study portal

Lecture (V)

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.

T 4.66 Course: Digital Health [T-WIWI-109246]

Responsible: Prof. Dr. Ali Sunyaev
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2511402	Digital Health	2 SWS	Lecture /	Sunyaev, Thiebes, Schmidt-Kraepelin
Exams					
WT 24/25	7900068	Digital Health			Sunyaev

Legend: Online, Blended (On-Site/Online), On-Site, x Cancelled

Competence Certificate
Alternative exam assessment (written elaboration, presentation, peer review, oral participation) according to §4(2),3 of the examination regulation. Details of the grading will be announced at the beginning of the course. The examination is only offered to first-time writers in the winter semester, but can be repeated in the following summer semester.

Prerequisites
None.

Workload
120 hours

T 4.67 Course: Digital Marketing [T-WIWI-112693]

Responsible: Prof. Dr. Ann-Kristin Kupfer
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105312 - Marketing and Sales Management
M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2571185	Digital Marketing	2 SWS	Lecture / 🗣	Kupfer
ST 2025	2571186	Digital Marketing Exercise	1 SWS	Practice / 🗣	Kopp
Exams					
ST 2025	7900064	Digital Marketing			Kupfer

Legend: 📱 Online, ✳ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed in the form of an examination of another type. The following aspects are included in the assessment:

- Elaboration and presentation of a group task
- Written exam

Further details on the organization of the performance and the points system for the assessment will be announced in the lecture.

Prerequisites
None

Recommendation
Students are highly encouraged to actively participate in class.

Workload
135 hours

Below you will find excerpts from events related to this course:

V Digital Marketing
2571185, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
Students learn the theoretical foundations of digital marketing and its most important concepts. They develop an understanding both for the digital consumer and the digital environment. Special emphasis will be given to digital marketing strategies and practices, such as content marketing and influencer marketing. A tutorial offers the opportunity to apply the key learnings of the lecture as part of a group work.

The learning objectives are as follows:

- Getting to know the theoretical foundations of digital marketing
- Evaluating digital marketing strategies and practices (e.g., in the context of content marketing and influencer marketing)
- Fostering critical and analytical thinking skills and the application of knowledge to marketing problems
- Improving English skills

Total time required for 4.5 credit points: approx. 135 hours
Attendance time: 30 hours
Self-study: 105 hours

Organizational issues
Termine werden bekannt gegeben.

T 4.68 Course: Digital Marketing and Sales in B2B [T-WIWI-106981]

Responsible:	Prof. Dr. Martin Klarmann Anja Konhäuser
Organisation:	KIT Department of Economics and Management
Part of:	M-WIWI-105312 - Marketing and Sales Management M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	1,5	Grade to a third	Each summer term	1

Events					
ST 2025	2571156	Digital Marketing and Sales in B2B	1 SWS	Others (sons /	Konhäuser

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Alternative exam assessment according to § 4 paragraph 2 Nr. 3 of the examination regulation. (team presentation of a case study with subsequent discussion totalling 30 minutes).

Prerequisites
None.

Annotation
This course will not take place in the summer term 2023, but is expected to be offered again on a regular basis starting in the summer term 2024.
Participation requires an application. The application period starts at the beginning of the semester. More information can be obtained on the website of the research group Marketing and Sales (marketing.iism.kit.edu). Access to this course is restricted. Typically all students will be granted the attendance of one course with 1.5 ECTS. Nevertheless attendance can not be guaranteed.For further information please contact Marketing and Sales Research Group (marketing.iism.kit.edu).Please note that only one of the 1.5-ECTS courses can be attended in this module.

Workload
45 hours

Below you will find excerpts from events related to this course:

V Digital Marketing and Sales in B2B
2571156, SS 2025, 1 SWS, Language: English, Open in study portal

Others (sonst.)
On-Site

Content

Learning Sessions:

The class gives insights into digital marketing strategies as well as the effects and potential of different channels (e.g., SEO, SEA, Social Media). After an overview of possible activities and leverages in the digital marketing field, including their advantages and limits, the focus will turn to the B2B markets. There are certain requirements in digital strategy specific to the B2B market, particularly in relation to the value chain, sales management and customer support. Therefore, certain digital channels are more relevant for B2B marketing than for B2C marketing.
Once the digital marketing and tactics for the B2B markets are defined, further insights will be given regarding core elements of a digital strategy: device relevance (mobile, tablet), usability concepts, website appearance, app decision, market research and content management. A major advantage of digital marketing is the possibility of being able to track many aspects of of user reactions and user behaviour. Therefore, an overview of key performance indicators (KPIs) will be discussed and relationships between these KPIs will be explained. To measure the effectiveness of digital activities, a digital report should be set up and connected to the performance numbers of the company (e.g. product sales) – within the course the setup of the KPI dashboard and combination of digital and non-digital measures will be shown to calculate the Return on Investment (RoI).

Presentation Sessions:

After the learning sessions, the students will form groups and work on digital strategies within a case study format. The presentation of the digital strategy will be in front of the class whereas the presentation will take 20 minutes followed by 10 minutes questions and answers.

- Understand digital marketing and sales approaches for the B2B sector
- Recognise important elements and understand how-to-setup of digital strategies
- Become familiar with the effectiveness and usage of different digital marketing channels
- Understand the effect of digital sales on sales management, customer support and value chain
- Be able to measure and interpret digital KPIs
- Calculate the Return on Investment (RoI) for digital marketing by combining online data with company performance data

time of presentness = 15 hrs.

private study = 30 hrs.

Organizational issues

Blockveranstaltung, Raum B5.26, Geb. 10.81, Termine werden noch bekannt gegeben

Literature

-

T 4.69 Course: Discrete Dynamical Systems [T-MATH-110952]

Responsible: PD Dr. Gerd Herzog
Organisation: KIT Department of Mathematics
Part of: M-MATH-105432 - Discrete Dynamical Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Irregular	1

Events					
ST 2025	0106450	Diskrete dynamische Systeme	2 SWS	Lecture / 🗣	Herzog

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

Workload
90 hours

T 4.70 Course: Discrete Time Finance [T-MATH-105839]

Responsible: Prof. Dr. Nicole Bäuerle
Prof. Dr. Vicky Fasen-Hartmann
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: M-MATH-102919 - Discrete Time Finance

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Each winter term	1

Events					
WT 24/25	0108400	Finanzmathematik in diskreter Zeit	4 SWS	Lecture / 🗣	Fasen-Hartmann
WT 24/25	0108500	Übungen zu 0108400 (Finanzmathematik in diskreter Zeit)	2 SWS	Practice / 🗣	Fasen-Hartmann
Exams					
WT 24/25	7700038	Discrete Time Finance			Fasen-Hartmann
WT 24/25	7700050	Discrete Time Finance			Fasen-Hartmann

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written exam of 2h.

Prerequisites
none

Recommendation
The contents of the module „Probability theory“ are strongly recommended.

Workload
240 hours

T 4.71 Course: Discrete-Event Simulation in Production and Logistics [T-WIWI-102718]

Responsible: Hon.-Prof. Dr. Sven Spieckermann
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102805 - Service Operations
M-WIWI-102832 - Operations Research in Supply Chain Management

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	2

Events					
ST 2025	2550488	Ereignisdiskrete Simulation in Produktion und Logistik	3 SWS	Lecture / 🗣	Spieckermann

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written paper and an oral exam of about 30-40 min (alternative exam assessment).

Prerequisites
None

Recommendation
Basic knowledge as conveyed in the module "Introduction to Operations Research" is assumed.

Annotation
Due to capacity restrictions, registration before course start is required. For further information see the webpage of the course.

The course is planned to be held every summer term.

The planned lectures and courses for the next three years are announced online.

Below you will find excerpts from events related to this course:

V Ereignisdiskrete Simulation in Produktion und Logistik

2550488, SS 2025, 3 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
Simulation of production and logistics systems is an interdisciplinary subject connecting expert knowledge from production management and operations research with mathematics/statistics as well as computer science and software engineering. With completion of this course, students know statistical foundations of discrete simulation, are able to classify and apply related software applications, and know the relation between simulation and optimization as well as a number of application examples. Furthermore, students are enabled to structure simulation studies and are aware of specific project scheduling issues.

Organizational issues
Den Bewerbungszeitraum finden Sie auf der Veranstaltungswebseite im Lehre-Bereich unter dol.ior.kit.edu

Literature

- Gutenschwager K., Rabe M., Spieckermann S. und S. Wenzel (2017): Simulation in Produktion und Logistik, Springer, Berlin.
- Banks J., Carson II J. S., Nelson B. L., Nicol D. M. (2010) Discrete-event system simulation, 5.Aufl., Pearson, Upper Saddle River.
- Eley, M. (2012): Simulation in der Logistik - Einführung in die Erstellung ereignisdiskreter Modelle unter Verwendung des Werkzeuges "Plant Simulation“, Springer, Berlin und Heidelberg
- Kosturiak, J. und M. Gregor (1995): Simulation von Produktionssystemen. Springer, Wien und New York.
- Law, A. M. (2015): Simulation Modeling and Analysis. 5th Edition, McGraw-Hill, New York usw.
- Liebl, F. (1995): Simulation. 2. Auflage, Oldenbourg, München.
- Noche, B. und S. Wenzel (1991): Marktspiegel Simulationstechnik. In: Produktion und Logistik. TÜV Rheinland, Köln.
- Pidd, M. (2004): Computer Simulation in Management Science. 5th Edition, Wiley, Chichester.
- Robinson S (2004) Simulation: the practice of model development and use. John Wiley & Sons, Chichester
- VDI (2014): Simulation von Logistik-, Materialfluß- und Produktionssystemen. VDI Richtlinie 3633, Blatt 1, VDI-Verlag, Düsseldorf.

T 4.72 Course: Dispersive Equations [T-MATH-109001]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-104425 - Dispersive Equations

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Prerequisites
none

T 4.73 Course: Dynamical Systems [T-MATH-106114]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-103080 - Dynamical Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Prerequisites
none

T 4.74 Course: Economic Decision Making [T-WIWI-114174]

Responsible: Prof. Dr. Benjamin Scheibehenne
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105312 - Marketing and Sales Management
M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	4,5	Grade to a third	Each winter term	1 terms	1

Competence Certificate
Alternative exam assessment. The grading includes the following aspects:

- a written exam (60 minutes)
- a presentation during the exercise.

The scoring system for the grading will be announced at the beginning of the course.

Prerequisites
Registration via the CAMPUS Portal is required for participation in the Übung. The Übung is a prerequisite for the exam.

Annotation
The judgments and decisions that we make can have long ranging and important consequences for our (financial) well-being and individual health. Hence, the goal of this lecture is to gain a better understanding of how people make judgments and decisions and the factors that influences their behavior. We will look into simple heuristics and mental shortcuts that decision makers use to navigate their environment, in particular so in an economic context. Following this, the lecture will provide an overview into social and emotional influences on decision making. In the second half of the semester we will look into some more specific topics including self-control, nudging, and food choice. The last part of the lecture will focus on risk communication and risk perception. We will address these questions from an interdisciplinary perspective at the intersection of Psychology, Behavioral Economics, Marketing, Cognitive Science, and Biology. Across all topics covered in class, we will engage with basic theoretical work as well as with groundbreaking empirical research and current scientific debates.
The workload of the class is 4.5 ECTS. This consists of 3 ETCS for the lecture and 1.5 ETCS for the Übung. Details about the Übung will be communicated at the first day of the class.

Workload
135 hours

T 4.75 Course: Efficient Energy Systems and Electric Mobility [T-WIWI-102793]

Responsible: Prof. Dr. Patrick Jochem
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each summer term	1

Events					
ST 2025	2581006	Efficient Energy Systems and Electric Mobility	2 SWS	Lecture / 🗣	Jochem
Exams					
WT 24/25	7981006	Efficient Energy Systems and Electric Mobility			Fichtner

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

Prerequisites
None

Recommendation
None

Below you will find excerpts from events related to this course:

V Efficient Energy Systems and Electric Mobility
2581006, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
This lecture series combines two of the most central topics in the field of energy economics at present, namely energy efficiency and electric mobility. The objective of the lecture is to provide an introduction and overview to these two subject areas, including theoretical as well as practical aspects, such as the technologies, political framework conditions and broader implications of these for national and international energy systems.

- Understand the concept of energy efficiency as applied to specific systems
- Obtain an overview of the current trends in energy efficiency
- Be able to determine and evaluate alternative methods of energy efficiency improvement
- Overview of technical and economical stylized facts on electric mobility
- Judging economical, ecological and social impacts through electric mobility

Organizational issues
Termine: 09.05., 23.05., 06.06., 27.06., 11.07., 25.07., 01.08.

Literature
Wird in der Vorlesung bekanntgegeben.

T 4.76 Course: eFinance: Information Systems for Securities Trading [T-WIWI-110797]

Responsible: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2540454	eFinance: Information Systems for Securities Trading	2 SWS	Lecture / 🗣	Weinhardt
WT 24/25	2540455	Übungen zu eFinance: Information Systems for Securities Trading	1 SWS	Practice / 🗣	Motz, Motz
Exams					
WT 24/25	7900182	eFinance: Information Engineering and Management for Securities Trading			Weinhardt
ST 2025	7900269	eFinance: Information Systems for Securities Trading			Weinhardt

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is monitored by means of ongoing elaborations and presentations of tasks and an examination (60 minutes) at the end of the lecture period. The scoring scheme for the overall evaluation will be announced at the beginning of the course.

Annotation
The course"eFinance: Information Systems for Securities Trading" covers different actors and their function in the securities industry in-depth, highlighting key trends in modern financial markets, such as Distributed Ledger Technology, Sustainable Finance, and Artificial Intelligence. Security prices evolve through a large number of bilateral trades, performed by market participants that have specific, well-regulated and institutionalized roles. Market microstructure is the subfield of financial economics that studies the price formation process. This process is significantly impacted by regulation and driven by technological innovation. Using the lens of theoretical economic models, this course reviews insights concerning the strategic trading behaviour of individual market participants, and models are brought market data. Analytical tools and empirical methods of market microstructure help to understand many puzzling phenomena in securities markets.

Workload
135 hours

Below you will find excerpts from events related to this course:

V eFinance: Information Systems for Securities Trading
2540454, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Literature

- Picot, Arnold, Christine Bortenlänger, Heiner Röhrl (1996): "Börsen im Wandel". Knapp, Frankfurt
- Harris, Larry (2003): "Trading and Exchanges - Market Microstructure for Practitioners"". Oxford University Press, New York

Weiterführende Literatur:

- Gomber, Peter (2000): "Elektronische Handelssysteme - Innovative Konzepte und Technologien". Physika Verlag, Heidelberg
- Schwartz, Robert A., Reto Francioni (2004): "Equity Markets in Action - The Fundamentals of Liquidity, Market Structure and Trading". Wiley, Hoboken, NJ

T 4.77 Course: Emerging Trends in Digital Health [T-WIWI-110144]

Responsible: Prof. Dr. Ali Sunyaev
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	2

Competence Certificate
The alternative exam assessment consists of a final thesis.

Prerequisites
None.

Annotation
The course is usually held as a block course.

Workload
135 hours

T 4.78 Course: Emerging Trends in Internet Technologies [T-WIWI-110143]

Responsible: Prof. Dr. Ali Sunyaev
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	2

Competence Certificate
The alternative exam assessment consists of a final thesis.

Prerequisites
None.

Annotation
The course is usually held as a block course.

Workload
135 hours

T 4.79 Course: Energy and Environment [T-WIWI-102650]

Responsible: Ute Karl
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each summer term	2

Events					
ST 2025	2581003	Energy and Environment	2 SWS	Lecture / 🗣	Karl
Exams					
WT 24/25	7900302	Energy and Environment NEW			Karl
WT 24/25	7981003	Energy and Environment			Fichtner

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

Prerequisites
None.

Workload
105 hours

Below you will find excerpts from events related to this course:

V Energy and Environment

2581003, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
The lecture focuses on the environmental impacts arising from fossil fuels use and on the methods for the evaluation of such impacts. The first part of the lecture describes the environmental impacts of air pollutants and greenhouse gases as well as technical measures for emission control. The second part covers methods of impact assessment and their use in environmental communication as well as methods for the scientific support of emission control strategies.

The topics include:

- Fundamentals of energy conversion
- Formation of air pollutants during combustion
- Technical measures to control emissions from fossil-fuel combustion processes
- External effects of energy supply (life cycle analyses of selected energy systems)
- Environmental communication on energy services (e.g. electricity labelling, carbon footprint)
- Integrated Assessment Modelling to support the European Clean Air Strategy
- Cost-effectiveness analyses and cost-benefit analyses for emission control strategies
- Monetary valuation of external effects (external costs)

Literature
Die Literaturhinweise sind in den Vorlesungsunterlagen enthalten (vgl. ILIAS)

T 4.80 Course: Energy Market Engineering [T-WIWI-107501]

Responsible: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101451 - Energy Economics and Energy Markets
M-WIWI-103720 - eEnergy: Markets, Services and Systems

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2540464	Energy Market Engineering	2 SWS	Lecture / Blended	Weinhardt, Miskiw
ST 2025	2540465	Übung zu Energy Market Engineering	1 SWS	Practice / On-Site	Semmelmann
Exams					
WT 24/25	7900127	Energy Market Engineering			Weinhardt

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The assessment consists of a written exam (60 min) (according to §4(2), 1 of the examination regulations). By successful completion of the exercises (§4 (2), 3 SPO 2007 respectively §4 (3) SPO 2015) a bonus can be obtained. If the grade of the written exam is at least 4.0 and at most 1.3, the bonus will improve it by one grade level (i.e. by 0.3 or 0.4).

Prerequisites
None

Recommendation
None

Annotation
Former course title until summer term 2017: T-WIWI-102794 "eEnergy: Markets, Services, Systems".

The lecture has also been added in the IIP Module *Basics of Liberalised Energy Markets*.

Below you will find excerpts from events related to this course:

V Energy Market Engineering
2540464, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
Blended (On-Site/Online)

Content
The lecture "Energy Market Engineering" addresses the design and analysis of energy markets considering current developments and challenges. A particular focus is on the integration of renewable energies and the associated market mechanisms and regulations.

Specifically, the following topics are covered:

- **Introduction to Market Engineering**: What design elements do markets and specifically auctions have in general, and what influence does this have on participant behavior.
- **Introduction to Energy Markets**: Fundamentals and current trends in the energy system, including climate change and the expansion of renewable energies.
- **Market Design and Products**: Various pricing models such as nodal pricing, zonal pricing, and the structure of capacity markets.
- **Grid Expansion, Distribution Networks, and Flexibility Markets**: Analysis of distribution network markets and the role of flexibility options like demand response and storage technologies.
- **Intermittent Generation and Grid Stability**: Challenges posed by fluctuating renewable energies and strategies to ensure grid stability.
- **Digitalization and Market Transparency**: The role of digitalization in improving market transparency and efficiency, including the use of smart metering systems and data-driven approaches.
- **Current Research Projects and Developments**: Presentation of ongoing research projects and their significance for the future design of energy markets.

Organizational issues

Die Vorlesung findet hybrid statt, mit Videos die während des Semester von den Studierenden eigenständig durchgearbeitet werden und einer Blockveranstaltung im Juli, welche die Vorlesungsinhalte anreichert und vertieft. Mehr Infos in der Auftaktverantsaltung in Präsenz in der ersten Vorlesungswoche.

Literature

- Erdmann G, Zweifel P. *Energieökonomik, Theorie und Anwendungen*. Berlin Heidelberg: Springer; 2007.
- Grimm V, Ockenfels A, Zoettl G. Strommarktdesign: Zur Ausgestaltung der Auktionsregeln an der EEX *. *Zeitschrift für Energiewirtschaft*. 2008:147-161.
- Stoft S. *Power System Economics: Designing Markets for Electricity*. IEEE; 2002.,
- Ströbele W, Pfaffenberger W, Heuterkes M. *Energiewirtschaft: Einführung in Theorie und Politik*. 2nd ed. München: Oldenbourg Verlag; 2010:349.

T 4.81 Course: Energy Networks and Regulation [T-WIWI-107503]

Responsible: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-103720 - eEnergy: Markets, Services and Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2540494	Energy Networks and Regulation	2 SWS	Lecture / 🗣	Rogat, Miskiw
WT 24/25	2540495	Übung zu Energy Networks and Regulation	1 SWS	Practice / 🗣	Rogat, Miskiw
Exams					
WT 24/25	7900198	Energy Networks and Regulation			Weinhardt

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed in the form of an oral examination (in accordance with §4(2), 1 SPO).
The examination is offered in the semester of the lecture.

Prerequisites
None

Recommendation
None

Below you will find excerpts from events related to this course:

V Energy Networks and Regulation
2540494, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
Learning Goals

The student,

- understands the business model of a network operator and knows its central tasks in the energy supply system,
- has a holistic overview of the interrelationships in the network economy,
- understands the regulatory and business interactions,
- is in particular familiar with the current model of incentive regulation with its essential components and understands its implications for the decisions of a network operator
- is able to analyse and assess controversial issues from the perspective of different stakeholders.

Content of teaching

The lecture “Energy Networks and Regulation” provides insights into the regulatory framework of electricity and gas. It touches upon the way the grids are operated and how regulation affects almost all grid activities. The lecture also addresses approaches of grid companies to cope with regulation on a managerial level. We analyze how the system influences managerial decisions and strategies such as investment or maintenance. Furthermore, we discuss how the system affects the operator’s abilities to deal with the massive challenges lying ahead (“Energiewende”, redispatch, European grid integration, electric vehicles etc.). Finally, we look at current developments and major upcoming challenges, e.g., the smart meter rollout. Covered topics include:

- Grid operation as a heterogeneous landscape: big vs. small, urban vs. rural, TSO vs. DSO
- Objectives of regulation: Fair price calculation and high standard access conditions
- The functioning of incentive regulation
- First major amendment to the incentive regulation: its merits, its flaws
- The revenue cap and how it is adjusted according to certain exogenous factors
- Grid tariffs: How are they calculated, what is the underlying rationale, do we need a reform (and which)?
- Exogenous costs shifted (arbitrarily?) into the grid, e.g. feed-in tariffs for renewable energy or decentralized supply.

Literature

Linnemann, M. (2024). Energiewirtschaft für (Quer-)Einsteiger: Einmaleins der Stromwirtschaft. Deutschland: Springer Fachmedien Wiesbaden.

Averch, H.; Johnson, L.L (1962). Behavior of the firm under regulatory constraint, in: American Economic Review, 52 (5), S. 1052 – 1069.

Bundesnetzagentur (2006): Bericht der Bundesnetzagentur nach § 112a EnWG zur Einführung der Anreizregulierung nach § 21a EnWG, http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Energie/Unternehmen_Institutionen/Netzentgelte/Anreizregulierung/BerichtEinfuehrgAnreizregulierung.pdf?__blob=publicationFile&v=3.

Bundesnetzagentur (2015): Evaluierungsbericht nach § 33 Anreizregulierungsverordnung, https://www.bmwi.de/Redaktion/DE/Downloads/A/anreizregulierungsverordnung-evaluierungsbericht.pdf?__blob=publicationFile&v=1.

Filippini, M.; Wild, J.; Luchsinger, C. (2001) : Regulierung der Verteilnetzpreise zu Beginn der Marktöffnung. Erfahrungen in Norwegen und Schweden, Bundesamt für Energie, Bern, http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/34/066/34066585.pdf.

Gómez, T. (2013): Monopoly Regulation, in: Pérez-Arriaga, I.J. (Hg.): Regulation of the Power Sector, S. 151 – 198, Springer-Verlag, London.

Gómez, T. (2013): Electricity Distribution, in: Pérez-Arriaga, I.J. (Hg.): Regulation of the Power Sector, S. 199 – 250, Springer-Verlag, London.

Pérez-Arriaga, I.J. (2013): Challenges in Power Sector Regulation, in: Pérez-Arriaga, I.J. (Hg.): Regulation of the Power Sector, S. 647 – 678, Springer-Verlag, London.

Rivier, M.; Pérez-Arriaga, I.J.; Olmos, L. (2013): Electricity Transmission, in: Pérez-Arriaga, I.J. (Hg.): Regulation of the Power Sector, S. 251 – 340, Springer-Verlag, London.

T 4.82 Course: Energy Trading and Risk Management [T-WIWI-112151]

Responsible: N.N.
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each summer term	2

Events					
ST 2025	2581020	Energy Trading and Risk Management	2 SWS	Lecture / 🗣	Kraft, Fichtner, Beranek
Exams					
WT 24/25	7981020	Energy Trading and Risk Management			Fichtner

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The lecture "Energiehandel und Risikomanagement" will be held in English under the title "Energy Trading and Risk Management" from the summer semester 2022. The examination for the English-language lecture will be offered in English from the summer semester 2022.
The assessment consists of a written exam (60 minutes). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment).

Prerequisites
None

Recommendation
None

Workload
105 hours

Below you will find excerpts from events related to this course:

V Energy Trading and Risk Management — **Lecture (V) On-Site**
2581020, SS 2025, 2 SWS, Language: English, Open in study portal

Content

1. Introduction to Markets, Mechanisms and Interaction
2. Electricity Trading (platforms, products, mechanisms)
3. Balancing Energy Markets and Congestion Management
4. Coal Markets (reserves, supply, demand, and transport)
5. Investments and Capacity Markets
6. Oil and Gas Markets (supply, demand, trade, and players)
7. Trading Game
8. Risk Management in Energy Trading

Organizational issues
Termine 14-täglich nach Vereinbarung

Literature
Weiterführende Literatur:

Burger, M., Graeber, B., Schindlmayr, G. (2007): *Managing energy risk: An integrated view on power and other energy markets*, Wiley&Sons, Chichester, England

EEX (2010): *Einführung in den Börsenhandel an der EEX auf Xetra und Eurex*, www.eex.de

Erdmann, G., Zweifel, P. (2008), Energieökonomik, Theorie und Anwendungen, Springer, ISBN: 978-3-540-71698-3

Hull, J.C. (2006): *Options, Futures and other Derivatives*, 6. Edition, Pearson Prentice Hall, New Jersey, USA

Borchert, J., Schlemm, R., Korth, S. (2006): *Stromhandel: Institutionen, Marktmodelle, Pricing und Risikomanagement (Gebundene Ausgabe)*, Schäffer-Poeschel Verlag

www.riskglossary.com

T 4.83 Course: Ergodic Theory [T-MATH-113086]

Responsible: Dr. Gabriele Link
Organisation: KIT Department of Mathematics
Part of: M-MATH-106473 - Ergodic Theory

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	8	Grade to a third	Irregular	1 terms	1

Competence Certificate
Oral examination of ca. 20-30 minutes.

Prerequisites
none

Recommendation
Some basic knowledge of measure theory, topology, geometry, group theory and functional analysis is recommended.

Workload
240 hours

T 4.84 Course: Evolution Equations [T-MATH-105844]

Responsible: Prof. Dr. Dorothee Frey
apl. Prof. Dr. Peer Kunstmann
Prof. Dr. Roland Schnaubelt

Organisation: KIT Department of Mathematics

Part of: M-MATH-102872 - Evolution Equations

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T 4.85 Course: Experimental Economics [T-WIWI-102614]

Responsible: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101505 - Experimental Economics
M-WIWI-102970 - Decision and Game Theory

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2540489	Experimental Economics	2 SWS	Lecture / On-Site	Knierim
WT 24/25	2540493	Übung zu Experimental Economics	1 SWS	Practice / On-Site	del Puppo
Exams					
WT 24/25	7900096	Experimental Economics			Weinhardt

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The assessment consists of a written exam (60 min).

Prerequisites
None

Annotation
The lecture will be taught in English.

Below you will find excerpts from events related to this course:

V Experimental Economics
2540489, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Literature

- Strategische Spiele; S. Berninghaus, K.-M. Ehrhart, W. Güth; Springer Verlag, 2. Aufl. 2006.
- Handbook of Experimental Economics; J. Kagel, A. Roth; Princeton University Press, 1995.
- Experiments in Economics; J.D. Hey; Blackwell Publishers, 1991.
- Experimental Economics; D.D. Davis, C.A. Holt; Princeton University Press, 1993.
- Experimental Methods: A Primer for Economists; D. Friedman, S. Sunder; Cambridge University Press, 1994.

T 4.86 Course: Exponential Integrators [T-MATH-107475]

Responsible: Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke

Organisation: KIT Department of Mathematics

Part of: M-MATH-103700 - Exponential Integrators

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Prerequisites

none

T 4.87 Course: Extremal Graph Theory [T-MATH-105931]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-102957 - Extremal Graph Theory

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	2

Exams			
WT 24/25	7700145	Extremal Graph Theory	Sagdeev
WT 24/25	7700146	Extremal Graph Theory	Sagdeev

Prerequisites
none

T 4.88 Course: Extreme Value Theory [T-MATH-105908]

Responsible: Prof. Dr. Vicky Fasen-Hartmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-102939 - Extreme Value Theory

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	2

T 4.89 Course: Facility Location and Strategic Supply Chain Management [T-WIWI-102704]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101413 - Applications of Operations Research
M-WIWI-101414 - Methodical Foundations of OR

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2550486	Facility Location and Strategic Supply Chain Management	2 SWS	Lecture / 🗣	Nickel
WT 24/25	2550487	Exercises for Facility Location and Strategic Supply Chain Management	1 SWS	Practice / 🗣	Hoffmann
Exams					
WT 24/25	7900091	Facility Location and Strategic Supply Chain Management			Nickel

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 min) according to Section 4 (2), 1 of the examination regulation.
The exam takes place in every semester.
Prerequisite for admission to examination is the succesful completion of the online assessments.

Prerequisites
Prerequisite for admission to examination is the succesful completion of the online assessments.

Recommendation
None

Annotation
The lecture is held in every winter term. The planned lectures and courses for the next three years are announced online.

Below you will find excerpts from events related to this course:

V Facility Location and Strategic Supply Chain Management
2550486, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Organizational issues
Für die Klausurzulassung müssen 4 von 5 Online-Tests bestanden sein.

Die Zulassung ist ein Jahr gültig, außer es handelt sich um einen Zweitversuch. In diesem Falle müssen die Online-Tests nicht erneut absolviert werden.

Literature
Weiterführende Literatur:

- Daskin: Network and Discrete Location: Models, Algorithms, and Applications, Wiley, 1995
- Domschke, Drexl: Logistik: Standorte, 4. Auflage, Oldenbourg, 1996
- Francis, McGinnis, White: Facility Layout and Location: An Analytical Approach, 2nd Edition, Prentice Hall, 1992
- Love, Morris, Wesolowsky: Facilities Location: Models and Methods, North Holland, 1988
- Thonemann: Operations Management - Konzepte, Methoden und Anwendungen, Pearson Studium, 2005

T 4.90 Course: Financial Analysis [T-WIWI-102900]

Responsible: Dr. Torsten Luedecke
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2025	2530205	Financial Analysis	2 SWS	Lecture / 🗣	Luedecke
ST 2025	2530206	Übungen zu Financial Analysis	2 SWS	Practice / 🗣	Luedecke
Exams					
WT 24/25	7900059	Financial Analysis			Ruckes, Luedecke
ST 2025	7900075	Financial Analysis			Luedecke

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
See German version.

Prerequisites
None

Recommendation
Basic knowledge in corporate finance, accounting, and valuation is required.

Below you will find excerpts from events related to this course:

V Financial Analysis
2530205, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Literature

- Alexander, D. and C. Nobes (2017): Financial Accounting – An International Introduction, 6th ed., Pearson.
- Penman, S.H. (2013): Financial Statement Analysis and Security Valuation, 5th ed., McGraw Hill.

T 4.91 Course: Financial Econometrics [T-WIWI-103064]

Responsible: Prof. Dr. Melanie Schienle
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2520022	Financial Econometrics I	2 SWS	Lecture / 🗣	Schienle, Buse
WT 24/25	2520023	Übungen zu Financial Econometrics I	2 SWS	Practice / 🗣	Schienle, Buse
Exams					
WT 24/25	7900123	Financial Econometrics II			Schienle
WT 24/25	7900126	Financial Econometrics			Schienle
ST 2025	7900223	Financial Econometrics			Schienle

Legend: 📱 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (90 minutes) (following §4(2), 1 of the examination regulation).

Prerequisites
The course T-MATH-105874 "Time Series Analysis" may not be chosen.

Recommendation
Knowledge of the contents covered by the course "Economics III: Introduction in Econometrics"[2520016]

Annotation
The next lecture will take place in the winter semester 2022/23.

Below you will find excerpts from events related to this course:

V Financial Econometrics I

2520022, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
Learning objectives:

The student

- shows a broad knowledge of fincancial econometric estimation and testing techniques
- is able to apply his/her technical knowledge using software in order to critically assess empirical problems

Content:

ARMA, ARIMA, ARFIMA, (non)stationarity, causality, cointegration, ARCH/GARCH, stochastic volatility models, computer based exercises

Requirements:

It is recommended to attend the course *Economics III: Introduction to Econometrics* [2520016] prior to this course.

Workload:

Total workload for 4.5 CP: approx. 135 hours

Attendance: 30 hours

Preparation and follow-up: 65 hours

Exam preparation: 40 hours

Literature

Taylor, S. J. (2005): "Asset Price Dynamics, Volatility, and Prediction", Princeton University Press.

Tsay, R. S. (2005): "Analysis of Financial Time Series: Financial Econometrics", Wiley, 2nd edition.

Cochrane, J. H. (2005): "Asset Pricing", revised edition, Princeton University Press.

Campbell, J. Y., A. W. Lo, and A. C. MacKinlay (1997): "The Econometrics of Financial Markets", Princeton University Press.

Hamilton, J. D. (1994): "Time Series Analysis", Princeton University Press.

Additional literature will be discussed in the lecture.

T 4.92 Course: Financial Econometrics II [T-WIWI-110939]

Responsible: Prof. Dr. Melanie Schienle
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2025	2521302	Financial Econometrics II	2 SWS	Lecture / 🗣	Schienle, Buse
ST 2025	2521303	Übung zu Financial Econometrics II	1 SWS	Practice / 🗣	Buse, Schienle
Exams					
ST 2025	7900081	Financial Econometrics II			Schienle

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination (90 minutes). If the number of participants is low, an oral examination will be held instead.

Prerequisites
None

Recommendation
Knowledge of the contents covered by the course "Financial Econometrics"

Annotation
Course language is English
The next lecture will take place in the summer semester of 2023.

Workload
135 hours

T 4.93 Course: Financial Intermediation [T-WIWI-102623]

Responsible: Prof. Dr. Martin Ruckes
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2
M-WIWI-101502 - Economic Theory and its Application in Finance

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2530232	Financial Intermediation	2 SWS	Lecture / 🗣	Ruckes
WT 24/25	2530233	Übung zu Finanzintermediation	1 SWS	Practice	Ruckes, Benz
Exams					
WT 24/25	7900063	Financial Intermediation			Ruckes
ST 2025	7900078	Financial Intermediation			Ruckes

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of this course is a written examination (following §4(2), 1 SPO) of 60 mins.

The exam is offered each semester.

Prerequisites
None

Recommendation
None

Below you will find excerpts from events related to this course:

V Financial Intermediation
2530232, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Organizational issues
Terminankündigungen des Instituts beachten

Literature
Weiterführende Literatur:

- Hartmann-Wendels/Pfingsten/Weber (2014): Bankbetriebslehre, 6. Auflage, Springer Verlag.
- Freixas/Rochet (2008): Microeconomics of Banking, 2. Auflage, MIT Press.

T 4.94 Course: Finite Element Methods [T-MATH-105857]

Responsible: Prof. Dr. Willy Dörfler
Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke
TT-Prof. Dr. Roland Maier
Prof. Dr. Andreas Rieder
Prof. Dr. Christian Wieners

Organisation: KIT Department of Mathematics

Part of: M-MATH-102891 - Finite Element Methods

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0110300	Finite Element Methods	4 SWS	Lecture	Maier
WT 24/25	0110310	Tutorial for 0110300 (Finite Element Methods)	2 SWS	Practice	Maier
Exams					
WT 24/25	7700142	Finite Element Methods (examinations on March 26 and 27)			Maier
WT 24/25	7700151	Finite Element Methods (examinations on February 20 and 21)			Maier
ST 2025	7700142	Finite Element Methods (examinations on April 23)			Maier

Below you will find excerpts from events related to this course:

V Finite Element Methods

0110300, WS 24/25, 4 SWS, Open in study portal

Lecture (V)

Content

This course is about numerically solving elliptic boundary value problems using the finite element method. We will introduce necessary basic definitions and then discuss the method in its various aspects. In particular, we will study grid generation, error estimates, and the practical realization of the approach.

T 4.95 Course: Forecasting: Theory and Practice [T-MATH-105928]

Responsible: Prof. Dr. Tilmann Gneiting
Organisation: KIT Department of Mathematics
Part of: M-MATH-102956 - Forecasting: Theory and Practice

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

Events					
WT 24/25	0123100	Forecasting: Theory and Praxis	2 SWS	Lecture	Gneiting
WT 24/25	0123110	Tutorial for 0123100 (Forecasting: Theory and Praxis)	2 SWS	Practice	Gneiting
ST 2025	0178000	Forecasting: Theory and Practice II	2 SWS	Lecture	Gneiting
ST 2025	0178010	Tutorial for 0178010 (Forecasting: Theory and Practice II)	1 SWS	Practice	Gneiting

Below you will find excerpts from events related to this course:

V Forecasting: Theory and Praxis

Lecture (V)

0123100, WS 24/25, 2 SWS, Language: English, Open in study portal

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.

V Forecasting: Theory and Practice II

Lecture (V)

0178000, SS 2025, 2 SWS, Language: English, Open in study portal

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.

T 4.96 Course: Foundations of Continuum Mechanics [T-MATH-107044]

Responsible: Prof. Dr. Christian Wieners
Organisation: KIT Department of Mathematics
Part of: M-MATH-103527 - Foundations of Continuum Mechanics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Once	2

Events					
ST 2025	0155410	Foundations of continuum mechanics	2 SWS	Lecture	Wieners
ST 2025	0155420	Übungen zu 0155410 (Grundlagen der Kontinuumsmechanik)	1 SWS	Practice	Wieners

Competence Certificate
Oral exam of approx. 20 minutes.

Prerequisites
none

T 4.97 Course: Fourier Analysis and its Applications to PDEs [T-MATH-109850]

Responsible: TT-Prof. Dr. Xian Liao
Organisation: KIT Department of Mathematics
Part of: M-MATH-104827 - Fourier Analysis and its Applications to PDEs

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	3

Prerequisites
none

T 4.98 Course: Fractal Geometry [T-MATH-111296]

Responsible: PD Dr. Steffen Winter
Organisation: KIT Department of Mathematics
Part of: M-MATH-105649 - Fractal Geometry

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Prerequisites
none

T 4.99 Course: Functional Analysis [T-MATH-102255]

Responsible: Prof. Dr. Dorothee Frey
PD Dr. Gerd Herzog
Prof. Dr. Dirk Hundertmark
Prof. Dr. Tobias Lamm
TT-Prof. Dr. Xian Liao
Prof. Dr. Wolfgang Reichel
Prof. Dr. Roland Schnaubelt
Dr. rer. nat. Patrick Tolksdorf

Organisation: KIT Department of Mathematics

Part of: M-MATH-101320 - Functional Analysis

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Each winter term	3

Events					
WT 24/25	0104800	Functional Analysis	4 SWS	Lecture / 🗣	Reichel
WT 24/25	0104810	Tutorial for 0104800 (Functional Analysis)	2 SWS	Practice / 🗣	Reichel
Exams					
WT 24/25	0100047	Functional Analysis			Lamm, Hundertmark, Kunstmann, Schnaubelt, Frey, Liao, Reichel, Tolksdorf

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination of 120 minutes.

Prerequisites
none

Workload
240 hours

Below you will find excerpts from events related to this course:

V Functional Analysis

0104800, WS 24/25, 4 SWS, Open in study portal

Lecture (V)
On-Site

Content
The lecture deals with Banach and Hilbert spaces and the linear operators on these spaces. Typical examples are spaces of continuous or integrable functions, and linear operators on these spaces occur in the study of integral and differential equations. The development of functional analysis in the 20th century contributed significantly to the modern theory of differential equations. Today, functional analysis is a fundamental discipline of modern analysis and is widely used, for example, in the theory of partial differential equations, numerical mathematics, mathematical physics and many other areas of application.

Topics of the lecture:
basic properties and examples of metric spaces and Banach spaces, continuous linear operators on Banach spaces, uniform boundedness principle, homomorphism theorem, Hilbert spaces, orthonormal bases, Sobolev spaces, dual spaces, Hahn-Banach theorem, weak convergence, Banach-Alaoglu theorem, reflexivity, compact linear operators

The contents of the basic lectures Analysis 1-3 and Linear Algebra 1+2 are assumed.

Literature

- D. Werner: Funktionalanalysis.

- H.W. Alt: Lineare Funktionalanalysis.
- H. Brezis: Functional Analysis, Sobolev Spaces and Partial Differential Equations.
- J.B. Conway: A Course in Functional Analysis.
- M. Reed, B. Simon: Functional Analysis.
- W. Rudin: Functional Analysis.
- A.E. Taylor, D.C. Lay: Introduction to Functional Analysis.
- J. Wloka: Funktionalanalysis und Anwendungen.

T 4.100 Course: Functional Data Analysis [T-MATH-113102]

Responsible: Dr. rer. nat. Bruno Ebner
PD Dr. Bernhard Klar
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: M-MATH-106485 - Functional Data Analysis

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Competence Certificate
Oral examination of ca. 25 minutes.

Prerequisites
none

Recommendation
The contents of the modules "Probability Theory" and "Mathematical Statistics" are strongly recommended.

Workload
120 hours

T 4.101 Course: Functions of Matrices [T-MATH-105906]

Responsible: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: M-MATH-102937 - Functions of Matrices

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
WT 24/25	00017	Functions of Matrices	Grimm

Prerequisites
none

T 4.102 Course: Functions of Operators [T-MATH-105905]

Organisation: KIT Department of Mathematics
Part of: M-MATH-102936 - Functions of Operators

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

T 4.103 Course: Fundamentals for Financial -Quant and -Machine Learning Research [T-WIWI-111846]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105894 - Foundations for Advanced Financial -Quant and -Machine Learning Research

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	9	Grade to a third	see Annotations	1

Competence Certificate

The module examination is an alternative exam assessment with a maximum score of 100 points to be achieved. These points are distributed over 4 worksheets to be submitted during the semester. The worksheets cover the respective material of the module and are handed out, worked on and assessed in lecture weeks 3 (10 points), 6 (20 points), 9 (30 points) and 12 (40 points).

The module-wide exam (all 4 worksheets) must be taken in the same semester.

The worksheets are a mixture of analytical tasks and programming tasks with financial data.

Recommendation

- Strongly recommended to have good knowledge in financial econometrics (MLE, OLS, GLS, ARMA-GARCH), mathematics (differential equations, difference equations and optimization), investments (CAPM, factor models), asset pricing (SDF, SDF pricing), derivatives (Black-Scholes, risk-neutral pricing), and programming of statistical concepts (Java or R or Python or Matlab or C or ...)
- Strongly recommended to have a strong interest for interdisciplinary research work in statistics, programming, applied math and financial economics.
- Students lacking the prior knowledge might find the resources of the Chair helpful: www.youtube.com/c/cram-kit.

Annotation

Teaching and learning format: Lecture and exercise.

The course is offered every second year.

Workload

270 hours

T 4.104 Course: Generalized Regression Models [T-MATH-105870]

Responsible: Dr. rer. nat. Bruno Ebner
Prof. Dr. Vicky Fasen-Hartmann
PD Dr. Bernhard Klar
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: M-MATH-102906 - Generalized Regression Models

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	3

Events					
ST 2025	0161400	Generalisierte Regressionsmodelle	2 SWS	Lecture	Ebner
ST 2025	0161410	Übungen zu 0161400 (generalisierte Regressionsmodelle)	1 SWS	Practice	Ebner
Exams					
WT 24/25	7700066	Generalized Regression Models (Termin 3)			Klar

Workload
120 hours

T 4.105 Course: Geometric Group Theory [T-MATH-105842]

Responsible: Prof. Dr. Frank Herrlich
Dr. Gabriele Link
Jun.-Prof. Dr. Claudio Llosa Isenrich
Prof. Dr. Roman Sauer
Prof. Dr. Wilderich Tuschmann

Organisation: KIT Department of Mathematics

Part of: M-MATH-102867 - Geometric Group Theory

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	1

Events					
ST 2025	0153300	Geometric Group Theory	4 SWS	Lecture	Link
ST 2025	0153310	Tutorial for 0153300 (Geometric Group Theory)	2 SWS	Practice	Link
Exams					
WT 24/25	7700112	Geometric Group Theory			Link

Below you will find excerpts from events related to this course:

V Geometric Group Theory

Lecture (V)

0153300, SS 2025, 4 SWS, Language: English, Open in study portal

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.

T 4.106 Course: Geometric Numerical Integration [T-MATH-105919]

Responsible: Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke

Organisation: KIT Department of Mathematics

Part of: M-MATH-102921 - Geometric Numerical Integration

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

Prerequisites
none

Workload
180 hours

4.107 Course: Geometric Variational Problems [T-MATH-113418]

Responsible: Prof. Dr. Tobias Lamm
Organisation: KIT Department of Mathematics
Part of: M-MATH-106667 - Geometric Variational Problems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Competence Certificate
oral exam of ca. 30 min

Prerequisites
none

Workload
240 hours

T 4.108 Course: Geometry of Schemes [T-MATH-105841]

Responsible: Prof. Dr. Frank Herrlich
PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: M-MATH-102866 - Geometry of Schemes

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0102600	Geometrie der Schemata	4 SWS	Lecture	Herrlich
WT 24/25	0102700	Übungen zu 0102600 (Geometrie der Schemata)	2 SWS	Practice	Herrlich
Exams					
WT 24/25	7700143	Geometry of Schemes			Herrlich

T 4.109 Course: Global Differential Geometry [T-MATH-105885]

Responsible: Prof. Dr. Wilderich Tuschmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-102912 - Global Differential Geometry

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Prerequisites
none

Workload
240 hours

T 4.110 Course: Global Optimization I [T-WIWI-102726]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101413 - Applications of Operations Research
M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2550134	Global Optimization I	2 SWS	Lecture / 🗣	Stein
Exams					
WT 24/25	7900004_WS2425_NK	Global Optimization I			Stein
ST 2025	7900205_SS2025_HK	Global Optimization I			Stein

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is in the form of a written examination (60 min.) (according to § 4(2), 1 SPO). The successful completion of the exercises is required for admission to the written exam.

The exam is offered in the lecture of semester and the following semester.

The success check can be done also with the success control for "Global optimization II". In this case, the duration of the written exam is 120 min.

Prerequisites
None

Recommendation
None

Annotation
Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from events related to this course:

V Global Optimization I
2550134, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content

In many optimization problems from economics, engineering and natural sciences, solution algorithms are only able to efficiently identify *local* optimizers, while it is much harder to find *globally* optimal points. This corresponds to the fact that by local search it is easy to find the summit of the closest mountain, but that the search for the summit of Mount Everest is rather elaborate.

The lecture treats methods for global optimization of convex functions under convex constraints. It is structured as follows:

- Introduction, examples, and terminology
- Existence results for optimal points
- Optimality in convex optimization
- Duality, bounds, and constraint qualifications
- Algorithms (Kelley's cutting plane method, Frank-Wolfe method, primal-dual interior point methods)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

Remark:

The treatment of *nonconvex* optimization problems forms the contents of the lecture "Global Optimization II". The lectures "Global Optimization I" and "Global Optimization II" are held consecutively *in the same semester*.

Learning objectives:

The student

- knows and understands the fundamentals of deterministic global optimization in the convex case,
- is able to choose, design and apply modern techniques of deterministic global optimization in the convex case in practice.

Literature

O. Stein, Grundzüge der Globalen Optimierung, SpringerSpektrum, 2018.

Weiterführende Literatur:

- W. Alt, Numerische Verfahren der konvexen, nichtglatten Optimierung, Teubner, 2004
- C.A. Floudas, Deterministic Global Optimization, Kluwer, 2000
- R. Horst, H. Tuy, Global Optimization, Springer, 1996
- A. Neumaier, Interval Methods for Systems of Equations, Cambridge University Press, 1990

T 4.111 Course: Global Optimization I and II [T-WIWI-103638]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading scale	Recurrence	Version
Written examination	9	Grade to a third	Each summer term	1

Events					
ST 2025	2550134	Global Optimization I	2 SWS	Lecture / 🗣	Stein
ST 2025	2550135	Exercise to Global Optimization I	1 SWS	Practice / 🗣	Stein, Beck
ST 2025	2550136	Global Optimization II	2 SWS	Lecture / 🗣	Stein
Exams					
WT 24/25	7900006_WS2425_NK	Global Optimization I and II			Stein
ST 2025	7900207_SS2025_HK	Global Optimization I and II			Stein

Legend: 🖥 Online, ❃ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of the lecture is a written examination (120 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

Prerequisites
None

Recommendation
None

Annotation
Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from events related to this course:

V Global Optimization I
2550134, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
In many optimization problems from economics, engineering and natural sciences, solution algorithms are only able to efficiently identify *local* optimizers, while it is much harder to find *globally* optimal points. This corresponds to the fact that by local search it is easy to find the summit of the closest mountain, but that the search for the summit of Mount Everest is rather elaborate.

The lecture treats methods for global optimization of convex functions under convex constraints. It is structured as follows:

- Introduction, examples, and terminology
- Existence results for optimal points
- Optimality in convex optimization
- Duality, bounds, and constraint qualifications
- Algorithms (Kelley's cutting plane method, Frank-Wolfe method, primal-dual interior point methods)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

Remark:

The treatment of *nonconvex* optimization problems forms the contents of the lecture "Global Optimization II". The lectures "Global Optimization I" and "Global Optimization II" are held consecutively *in the same semester*.

Learning objectives:

The student

- knows and understands the fundamentals of deterministic global optimization in the convex case,
- is able to choose, design and apply modern techniques of deterministic global optimization in the convex case in practice.

Literature
O. Stein, Grundzüge der Globalen Optimierung, SpringerSpektrum, 2018.

Weiterführende Literatur:

- W. Alt, Numerische Verfahren der konvexen, nichtglatten Optimierung, Teubner, 2004
- C.A. Floudas, Deterministic Global Optimization, Kluwer, 2000
- R. Horst, H. Tuy, Global Optimization, Springer, 1996
- A. Neumaier, Interval Methods for Systems of Equations, Cambridge University Press, 1990

V	**Global Optimization II** 2550136, SS 2025, 2 SWS, Language: German, Open in study portal	**Lecture (V)** **On-Site**

Content
In many optimization problems from economics, engineering and natural sciences, solution algorithms are only able to efficiently identify *local* optimizers, while it is much harder to find *globally* optimal points. This corresponds to the fact that by local search it is easy to find the summit of the closest mountain, but that the search for the summit of Mount Everest is rather elaborate.

The lecture treats methods for global optimization of nonconvex functions under nonconvex constraints. It is structured as follows:

- Introduction and examples
- Convex relaxation
- Interval arithmetic
- Convex relaxation via alphaBB method
- Branch-and-bound methods
- Lipschitz optimization

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

Remark:

The treatment of *convex* optimization problems forms the contents of the lecture "Global Optimization I". The lectures "Global Optimization I" and "Global Optimization II" are held consecutively *in the same semester*.

Learning objectives:

The student

- knows and understands the fundamentals of deterministic global optimization in the nonconvex case,
- is able to choose, design and apply modern techniques of deterministic global optimization in the nonconvex case in practice.

Literature
O. Stein, Grundzüge der Globalen Optimierung, SpringerSpektrum, 2018.

Weiterführende Literatur:

- W. Alt, Numerische Verfahren der konvexen, nichtglatten Optimierung, Teubner, 2004
- C.A. Floudas, Deterministic Global Optimization, Kluwer, 2000
- R. Horst, H. Tuy, Global Optimization, Springer, 1996
- A. Neumaier, Interval Methods for Systems of Equations, Cambridge University Press, 1990

T 4.112 Course: Global Optimization II [T-WIWI-102727]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2025	2550136	Global Optimization II	2 SWS	Lecture / 🗣	Stein
ST 2025	2550137	Exercise to Global Optimization II	1 SWS	Practice / 🗣	Stein, Beck
Exams					
WT 24/25	7900005_WS2425_NK	Global Optimization II			Stein
ST 2025	7900206_SS2025_HK	Global Optimization II			Stein

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

The examination can also be combined with the examination of "Global optimization I". In this case, the duration of the written examination takes 120 minutes.

Prerequisites
None

Annotation
Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from events related to this course:

V Global Optimization II — **Lecture (V) On-Site**
2550136, SS 2025, 2 SWS, Language: German, Open in study portal

Content

In many optimization problems from economics, engineering and natural sciences, solution algorithms are only able to efficiently identify *local* optimizers, while it is much harder to find *globally* optimal points. This corresponds to the fact that by local search it is easy to find the summit of the closest mountain, but that the search for the summit of Mount Everest is rather elaborate.

The lecture treats methods for global optimization of nonconvex functions under nonconvex constraints. It is structured as follows:

- Introduction and examples
- Convex relaxation
- Interval arithmetic
- Convex relaxation via alphaBB method
- Branch-and-bound methods
- Lipschitz optimization

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

Remark:

The treatment of *convex* optimization problems forms the contents of the lecture "Global Optimization I". The lectures "Global Optimization I" and "Global Optimization II" are held consecutively *in the same semester*.

Learning objectives:

The student

- knows and understands the fundamentals of deterministic global optimization in the nonconvex case,
- is able to choose, design and apply modern techniques of deterministic global optimization in the nonconvex case in practice.

Literature

O. Stein, Grundzüge der Globalen Optimierung, SpringerSpektrum, 2018.

Weiterführende Literatur:

- W. Alt, Numerische Verfahren der konvexen, nichtglatten Optimierung, Teubner, 2004
- C.A. Floudas, Deterministic Global Optimization, Kluwer, 2000
- R. Horst, H. Tuy, Global Optimization, Springer, 1996
- A. Neumaier, Interval Methods for Systems of Equations, Cambridge University Press, 1990

T 4.113 Course: Graph Theory [T-MATH-102273]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-101336 - Graph Theory

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	2

Prerequisites
None

T 4.114 Course: Graph Theory and Advanced Location Models [T-WIWI-102723]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	2

Competence Certificate
The assessment is a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

The examination is held in the term of the lecture and the following lecture.

Prerequisites
None

Recommendation
Basic knowledge as conveyed in the module "Introduction to Operations Research" is assumed.

Annotation
The course is offered irregularly. Planned lectures for the next three years can be found in the internet at http://dol.ior.kit.edu/english/Courses.php.

T 4.115 Course: Group Actions in Riemannian Geometry [T-MATH-105925]

Responsible: Prof. Dr. Wilderich Tuschmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-102954 - Group Actions in Riemannian Geometry

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

Prerequisites
none

T 4.116 Course: Harmonic Analysis [T-MATH-111289]

Responsible: Prof. Dr. Dorothee Frey
apl. Prof. Dr. Peer Kunstmann
Prof. Dr. Roland Schnaubelt
Dr. rer. nat. Patrick Tolksdorf

Organisation: KIT Department of Mathematics

Part of: M-MATH-105324 - Harmonic Analysis

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
WT 24/25	7700115	Harmonic Analysis	Frey, Tolksdorf

T 4.117 Course: Harmonic Analysis 2 [T-MATH-113103]

Responsible: Prof. Dr. Dorothee Frey
apl. Prof. Dr. Peer Kunstmann
Dr. rer. nat. Patrick Tolksdorf

Organisation: KIT Department of Mathematics

Part of: M-MATH-106486 - Harmonic Analysis 2

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Competence Certificate
oral examination of ca. 30 minutes.

Prerequisites
none

Recommendation
The following modules are strongly recommended: "Harmonic Analysis", "Functional Analysis".

Workload
240 hours

T 4.118 Course: Heat Economy [T-WIWI-102695]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each summer term	2

Events					
ST 2025	2581001	Heat Economy	2 SWS	Lecture / 🗣	Fichtner
Exams					
WT 24/25	7981001	Heat Economy			Fichtner

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written (60 minutes) or oral exam (30 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Prerequisites
None.

Recommendation
None

Annotation
See German version.

Below you will find excerpts from events related to this course:

V Heat Economy

2581001, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Organizational issues
Block, Seminarraum Standort West - siehe Institutsaushang

4.119 Course: Homotopy Theory [T-MATH-105933]

Responsible: Prof. Dr. Roman Sauer
Organisation: KIT Department of Mathematics
Part of: M-MATH-102959 - Homotopy Theory

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T 4.120 Course: Human Factors in Autonomous Driving [T-WIWI-113059]

Responsible: Prof. Dr. Alexey Vinel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2511452	Human Factors in Autonomous Driving	2 SWS	Lecture / Blended	Vinel, Bied, Schrapel
WT 24/25	2511453	Exercises Human Factors in Autonomous Driving	1 SWS	Practice / Blended	Vinel, Bied, Schrapel
Exams					
WT 24/25	79AIFB_HFAD_C6	Human Factors in Autonomous Driving			Vinel
ST 2025	79AIFB_HFAD_C6	Human Factors in Autonomous Driving			Vinel

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
The assessment of this course is a written examination (60 min) or an oral exam (20 min).

The exam takes place every semester and can be repeated at every regular examination date.

Workload
135 hours

T 4.121 Course: Human Factors in Security and Privacy [T-WIWI-109270]

Responsible: Prof. Dr. Melanie Volkamer
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	3

Exams			
WT 24/25	79AIFB_HFSP_A1	Human Factors in Security and Privacy	Volkamer

Competence Certificate
The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation or an oral exam (30 min) following §4, Abs. 2, 2 of the examination regulation. Only those who have successfully participated in the exercises and the lecture will be admitted to the examination.

Prerequisites
Both need to be done:

- Pass Quiz on Paper for Graphical Passwords
- Presentation of Results Exercise 2

+ 9 of the following 11 need to be done:

- Submit ILIAS certificate until Oct 24
- Pass Quiz on InfoSec Lecture
- Active participation exercise 1 Part 1 - Evaluation and analyses methods
- Pass Quiz Paper Discussion 1 - User Behaviour and motivation theories
- Active participation exercise 1 Part 2
- Pass Quiz Paper Discussion 2 - User Behaviour and motivation theories
- Pass Quiz Paper Discussion 3 - Security Awareness
- Active participation exercise 1 Part 3
- Pass Quiz Paper Discussion 4 - Graphical Authentication
- Pass Quiz Paper Discussion 5 - Shoulder Surfing Authentication
- Active participation exercise 2

Recommendation
The prior attendance of the lecture "Information Security" is strongly recommended.

Annotation
The lecture will not be offered in winter semester 2020/21.

Some lectures are in English, some in German.

Workload
135 hours

T 4.122 Course: Incentives in Organizations [T-WIWI-105781]

Responsible: Prof. Dr. Petra Nieken
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101500 - Microeconomic Theory
M-WIWI-101505 - Experimental Economics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2573003	Incentives in Organizations	2 SWS	Lecture / 🗣	Nieken
ST 2025	2573004	Übung zu Incentives in Organizations	2 SWS	Practice / 🗣	Nieken, Mitarbeiter, Walther, Gorny
Exams					
WT 24/25	7900201	Incentives in Organizations			Nieken
ST 2025	7900132	Incentives in Organizations			Nieken

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of this course is a written examination (60 min). The exam takesplace in every semester. Re-examinations are offered at every ordinaryexamination date. In case of a small number of registrations, we might offer an oral exam instead of a written exam.

Prerequisites
None

Recommendation
Knowledge of microeconomics, game theory, and statistics is assumed.

Below you will find excerpts from events related to this course:

V Incentives in Organizations
2573003, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content

The students acquire profound knowledge about the design and the impact of different incentive and compensation systems. Topics covered are, for instance, performance based compensation, team work, intrinsic motivation, multitasking, and subjective performance evaluations. We will use microeconomic or behavioral models as well as empirical data to analyze incentive systems. We will investigate several widely used compensation schemes and their relationship with corporate strategy. Students will learn to develop practical implications which are based on the acquired knowledge of this course.

Aim

The student

- develops a strategic understanding about incentives systems and how they work.
- analyzes models from personnel economics.
- understands how econometric methods can be used to analyze performance and compensation data.
- knows incentive schemes that are used in companies and is able to evaluate them critically.
- can develop practical implications which are based on theoretical models and empirical data from companies.
- understands the challenges of managing incentive and compensation systems and their relationship with corporate strategy.

Workload

The total workload for this course is: approximately 135 hours.

Lecture: 32 hours

Preparation of lecture: 52 hours

Exam preparation: 51 hours

Literature

Slides, Additional case studies and research papers will be announced in the lecture.

Literature (complementary):

Managerial Economics and Organizantional Architecture, Brickley / Smith / Zimmerman, McGraw-Hill Education, 2015

Behavioral Game Theory, Camerer, Russel Sage Foundation, 2003

Personnel Economics in Practice, Lazear / Gibbs, Wiley, 2014

Introduction to Econometrics, Wooldridge, Andover, 2014

Econometric Analysis of Cross Section and Panel Data, Wooldridge, MIT Press, 2010

T 4.123 Course: Information Service Engineering [T-WIWI-106423]

Responsible: Prof. Dr. Harald Sack
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2025	2511606	Information Service Engineering	2 SWS	Lecture / On-Site	Sack
ST 2025	2511607	Exercises to Information Service Engineering	1 SWS	Practice / On-Site	Sack
Exams					
WT 24/25	79AIFB_ISE_B2	Information Service Engineering			Sack
ST 2025	79AIFB_ISE_B3	Information Service Engineering (Registration until 21.07.2025)			Sack

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation or an oral exam (20 min) following §4, Abs. 2, 2 of the examination regulation.

The exam takes place every semester and can be repeated at every regular examination date.

Prerequisites
None

Workload
150 hours

Below you will find excerpts from events related to this course:

V Information Service Engineering

2511606, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
- The Art of Understanding

- From Numbers to Insights
- Data, Information, and Knowledge
- Natural Language
- What is Successful Communication?
- The Art of Understanding

- Natural Language Processing

- NLP and Basic Linguistic Knowledge
- NLP Applications, Techniques and Challenges
- How to evaluate an NLP Experiment?
- Tokenization and Word Normalisation
- Statistical Language Models (N-Gram Model)
- Naive Bayes Text Classification
- Distributional Semantics and Word Vectors

- Knowledge Graphs

- Knowledge Representations and Ontologies
- Resource Description Framework (RDF)
- Modeling with RDFS
- Querying RDF(S) with SPARQL
- Popular Knowledge Graphs - Wikidata and DBpedia
- Ontologies with the Web Ontology Language (OWL)
- Linked Data Quality Assurance with SHACL
- From Linked Data to Knowledge Graphs

- Basic Machine Learning

- Machine Learning Fundamentals
- Evaluation and Generalization Problems
- Linear Regression
- Decision Trees
- Unsupervised Learning
- Neural Networks and Deep Learning
- Word Embeddings
- Knowledge Graph Embeddings

- ISE Applications

- Knowledge Graph Completion
- Knowledge Graphs and Large Language Models
- Semantic and Exploratory Search
- Semantic Recommender Systems

Learning objectives:

- The students know the fundamentals and measures of information theory and are able to apply those in the context of Information Service Engineering.
- The students have basic skills of natural language processing and are enabled to apply natural language processing technology to solve and evaluate simple text analysis tasks.
- The students have fundamental skills of knowledge representation with ontologies as well as basic knowledge of Semantic Web and Linked Data technologies. The students are able to apply these skills for simple representation and analysis tasks.
- The students have fundamental skills of information retrieval and are enabled to conduct and to evaluate simple information retrieval tasks.
- The students apply their skills of natural language processing, Linked Data engineering, and Information Retrieval to conduct and evaluate simple knowledge mining tasks.
- The students know the fundamentals of recommender systems as well as of semantic and exploratory search.

Literature

- D. Jurafsky, J.H. Martin, Speech and Language Processing, 2nd ed. Pearson Int., 2009.
- A. Hogan, The Web of Data, Springer, 2020.
- G. Rebala, A. Ravi, S. Churiwala, An Introduction to Machine Learning, Springer, 2019.

T 4.124 Course: Integral Equations [T-MATH-105834]

Responsible: PD Dr. Tilo Arens
Prof. Dr. Roland Griesmaier
PD Dr. Frank Hettlich

Organisation: KIT Department of Mathematics

Part of: M-MATH-102874 - Integral Equations

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Exams			
WT 24/25	7700114	Integral Equations	Hettlich

4.125 Course: International Business Development and Sales [T-WIWI-110985]

Responsible: Erice Casenave
Prof. Dr. Martin Klarmann
Prof. Dr. Orestis Terzidis

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-105312 - Marketing and Sales Management

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	see Annotations	1

Events					
WT 24/25	2572189	International Business Development and Sales	4 SWS	Block / 🗣	Klarmann, Terzidis, Schmitt
Exams					
WT 24/25	7900156	International Business Development and Sales			Klarmann, Terzidis

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Non exam assessment. The grade is based on the presentation, the subsequent discussion and the written elaboration.

Annotation
Please contact the Marketing and Sales Research Group for further information.

Workload
180 hours

Below you will find excerpts from events related to this course:

V International Business Development and Sales

2572189, WS 24/25, 4 SWS, Language: English, Open in study portal

Block (B)
On-Site

Content
This course is offered as part of the EUCOR programme in cooperation with EM Strasbourg. Max. 10 students of KIT and max. 10 students of EM Strasbourg will develop a sales presentation in tandems (teams of 2). This is based on the value proposition of a business model.

- An application is required to participate in this event. The application phase usually takes place at the beginning of the lecture period. Further information on the application process can be found on the website of the Marketing and Sales Research Group (marketing.iism.kit.edu) shortly before the start of the lecture period.

Total workload for 6 ECTS: about 180 hours.

T 4.126 Course: International Finance [T-WIWI-102646]

Responsible: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	see Annotations	1

Events					
ST 2025	2530570	International Finance	2 SWS	Lecture / 🗣	Walter, Uhrig-Homburg
Exams					
WT 24/25	7900052	International Finance			Uhrig-Homburg
ST 2025	7900097	International Finance			Uhrig-Homburg

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The success control takes place in form of a written examination (60 min). If the number of participants is low, an oral examination may also be offered. The examination is offered every semester and can be repeated at any regular examination date.

Prerequisites
None

Recommendation
None

Annotation
The course is offered as a 14-day or block course.

Below you will find excerpts from events related to this course:

V International Finance

2530570, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Organizational issues
Kickoff am Mittwoch, 30.04.25, 16:00 - 19:15 Uhr im Raum 320 im Geb. 09.21 (Blücherstr. 17). Die Veranstaltung wird samstags als Blockveranstaltung angeboten (nach dem Kickoff nach Absprache).

Literature
Weiterführende Literatur:

- Eiteman, D. et al., Multinational Business Finance, 13. Auflage, 2012.
- Solnik, B. und D. McLeavey, Global Investments, 6. Auflage, 2008.

4.127 Course: Introduction into Particulate Flows [T-MATH-105911]

Responsible: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: M-MATH-102943 - Introduction into Particulate Flows

Type	Credits	Grading scale	Version
Oral examination	3	Grade to a third	1

Prerequisites
none

T 4.128 Course: Introduction to Convex Integration [T-MATH-112119]

Responsible: Dr. Christian Zillinger
Organisation: KIT Department of Mathematics
Part of: M-MATH-105964 - Introduction to Convex Integration

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

Competence Certificate
oral examination of approx. 30 minutes

Prerequisites
none

Recommendation
The courses "Classical Methods for Partial Differential Equations" and "Functional Analysis" are recommended.

Workload
90 hours

T 4.129 Course: Introduction to Dynamical Systems [T-MATH-113263]

Responsible: Dr. Björn de Rijk
Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-106591 - Introduction to Dynamical Systems

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Exams			
WT 24/25	7700119	Introduction to Dynamical Systems	de Rijk

Competence Certificate
oral exam of ca. 30 min

Prerequisites
none

Workload
180 hours

T 4.130 Course: Introduction to Fluid Dynamics [T-MATH-111297]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-105650 - Introduction to Fluid Dynamics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Irregular	1

Prerequisites
none

T 4.131 Course: Introduction to Fluid Mechanics [T-MATH-112927]

Responsible: TT-Prof. Dr. Xian Liao
Organisation: KIT Department of Mathematics
Part of: M-MATH-106401 - Introduction to Fluid Mechanics

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	6	Grade to a third	Irregular	1 terms	1

Exams			
WT 24/25	7700135	Introduction to Fluid Mechanics	Liao

Competence Certificate
The module examination takes the form of an oral examination of approx. 25 minutes.

Prerequisites
none

Recommendation
The module *Functional Analysis* is strongly recommended.

Workload
180 hours

T 4.132 Course: Introduction to Geometric Measure Theory [T-MATH-105918]

Responsible: PD Dr. Steffen Winter
Organisation: KIT Department of Mathematics
Part of: M-MATH-102949 - Introduction to Geometric Measure Theory

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

Prerequisites
none

T 4.133 Course: Introduction to Homogeneous Dynamics [T-MATH-110323]

Responsible: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: M-MATH-105101 - Introduction to Homogeneous Dynamics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Prerequisites
none

T 4.134 Course: Introduction to Kinetic Equations [T-MATH-111721]

Responsible: Dr. Christian Zillinger
Organisation: KIT Department of Mathematics
Part of: M-MATH-105837 - Introduction to Kinetic Equations

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

Competence Certificate
oral examination of circa 30 minutes

Prerequisites
none

Recommendation
The course "Classical Methods for Partial Differential Equations" should be studied beforehand.

T 4.135 Course: Introduction to Kinetic Theory [T-MATH-108013]

Responsible: Prof. Dr. Martin Frank
Organisation: KIT Department of Mathematics
Part of: M-MATH-103919 - Introduction to Kinetic Theory

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	0155450	Introduction to Kinetic Theory	2 SWS	Lecture /	Frank
WT 24/25	0155460	Tutorial for 0155450 (Introduction to Kinetic Theory)	1 SWS	Practice	Frank
Exams					
WT 24/25	7700078	Introduction to Kinetic Theory			Frank

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Prerequisites
none

Below you will find excerpts from events related to this course:

V Introduction to Kinetic Theory

0155450, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
Blended (On-Site/Online)

Content
Kinetic descriptions play an important role in a variety of physical, biological, and even social applications, for instance, in the description of gases, radiations, bacteria or financial markets. Typically, these systems are described locally not by a finite set of variables but instead by a probability density describing the distribution of a microscopic state. Its evolution is typically given by an integro-differential equation. Unfortunately, the large phase space associated with the kinetic description has made simulations impractical in most settings in the past. However, recent advances in computer resources, reduced-order modeling and numerical algorithms are making accurate approximations of kinetic models more tractable, and this trend is expected to continue in the future. On the theoretical mathematical side, two rather recent Fields medals (Pierre-Louis Lions 1994, Cédric Villani 2010) also indicate the continuing interest in this field, which was already the subject of Hilbert's sixth out of the 23 problems presented at the World Congress of Mathematicians in 1900.

This course gives an introduction to kinetic theory. Our purpose is to discuss the mathematical passage from a microscopic description of a system of particles, via a probabilistic description to a macroscopic view. This is done in a complete way for the linear case of particles that are interacting with a background medium. The nonlinear case of pairwise interacting particles is treated on a more phenomenological level.

An extremely broad range of mathematical techniques is used in this course. Besides mathematical modeling, we make use of statistics and probability theory, ordinary differential equations, hyperbolic partial differential equations, integral equations (and thus functional analysis) and infinite-dimensional optimization. Among the astonishing discoveries of kinetic theory are the statistical interpretation of the Second Law of Thermodynamics, induced by the Boltzmann-Grad limit, and the result that the macroscopic equations describing fluid motion (namely the Euler and Navier-Stokes equations) can be inferred from abstract geometrical properties of integral scattering operators.

Organizational issues
The course will be offered in flipped classroom format. Flipped classroom means that the lectures will be made available as videos. We will regularly meet for tutorials and discussion sessions.

4.136 Course: Introduction to Microlocal Analysis [T-MATH-111722]

Responsible: TT-Prof. Dr. Xian Liao
Organisation: KIT Department of Mathematics
Part of: M-MATH-105838 - Introduction to Microlocal Analysis

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

Competence Certificate
oral examination of circa 30 minutes

Prerequisites
none

Recommendation
The courses "Classical Methods for Partial Differential Equations" and "Functional Analysis" should be studied beforehand.

T 4.137 Course: Introduction to Scientific Computing [T-MATH-105837]

Responsible: Prof. Dr. Willy Dörfler
Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke
Prof. Dr. Andreas Rieder
Prof. Dr. Christian Wieners

Organisation: KIT Department of Mathematics

Part of: M-MATH-102889 - Introduction to Scientific Computing

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	3

Events					
ST 2025	0165000	Einführung in das Wissenschaftliche Rechnen	3 SWS	Lecture	Hochbruck, Dörich
ST 2025	0165010	Praktikum zu 0165000 (Einführung in das Wissenschaftliche Rechnen)	3 SWS	Practical course	Hochbruck, Dörich

T 4.138 Course: Introduction to Stochastic Differential Equations [T-MATH-112234]

Responsible: Josef Janák
Prof. Dr. Mathias Trabs
Organisation: KIT Department of Mathematics
Part of: M-MATH-106045 - Introduction to Stochastic Differential Equations

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Competence Certificate
The module will be completed with an oral exam (approx. 30 min).

Prerequisites
none

Recommendation
The contents of the module "Probability Theory" are strongly recommended. The module "Continuous Time Finance" is recommended.

Workload
120 hours

T 4.139 Course: Introduction to Stochastic Optimization [T-WIWI-106546]

Responsible: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2025	2550470	Introduction to Stochastic Optimization	2 SWS	Lecture /	Rebennack
ST 2025	2550471	Übung zur Einführung in die Stochastische Optimierung	1 SWS	Practice /	Rebennack, Kandora
ST 2025	2550474	Rechnerübung zur Einführung in die Stochastische Optimierung	2 SWS	Others (sons	Rebennack, Kandora
Exams					
WT 24/25	7900242	Introduction to Stochastic Optimization			Rebennack
ST 2025	7900311	Introduction to Stochastic Optimization			Rebennack

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes). The exam takes place in every semester.

Prerequisites
None.

Workload
135 hours

T 4.140 Course: Inverse Problems [T-MATH-105835]

Responsible: PD Dr. Tilo Arens
Prof. Dr. Roland Griesmaier
PD Dr. Frank Hettlich
Prof. Dr. Andreas Rieder

Organisation: KIT Department of Mathematics

Part of: M-MATH-102890 - Inverse Problems

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0105100	Inverse Problems	4 SWS	Lecture / 🗣	Rieder
WT 24/25	0105110	Tutorial for 0105100 (Inverse Problems)	2 SWS	Practice / 🗣	Rieder
Exams					
WT 24/25	7700075	Inverse Problems			Rieder

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 4.141 Course: Knowledge Discovery [T-WIWI-102666]

Responsible: Dr.-Ing. Tobias Käfer
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2511303	Knowledge Discovery, Graph Neural Networks, and Language Models	3 SWS	Lecture / Practice (/	Käfer, Shao, Noullet
Exams					
WT 24/25	79AIFB_KD_B3	Knowledge Discovery			Käfer
ST 2025	79AIFB_KD_C4	Knowledge Discovery (Registration until 21.07.2025)			Färber

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The overall grade will be determined using assignments during the semester (40% of the grade) and a final exam (60% of the grade).

Prerequisites
None

Workload
135 hours

Below you will find excerpts from events related to this course:

V Knowledge Discovery, Graph Neural Networks, and Language Models

2511303, WS 24/25, 3 SWS, Language: English, Open in study portal

Lecture / Practice (VÜ)
Blended (On-Site/Online)

Content

The lecture provides a comprehensive overview of various approaches in machine learning and data mining for knowledge extraction. It explores multiple fields, including machine learning, natural language processing, and knowledge representation. The main focus is on discovering patterns and regularities in extensive data sets, particularly unstructured text found in news articles, publications, and social media. This process is known as knowledge discovery. The lecture delves into specific techniques, methods, challenges, as well as current and future research topics within this field.

One part of the lecture is dedicated to understanding large language models (LLMs), such as ChatGPT, by exploring their underlying principles, training methods, and applications. Additionally, the lecture dives into graph representation learning, which involves extracting meaningful representations from graph data. It covers the mathematical foundations of graph and geometric deep learning, highlighting the latest applications in areas like explainable recommender systems.

Moreover, the lecture highlights the integration of knowledge graphs with large language models, known as neurosymbolic AI. This integration aims to combine structured and unstructured data to enhance knowledge extraction and representation.

The content of the lecture encompasses the entire machine learning and data mining process. It covers topics on supervised and unsupervised learning techniques, as well as empirical evaluation. Various learning methods are explored, ranging from classical approaches like decision trees, support vector machines, and neural networks to more recent advancements such as graph neural networks.

Learning obectives:

Students

- know fundamentals of Machine Learning, Data Mining and Knowledge Discovery.
- are able to design, train and evaluate adaptive systems.
- conduct Knowledge Discovery projects in regards to algorithms, representations and applications.

Workload:

- The total workload for this course is approximately 135 hours
- Time of presentness: 45 hours
- Time of preperation and postprocessing: 60 hours
- Exam and exam preperation: 30 hours

Literature

- T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning: Data Mining, Inference, and Prediction (http://www-stat.stanford.edu/~tibs/ElemStatLearn/)
- T. Mitchell. Machine Learning. 1997
- M. Berhold, D. Hand (eds). Intelligent Data Analysis - An Introduction. 2003
- P. Tan, M. Steinbach, V. Kumar: Introduction to Data Mining, 2005, Addison Wesley

T 4.142 Course: Large-scale Optimization [T-WIWI-106549]

Responsible: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2025	2550475	Large-Scale Optimization	2 SWS	Lecture / 🖥	Rebennack
ST 2025	2550476	Übung zu Large-Scale Optimization	1 SWS	Practice / 🗣	Bijiga, Rebennack
ST 2025	2550477	Rechnerübung zu Large-scale Optimization	2 SWS	Others (sons	Rebennack, Bijiga
Exams					
WT 24/25	7900244	Large-scale Optimization			Rebennack
ST 2025	7900291	Large-scale Optimization			Rebennack

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes). The exam takes place in every semester.

Prerequisites
None.

Workload
135 hours

T 4.143 Course: Liberalised Power Markets [T-WIWI-107043]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading scale	Recurrence	Version
Written examination	5,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2581998	Liberalised Power Markets	2 SWS	Lecture / 🗣	Fichtner
WT 24/25	2581999	Übungen zu Liberalised Power Markets	2 SWS	Practice / 🗣	Signer, Fichtner, Beranek
Exams					
WT 24/25	7900160	Liberalised Power Markets NEW			Fichtner

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

Recommendation
None

Workload
165 hours

Below you will find excerpts from events related to this course:

V Liberalised Power Markets — **Lecture (V) On-Site**
2581998, WS 24/25, 2 SWS, Language: English, Open in study portal

Content

1. Power markets in the past, now and in future

2. Designing liberalised power markets

2.1. Unbundling Dimensions of liberalised power markets
2.2. Central dispatch versus markets without central dispatch
2.3. The short-term market model
2.4. The long-term market model
2.5. Market flaws and market failure
2.6. Regulation in liberalised markets

3. The power (sub)markets

3.1 Day-ahead market
3.2 Intraday market
3.3 (Long-term) Forwards and futures markets
3.4 Emission rights market
3.5 Market for ancillary services
3.6 The “market” for renewable energies
3.7 Future market segments

4. Grid operation and congestion management

4.1. Grid operation
4.2. Congestion management

5. Market power

5.1. Defining market power
5.2. Indicators of market power
5.3. Reducing market power

6. Future market structures in the electricity value chain

1. Power markets in the past, now and in future

2. Designing liberalised power markets

2.2. Unbundling Dimensions of liberalised power markets
2.3. Central dispatch versus markets without central dispatch
2.4. The short-term market model
2.5. The long-term market model
2.6. Market flaws and market failure
2.7. Regulation in liberalised markets

3. The power (sub)markets

3.1 Day-ahead market
3.2 Intraday market
3.3 (Long-term) Forwards and futures markets
3.4 Emission rights market
3.5 Market for ancillary services
3.6 The “market” for renewable energies
3.7 Future market segments

4. Grid operation and congestion management

4.1. Grid operation
4.2. Congestion management

5. Market power

5.1. Defining market power
5.2. Indicators of market power
5.3. Reducing market power

6. Future market structures in the electricity value chain

Literature
Weiterführende Literatur:

Power System Economics; Steven Stoft, IEEE Press/Wiley-Interscience Press, 0-471-15040-1

T 4.144 Course: Lie Groups and Lie Algebras [T-MATH-108799]

Responsible: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: M-MATH-104261 - Lie Groups and Lie Algebras

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T 4.145 Course: Lie-Algebras [T-MATH-113907]

Responsible: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: M-MATH-106950 - Lie-Algebras

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	8	Grade to a third	Irregular	1 terms	1

Exams			
WT 24/25	7712345	Lie-Algebras	Hartnick

Prerequisites
none

T 4.146 Course: Machine Learning 1 - Basic Methods [T-WIWI-106340]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2511500	Machine Learning 1 - Fundamental Methods	2 SWS	Lecture / 🗣	Zöllner
WT 24/25	2511501	Exercises to Machine Learning 1 - Fundamental Methods	1 SWS	Practice / 🗣	Zöllner, Polley, Fechner, Daaboul
Exams					
WT 24/25	79AIFB_ML1_C5	Machine Learning 1 - Basic Methods			Zöllner
ST 2025	79AIFB_ML1_C4	Machine Learning 1 - Basic Methods (Registration until 21.07.2025)			Zöllner

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Depending on further pandemic developments, the exam will be offered either as an open-book exam, or as a written exam (60 min):

The exam takes place every semester and can be repeated at every regular examination date.

A grade bonus can be earned by successfully completing practice exercises. If the grade of the written exam is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

Prerequisites
None.

Workload
150 hours

Below you will find excerpts from events related to this course:

V Machine Learning 1 - Fundamental Methods

2511500, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
The course prepares students for the rapidly evolving field of machine learning by providing a solid foundation, covering core concepts and techniques to get started in the field. Students delve into different methods in supervised, unsupervised, and reinforcement learning, as well as various model types, ranging from basic linear classifiers to more complex methods, such as deep neural networks. Topics include general learning theory, support vector machines, decision trees, neural network fundamentals, convolutional neural networks, recurrent neural networks, unsupervised learning, reinforcement learning, and Bayesian learning.

The course is accompanied by a corresponding exercise, where students gain hands-on experience by implementing and experimenting with different machine learning algorithms, helping them to apply machine learning algorithms on real world problems.

By the end of the course, students will have acquired a solid foundation in machine learning, enabling them to apply state-of-the-art algorithms to solve complex problems, contribute to research efforts, and explore advanced topics in the field.

Learning obectives:

- Students acquire knowledge of the fundamental methods in the field of machine learning.
- Students can classify, formally describe and evaluate methods of machine learning.
- Students can use their knowledge to select suitable models and methods for selected problems in the field of of machine learning.

Literature
Die Foliensätze sind als PDF verfügbar

Weiterführende Literatur

- Machine Learning - Tom Mitchell
- Deep Learning - Ian Goodfellow, Yoshua Bengio, Aaron Courville
- Pattern Recognition and Machine Learning - Christopher M. Bishop
- Artificial Intelligence: A Modern Approach - Peter Norvig and Stuart J. Russell
- Reinforcement Learning: An Introduction - Richard S. Sutton and Andrew G. Barto

Weitere (spezifische) Literatur zu einzelnen Themen wird in der Vorlesung angegeben.

T 4.147 Course: Machine Learning 2 – Advanced Methods [T-WIWI-106341]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics
M-WIWI-101637 - Analytics and Statistics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	4

Events					
ST 2025	2511502	Machine Learning 2 - Advanced Methods	2 SWS	Lecture / 🗣	Zöllner, Fechner, Polley, Stegmaier
ST 2025	2511503	Exercises for Machine Learning 2 - Advanced Methods	1 SWS	Practice / 🗣	Zöllner, Fechner, Polley, Stegmaier
Exams					
WT 24/25	79AIFB_ML2_B8	Machine Learning 2 – Advanced Methods			Zöllner
ST 2025	79AIFB_ML2_B1	Machine Learning 2 – Advanced Methods (Registration until 21.07.2025)			Zöllner

Legend: 🖥 Online, ♲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Depending on further pandemic developments, the exam will be offered either as an open-book exam, or as a written exam (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

Prerequisites
None.

Workload
150 hours

Below you will find excerpts from events related to this course:

V Machine Learning 2 - Advanced Methods
2511502, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
The subject area of machine intelligence and, in particular, machine learning, taking into account real challenges of complex application domains, is a rapidly expanding field of knowledge and the subject of numerous research and development projects.

The lecture "Machine Learning 2" deals with modern advanced methods of machine learning such as semi-supervised, self-supervised and active learning, deep neural networks (deep learning, CNNs, GANs, diffusion models, transformer, adversarial attacks) and hierarchical approaches, e.g. reinforcement learning. Another focus is the embedding and application of machine learning methods in real systems.

The lecture introduces the latest basic principles as well as extended basic structures and elucidates previously developed algorithms. The structure and the mode of operation of the methods and methods are presented and explained by means of some application scenarios, especially in the field of technical (sub) autonomous systems (vehicles, robotics, neurorobotics, image processing, etc.).

Learning objectives:

- Students understand extended concepts of machine learning and their possible applications.
- Students can classify, formally describe and evaluate methods of machine learning.
- In detail, methods of machine learning can be embedded and applied in complex decision and inference systems.
- Students can use their knowledge to select suitable models and methods of machine learning for existing problems in the field of machine intelligence.

Recommendations:

Attending the lecture ***Machine Learning 1*** or a comparable lecture is very helpful in understanding this lecture.

Literature
Die Foliensätze sind als PDF verfügbar

Weiterführende Literatur

- Deep Learning - Ian Goodfellow
- Artificial Intelligence: A Modern Approach - Peter Norvig and Stuart J. Russell
- Machine Learning - Tom Mitchell
- Pattern Recognition and Machine Learning - Christopher M. Bishop
- Reinforcement Learning: An Introduction - Richard S. Sutton and Andrew G. Barto
- Deep Learning - Ian Goodfellow, Yoshua Bengio, Aaron Courville

Weitere (spezifische) Literatur zu einzelnen Themen wird in der Vorlesung angegeben.

T 4.148 Course: Machine Learning and Optimization in Energy Systems [T-WIWI-113073]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2581050	Machine Learning and Optimization in Energy Systems	3 SWS	Lecture / Practice (/ 🗣	Dengiz, Yilmaz
Exams					
WT 24/25	7900179	Machine Learning and Optimization in Energy Systems			Fichtner

Legend: 🖥 Online, ✿ Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
The assessment of this course is a written examination (60 min) or an oral exam (30 min) depending on the number of participants. A bonus can be acquired through successful participation in the computer exercise. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4). The exact criteria for awarding a bonus will be announced at the beginning of the exercises.

Workload
105 hours

Below you will find excerpts from events related to this course:

V Machine Learning and Optimization in Energy Systems

2581050, WS 24/25, 3 SWS, Language: English, Open in study portal

Lecture / Practice (VÜ)
On-Site

Content
Goals:
Participants should know about the most common optimization and machine learning approaches for the application in energy systems. They should understand the basic principles of the methods and should be able to apply them for solving important problems of future energy systems with high shares of renewable energy sources.

Content:
In the beginning, the essential transition of the energy system into a smart grid and the need for methods from the field of optimization and machine learning are explained. The course can be subdivided into an optimization part and a larger machine learning part. In the optimization part, the basics of optimization approaches that are used in energy systems are shown. Further, heuristic methods and approaches from the field of multiobjective optimization are introduced. In the machine learning part, the most important methods from the field of unsupervised learning, supervised learning and reinforcement learning are introduced and their application in future energy systems are investigated.

Amongst the considered applications are power plant dispatch, intelligent heating with heat pumps, charging strategies for electric vehicles, clustering of energy data for energy system models and electricity demand and renewable generation forecasting.

We also offer a voluntary computer exercise that deepens the understanding of the methods and applications covered in the lecture. The students will have the opportunity to solve problems from the energy domain by using optimization and machine learning approaches implemented in the programming language Python.

The course's general focus is on the application of the methods in the energy field and not on the mathematical details of the different approaches.

The total workload for this course is approximately 105 hours:

- Attendance: 30 hours
- Self-study: 30 hours
- Exam preparation: 45 hours

T 4.149 Course: Management of IT-Projects [T-WIWI-113968]

Responsible: Dr. Sascha Alpers
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2511214	IT Project Management	2 SWS	Lecture / 🗣	Alpers
ST 2025	2511215	Exercise IT Project Management	1 SWS	Practice / 🗣	Rybinski
Exams					
ST 2025	7900302	IT Project Management (Registration until 21.07.2025)			Oberweis

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed in the form of a written examination (written exam) lasting 60 minutes.

Workload
135 hours

Below you will find excerpts from events related to this course:

V **IT Project Management** **Lecture (V)**
2511214, SS 2025, 2 SWS, Language: German, Open in study portal **On-Site**

Content
Contents:

The lecture deals with the general framework, impact factors and methods for planning, handling, and controlling of IT projects. Especially following topics are addressed:

- project environment
- project organisation
- project planning including the following items:
  - plan of the project structure
  - flow chart
  - project schedule
  - plan of resources
- effort estimation
- project infrastructur
- project controlling
- risk management
- feasibility studies
- decision processes, conduct of negotiations, time management.

Learning objectives:

Students

- explain the terminology of IT project management and typical used methods for planning, handling and controlling,
- apply methods appropiate to current project phases and project contexts,
- consider organisational and social impact factors.

Recommendations:

Knowledge about Software Engineering is helpful.

Workload:

- Lecture 30h
- Exercise 15h
- Preparation of lecture 24h
- Preparation of exercises 25h
- Exam preparation 40h
- Exam 1h

Literature

- B. Hindel, K. Hörmann, M. Müller, J. Schmied. Basiswissen Software-Projektmanagement. dpunkt.verlag 2004
- Project Management Institute Standards Committee. A Guide to the Project Management Body of Knowledge (PMBoK guide). Project Management Institute. Four Campus Boulevard. Newton Square. PA 190733299. U.S.A.

V **Exercise IT Project Management**
2511215, SS 2025, 1 SWS, Language: German, Open in study portal

Practice (Ü)
On-Site

Content
The general conditions, influencing factors and methods in the planning, execution and control of IT projects are dealt with. In particular, the following topics will be dealt with: Project environment, project organization, project structure plan, effort estimation, project infrastructure, project control, decision-making processes, negotiation, time management.

T 4.150 Course: Market Research [T-WIWI-107720]

Responsible: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101647 - Data Science: Evidence-based Marketing
M-WIWI-105312 - Marketing and Sales Management
M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2025	2571150	Market Research	2 SWS	Lecture / 🗣	Klarmann
ST 2025	2571151	Market Research Tutorial	1 SWS	Practice / 🗣	Klarmann
Exams					
WT 24/25	7900053	Market Research			Klarmann
ST 2025	7900015	Market Research			Klarmann

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of success takes place through a written exam (70 minutes) with additional aids in the sense of an open book exam. Further details will be announced during the lecture.

Prerequisites
None

Recommendation
None

Annotation
Please note that this course has to be completed successfully by students interested in master thesis positions at the Marketing & Sales Research Group.

Below you will find excerpts from events related to this course:

V Market Research
2571150, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content

Within the lecture, essential statistical methods for measuring customer attitudes (e.g. satisfaction measurement), understanding customer behavior and making strategic decisions will be discussed. The practical use as well as the correct handling of different survey methods will be taught, such as experiments and surveys. To analyze the collected data, various analysis methods are presented, including hypothesis tests, factor analyses, cluster analyses, variance and regression analyses. Building on this, the interpretation of the results will be discussed.

Topics addressed in this course are for example:

- Theoretical foundations of market research
- Statistical foundations of market research
- Measuring customer attitudes
- Understanding customer reactions
- Strategical decision making

The aim of this lecture is to give an overview of essential statistical methods. In the lecture students learn the practical use as well as the correct handling of different statistical survey methods and analysis procedures. In addition, emphasis is put on the interpretation of the results after the application of an empirical survey. The derivation of strategic options is an important competence that is required in many companies in order to react optimally to customer needs.

The assessment is carried out (according to §4(2), 3 SPO) in the form of a written open book exam.

The total workload for this course is approximately 135.0 hours.

Presence time: 30 hours

Preparation and wrap-up of the course: 45.0 hours

Exam and exam preparation: 60.0 hours

Please note that this course has to be completed successfully by students interested in master thesis positions at the chair of marketing.

Literature

Homburg, Christian (2016), Marketingmanagement, 6. Aufl., Wiesbaden.

T 4.151 Course: Marketing Analytics [T-WIWI-103139]

Responsible: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101647 - Data Science: Evidence-based Marketing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	6

Events					
WT 24/25	2572170	Marketing Analytics	2 SWS	Lecture / 🗣	Klarmann
WT 24/25	2572171		1 SWS	Practice / 🗣	Martin
Exams					
WT 24/25	7900082	Marketing Analytics			Klarmann

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative (according to §4(2), 3 of the examination regulation) exam assessment (working on tasks in groups during the lecture).

Prerequisites
The prerequisite for taking the course is the successful completion of the course "Market Research".

Recommendation
It is strongly recommended to complete the course "Market Research" prior to taking the "Marketing Analytics" course.

Annotation
"Marketing Analytics" is offered as a block course with an alternative exam assessment.
Starting in the winter semester 22/23, the course will be scheduled to be completed after two thirds of the semester. For further information, please contact the Marketing and Sales Research Group (marketing.iism.kit.edu). Exchange students can bypass the requirement of passing Market Research if they can prove that they possess sufficient statistical knowledge based on courses attended at their home institution. This will be examined individually by the Marketing and Sales Research Group.

Below you will find excerpts from events related to this course:

V Marketing Analytics

2572170, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
In this course various relevant market research questions are addressed, as for example measuring and understanding customer attitudes, preparing strategic decisions and sales forecasting. In order to analyze these questions, students learn to handle social media data, panel data, nested observations and experimental design. To analyze the data, advanced methods, as for example multilevel modeling and return on marketing models are taught. Also, problems of causality are addressed in-depth. The lecture is accompanied by a computer-based exercise, in the course of which the methods are applied practically.

Students

- receive based on the course market research an overview of advanced empirical methods
- learn in the course of the lecture to handle advanced data collection and data analysis methods
- are based on the acquired knowledge able to interpret results and derive strategic implications

Total workload for 4.5 ECTS: ca. 135 hours.

In order to attend Marketing Analytics, students are required to have passed the course Market Research.

Exchange students can bypass the requirement of passing Market Research if they can prove that they possess sufficient statistical knowledge based on courses attended at their home institution. This will be examined individually by the Marketing & Sales Research Group.

For further information please contact the Marketing and Sales Research Group (marketing.iism.kit.edu).

Literature

- Hanssens, Dominique M., Parsons, Leonard J., Schultz, Randall L. (2003), Market response models: Econometric and time series analysis, 2nd ed, Boston.
- Gelman, Andrew, Hill, Jennifer (2006), Data analysis using regression and multilevel/hierarchical models, New York.
- Cameron, A. Colin, Trivedi, Pravin K. (2005), Microeconometrics: methods and applications, New York.
- Chapman, Christopher, Feit, Elea M. (2015), R for Marketing Research and Analytics, Cham.
- Ledolter, Johannes (2013), Data mining and business analytics with R, New York.

V

2572171, WS 24/25, 1 SWS, Language: English, Open in study portal

Practice (Ü)
On-Site

Content
Tasks parallel to the lecture to work on in a group of students.

Organizational issues
Blockveranstaltung: genaue Uhrzeiten und Raum werden noch bekannt gegeben

T 4.152 Course: Markov Decision Processes [T-MATH-105921]

Responsible: Prof. Dr. Nicole Bäuerle
Organisation: KIT Department of Mathematics
Part of: M-MATH-102907 - Markov Decision Processes

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

Events					
ST 2025	0159900	Markov Decision Processes	2 SWS	Lecture	Bäuerle
ST 2025	0159910	Tutorial for 0159900 (Markov Decision Processes)	2 SWS	Practice	Bäuerle

Prerequisites
none

Workload
150 hours

Below you will find excerpts from events related to this course:

V Markov Decision Processes

0159900, SS 2025, 2 SWS, Open in study portal

Lecture (V)

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.

T 4.153 Course: Master's Thesis [T-MATH-105878]

Responsible: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: M-MATH-102917 - Master's Thesis

Type	Credits	Grading scale	Version
Final Thesis	30	Grade to a third	1

Final Thesis
This course represents a final thesis. The following periods have been supplied:

Submission deadline	6 months
Maximum extension period	3 months
Correction period	8 weeks

4.154 Course: Matching Theory [T-WIWI-113264]

Responsible: Prof. Dr. Clemens Puppe
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101500 - Microeconomic Theory

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2500042	Matching Theory	3 SWS	Lecture / Practice (/	Okulicz
Exams					
WT 24/25	7900347	Matching Theory			Puppe
ST 2025	7900260	Matching Theory			Puppe

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Written examination (90 minutes)

Workload
135 hours

Below you will find excerpts from events related to this course:

Matching Theory

2500042, WS 24/25, 3 SWS, Language: English, Open in study portal

Lecture / Practice (VÜ)
On-Site

Content
How should we organize recruitment of students to schools? Could we improve the placement of doctors to hospitals? Why there always seems to be a better roommate to the one you currently have? Matching Theory answers all these questions and more. During the course we will formally study mathematical systems of allocating goods and people, and see their many real life applications from organizing kidney exchange to improving dating apps. The course will cover three main topics in Matching Theory and Market Design: (1) assignment problems (e.g., allocation of social housing), (2) two-sided matching (e.g., allocation of children to schools), (3) transferable-utility matching (e.g., labor market).

The students are expected to:

1. Understand the mathematical properties of allocations and commonly used mechanism
2. Understand the connection between Matching Theory and real-life allocation systems
3. Be able to use their knowledge to propose solutions for novel real-life problems

T 4.155 Course: Mathematical Methods in Signal and Image Processing [T-MATH-105862]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-102897 - Mathematical Methods in Signal and Image Processing

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Prerequisites
none

Workload
240 hours

T 4.156 Course: Mathematical Methods of Imaging [T-MATH-106488]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-103260 - Mathematical Methods of Imaging

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

Prerequisites
None

T 4.157 Course: Mathematical Modelling and Simulation in Practise [T-MATH-105889]

Responsible: PD Dr. Gudrun Thäter
Organisation: KIT Department of Mathematics
Part of: M-MATH-102929 - Mathematical Modelling and Simulation in Practise

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	2

T 4.158 Course: Mathematical Statistics [T-MATH-105872]

Responsible: Dr. rer. nat. Bruno Ebner
Prof. Dr. Vicky Fasen-Hartmann
PD Dr. Bernhard Klar
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: M-MATH-102909 - Mathematical Statistics

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

Exams			
WT 24/25	7700136	Mathematical Statistics (Termin 1)	Klar
ST 2025	7700136	Mathematical Statistics (Termin 2)	Klar

Prerequisites
none

Workload
240 hours

4.159 Course: Mathematical Topics in Kinetic Theory [T-MATH-108403]

Responsible: Prof. Dr. Dirk Hundertmark
Organisation: KIT Department of Mathematics
Part of: M-MATH-104059 - Mathematical Topics in Kinetic Theory

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Prerequisites
none

T 4.160 Course: Mathematics for High Dimensional Statistics [T-WIWI-111247]

Responsible: Prof. Dr. Oliver Grothe
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-101637 - Analytics and Statistics
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	Irregular	1

Events					
ST 2025	2550562	Mathematische Grundlagen hochdimensionaler Statistik	2 SWS	Lecture / 🗣	Grothe
ST 2025	2550563	Übung zu Mathematische Grundlagen hochdimensionaler Statistik	2 SWS	Practice / 🗣	Grothe

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of an oral exam (approx. 30 min.) taking place in the recess period.

Prerequisites
None

Recommendation
Basic knowledge of mathematics and statistics is assumed.
Knowledge in multivariate statistics is an advantage, but not necessary for the course.

Annotation
Teaching and learning format: Lecture and exercise

Below you will find excerpts from events related to this course:

V Mathematische Grundlagen hochdimensionaler Statistik
2550562, SS 2025, 2 SWS, Open in study portal

Lecture (V)
On-Site

Content
Content:

The lecture focuses on modelling statistical objects (random vectors, random matrices and random graphs) in high dimensions. It deals with concentration inequalities that limit the fluctuations of such objects as well as complexity measures for quantities and functions. The theory is transferred to well-known and widespread applications such as neighbourhood detection in networks, statistical learning theory and LASSO.

Learning objectives:

Students are able to

- name and justify statistical properties of high-dimensional objects (vectors, matrices, functions).
- describe and explain differences in the behaviour between low- and high-dimensional random objects.
- name procedures for assess uncertainties in statistical models and apply them in simple examples.
- decide well-founded which modeling of high-dimensional structures is best suited in a specific situation.
- transform data into lower dimensions and quantify approximation errors.
- understand basic proofs in high-dimensional statistics using examples.
- develop, implement and evaluate smaller simulations in a programming language of their choice.

T 4.161 Course: MathSEE Modeling Week [T-MATH-113711]

Responsible: TT-Prof. Dr. Sebastian Krumscheid
PD Dr. Stefan Kühnlein

Organisation: KIT Department of Mathematics

Part of: M-MATH-106836 - MathSEE Modeling Week

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Competence Certificate
The performance review takes the form of a presentation on the results of the respective project together with a final report.

Prerequisites
none

Workload
90 hours

T 4.162 Course: Maxwell's Equations [T-MATH-105856]

Responsible:	PD Dr. Tilo Arens Prof. Dr. Roland Griesmaier PD Dr. Frank Hettlich
Organisation:	KIT Department of Mathematics
Part of:	M-MATH-102885 - Maxwell's Equations

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T 4.163 Course: Media Management [T-WIWI-112711]

Responsible: Prof. Dr. Ann-Kristin Kupfer
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2572192	Media Management	2 SWS	Lecture / 🗣	Kupfer
WT 24/25	2572193	Media Management Exercise	1 SWS	Practice / 🗣	Kopp
Exams					
WT 24/25	7900135	Media Management			Kupfer
ST 2025	7900004	Media Management			Kupfer

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed in the form of an examination of another type. The following aspects are included in the assessment:

- Elaboration and presentation of a group task
- Written exam

Further details on the organization of the performance and the points system for the assessment will be announced in the lecture.

Prerequisites
None

Recommendation
Students are highly encouraged to actively participate in class.

Workload
135 hours

Below you will find excerpts from events related to this course:

V Media Management
2572192, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
Students learn the theoretical foundations of media management and its most important concepts. They learn both about the key characteristics of both media products and media markets. They further get to know essential business models of media markets. Special emphasis will be given to understanding media consumers and the marketing mix of media products. A tutorial offers the opportunity to apply the key learnings of the lecture.

The learning objectives are as follows:

- Getting to know the theoretical foundations of media management
- Evaluating strategies for media products and services as media-specific marketing mix instruments
- Fostering critical and analytical thinking skills and the application of knowledge to marketing problems
- Improvement of skills and competences in the area of project management within the framework of group work
- Improvement of foreign language skills (business English)

Total time required for 4.5 credit points: approx. 135 hours

Attendance time: 30 hours

Self-study: 105 hours

Organizational issues
Appointments to be announced.

T 4.164 Course: Metric Geometry [T-MATH-111933]

Responsible: Prof. Dr. Alexander Lytchak
Dr. Artem Nepechiy

Organisation: KIT Department of Mathematics

Part of: M-MATH-105931 - Metric Geometry

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Competence Certificate
oral examination of circa 20 minutes

Prerequisites
none

T 4.165 Course: Minimal Surfaces [T-MATH-113417]

Responsible: Dr. Peter Lewintan
Organisation: KIT Department of Mathematics
Part of: M-MATH-106666 - Minimal Surfaces

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

Prerequisites
None

Workload
90 hours

T 4.166 Course: Mixed Integer Programming I [T-WIWI-102719]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Competence Certificate

The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

The examination can also be combined with the examination of *Mixed Integer Programming II* [25140]. In this case, the duration of the written examination takes 120 minutes.

Prerequisites

None

Recommendation

It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Annotation

The lecture is offered irregularly. The curriculum of the next three years is available online (kop.ior.kit.edu).

4.167 Course: Mixed Integer Programming II [T-WIWI-102720]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Competence Certificate
The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.
The examination is held in the semester of the lecture and in the following semester.
The examination can also be combined with the examination of *Mixed Integer Programming I* [2550138]. In this case, the duration of the written examination takes 120 minutes.

Prerequisites
None

Recommendation
It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Annotation
The lecture is offered irregularly. The curriculum of the next three years is available online (kop.ior.kit.edu).

T 4.168 Course: Modeling and OR-Software: Advanced Topics [T-WIWI-106200]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102832 - Operations Research in Supply Chain Management

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2550490	Modellieren und OR-Software: Fortgeschrittene Themen	3 SWS	Practical course /	Pomes, Linner, Nickel
Exams					
WT 24/25	7900071	Modeling and OR-Software: Advanced Topics			Nickel
ST 2025	7900188	Modeling and OR-Software: Advanced Topics			Nickel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The assessment is a written examination. The examination is held in every semester. The prerequisite can only be obtained in semesters in which the course exercises are offered.

Prerequisites
Prerequisite for admission to the exam is the successful participation in the exercises. This includes the processing and presentation of exercises.

Recommendation
Basic knowledge as conveyed in the module *Introduction to Operations Research* is assumed.

Successful completion of the course *Modeling and OR-Software: Introduction*.

Annotation
Due to the limited number of participants, please register in advance. Further information can be found on the website of the course. Registration in WS 24/25 takes place via the Wiwi-Portal: https://portal.wiwi.kit.edu/ys/8209.
The course is offered every semester. The range of courses planned for three academic years in advance can be found on the Internet.

Workload
135 hours

Below you will find excerpts from events related to this course:

V Modellieren und OR-Software: Fortgeschrittene Themen

2550490, WS 24/25, 3 SWS, Language: German, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content
The advanced course is designated for Master students that already attended the introductory course or gained equivalent experience elsewhere, e.g. during a seminar or bachelor thesis. We will work on advanced topics and methods in OR, among others cutting planes, column generation and constraint programming. The Software used for the exercises is IBM ILOG CPLEX Optimization Studio. The associated modelling progamming languages are OPL and ILOG Script.

T 4.169 Course: Modeling and OR-Software: Introduction [T-WIWI-106199]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101413 - Applications of Operations Research

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	4

Events					
ST 2025	2550490	Modellieren und OR-Software: Einführung	3 SWS	Practical course /	Nickel, Linner, Pomes, Subas
Exams					
WT 24/25	7900081	Modeling and OR-Software: Introduction			Nickel
ST 2025	7900153	Modeling and OR-Software: Introduction			Nickel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The assessment is a written examination (60 min.). The examination is held in every semester.

Recommendation
Firm knowledge of the contents from the lecture *Introduction to Operations Research I* [2550040] of the module *Operations Research*.

Annotation
Due to capacity restrictions, registration before course start is required. For further information see the webpage of the course.

The lecture is offered in every term. The planned lectures and courses for the next three years are announced online.

Below you will find excerpts from events related to this course:

V Modellieren und OR-Software: Einführung

2550490, SS 2025, 3 SWS, Language: German, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content
After an introduction to general concepts of modelling tools (implementation, data handling, result interpretation, …), the software IBM ILOG CPLEX Optimization Studio and the corresponding modeling language OPL will be discussed which can be used to solve OR problems on a computer-aided basis. Subsequently, a broad range of exercises will be discussed. The main goals of the exercises from literature and practical applications are to learn the process of modeling optimization problems as linear or mixed-integer programs, to efficiently utilize the presented tools for solving these optimization problems and to implement heuristic solution procedures for mixed-integer programs.

Organizational issues
Die Teilnehmerzahl für diese Veranstaltung ist begrenzt.

Die Bewerbung erfolgt über das Wiwi-Portal

Der Bewerbungszeitraum ist vom 07.03.25 bis zum 30.03.25.

Die Kick-Off Veranstaltung findet am 30.04.25 um 09:45 Uhr statt.

T 4.170 Course: Modeling and Simulation [T-WIWI-112685]

Responsible: Prof. Dr. Sanja Lazarova-Molnar
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2511100	Modeling and Simulation	2 SWS	Lecture	Lazarova-Molnar
ST 2025	2511101	Exercises Modeling and Simulation	1 SWS	Practice	Lazarova-Molnar, Mostafa
Exams					
WT 24/25	79AIFB_MaS_A6	Modeling and Simulation			Lazarova-Molnar
ST 2025	79AIFB_MaS_C6	Modeling and Simulation (Registration until 21.07.2025)			Lazarova-Molnar

Competence Certificate
Depending on the number of participants in the course, the exam will be offered either as an oral exam (20 min), or as a written exam (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

Prerequisites
None

Recommendation
Some experience in programming and knowledge of basic mathematics and statistics.

Annotation
Instruction is in the form of lectures and exercises. A detailed course schedule will be published before the start of the semester.

Workload
135 hours

Below you will find excerpts from events related to this course:

V Modeling and Simulation

Lecture (V)

2511100, SS 2025, 2 SWS, Language: English, Open in study portal

Content

Modeling and Simulation is the most widely used operations research / systems engineering technique for designing new systems and optimizing the performance of existing systems. In one way or another, just about every engineering or scientific field uses simulation as an exploration, modeling, or analysis technique. The course is designed to provide students with basic knowledge of modeling and simulation approaches and to provide them with first experience of using a simulation package. The course will focus on modeling and simulation of real-world discrete event systems. Examples of discrete events are customer arrivals at a queue of a service desk, machine failures in manufacturing systems, telephone calls in a call center, etc. Moreover, continuous and hybrid models will be also discussed. Topics include Discrete-Event Simulation, Input Modeling, Output Analysis, Random Number Generation, Verification and Validation, Stochastic Petri Nets and Markov Chains.

Competence Certificate

Depending on the number of participants in the course, the exam will be offered either as an oral exam (20 min), or as a written exam (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

Learning Objectives

Knowledge:

- Demonstrate knowledge about general and specific theories, challenges, algorithms, methods, technologies, and tools related to modelling and simulation
- Demonstrate knowledge of two important classes of simulation:
    - Discrete-event Monte-Carlo simulation,
    - Continuous simulation with ODEs
- Demonstrate knowledge of algorithms necessary to build a simulator

Skills:

- Analyse suitability of an approach/tool for a given modelling problem
- Understand simulation models of various types
- Demonstrate methods and techniques to overcome common challenges in modelling and simulation
- Model simulation input data
- Analyse and model discrete stochastic systems
- Analyse and interpret simulation results

Competences:

- Use different methods to conduct simulation-based analysis of real-world data
- Build and simulate stochastic models
- Use simulation software

Prerequisites

Some experience in programming and knowledge of basic mathematics and statistics

Form of instruction

Lectures and exercises. A detailed course plan will be published before the semester start.

Literature

Discrete-Event System Simulation, 5th Edition

Jerry Banks, John S. Carson, II, Barry L. Nelson and David M. Nicol

4.171 Course: Modeling the Dynamics of Financial Markets [T-WIWI-113414]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-106660 - Modeling the Dynamics of Financial Markets

Type	Credits	Grading scale	Recurrence	Version
Written examination	9	Grade to a third	Each summer term	1

Exams			
WT 24/25	7900024	Modeling the Dynamics of Financial Markets	Ulrich

Competence Certificate
The examination takes the form of a one-hour written comprehensive examination on the courses "Dynamic Capital Marke Theory", "Essentials for Dynamic Financial Machine Learning" and "Exercises, Python, Resesearch Frontier in Dynamic Capital Markets".

Recommendation
Recommendation: Knowledge in the fields of Advanced Statistics, Deep Learning, Financial Economics, Differential Equations, Optimization.

Workload
270 hours

T 4.172 Course: Modelling and Simulation of Lithium-Ion Batteries [T-MATH-113382]

Responsible: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: M-MATH-106640 - Modelling and Simulation of Lithium-Ion Batteries

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Competence Certificate
oral exam (ca. 20 min)

Prerequisites
None

Workload
120 hours

T 4.173 Course: Modern Methods in Combinatorics [T-MATH-113911]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-106957 - Modern Methods in Combinatorics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Competence Certificate
Oral examination (approx. 30 min)

Prerequisites
None

Workload
180 hours

T 4.174 Course: Monotonicity Methods in Analysis [T-MATH-105877]

Responsible: PD Dr. Gerd Herzog
Organisation: KIT Department of Mathematics
Part of: M-MATH-102887 - Monotonicity Methods in Analysis

Type	Credits	Grading scale	Version
Oral examination	3	Grade to a third	1

Events					
WT 24/25	0106100	Monotoniemethoden in der Analysis	2 SWS	Lecture	Herzog
Exams					
WT 24/25	7700099	Monotonicity Methods in Analysis			Herzog

T 4.175 Course: Multicriteria Optimization [T-WIWI-111587]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	see Annotations	1

Events					
WT 24/25	2550155	Multicriteria Optimization	2 SWS	Lecture / 🗣	Stein
WT 24/25	2550156	Exercises Multicriteria Optimization		Practice / 🗣	Stein, Beck
Exams					
WT 24/25	7900009_WS2425_HK	Multicriteria Optimization			Stein
ST 2025	7900209_SS2025_NK	Multicriteria Optimization			Stein

Legend: 🖥 Online, ✪ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.
The examination is held in the semester of the lecture and in the following semester.

Prerequisites
None

Recommendation
It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Annotation
The course is offered every second winter semester (starting WiSe 22/23). The curriculum of the next three years is available online (www.ior.kit.edu).

Contents:

Multicriteria optimization deals with optimization problems with multiple objective functions. In practice, the minimization or maximization of several objectives often conflict with each other, such as weight and stability of mechanical components, return and risk of stock portfolios, or cost and duration of transports. Various scalarization approaches allow one to formulate single-objective problems that can be solved using nonlinear or global optimization techniques, and whose optimal points have a reasonable interpretation for the underlying multicriteria problem.

However, some seemingly obvious scalarization approaches suffer from various drawbacks, so that regardless of scalarization approaches, it is necessary to clarify what is meant by the solution of a multicriteria optimization problem in the first place. For such Pareto-optimal points, optimality conditions and solution procedures based on them can be formulated. From the usually non-unique Pareto set, decision makers finally choose an alternative based on their subjective preferences.

The lecture gives a mathematically sound introduction to multicriteria optimization and is structured as follows:

- Introductory examples and terminology
- Solution concepts
- Methods for the determination of the Pareto set
- Selection of Pareto-optimal points under subjective preferences

Workload
135 hours

Below you will find excerpts from events related to this course:

V Multicriteria Optimization
2550155, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content

Multicriteria optimization deals with optimization problems with multiple objective functions. In practice, the minimization or maximization of several objectives often conflict with each other, such as weight and stability of mechanical components, return and risk of stock portfolios, or cost and duration of transports. Various scalarization approaches allow one to formulate single-objective problems that can be solved using nonlinear or global optimization techniques, and whose optimal points have a reasonable interpretation for the underlying multicriteria problem.

However, some seemingly obvious scalarization approaches suffer from various drawbacks, so that regardless of scalarization approaches, it is necessary to clarify what is meant by the solution of a multicriteria optimization problem in the first place. For such Pareto-optimal points, optimality conditions and solution procedures based on them can be formulated. From the usually non-unique Pareto set, decision makers finally choose an alternative based on their subjective preferences.

The lecture gives a mathematically sound introduction to multicriteria optimization and is structured as follows:

- Introductory examples and terminology
- Solution concepts
- Methods for the determination of the Pareto set
- Selection of Pareto-optimal points under subjective preferences

Learning objectives:

The student

- knows and understands the fundamentals of multicriteria optimization,
- is able to choose, design and apply modern techniques of multicriteria optimization in practice.

Literature

- M. Ehrgott, Multicriteria Optimization, Second Edition, Springer, Berlin, 2005
- J. Jahn, Vector Optimization, Second Edition, Springer, Berlin, 2011
- K. Miettinen, Nonlinear Multiobjective Optimization, Springer, New York, 2004
- Y. Sawaragi, H. Nakayama, T. Tanino, Theory of Multiobjective Optimization, Academic Press, Orlando, FL, 1985

T 4.176 Course: Multivariate Statistical Methods [T-WIWI-103124]

Responsible: Prof. Dr. Oliver Grothe
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-101637 - Analytics and Statistics
M-WIWI-101639 - Econometrics and Statistics II
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Events					
WT 24/25	2550554	Multivariate Verfahren	2 SWS	Lecture / 🗣	Grothe
WT 24/25	2550555	Practice Multivariate Statistical Methods	2 SWS	Practice / 🗣	Liu
Exams					
WT 24/25	7900217	Multivariate Statistical Methods			Grothe
ST 2025	7900351	Multivariate Statistical Methods			Grothe

Legend: 🖥 Online, ❂ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Witten examination lasting 60 minutes.

The examination is offered during the examination period of the lecture semester. Only repeaters (and not first-time writers) are admitted to the repeat examination in the examination period of the following semester.

Prerequisites
None

Recommendation
The course covers highly advanced statistical methods with a quantitative focus. Hence, participants are necessarily expected to have advanced statistical knowledge, e.g. acquired in the course "Advanced Statistics". Without this, participation in the course is not advised.

Previous attendance of the course Analysis of Multivariate Data is recommended. Alternatively, the script can be provided to interested students.

Annotation
The course (lecture and exercise) is offered irregularly. Detailed information can be found on the chair's website.

Workload
135 hours

T 4.177 Course: Nature-Inspired Optimization Methods [T-WIWI-102679]

Responsible: Prof. Dr. Pradyumn Kumar Shukla
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2025	2511106	Nature-Inspired Optimization Methods	2 SWS	Lecture / Blended	Shukla
ST 2025	2511107	Übungen zu Nature-Inspired Optimization Methods	1 SWS	Practice / Blended	Shukla
Exams					
WT 24/25	79AIFB_NOM_B5	Nature-Inspired Optimisation Methods			Shukla
ST 2025	79AIFB_NOM_C1	Nature-Inspired Optimization Methods (Registration until 21.07.2025)			Shukla

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Please note: no exam can be offered in the winter semester 2023/2024.

Prerequisites
None

Below you will find excerpts from events related to this course:

V Nature-Inspired Optimization Methods
2511106, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
Blended (On-Site/Online)

Content
Many optimization problems are too complex to be solved to optimality. A promising alternative is to use stochastic heuristics, based on some fundamental principles observed in nature. Examples include evolutionary algorithms, ant algorithms, or simulated annealing. These methods are widely applicable and have proven very powerful in practice. During the course, such optimization methods based on natural principles are presented, analyzed and compared. Since the algorithms are usually quite computational intensive, possibilities for parallelization are also investigated.

Learning objectives:

Students learn:

- Different nature-inspired methods: local search, simulated annealing, tabu search, evolutionary algorithms, ant colony optimization, particle swarm optimization
- Different aspects and limitation of the methods
- Applications of such methods
- Multi-objective optimization methods
- Constraint handling methods
- Different aspects in parallelization and computing platforms

Literature
* E. L. Aarts and J. K. Lenstra: 'Local Search in Combinatorial Optimization'. Wiley, 1997 * D. Corne and M. Dorigo and F. Glover: 'New Ideas in Optimization'. McGraw-Hill, 1999 * C. Reeves: 'Modern Heuristic Techniques for Combinatorial Optimization'. McGraw-Hill, 1995 * Z. Michalewicz, D. B. Fogel: How to solve it: Modern Heuristics. Springer, 1999 * E. Bonabeau, M. Dorigo, G. Theraulaz: 'Swarm Intelligence'. Oxford University Press, 1999 * A. E. Eiben, J. E. Smith: 'Introduction to Evolutionary Computation'. * M. Dorigo, T. Stützle: 'Ant Colony Optimization'. Bradford Book, 2004 Springer, 2003

T 4.178 Course: Non- and Semiparametrics [T-WIWI-103126]

Responsible: Prof. Dr. Melanie Schienle
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Competence Certificate
The assessment consists of a written exam (90 minutes) (following §4(2), 1 of the examination regulation).

Prerequisites
None

Recommendation
Knowledge of the contents covered by the course *"Applied Econometrics"* [2520020]

Annotation
The course takes place every second winter semester: 2018/19 then 2020/21

T 4.179 Course: Nonlinear Analysis [T-MATH-107065]

Responsible: Prof. Dr. Tobias Lamm
Organisation: KIT Department of Mathematics
Part of: M-MATH-103539 - Nonlinear Analysis

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Prerequisites
none

T 4.180 Course: Nonlinear Maxwell Equations [T-MATH-110283]

Responsible: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: M-MATH-105066 - Nonlinear Maxwell Equations

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Exams			
WT 24/25	7700139	Nonlinear Maxwell Equations	Schnaubelt

Prerequisites
none

T 4.181 Course: Nonlinear Optimization I [T-WIWI-102724]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2550111	Nonlinear Optimization I	2 SWS	Lecture / 🗣	Stein
WT 24/25	2550112	Exercises Nonlinear Optimization I	1 SWS	Practice / 🗣	Stein, Schwarze, Neussel
Exams					
WT 24/25	7900001_WS2425_HK	Nonlinear Optimization I			Stein
ST 2025	7900202_SS2025_NK	Nonlinear Optimization I			Stein

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes) according to Section 4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam. The exam takes place in the semester of the lecture and in the following semester.
The examination can also be combined with the examination of Nonlinear Optimization II [2550113]. In this case, the duration of the written examination takes 120 minutes.

Prerequisites
The module component exam T-WIWI-103637 "Nonlinear Optimization I and II" may not be selected.

Annotation
Part I and II of the lecture are held consecutively in the *same* semester.

Below you will find excerpts from events related to this course:

V Nonlinear Optimization I

2550111, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
The lecture treats the minimization of smooth nonlinear functions without constraints. For such problems, which occur very often in economics, engineering, and natural sciences, optimality conditions are derived and, based on them, solution algorithms are developed. The lecture is structured as follows:

- Introduction, examples, and terminology
- Existence results for optimal points
- First and second order optimality condtions
- Algorithms (line search, steepest descent method, variable metric methods, Newton method, Quasi Newton methods, CG method, trust region method)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

Remark:

The treatment of optimization problems *with* constraints forms the contents of the lecture "Nonlinear Optimization II". The lectures "Nonlinear Optimization I" and "Nonlinear Optimization II" are held consecutively *in the same semester*.

Learning objectives:

The student

- knows and understands fundamentals of unconstrained nonlinear optimization,
- is able to choose, design and apply modern techniques of unconstrained nonlinear optimization in practice.

Literature
O. Stein, Grundzüge der Nichtlinearen Optimierung, 2. Aufl., SpringerSpektrum, 2021

Weiterführende Literatur:

- W. Alt, Nichtlineare Optimierung, Vieweg, 2002
- M.S. Bazaraa, H.D. Sherali, C.M. Shetty, Nonlinear Programming, Wiley, 1993
- O. Güler, Foundations of Optimization, Springer, 2010
- H.Th. Jongen, K. Meer, E. Triesch, Optimization Theory, Kluwer, 2004
- J. Nocedal, S. Wright, Numerical Optimization, Springer, 2000

T 4.182 Course: Nonlinear Optimization I and II [T-WIWI-103637]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading scale	Recurrence	Version
Written examination	9	Grade to a third	Each winter term	6

Events					
WT 24/25	2550111	Nonlinear Optimization I	2 SWS	Lecture / 🗣	Stein
WT 24/25	2550112	Exercises Nonlinear Optimization I	1 SWS	Practice / 🗣	Stein, Schwarze, Neussel
WT 24/25	2550113	Nonlinear Optimization II	2 SWS	Lecture / 🗣	Stein
Exams					
WT 24/25	7900003_WS2425_HK	Nonlinear Optimization I and II			Stein
ST 2025	7900204_SS2025_NK	Nonlinear Optimization I and II			Stein

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consits of a written exam (120 minutes) according to Section 4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The exam takes place in the semester of the lecture and in the following semester.

Prerequisites
None.

Annotation
Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from events related to this course:

V Nonlinear Optimization I
2550111, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
The lecture treats the minimization of smooth nonlinear functions without constraints. For such problems, which occur very often in economics, engineering, and natural sciences, optimality conditions are derived and, based on them, solution algorithms are developed. The lecture is structured as follows:

- Introduction, examples, and terminology
- Existence results for optimal points
- First and second order optimality condtions
- Algorithms (line search, steepest descent method, variable metric methods, Newton method, Quasi Newton methods, CG method, trust region method)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

Remark:

The treatment of optimization problems *with* constraints forms the contents of the lecture "Nonlinear Optimization II". The lectures "Nonlinear Optimization I" and "Nonlinear Optimization II" are held consecutively *in the same semester*.

Learning objectives:

The student

- knows and understands fundamentals of unconstrained nonlinear optimization,
- is able to choose, design and apply modern techniques of unconstrained nonlinear optimization in practice.

Literature
O. Stein, Grundzüge der Nichtlinearen Optimierung, 2. Aufl., SpringerSpektrum, 2021

Weiterführende Literatur:

- W. Alt, Nichtlineare Optimierung, Vieweg, 2002
- M.S. Bazaraa, H.D. Sherali, C.M. Shetty, Nonlinear Programming, Wiley, 1993
- O. Güler, Foundations of Optimization, Springer, 2010
- H.Th. Jongen, K. Meer, E. Triesch, Optimization Theory, Kluwer, 2004
- J. Nocedal, S. Wright, Numerical Optimization, Springer, 2000

V **Nonlinear Optimization II**
2550113, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
The lecture treats the minimization of smooth nonlinear functions under nonlinear constraints. For such problems, which occur very often in economics, engineering, and natural sciences, optimality conditions are derived and, based on them, solution algorithms are developed. The lecture is structured as follows:

- Topology and first order approximations of the feasible set
- Theorems of the alternative, first and second order optimality conditions
- Algorithms (penalty method, multiplier method, barrier method, interior point method, SQP method, quadratic optimization)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

Remark:

The treatment of optimization problems *without* constraints forms the contents of the lecture "Nonlinear Optimization I". The lectures "Nonlinear Optimization I" and "Nonlinear Optimization II" are held consecutively *in the same semester*.

Learning objectives:

The student

- knows and understands fundamentals of constrained nonlinear optimization,
- is able to choose, design and apply modern techniques of constrained nonlinear optimization in practice.

Literature
O. Stein, Grundzüge der Nichtlinearen Optimierung, 2. Aufl., SpringerSpektrum, 2021

Weiterführende Literatur:

- W. Alt, Nichtlineare Optimierung, Vieweg, 2002
- M.S. Bazaraa, H.D. Sherali, C.M. Shetty, Nonlinear Programming, Wiley, 1993
- O. Güler, Foundations of Optimization, Springer, 2010
- H.Th. Jongen, K. Meer, E. Triesch, Optimization Theory, Kluwer, 2004
- J. Nocedal, S. Wright, Numerical Optimization, Springer, 2000

T 4.183 Course: Nonlinear Optimization II [T-WIWI-102725]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2550112	Exercises Nonlinear Optimization I	1 SWS	Practice / 🗣	Stein, Schwarze, Neussel
WT 24/25	2550113	Nonlinear Optimization II	2 SWS	Lecture / 🗣	Stein
Exams					
WT 24/25	7900002_WS2425_HK	Nonlinear Optimization II			Stein
ST 2025	7900203_SS2025_NK	Nonlinear Optimization II			Stein

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consits of a written exam (60 minutes) according to Section 4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The exam takes place in the semester of the lecture and in the following semester.

The exam can also be combined with the examination of *Nonlinear Optimization I* [2550111]. In this case, the duration of the written exam takes 120 minutes.

Prerequisites
None.

Annotation
Part I and II of the lecture are held consecutively in the same semester.

Below you will find excerpts from events related to this course:

V Nonlinear Optimization II

2550113, WS 24/25, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
The lecture treats the minimization of smooth nonlinear functions under nonlinear constraints. For such problems, which occur very often in economics, engineering, and natural sciences, optimality conditions are derived and, based on them, solution algorithms are developed. The lecture is structured as follows:

- Topology and first order approximations of the feasible set
- Theorems of the alternative, first and second order optimality conditions
- Algorithms (penalty method, multiplier method, barrier method, interior point method, SQP method, quadratic optimization)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

Remark:

The treatment of optimization problems *without* constraints forms the contents of the lecture "Nonlinear Optimization I". The lectures "Nonlinear Optimization I" and "Nonlinear Optimization II" are held consecutively *in the same semester*.

Learning objectives:

The student

- knows and understands fundamentals of constrained nonlinear optimization,
- is able to choose, design and apply modern techniques of constrained nonlinear optimization in practice.

Literature

O. Stein, Grundzüge der Nichtlinearen Optimierung, 2. Aufl., SpringerSpektrum, 2021

Weiterführende Literatur:

- W. Alt, Nichtlineare Optimierung, Vieweg, 2002
- M.S. Bazaraa, H.D. Sherali, C.M. Shetty, Nonlinear Programming, Wiley, 1993
- O. Güler, Foundations of Optimization, Springer, 2010
- H.Th. Jongen, K. Meer, E. Triesch, Optimization Theory, Kluwer, 2004
- J. Nocedal, S. Wright, Numerical Optimization, Springer, 2000

T 4.184 Course: Nonlinear Wave Equations [T-MATH-110806]

Responsible: Prof. Dr. Wolfgang Reichel
Prof. Dr. Roland Schnaubelt

Organisation: KIT Department of Mathematics

Part of: M-MATH-105326 - Nonlinear Wave Equations

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Prerequisites
none

T 4.185 Course: Nonparametric Statistics [T-MATH-105873]

Responsible: Dr. rer. nat. Bruno Ebner
Prof. Dr. Vicky Fasen-Hartmann
PD Dr. Bernhard Klar
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: M-MATH-102910 - Nonparametric Statistics

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	2

Competence Certificate
oral exam of ca. 20 minutes

Workload
120 hours

T 4.186 Course: Numerical Analysis of Helmholtz Problems [T-MATH-111514]

Responsible: TT-Prof. Dr. Barbara Verfürth
Organisation: KIT Department of Mathematics
Part of: M-MATH-105764 - Numerical Analysis of Helmholtz Problems

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

T 4.187 Course: Numerical Analysis of Neural Networks [T-MATH-113470]

Responsible: TT-Prof. Dr. Roland Maier
Organisation: KIT Department of Mathematics
Part of: M-MATH-106695 - Numerical Analysis of Neural Networks

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

Exams			
WT 24/25	7700152	Numerical Analysis of Neural Networks (examination on November 18)	Maier

Competence Certificate
oral exam of ca. 30 minutes

Prerequisites
none

Workload
180 hours

T 4.188 Course: Numerical Complex Analysis [T-MATH-112280]

Responsible: Prof. Dr. Marlis Hochbruck
Organisation: KIT Department of Mathematics
Part of: M-MATH-106063 - Numerical Complex Analysis

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	6	Grade to a third	Irregular	1 terms	1

Competence Certificate
oral exam of ca. 20 minutes

Prerequisites
none

Recommendation
Some basic knowledge of Complex Analysis is strongly recommended.

Workload
180 hours

T 4.189 Course: Numerical Linear Algebra for Scientific High Performance Computing [T-MATH-107497]

Responsible: Prof. Dr. Hartwig Anzt
Organisation: KIT Department of Mathematics
Part of: M-MATH-103709 - Numerical Linear Algebra for Scientific High Performance Computing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	5	Grade to a third	Irregular	2

Prerequisites
none

T 4.190 Course: Numerical Linear Algebra in Image Processing [T-MATH-108402]

Responsible: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: M-MATH-104058 - Numerical Linear Algebra in Image Processing

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Prerequisites
none

T 4.191 Course: Numerical Methods for Differential Equations [T-MATH-105836]

Responsible: Prof. Dr. Willy Dörfler
Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke
Prof. Dr. Andreas Rieder
Prof. Dr. Christian Wieners

Organisation: KIT Department of Mathematics

Part of: M-MATH-102888 - Numerical Methods for Differential Equations

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Each winter term	3

Events					
WT 24/25	0110700	Numerische Methoden für Differentialgleichungen	4 SWS	Lecture / 🗣	Hochbruck
WT 24/25	0110800	Übungen zu 0110700 (numerische Methoden für Differentialgleichungen)	2 SWS	Practice / 🗣	Hochbruck
Exams					
WT 24/25	7700046	Numerical Methods for Differential Equations			Hochbruck
WT 24/25	7700047	Numerical Methods for Differential Equations			Hochbruck

Legend: 🖥 Online, ⚄ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed in form of an oral or written examination. This will be determined by the lecturer at the beginning of the course.

Prerequisites
None

Workload
240 hours

T 4.192 Course: Numerical Methods for Hyperbolic Equations [T-MATH-105900]

Responsible: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: M-MATH-102915 - Numerical Methods for Hyperbolic Equations

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

Prerequisites
none

Workload
180 hours

T 4.193 Course: Numerical Methods for Integral Equations [T-MATH-105901]

Responsible: PD Dr. Tilo Arens
PD Dr. Frank Hettlich

Organisation: KIT Department of Mathematics

Part of: M-MATH-102930 - Numerical Methods for Integral Equations

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0112600	Numerical Methods for Integral Equations	4 SWS	Lecture	Arens
WT 24/25	0112610	Tutorial for 0112600 (Numerical Methods for Integral Equations)	2 SWS	Practice	Arens
Exams					
WT 24/25	7700133	Numerical Methods for Integral Equations			Arens

Below you will find excerpts from events related to this course:

V Numerical Methods for Integral Equations

0112600, WS 24/25, 4 SWS, Open in study portal

Lecture (V)

Content
In this course, we will learn about a number of methods to numerically solve integral equations, such as Nyström, collocation and Galerkin methods. The lectures will be accompanied by a programming practical in which the methods will be implemented and tested.

T 4.194 Course: Numerical Methods for Maxwell's Equations [T-MATH-105920]

Responsible:	Prof. Dr. Marlis Hochbruck Prof. Dr. Tobias Jahnke
Organisation:	KIT Department of Mathematics
Part of:	M-MATH-102931 - Numerical Methods for Maxwell's Equations

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

T 4.195 Course: Numerical Methods for Oscillatory Differential Equations [T-MATH-113437]

Responsible: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: M-MATH-106682 - Numerical Methods for Oscillatory Differential Equations

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Competence Certificate
oral exam of ca. 30 minutes

Prerequisites
none

Workload
240 hours

T 4.196 Course: Numerical Methods for Time-Dependent Partial Differential Equations [T-MATH-105899]

Responsible: Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke

Organisation: KIT Department of Mathematics

Part of: M-MATH-102928 - Numerical Methods for Time-Dependent Partial Differential Equations

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Competence Certificate
Success is assessed in form of an oral examination lasting approx. 25 minutes.

Prerequisites
None.

Workload
240 hours

T 4.197 Course: Numerical Methods in Computational Electrodynamics [T-MATH-105860]

Responsible: Prof. Dr. Willy Dörfler
Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke
Prof. Dr. Andreas Rieder
Prof. Dr. Christian Wieners

Organisation: KIT Department of Mathematics

Part of: M-MATH-102894 - Numerical Methods in Computational Electrodynamics

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

Prerequisites
none

Workload
180 hours

T 4.198 Course: Numerical Methods in Fluid Mechanics [T-MATH-105902]

Responsible: Prof. Dr. Willy Dörfler
PD Dr. Gudrun Thäter

Organisation: KIT Department of Mathematics

Part of: M-MATH-102932 - Numerical Methods in Fluid Mechanics

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

T 4.199 Course: Numerical Methods in Mathematical Finance [T-MATH-105865]

Responsible: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: M-MATH-102901 - Numerical Methods in Mathematical Finance

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0107800	Numerical methods in mathematical finance	4 SWS	Lecture	Jahnke
WT 24/25	0107900	Tutorial for 0107800 (numerical methods for mathematical finance)	2 SWS	Practice	Jahnke, Kirn
Exams					
WT 24/25	6700028	Numerical Methods in Mathematical Finance			Jahnke

Competence Certificate
oral exam of ca. 30 minutes

Prerequisites
none

Workload
240 hours

Below you will find excerpts from events related to this course:

V Numerical methods in mathematical finance

0107800, WS 24/25, 4 SWS, Language: English, Open in study portal

Lecture (V)

Content
An option is a contract which gives its owner the right to buy or sell an underlying asset at a future time at a fixed price. The underlying asset is typically a stock of a company or a commodity, and since its value varies randomly, computing the fair price of the corresponding option is an important and interesting problem which yields a number of mathematical challenges. This lecture provides an introduction to a number of mathematical models for option pricing. The main goal, however, is the construction and analysis of numerical methods which approximate the solution of the corresponding differential equations in a stable, accurate and efficient way. The following topics will be treated:

* Options, arbitrage and other basic concepts
* Black-Scholes equation und Black-Scholes formulas
* Numerical methods for stochastic differential equations
* (Multilevel) Monte Carlo methods
* (Quasi-)Monte Carlo integration
* Numerical methods for Black-Scholes equations
* Numerical methods for American options

Prerequisites: Participants are expected to be familiar with stochastic differential equations, the Ito integral, and the Ito formula. A short introduction to these topics (approx. 25 pages) is provided for those students who wish to acquire the relevant background through self-study. Moreover, programming skills (MATLAB or Python) are strongly recommended for the programming exercises.

T 4.200 Course: Numerical Optimisation Methods [T-MATH-105858]

Responsible: Prof. Dr. Willy Dörfler
Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke
Prof. Dr. Andreas Rieder
Prof. Dr. Christian Wieners

Organisation: KIT Department of Mathematics

Part of: M-MATH-102892 - Numerical Optimisation Methods

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

4.201 Course: Numerical Simulation in Molecular Dynamics [T-MATH-110807]

Responsible: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: M-MATH-105327 - Numerical Simulation in Molecular Dynamics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Prerequisites
none

T 4.202 Course: Online Concepts for Karlsruhe City Retailers [T-WIWI-111848]

Responsible: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105312 - Marketing and Sales Management
M-WIWI-106258 - Digital Marketing

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	2

Events					
ST 2025	2571184	Online concepts for Karlsruhe city retailers	2 SWS	Others (sons / 🗣	Kupfer

Legend: 📱 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative exam assessment:

- presentations in teams (in each case to the extent of approx. 15 minutes per team with subsequent discussio)
- delivery of a written elaboration per team.

Annotation
Please note that an application is required to participate in this workshop. The application phase usually takes place at the beginning of the lecture period in the summer semester. More information on the application process is usually available on the Marketing and Sales Research Group website (marketing.iism.kit.edu) shortly before the start of the lecture period in the summer semester.

Workload
90 hours

Below you will find excerpts from events related to this course:

V Online concepts for Karlsruhe city retailers

2571184, SS 2025, 2 SWS, Language: German, Open in study portal

Others (sonst.)
On-Site

Content
Content
As part of a practical project in cooperation with the city marketing department of KME Karlsruhe Marketing und Event GmbH, students will have the opportunity to directly interact with retailers in Karlsruhe. Challenges of the digitalization of brick-and-mortar retailing will be analyzed and solutions will be developed and implemented.

In a theoretical part at the beginning of the event, students will gain an insight into the theoretical foundations of specific online marketing instruments. In cooperation with Karlsruhe City Marketing, students are taught application-oriented skills in online marketing tools, such as content management systems, social media platforms, search engine optimization or Google Ads campaigns.

In the practical part of the course, student teams cooperate with a real retailer in Karlsruhe's city center and learn how to analyze and optimize online presences and digital solutions based on key performance indicators. Possible use cases range from social media communication and website optimization to the introduction of innovative pricing and payment methods. In this way, students are given the tools for developing, maintaining and optimizing individual websites and digital solutions in stationary retailing.

Learning objectives result accordingly as follows:
- Learning of theoretical basics of central, application-oriented tools of online marketing
- Application and practical deep-dive of the acquired knowledge in a real case
- Concise and structured presentation of results

Total time required for 3 credit points: approx. 90.0 hours

Attendance time: 12 hours

Preparation and wrap-up of the course: 58 hours

Exam and exam preparation: 20 hours

T 4.203 Course: Operations Research in Health Care Management [T-WIWI-102884]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102805 - Service Operations

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each term	3

Events					
WT 24/25	2550495	Operations Research in Health Care Management	2 SWS	Lecture / 🗣	Graß
WT 24/25	2550496	Übungen zu OR im Health Care Management	1 SWS	Practice	Graß
ST 2025	2550495	Operations Research in Health Care Management	2 SWS	Lecture / 🖥	Graß
ST 2025	2550496	Übungen zu OR im Health Care Management	1 SWS	Practice / 🖥	Graß
Exams					
WT 24/25	7900010	Operations Research in Health Care Management			Graß
WT 24/25	7900032	Operations Research in Health Care Management			Graß
ST 2025	7900229	Operations Research in Health Care Management			Graß

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Success is assessed in English in the form of a 60-minute written examination (in accordance with §4(2), 1 SPO).

The examination is offered every semester.

Prerequisites
None

Recommendation
Basic knowledge as co nveyed in the module "Introduction to Operations Research" is assumed.

Annotation
Lectures and examinations are held in English.

Workload
135 hours

Below you will find excerpts from events related to this course:

V Operations Research in Health Care Management
2550495, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Literature
Elective literature:

- Fleßa: Grundzüge der Krankenhausbetriebslehre, Oldenbourg, 2007
- Fleßa: Grundzüge der Krankenhaussteuerung, Oldenbourg, 2008
- Hall: Patient flow: reducing delay in healthcare delivery, Springer, 2006

V Operations Research in Health Care Management
2550495, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
Online

Literature
Weiterführende Literatur:

- Fleßa: Grundzüge der Krankenhausbetriebslehre, Oldenbourg, 2007
- Fleßa: Grundzüge der Krankenhaussteuerung, Oldenbourg, 2008
- Hall: Patient flow: reducing delay in healthcare delivery, Springer, 2006

T 4.204 Course: Operations Research in Supply Chain Management [T-WIWI-102715]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102805 - Service Operations
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	2

Events					
ST 2025	2550480	Operations Research in Supply Chain Management	2 SWS	Lecture / 🗣	Nickel
ST 2025	2550481	Übungen zu OR in Supply Chain Management	1 SWS	Practice / 🗣	Hoffmann

Legend: 🖥 Online, ❖ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment is a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

The examination is held in the term of the lecture and the following lecture.

Prerequisites
None

Recommendation
Basic knowledge as conveyed in the module Introduction to Operations Research and in the lectures Facility Location and Strategic SCM,Tactical and operational SCMis assumed.

Annotation
The course is offered irregularly. Planned lectures for the next three years can be found in the internet at http://dol.ior.kit.edu/english/Courses.php.

Below you will find excerpts from events related to this course:

V Operations Research in Supply Chain Management

2550480, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
Supply Chain Management constitutes a general tool for logistics process planning in supply networks. To an increasing degree quantitative decision support is provided by methods and models from Operations Research. The lecture "OR in Supply Chain Management" conveys concepts and approaches for solving practical problems and presents an insight to current research topics. The lecture's focus is set on modeling and solution methods for applications originating in different domains of a supply chain. The emphasis is put on mathematical methods like mixed integer programming, valid inequalities or column generation, and the derivation of optimal solution strategies.

In form and content, the lecture addresses multiple areas of Supply Chain Management: After a short introduction, inventory models, scheduling, assembly line balancing as well as cutting and packing will be discussed. Another main focus of the lecture is the application of methods from online optimization. This optimization discipline has gained more and more importance in the optimization of supply chains over the several past years due to an increasing amount of dynamic data flows.

Literature

- Simchi-Levi, D.; Chen, X.; Bramel, J.: The Logic of Logistics: Theory, Algorithms, and Applications for Logistics and Supply Chain Management, 2nd edition, Springer, 2005
- Simchi-Levi, D.; Kaminsky, P.; Simchi-Levi, E.: Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies, McGraw-Hill, 2000
- Silver, E. A.; Pyke, D. F.; Peterson, R.: Inventory Management and Production Planning and Scheduling, 3rd edition, Wiley, 1998
- Blazewicz, J.: Handbook on Scheduling - From Theory to Applications, Springer, 2007
- Pinedo, M. L.: Scheduling - Theory, Algorithms, and Systems (3rd edition), Springer, 2008
- Dyckhoff, H.; Finke, U.: Cutting and Packing in Production and Distribution - A Typology and Bibliography, Physica-Verlag, 1992
- Borodin, A.; El-Yaniv, R.: Online Computation and Competitive Analysis, Cambridge University Press, 2005
- Francis, R. L.; McGinnis, L. F.; White, A.: Facility Layout and Location: An Analytical Approach, 2nd edition, Prentice-Hall, 1992

T 4.205 Course: Optimisation and Optimal Control for Differential Equations [T-MATH-105864]

Organisation: KIT Department of Mathematics
Part of: M-MATH-102899 - Optimisation and Optimal Control for Differential Equations

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Prerequisites
none

Workload
120 hours

T 4.206 Course: Optimization in Banach Spaces [T-MATH-105893]

Responsible: Prof. Dr. Roland Griesmaier
PD Dr. Frank Hettlich

Organisation: KIT Department of Mathematics

Part of: M-MATH-102924 - Optimization in Banach Spaces

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	2

Competence Certificate
oral examination of approximately 30 minutes

Prerequisites
none

Recommendation
Some basic knowledge of finite dimensional optimization theory and functional analysis is desirable.

Workload
150 hours

4.207 Course: Optimization under Uncertainty [T-WIWI-106545]

Responsible: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101413 - Applications of Operations Research
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2550464	Optimization Under Uncertainty	2 SWS	Lecture / 🔀	Rebennack
WT 24/25	2550465	Übungen zu Optimierungsansätze unter Unsicherheit	1 SWS	Practice / 🗣	Rebennack
WT 24/25	2550466		2 SWS	Others (sons	Rebennack
Exams					
WT 24/25	7900240	Optimization under Uncertainty			Rebennack
ST 2025	7900309	Optimization under Uncertainty			Rebennack

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes) according to Section 4(2), 1 of the examination regulation. The exam takes place in every the semester.

Prerequisites
None.

Workload
135 hours

T 4.208 Course: Panel Data [T-WIWI-103127]

Responsible: apl. Prof. Dr. Wolf-Dieter Heller
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	2

Events					
ST 2025	2520320	Panel Data	2 SWS	Lecture	Heller
ST 2025	2520321	Übungen zu Paneldaten	2 SWS	Practice	Heller

Competence Certificate
The performance assessment is an alternative exam assessment in the form of a one-hour examination comprising a written and an oral part. The examination takes place as an individual examination or in groups of two.

Prerequisites
None

Workload
135 hours

Below you will find excerpts from events related to this course:

V Panel Data

2520320, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)

Content
Content:

Fixed-Effects-Models, Random-Effects-Models, Time-Demeaning

Workload:

Total workload for 4.5 CP: approx. 135 hours

Attendance: 30 hours

Preparation and follow-up: 65 hours

Exam preparation: 40 hours

Exam preparation: 40 hours

Literature

Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. Cambridge and London: MIT Press.

Wooldridge, J. M. (2009). *Introductory Econometrics: A Modern Approach* (5th ed.). Mason, Ohio: South-Western Cengage Learning.

T 4.209 Course: Parallel Computing [T-MATH-102271]

Responsible: PD Dr. Mathias Krause
Prof. Dr. Christian Wieners
Organisation: KIT Department of Mathematics
Part of: M-MATH-101338 - Parallel Computing

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

Events					
WT 24/25	0100055	Parallel Computing	3 SWS	Lecture	Krause, Simonis
Exams					
WT 24/25	00081	Parallel Computing			Krause

Below you will find excerpts from events related to this course:

V Parallel Computing

0100055, WS 24/25, 3 SWS, Language: English, Open in study portal

Lecture (V)

Content

Modern computer hardware is massively and heterogeneously parallel. Only parallel algorithms enable us to take advantage of the exponentially increasing compute power. Therefore, parallel computing is the dominant paradigm to perform simulations of realistic phenomena in economics, natural and engineering sciences. Thus, novel physical insights, ground truth simulations or large-scale predictions are only achieved with highly efficient, massively parallel algorithms.

Topics covered in this course:

- Parallel programming models
- Parallel solving of linear equation systems
- Parallel finite elements, finite volumes finite differences, lattice Boltzmann methods
- Methods of domain decomposition
- Parallel matrix-matrix and matrix-vector operations
- Convergence and (parallel) cost analysis
- Load balancing strategies
- Applications in natural and engineering sciences

T 4.210 Course: Parametric Optimization [T-WIWI-102855]

Responsible: Prof. Dr. Oliver Stein
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Competence Certificate
The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

Prerequisites
None

Recommendation
It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Annotation
The lecture is offered irregularly. The curriculum of the next three years is available online (www.ior.kit.edu).

T 4.211 Course: Percolation [T-MATH-105869]

Responsible: Prof. Dr. Daniel Hug
Prof. Dr. Günter Last
PD Dr. Steffen Winter

Organisation: KIT Department of Mathematics

Part of: M-MATH-102905 - Percolation

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	2

Events					
ST 2025	0117000	Perkolation	2 SWS	Lecture	Last
ST 2025	0117100	Übungen zu 0117000 (Perkolation)	2 SWS	Practice	Last

Prerequisites
none

Workload
150 hours

T 4.212 Course: Poisson Processes [T-MATH-105922]

Responsible:	Prof. Dr. Vicky Fasen-Hartmann Prof. Dr. Daniel Hug Prof. Dr. Günter Last Dr. Franz Nestmann PD Dr. Steffen Winter
Organisation:	KIT Department of Mathematics
Part of:	M-MATH-102922 - Poisson Processes

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

Prerequisites
none

Workload
150 hours

T 4.213 Course: Portfolio and Asset Liability Management [T-WIWI-103128]

Responsible: Dr. Mher Safarian
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2520357	Portfolio and Asset Liability Management	2 SWS	Lecture	Safarian
ST 2025	2520358	Übungen zu Portfolio and Asset Liability Management	2 SWS	Practice	Safarian

Competence Certificate
The assessment of this course consists of a written examination (following §4(2), 1 SPOs, 180 min.).

Prerequisites
None

Below you will find excerpts from events related to this course:

V Portfolio and Asset Liability Management

2520357, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)

Content
Learning objectives:

Knowledge of various portfolio management techniques in the financial industry.

Content:

Portfolio theory: principles of investment, Markowitz- portfolio analysis, Modigliani-Miller theorems and absence of arbitrage, efficient markets, capital asset pricing model (CAPM), multi factorial CAPM, arbitragepricing theory (APT), arbitrage and hedging, multi factorial models, equity-portfolio management, passive strategies, active investment

Asset liability: statistical portfolio analysis in stock allocation, measures of success, dynamic multi seasonal models, models in building scenarios, stochastic programming in bond and liability management, optimal investment strategies, integrated asset liability management

Workload:

Total workload for 4.5 CP: approx. 135 hours

Attendance: 30 hours

Preparation and follow-up: 65 hours

Exam preparation: 40 hours

Exam preparation: 40 hours

Organizational issues
Blockveranstaltung, Termine werden über Ilias bekanntgegeben

Literature
To be announced in the lecture

T 4.214 Course: Potential Theory [T-MATH-105850]

Responsible: PD Dr. Tilo Arens
Prof. Dr. Roland Griesmaier
PD Dr. Frank Hettlich
Prof. Dr. Wolfgang Reichel

Organisation: KIT Department of Mathematics

Part of: M-MATH-102879 - Potential Theory

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

4.215 Course: Practical Seminar: Health Care Management (with Case Studies) [T-WIWI-102716]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102805 - Service Operations

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	2

Events					
WT 24/25	2500008	Practical seminar: Health Care Management	3 SWS	Others (sons /	Nickel, Mitarbeiter
ST 2025	2550498	Practical seminar: Health Care Management	3 SWS	Seminar /	Nickel, Mitarbeiter
Exams					
WT 24/25	7900105	Practical Seminar: Health Care Management (with Case Studies)			Nickel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The assessment consists in a case study, the writing of a corresponding paper, and an oral exam (according to §4(2), 2 of the examination regulation).

Prerequisites
None.

Recommendation
Basic knowledge as conveyed in the module *Introduction toOperations Research* is assumed.

Annotation
The credits have been reduced to 4,5 starting summer term 2016.

The lecture is offered every term.

The planned lectures and courses for the next three years are announced online.

Workload
135 hours

T 4.216 Course: Practical Seminar: Human-Centered Systems [T-WIWI-113459]

Responsible: Prof. Dr. Alexander Mädche
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-104068 - Information Systems in Organizations

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Events					
WT 24/25	2540554	Practical Seminar: Human-Centered Systems	3 SWS	Lecture /	Mädche
ST 2025	2540554	Practical Seminar: Human-Centered Systems	3 SWS	Lecture /	Mädche
Exams					
WT 24/25	7900341	Practical Seminar: Human-Centered Systems			Mädche

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The assessment of this course is in the form of a different type of examination. The assessment is carried out by a practical component, preparing written documentation and actively participating in the discussions. A total of 60 points can be achieved, of which:

- a maximum of 25 points for the written documentation
- a maximum of 25 points for the practical component
- a maximum of 10 points for active participation in the discussions

At least 30 points must be achieved to pass the performance assessment. Please note that a practical component such as conducting a survey or implementing an application is also part of the regular scope of the course in addition to the written documentation. The respective tasks can be found in the announcement on the institute's website https://h-lab.iism.kit.edu.

Below you will find excerpts from events related to this course:

V Practical Seminar: Human-Centered Systems
2540554, WS 24/25, 3 SWS, Language: English, Open in study portal

Lecture (V)
Blended (On-Site/Online)

V Practical Seminar: Human-Centered Systems
2540554, SS 2025, 3 SWS, Language: English, Open in study portal

Lecture (V)
Blended (On-Site/Online)

Content
In this practical seminar, students get an individual assignment and develop a running software prototype. Beside the software prototype, the students also deliver a written documentation.

Please find the current open offerings on our website: https://h-lab.iism.kit.edu/thesis.php

Prerequisites
Profound skills in software development are required

Literature
Further literature will be made available in the seminar.

T 4.217 Course: Predictive Mechanism and Market Design [T-WIWI-102862]

Responsible: Prof. Dr. Johannes Philipp Reiß
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101505 - Experimental Economics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Competence Certificate
The assessment consists of a written exam (60 minutes) (following §4(2), 1 of the examination regulation).

Prerequisites
None

Annotation
The course is given every second fall term, e.g., WS2017/18, WS2019/20, ...

The retake exam is given in the summer term subsequent to the fall term where the course (lecture and final exam) is given.

T 4.218 Course: Predictive Modeling [T-WIWI-110868]

Responsible: Prof. Dr. Fabian Krüger
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	2

Exams			
WT 24/25	7900014	Predictive Modeling	Krüger

Competence Certificate
The assessment of this course is a written examination (90 minutes) according to §4(2), 1 of the examination regulation. A bonus can be acquired by successful completion of an assignment (written report + short in-class presentation) during the semester. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4).

Prerequisites
None

Workload
135 hours

T 4.219 Course: Pricing [T-WIWI-102883]

Responsible: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105312 - Marketing and Sales Management

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2572199	Pricing	3 SWS	Block / 🗣	Schröder, Klarmann, Bill
Exams					
WT 24/25	7900343	Pricing			Klarmann

Legend: 🖥 Online, ✲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative exam assessment. The examination (and thus the grade) is composed of three parts:

1. The design and execution of your own small experimental study around the topic of behavioral pricing (as group work).
2. The processing and presentation of a case study on pricing (as group work).
3. The execution of a simulated price negotiation based on a systematic preparation (usually in teams of two).

Prerequisites
Since the earlier course (a) "Pricing Excellence" and (b) "Price Negotiations and Sales Presentations" become parts of the Pricing course, Pricing cannot be taken if (a) and/or (b) have already been completed.

Recommendation
Students are highly encouraged to actively participate in class.

Annotation
A small application is required for participation in this class. The application phase usually takes place at the beginning of the lecture period in the winter semester. More information on the application process will be made available on the Marketing and Sales Research Group website (marketing.iism.kit.edu) shortly before the start of the winter semester lecture period. This course is limited to 24 participants.

Below you will find excerpts from events related to this course:

V Pricing — **Block (B) On-Site**
2572199, WS 24/25, 3 SWS, Language: English, Open in study portal

Content

At the Pricing lecture, students learn about current research and best practices in price management. Delivered in workshop format, the lecture has three key elements:

1. "Behavioral Pricing" workshop
   In this part of the course, central concepts and findings from behavioral pricing research (e.g. price information processing, reference prices, price fairness and mental accounting) are presented and discussed on the basis of important behavioral theories (e.g. prospect theory and information economics). After a brief introduction to experimental research, participants will then conduct their own small experimental study in the form of group work on a hypothesis they have developed on pricing behavior, analyze the data, and present it.

2. "Pricing Excellence" workshop
   In a theory section at the beginning of the course, students are taught theoretical principles of pricing. This includes an introduction to (1) pricing of product prices as well as (2) pricing of net customer prices (development of discount systems). Furthermore, theoretical basics of price enforcement and price monitoring are discussed. This will be followed by a practical application of what has been learned by working on a case study in small groups with a concluding presentation.

3. "Price Negotiation" workshop
   After an introduction to key theories and concepts of negotiation, students prepare and then conduct a simulated price negotiation in small groups with guidance.

Learning Objectives:

Students...

- are familiar with central theories explaining behavioral phenomena regarding consumers dealing with prices
- are able to describe and explain central phenomena of behavioral science with regard to price behavior and derive implications from them
- can formulate their own hypotheses on price behavior and design, conduct and evaluate a suitable experimental study for this purpose
- learn theoretical basics of pricing behavior
- learn the theoretical basics of price enforcement and price monitoring
- apply the acquired knowledge in a practical case study
- know important conceptual basics on the subject of price negotiations
- can prepare and competently conduct price negotiations
- present the results of their group work in a concise and structured manner

All events will take place in presence with compulsory attendance at all dates.

Total time required for 4.5 credit points: approx. 135 hours

Attendance time: 30 hours

Self-study: 105 hours

Organizational issues

Dates will be announced.

T 4.220 Course: Probabilistic Time Series Forecasting Challenge [T-WIWI-111387]

Responsible: Prof. Dr. Fabian Krüger
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Irregular	2

Events					
WT 24/25	2500080	Probabilistic Time Series Forecasting Challenge	2 SWS	Practice /	Bracher, Koster, Lerch, Krüger
WT 24/25	2500081	Probabilistic Time Series Forecasting Challenge		Project (P /	Krüger, Bracher, Koster, Lerch
Exams					
WT 24/25	7900338	Probabilistic Time Series Forecasting Challenge			Krüger, Lerch

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Alternative exam assessment. Necessary conditions to pass the course:

- Weekly submission of statistical forecasts during the semester (excluding the Christmas break),
- Presentation (ca. 20 minutes) during the semester,
- Submission of a final report (5-10 pages) around the end of the semester.

Grading is based on the presentation (30%) and the final report (70%).

Prerequisites
Good methodological knowledge in statistics and data science.
Good knowledge in applied data analysis, incl. programming skills in R, Python or similar.
Knowledge of time series analysis is helpful, but not required.

Annotation
The course is limited in participation. Participants will be selected via the WIWI portal.

Workload
135 hours

Below you will find excerpts from events related to this course:

V Probabilistic Time Series Forecasting Challenge
2500081, WS 24/25, SWS, Language: English, Open in study portal

Project (PRO)
Blended (On-Site/Online)

Content
Statistical forecasts are relevant across all fields of society. In this data science project, students make, evaluate and communicate their own statistical forecasts in a real-time setting. We consider probabilistic forecasts that involve a measure of uncertainty in addition to a point forecast. Students are asked to make forecasts of several real-world time series (including weather variables and the DAX stock market index). Historical data on all series are available from public sources that are updated as time proceeds. While the time series differ from each other in important ways, statistical methods can meaningfully be used for prediction in all cases. We focus on quantile forecasts which are useful to measure forecast uncertainty in a relatively simple way.

Organizational issues

Short description

In this data science project, students make and evaluate statistical forecasts in a realistic setup (involving real-time predictions and real-world time series data). A kickoff meeting will take place in person in mid October. During the semester, there will be a weekly online meeting in which students and instructors discuss the current state of the forecasting challenge.

Prerequisites

Students should have a good working knowledge of statistics and data science, including proficiency in a programming language like R, Python, or Matlab. Knowledge of time series analysis is helpful but not strictly required. Motivation and curiosity are particularly important in this course format that requires regular, active participation over the whole semester.

Please note that the number of participants is limited due to the interactive course format. Application takes place via the Wiwi portal, where further information is available.

Examination rules

The course counts for 4.5 credit points (Leistungspunkte). Examination is via an alternative exam assessment (§4(2), 3 SPO).
Necessary conditions to pass the course:
1) Weekly submission of statistical forecasts during the semester, excluding the Christmas break,
2) A presentation (approx. 20 minutes) during the semester,
3) Submission of a final report (5-10 pages) around the end of the semester.
The presentation and the final report should describe the forecasting methods and their statistical evaluation. Grading is based on the presentation (30%) and the final report (70%).

T 4.221 Course: Probability Theory and Combinatorial Optimization [T-MATH-105923]

Responsible: Prof. Dr. Daniel Hug
Prof. Dr. Günter Last

Organisation: KIT Department of Mathematics

Part of: M-MATH-102947 - Probability Theory and Combinatorial Optimization

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Prerequisites
none

4.222 Course: Process Mining [T-WIWI-109799]

Responsible: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2025	2511204	Process Mining	2 SWS	Lecture / 🗣	Oberweis, Schreiber
ST 2025	2511205	Exercise Process Mining	1 SWS	Practice / 🗣	Oberweis, Schreiber, Rybinski
Exams					
WT 24/25	79AIFB_PM_A5	Process Mining			Oberweis
ST 2025	79AIFB_PM_C2	Process Mining (Registration until 21.07.2025)			Oberweis

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation in the first week after lecture period.

Prerequisites
None

Annotation
Former name (up to winter semester 2018/1019) "Workflow Management".

Below you will find excerpts from events related to this course:

V **Process Mining** — **Lecture (V) On-Site**
2511204, SS 2025, 2 SWS, Language: German, Open in study portal

Content

The area of process mining covers approaches which aim at deducting new knowledge on the basis of logfiles generated by information systems. Such information systems are e.g., workflow-management-systems which are used for an efficient control of processes in enterprises and organisations. The lecture introduces the foundations of processes and respective modeling and analysis techniques. In the following, the foundations of process mining and the three classical types of approaches - discovery, conformance and enhancement - will be taught. In addition to the theoretical basics, tools, application scenarios in practice and open research questions are covered as well.

Learning objectives:

Students

- understand the concepts and approaches of process mining and know how they are applied,
- create and evaluate business process models,
- analyze static and dynamic properties of workflows,
- apply approaches and tools of process mining.

Recommendations:

Knowledge of course Applied Informatics - Modelling is expected.

Workload:

- Lecture 30h
- Exercise 15h
- Preparation of lecture 24h
- Preparation of exercises 25h
- Exam preparation 40h
- Exam 1h

Literature

- W. van der Aalst, H. van Kees: Workflow Management: Models, Methods and Systems, Cambridge, The MIT Press, 2002.
- W. van der Aalst: Process Mining: Data Science in Action. Springer, 2016.
- J. Carmona, B. van Dongen, A. Solti, M. Weidlich: Conformance Checking: Relating Processes and Models. Springer, 2018.
- A. Drescher, A. Koschmider, A. Oberweis: Modellierung und Analyse von Geschäftsprozessen: Grundlagen und Übungsaufgaben mit Lösungen. De Gruyter Studium, 2017.
- A. Oberweis: Modellierung und Ausführung von Workflows mit Petri-Netzen. Teubner-Reihe Wirtschaftsinformatik, B.G. Teubner Verlag, 1996.
- R. Peters, M. Nauroth: Process-Mining: Geschäftsprozesse: smart, schnell und einfach, Springer, 2019.
- F. Schönthaler, G.Vossen, A. Oberweis, T. Karle: Business Processes for Business Communities: Modeling Languages, Methods, Tools. Springer, 2012.
- M. Weske: Business Process Management: Concepts, Languages, Architectures. Springer, 2012.

Weitere Literatur wird in der Vorlesung bekannt gegeben.

4.223 Course: Project Lab Cognitive Automobiles and Robots [T-WIWI-109985]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	5	Grade to a third	Each winter term	3

Events					
WT 24/25	2512501	Practical Course Cognitive automobiles and robots (Master)	3 SWS	Practical course / Blended	Zöllner, Daaboul
Exams					
WT 24/25	7900107	Advanced Lab Cognitive Automobile and Robots (Master)			Zöllner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Details of the grade formation will be announced at the beginning of the course.

Prerequisites
None

Workload
150 hours

Below you will find excerpts from events related to this course:

V Practical Course Cognitive automobiles and robots (Master)

2512501, WS 24/25, 3 SWS, Language: German/English, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content

The lab is intended as a practical supplement to courses such as "Machine Learning 1/2".
Scientific topics, mostly in the area of autonomous driving and robotics, will be addressed in joint work with ML/KI methods. The goal of the internship is for participants to design, develop, and evaluate ML Software system.

In addition to the scientific goals, such as the study and application of methods, the aspects of project-specific teamwork in research (from specification to presentation of results) are also worked on in this internship.

The individual projects require the analysis of the set task, selection of appropriate methods, specification and implementation and evaluation of the solution approach. Finally, the selected solution is to be documented and presented in a short lecture.

Learning Objectives:

- Students will be able to practically apply theoretical knowledge from lectures on machine learning to a selected area of current research.
- Students will be proficient in analyzing and solving thematic problems.
- Students will be able to evaluate, document, and present their concepts and results.

Recommendations:

- Theoretical knowledge of machine learning and/or AI.
- Python knowledge
- Initial experience with deep learning frameworks such as PyTorch/Jax/Tensorflow may be beneficial.

Workload:

The workload of 5 credit points consists of practical implementation of the selected solution, as well as time for literature research and planning/specification of the selected solution. In addition, a short report and presentation of the work performed will be prepared.

Organizational issues

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

T 4.224 Course: Project Lab Machine Learning [T-WIWI-109983]

Responsible: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	5	Grade to a third	Each summer term	3

Events					
ST 2025	2512500	Project Lab Machine Learning	3 SWS	Practical course /	Daaboul, Zöllner, Schneider

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Details of the grade formation will be announced at the beginning of the course.

Prerequisites
None

Workload
150 hours

Below you will find excerpts from events related to this course:

V Project Lab Machine Learning
2512500, SS 2025, 3 SWS, Language: German/English, Open in study portal

Practical course (P)
Blended (On-Site/Online)

Content
The lab is intended as a practical supplement to lectures such as "Machine Learning". The theoretical basics are applied in the lab course. The aim of the lab course is that the participants work together to design, develop and evaluate a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

In addition to the scientific objectives involved in the investigation and application of the methods, aspects of project-specific teamwork in research (from specification to presentation of the results) are also developed in this practical course.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and implementation and evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

Learning objectives:

- Students can practically apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles.
- Students master the analysis and solution of corresponding problems in a team.
- Students can evaluate, document and present their concepts and results.

Recommendations:

Attendance of the lecture machine learning, C/C++ knowledge, Python knowledge

Workload:

The workload of 5 credit points consists of the time spent in the lab for practical implementation of the selected solution, as well as the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

Organizational issues
Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

T 4.225 Course: Project Lab Scientific Computing [T-MATH-114059]

Responsible: Prof. Dr. Willy Dörfler
Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke
Prof. Dr. Andreas Rieder
Prof. Dr. Christian Wieners

Organisation: KIT Department of Mathematics

Part of: M-MATH-102889 - Introduction to Scientific Computing

Type	Credits	Grading scale	Version
Completed coursework	0	pass/fail	1

T 4.226 Course: Public Management [T-WIWI-102740]

Responsible: Prof. Dr. Berthold Wigger
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101504 - Collective Decision Making

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2561127	Public Management	3 SWS	Lecture / Practice (/	Wigger
Exams					
WT 24/25	790puma	Public Management			Wigger
ST 2025	790puma	Public Management			Wigger

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Depending on the further pandemic development the assessment will consist either of an open book exam (following Art. 4, para. 2, clause 3 of the examination regulation), or of an 1.5h written exam (following Art. 4, para. 2, clause 1 of the examination regulation).

Prerequisites
None

Recommendation
Basic knowledge of Public Finance is required.

Below you will find excerpts from events related to this course:

V Public Management
2561127, WS 24/25, 3 SWS, Language: German, Open in study portal

Lecture / Practice (VÜ)
Blended (On-Site/Online)

Literature
Weiterführende Literatur:

- Damkowski, W. und C. Precht (1995): Public Management; Kohlhammer
- Richter, R. und E.G. Furubotn (2003): Neue Institutionenökonomik; 3. Auflage, Mohr
- Schedler, K. und I. Proeller (2003): New Public Management; 2. Auflage; UTB
- Mueller, D.C. (2009): Public Choice III; Cambridge University Press
- Wigger, B.U. (2006): Grundzüge der Finanzwissenschaft; 2. Auflage; Springer

T 4.227 Course: Python for Computational Risk and Asset Management [T-WIWI-110213]

Responsible: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-105032 - Data Science for Finance

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	3

Competence Certificate
The examination takes the form of an alternative exam assessment.
The alternative exam assessment consists of a Python-based "Takehome Exam". At the end of the third week of January, the student is given a "Takehome Exam" which he processes and sends back independently within 4 hours using Python. Precise instructions will be announced at the beginning of the course. The alternative exam assessment can be repeated a maximum of once. A timely repeat option takes place at the end of the third week in March of the same year. More detailed instructions will be given at the beginning of the course.

Prerequisites
None.

Recommendation
Good knowledge of statistics and basic programming skills

Workload
135 hours

T 4.228 Course: Quantitative Methods in Energy Economics [T-WIWI-107446]

Responsible: Patrick Plötz
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2581007	Quantitative Methods in Energy Economics	2 SWS	Lecture / 🗣	Plötz
WT 24/25	2581008	Übungen zu Quantitative Methods in Energy Economics	1 SWS	Practice / 🗣	Plötz, Britto
Exams					
WT 24/25	7981007	Quantitative Methods in Energy Economics			Fichtner

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of an oral (app. 30 minutes) exam (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Prerequisites
None

Recommendation
None

Below you will find excerpts from events related to this course:

V Quantitative Methods in Energy Economics
2581007, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
Energy economics makes use of many quantitative methods in exploration and analysis of data as well as in simulations and modelling. This lecture course aims at introducing students of energy economics into the application of quantitative methods and techniques as taught in elementary courses to real problems in energy economics. The focus is mainly on regression, simulation, time series analysis and related statistical methods as applied in energy economics.

Learning Goals:

The student

- knows and understands selected quantitative methods of energy economics
- is able to use selected quantitative methods of energy economics
- understands they range of usage, limits and is autonomously able to adress new problems by them.

Literature
Wird in der Vorlesung bekannt gegeben.

T 4.229 Course: Random Graphs and Networks [T-MATH-112241]

Responsible: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: M-MATH-106052 - Random Graphs and Networks

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Competence Certificate
oral exam of ca. 30 min

Prerequisites
none

Recommendation
The contents of the module 'Probability Theory' are strongly recommended.

Workload
240 hours

T 4.230 Course: Regularity for Elliptic Operators [T-MATH-113472]

Responsible: apl. Prof. Dr. Peer Kunstmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-106696 - Regularity for Elliptic Operators

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

Competence Certificate
oral exam of ca. 30 minutes

Prerequisites
none

Workload
180 hours

4.231 Course: Regulation Theory and Practice [T-WIWI-102712]

Responsible: Prof. Dr. Kay Mitusch
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	see Annotations	2

Competence Certificate
The lecture is not offered for an indefinite period of time.
Result of success is made by a 20-30 minutes oral examination. Examination is offered every semester and can be retried at any regular examination date.

Prerequisites
None

Recommendation
Basic knowledge and skills of microeconomics from undergraduate studies (bachelor's degree) are expected.

Particularly helpful but not necessary: Industrial Economics and Principal-Agent- or Contract theories. Prior attendance of the lecture*Competition in Networks* [26240] is helpful in any case but not considered a formal precondition.

Annotation
The lecture is not offered for an indefinite period of time.

T 4.232 Course: Riemann Surfaces [T-MATH-113081]

Responsible: Prof. Dr. Frank Herrlich
Organisation: KIT Department of Mathematics
Part of: M-MATH-106466 - Riemann Surfaces

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	8	Grade to a third	Irregular	1 terms	1

Competence Certificate
Oral examination of ca. 30 minutes.

Prerequisites
none

Workload
240 hours

T 4.233 Course: Ruin Theory [T-MATH-108400]

Responsible: Prof. Dr. Vicky Fasen-Hartmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-104055 - Ruin Theory

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Prerequisites
none

T 4.234 Course: Scattering Theory [T-MATH-105855]

Responsible: PD Dr. Tilo Arens
Prof. Dr. Roland Griesmaier
PD Dr. Frank Hettlich

Organisation: KIT Department of Mathematics

Part of: M-MATH-102884 - Scattering Theory

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T 4.235 Course: Scattering Theory for Time-dependent Waves [T-MATH-113416]

Responsible: Prof. Dr. Roland Griesmaier
Organisation: KIT Department of Mathematics
Part of: M-MATH-106664 - Scattering Theory for Time-dependent Waves

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Competence Certificate
oral exam of ca. 30 min

Prerequisites
none

Workload
180 hours

4.236 Course: Selected Methods in Fluids and Kinetic Equations [T-MATH-111853]

Organisation: KIT Department of Mathematics
Part of: M-MATH-105897 - Selected Methods in Fluids and Kinetic Equations

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

Competence Certificate
oral examination of approx. 30 minutes

Prerequisites
none

Recommendation
The courses "Classical Methods for Partial Differential Equations" and "Functional Analysis" are recommended.

Workload
90 hours

T 4.237 Course: Selected Topics in Harmonic Analysis [T-MATH-109065]

Responsible: Prof. Dr. Dirk Hundertmark
Organisation: KIT Department of Mathematics
Part of: M-MATH-104435 - Selected Topics in Harmonic Analysis

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Irregular	1

Prerequisites
none

T 4.238 Course: Semantic Web Technologies [T-WIWI-110848]

Responsible: Dr.-Ing. Tobias Käfer
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2025	2511310	Semantic Web Technologies	2 SWS	Lecture / 🗣	Käfer, Braun, Kinder, Kubelka
ST 2025	2511311	Exercises to Semantic Web Technologies	1 SWS	Practice / 🗣	Käfer, Braun, Kinder
Exams					
WT 24/25	79AIFB_SWebT_A2	Semantic Web Technologies			Käfer
ST 2025	79AIFB_SWebT_A4	Semantic Web Technologies (Registration until 21.07.2025)			Käfer

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of an 1h written exam following §4, Abs. 2, 1 of the examination regulation or of an oral exam (20 min) following §4, Abs. 2, 2 of the examination regulation.

The exam takes place every semester and can be repeated at every regular examination date.

Prerequisites
None

Recommendation
Lectures on Informatics of the Bachelor on Information Systems (Semester 1-4) or equivalent are required.

Below you will find excerpts from events related to this course:

V Semantic Web Technologies
2511310, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
The aim of the Semantic Web is to make the meaning (semantics) of data on the web usable in intelligent systems, e.g. in e-commerce and internet portals

Central concepts are the representation of knowledge in form of RDF and ontologies, the access via Linked Data, as well as querying the data by using SPARQL. This lecture provides the foundations of knowledge representation and processing for the corresponding technologies and presents example applications.

The following topics are covered:

- Resource Description Framework (RDF) and RDF Schema (RDFS)
- Web Architecture and Linked Data
- Web Ontology Language (OWL)
- Query language SPARQL
- Rule languages
- Applications

Learning objectives:

The student

- understands the motivation and foundational ideas behind Semantic Web and Linked Data technologies, and is able to analyse and realise systems
- demonstrates basic competency in the areas of data and system integration on the web
- masters advanced knowledge representation scenarios involving ontologies

Recommendations:

Lectures on Informatics of the Bachelor on Information Systems (Semester 1-4) or equivalent are required. Knowledge of modeling with UML is required.

Workload:

- The total workload for this course is approximately 135 hours
- Time of presentness: 45 hours
- Time of preperation and postprocessing: 60 hours
- Exam and exam preperation: 30 hours

Literature

- Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, York Sure: Semantic Web – Grundlagen. Springer, 2008.
- John Domingue, Dieter Fensel, James A. Hendler (Editors). Handbook of Semantic Web Technologies. Springer, 2011.

Weitere Literatur

- S. Staab, R. Studer (Editors). Handbook on Ontologies. International Handbooks in Information Systems. Springer, 2003.
- Tim Berners-Lee. Weaving the Web. Harper, 1999 geb. 2000 Taschenbuch.
- Ian Jacobs, Norman Walsh. Architecture of the World Wide Web, Volume One. W3C Recommendation 15 December 2004. http://www.w3.org/TR/webarch/
- Dean Allemang. Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL. Morgan Kaufmann, 2008.
- Tom Heath and Chris Bizer. Linked Data: Evolving the Web into a Global Data Space. Synthesis Lectures on the Semantic Web: Theory and Technology, 2011.

V **Exercises to Semantic Web Technologies**
2511311, SS 2025, 1 SWS, Language: English, Open in study portal

Practice (Ü)
On-Site

Content

The exercises are related to the lecture Semantic Web Technologies.

Multiple exercises are held that capture the topics, held in the lecture Semantic Web Technologies, and discuss them in detail. Thereby, practical examples are given to the students in order to transfer theoretical aspects into practical implementation.

The following topics are covered:

- Resource Description Framework (RDF) and RDF Schema (RDFS)
- Web Architecture and Linked Data
- Web Ontology Language (OWL)
- Query language SPARQL
- Rule languages
- Applications

Learning objectives:

The student

- understands the motivation and foundational ideas behind Semantic Web and Linked Data technologies, and is able to analyse and realise systems
- demonstrates basic competency in the areas of data and system integration on the web
- masters advanced knowledge representation scenarios involving ontologies

Recommendations:

Lectures on Informatics of the Bachelor on Information Systems (Semester 1-4) or equivalent are required. Knowledge of modeling with UML is required.

Organizational issues

Die Übungen finden im Rahmen der Termine der Blockvorlesung statt.

Literature

- Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, York Sure: Semantic Web – Grundlagen. Springer, 2008.
- John Domingue, Dieter Fensel, James A. Hendler (Editors). Handbook of Semantic Web Technologies. Springer, 2011.

Weitere Literatur

- S. Staab, R. Studer (Editors). Handbook on Ontologies. International Handbooks in Information Systems. Springer, 2003.
- Tim Berners-Lee. Weaving the Web. Harper, 1999 geb. 2000 Taschenbuch.
- Ian Jacobs, Norman Walsh. Architecture of the World Wide Web, Volume One. W3C Recommendation 15 December 2004. http://www.w3.org/TR/webarch/
- Dean Allemang. Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL. Morgan Kaufmann, 2008.
- Tom Heath and Chris Bizer. Linked Data: Evolving the Web into a Global Data Space. Synthesis Lectures on the Semantic Web: Theory and Technology, 2011.

T 4.239 Course: Semigroup Theory for the Navier-Stokes Equations [T-MATH-113415]

Responsible: Dr. rer. nat. Patrick Tolksdorf
Organisation: KIT Department of Mathematics
Part of: M-MATH-106663 - Semigroup Theory for the Navier-Stokes Equations

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Exams			
WT 24/25	7700120	Semigroup Theory for the Navier-Stokes Equations	Tolksdorf

Competence Certificate
oral exam of ca. 30 min

Prerequisites
none

Workload
180 hours

T 4.240 Course: Seminar in Business Administration A (Master) [T-WIWI-103474]

Responsible: Professorenschaft des Fachbereichs Betriebswirtschaftslehre
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102971 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	00063	Seminar Social Sentiment in Times of Crises	2 SWS	Seminar	Fegert
WT 24/25	2500006	Digital Citizen Science	2 SWS	Seminar /	Greif-Winzrieth
WT 24/25	2500043	Development of Sustainable Digital Business Models	2 SWS	Seminar /	Weissenberger-Eibl
WT 24/25	2500045	Digital Democracy - Challenges and Opportunities of the Digital Society	2 SWS	Seminar /	Fegert, Stein, Bezzaoui, Pekkip
WT 24/25	2500049	AI Innovation Ecosystems	2 SWS	Seminar /	Beyer, Weissenberger-Eibl
WT 24/25	2500125	Human-Centered Systems Seminar: Engineering	2 SWS	Seminar /	Mädche
WT 24/25	2530293		2 SWS	Seminar /	Ruckes, Benz, Luedecke, Kohl, Sarac
WT 24/25	2530586			Seminar /	Uhrig-Homburg, Molnar
WT 24/25	2540473	Business Data Analytics	2 SWS	Seminar /	Grote, Schulz, Motz
WT 24/25	2540475	Positive Information Systems	2 SWS	Seminar /	Knierim, del Puppo
WT 24/25	2540478	Smart Grids and Energy Markets	2 SWS	Seminar /	Weinhardt, Semmelmann, Miskiw
WT 24/25	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar /	Geyer-Schulz, Nazemi
WT 24/25	2540557	Human-Centered Systems Seminar: Research	2 SWS	Seminar /	Mädche
WT 24/25	2545105	Case studies seminar: Innovation management	2 SWS	Seminar /	Weissenberger-Eibl
WT 24/25	2550493	Hospital Management	2 SWS	Block /	Hansis
WT 24/25	2571181	Seminar Digital Marketing (Master)	2 SWS	Seminar /	Kupfer
WT 24/25	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter
WT 24/25	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter
WT 24/25	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar /	Wouters, Dickemann
WT 24/25	2581030	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Sloot
WT 24/25	2581976	Seminar in Production and Operations Management I	2 SWS	Seminar /	Schultmann, Rudi
WT 24/25	2581977	Seminar in Production and Operations Management II	2 SWS	Seminar /	Volk, Schultmann
WT 24/25	2581978	Seminar in Production and Operations Management	2 SWS	Seminar /	Schultmann, Rosenberg
WT 24/25	2581979	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Kleinebrahm
WT 24/25	2581980	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Sandmeier
WT 24/25	2581981	Seminar in Energy Economics	2 SWS	Seminar /	Ardone, Fichtner, Slednev

ST 2025	00063	Seminar Social Sentiment in Times of Crises	2 SWS	Seminar	Fegert
ST 2025	2500018	Successful transformation through innovation	2 SWS	Seminar /	Busch
ST 2025	2500020	Digital Democracy - Challenges and opportunities of the digital society	2 SWS	Seminar /	Fegert
ST 2025	2500032	ERPSim Seminar	2 SWS	Seminar /	Mädche
ST 2025	2500033	Pioneering Leadership in the German Mittelstand	2 SWS	Seminar /	Weissenberger-Eibl
ST 2025	2500056	ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems	2 SWS	Seminar /	Mädche
ST 2025	2500125	Human-Centered Systems Seminar: Engineering	3 SWS	Seminar /	Mädche
ST 2025	2530580	Seminar in Finance (Master)	2 SWS	Seminar /	Uhrig-Homburg, Müller, Thimme, Walter
ST 2025	2540469	Master Seminar: Trustworthy AI	2 SWS	Seminar /	Gutschow
ST 2025	2540473	Business Data Analytics	2 SWS	Seminar	Hariharan
ST 2025	2540475	Positive Information Systems	2 SWS	Seminar	Knierim
ST 2025	2540478	Smart Grid Economics & Energy Markets	2 SWS	Seminar	Weinhardt
ST 2025	2540493	Data Science for Industrial Applications	2 SWS	Seminar /	Spitzer, Holstein, Hendriks
ST 2025	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar	Geyer-Schulz
ST 2025	2540553	User-Adaptive Systems Seminar	2 SWS	Seminar /	Mädche, Beigl
ST 2025	2540557	Human-Centered Systems Seminar: Research	3 SWS	Seminar /	Mädche
ST 2025	2545002	Entrepreneurship Research	2 SWS	Seminar /	Malik
ST 2025	2550493	Hospital Management	2 SWS	Block /	Hansis
ST 2025	2571180	Seminar in Marketing and Sales (Master)	2 SWS	Seminar /	Klarmann, Mitarbeiter
ST 2025	2571182	Seminar "The Future of Marketing" (Master)	2 SWS	Seminar /	Kupfer
ST 2025	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter, Gorny
ST 2025	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter, Walther
ST 2025	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar /	Letmathe
ST 2025	2581030	Seminar Energiewirtschaft IV	2 SWS	Seminar /	Fichtner, Sloot
ST 2025	2581031	Seminar Energiewirtschaft V	2 SWS	Seminar /	Plötz
ST 2025	2581032	Seminar Energiewirtschaft VI	2 SWS	Seminar /	Slednev, Fichtner
ST 2025	2581976	Seminar Produktionswirtschaft und Logistik I	2 SWS	Seminar /	Schultmann, Rudi
ST 2025	2581977	Seminar Produktionswirtschaft und Logistik II	2 SWS	Seminar /	Volk, Schultmann
ST 2025	2581978	Seminar Produktionswirtschaft und Logistik III	2 SWS	Seminar /	Schultmann
ST 2025	2581979	Seminar Energiewirtschaft I	2 SWS	Seminar /	Fichtner, Kleinebrahm
ST 2025	2581981	Seminar Energiewirtschaft III	2 SWS	Seminar /	Ardone, Fichtner
Exams					
WT 24/25	00064	Seminar Social Sentiment in Times of Crises			Weinhardt
WT 24/25	00072	Seminar Positive Information Systems			Weinhardt
WT 24/25	00074	Seminar Business Data Analytics			Weinhardt
WT 24/25	7900017	Seminar Smart Grid and Energy Markets			Weinhardt

WT 24/25	7900050	Development of Sustainable Business Models	Weissenberger-Eibl
WT 24/25	7900069	Human-Centered Systems Seminar: Engineering	Mädche
WT 24/25	7900106	Hospital Management	Hansis
WT 24/25	7900151	Master Seminar in Data Science and Machine Learning	Geyer-Schulz
WT 24/25	7900163	Seminar Human Resource Management (Master)	Nieken
WT 24/25	7900164	Seminar Human Resources and Organizations (Master)	Nieken
WT 24/25	7900184	Seminar in Finance (Master)	Ruckes
WT 24/25	7900203	Seminar "Finance in a nutshell"	Uhrig-Homburg
WT 24/25	7900233	Human-Centered Systems Seminar: Research	Mädche
WT 24/25	7900237	Case Studies Seminar: Innovation Management	Weissenberger-Eibl
WT 24/25	7900318	Bond Markets - Models & Derivatives	Uhrig-Homburg
WT 24/25	7900333	Seminar Digital Marketing (Master)	Kupfer
WT 24/25	7900335	Seminar Energy Economics IV	Fichtner
WT 24/25	7900344	Explainable AI in Computer Vision Applications: Reasoning the Segmentation	Satzger
WT 24/25	7900355	AI Innovation Ecosystems	Weissenberger-Eibl, Beyer
WT 24/25	7900364	Connecting the Challenges of Servitization with Circular Economy: A Literature Review	Satzger
WT 24/25	79-2579919-M	Seminar Management Accounting - Sustainability Topics (Master)	Wouters
WT 24/25	7981976	Seminar in Production and Operations Management I	Schultmann
WT 24/25	7981977	Seminar in Production and Operations Management II	Schultmann
WT 24/25	7981978	Seminar in Production and Operations Management III	Schultmann
WT 24/25	7981979	Seminar Energy Economics I	Fichtner
WT 24/25	7981980	Seminar Energy Economics II	Fichtner
WT 24/25	7981981	Seminar Energy Economics III	Fichtner
ST 2025	7900008	Hospital Management	Hansis
ST 2025	7900025	Successful Transformation Through Innovation	Busch
ST 2025	7900050	Language Models for Structured Literature Reviews	Satzger
ST 2025	7900101	Seminar Human Resource Management (Master)	Nieken
ST 2025	7900127	Seminar in Finance (Master)	Uhrig-Homburg
ST 2025	7900231	Seminar Human Resources and Organizations (Master)	Nieken
ST 2025	7900233	Seminar in Marketing and Sales (Master)	Klarmann
ST 2025	7900318	Practical Seminar: Data Science for Industrial Applications	Satzger
ST 2025	7900319	Service Design Thinking	Satzger
ST 2025	7900320	Practical Seminar Service Innovation	Satzger
ST 2025	792581030	Seminar Energy Economics IV	Fichtner
ST 2025	792581031	Seminar Energy Economics V	Plötz
ST 2025	7981976	Seminar in Production and Operations Management I	Schultmann
ST 2025	7981977	Seminar in Production and Operations Management II	Schultmann
ST 2025	7981979	Seminar Energy Economics I	Fichtner
ST 2025	7981981	Seminar Energy Economics III	Fichtner

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V	**Development of Sustainable Digital Business Models** 2500043, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
The topic of sustainability is becoming increasingly important for companies in Europe. For example, the demand for sustainable products has risen sharply in many sectors. More and more companies are obliged by guidelines and standards to report on the sustainability of their activities. At the same time, the digital transformation is progressing and offers companies opportunities to implement or communicate their plans digitally. The seminar examines how the topic of sustainability is anchored in the digital business modelling of companies.

Students first learn about the dimensions of business models and sustainability. The seminar then discusses various concepts from the literature that take sustainability into account in business modelling. Students develop their own approach to sustainable digital business modelling and apply it to selected company examples from different sectors. The results are 1) presented and discussed in presentations and 2) recorded in seminar papers.

V	**AI Innovation Ecosystems** 2500049, WS 24/25, 2 SWS, Language: German/English, Open in study portal	**Seminar (S)** **Online**

Content
This research seminar uses the example of three innovation clusters in Baden-Württemberg to analyse innovation ecosystems and their potential special features in the field of artificial intelligence. The practical seminar benefits from expert input, but also places a clear focus on research methods and scientific work. A toolbox will be developed together, including literature reviews and interview techniques, which will later facilitate the work on the Master's thesis.
Firstly, the concept of innovation ecosystems is examined. Despite the frequently used term, the state of the art is still relatively open and an overview can be developed together. Then, using the example of the AI Health Innovation Cluster, a cluster is presented and its political history, structure and goal (achievement) are analysed. In the following two sessions, the IPAI and Cyber Valley will be analysed by experts and groups of students.
Since the students will be responsible for much of the seminar themselves, in addition to practical and methodological inputs, a preliminary meeting will take place on 31 October (6-7 pm) to allow sufficient preparation time. The seminar will take place virtually.

V	2530586, WS 24/25, SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
Within this seminar eLearning videos are produced to different topics out of the contents of our lectures. The student gets in touch with scientific work. Through profound working on a specific scientific topic the student is meant to learn the foundations of scientific research and reasoning in particular in finance.Through conduction of the video the student becomes familiar with the fundamental techniques for presentations and foundations of scientific reasoning. In addition, the student earns rhetorical skills.

The success is monitored by the development of an eLearning video and by the writing of a project report (according to §4(2), 3 SPO).

The overall grade is made up of these partial performances.

Recommendations:

Knowledge of the content of the modules *Essentials of Finance* [WW3BWLFBV1] (for bachelor students) and *F1 (Finance)* [WW4BWLFBV1] (for master students) is assumed.

The total workload for this course is approximately 90 hours. For further information see German version.

Organizational issues
Kickoff am 21.10.24 um 16 Uhr, Zwischenpräsentation am 10.12.24, 16 Uhr und Abschlusspräsentation am 21.01.25, 17:45 Uhr am Campus B (Geb. 09.21), Raum 209

V	**Business Data Analytics** 2540473, WS 24/25, 2 SWS, Language: German/English, Open in study portal	**Seminar (S)** **On-Site**

Content
wird auf deutsch und englisch gehalten

Organizational issues
Blockveranstaltung, siehe WWW

V	**Master Seminar in Data Science and Machine Learning** 2540510, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

V	**Case studies seminar: Innovation management** 2545105, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
The objective of the seminar is to master selected concepts and methods of innovation management and then to apply these practically. Working in groups, the students apply the described concepts and methods of innovation management to a case study from the industry to answer specific questions. Accordingly, the block seminar involves a switch from input to the application of this input. At the end, the results of the group work are presented in the form of a seminar paper and discussed by the whole course. A short introduction to presentation techniques is planned to help students prepare the seminar papers.

Literature
Werden in der ersten Veranstaltung bekannt gegeben.

V	**Hospital Management** 2550493, WS 24/25, 2 SWS, Language: German, Open in study portal	**Block (B)** **Online**

V	**Seminar Human Resource Management (Master)** 2573012, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
The topics are redefined each semester on basis of current research topics. The topics will be announced on the website of the Wiwi-Portal.

Aim

The student

- looks critically into current research topics in the fields of Human Resource Management and Personnel Economics.
- trains his / her presentation skills.
- learns to get his / her ideas and insights across in a focused and concise way, both in oral and written form, and to sum up the crucial facts.
- cultivates the discussion of research approaches.

Workload

The total workload for this course is: approximately 90 hours.

Lecture: 30h
Preparation of lecture: 45h
Exam preparation: 15h

Literature

Selected journal articles and books.

Organizational issues
Blockveranstaltung siehe Homepage

V	**Seminar Human Resources and Organizations (Master)** 2573013, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
The topics are redefined each semester on basis of current research topics. The topics will be announced on the website of the Wiwi-Portal.

Aim

The student

- looks critically into current research topics in the fields of human resources and organizations.
- trains his / her presentation skills.
- learns to get his / her ideas and insights across in a focused and concise way, both in oral and written form, and to sum up the crucial facts.
- cultivates the discussion of research approaches.

Workload

The total workload for this course is: approximately 90 hours.

Lecture: 30h
Preparation of lecture: 45h
Exam preparation: 15h

Literature

Selected journal articles and books.

Organizational issues
Blockveranstaltung siehe Homepage

V	**Seminar Management Accounting - Sustainability Topics** 2579919, WS 24/25, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content
The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. Topics are selectively prediscibed. The seminar course is concentrated in several meetings that are spread throughout the semester.

Learning objectives:

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources.

Examination:

- The performance review is carried out in the form of a “Prüfungsleistung anderer Art” (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

Required prior Courses:

- The course requires a basic knowledge of finance and accounting.

Workload:

- The total workload for this course is approximately 90 hours. For further information see German version.

Note:

- Maximum of 8 students.

Organizational issues
Ort und Zeit werden noch bekannt gegeben bzw. über ILIAS

Literature
Will be announced in the course.

V **Successful transformation through innovation**
2500018, SS 2025, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content
This seminar uses strategic innovation management theory and concepts such as organisational ambidexterity, boundary spanning and stakeholder approaches how companies can increase their innovative increase their innovative capacity through innovation. The students will use a core paper to illustrate the steps towards becoming an innovative organisation. The aim is to understand how -with the help of the concepts mentioned above - medium-sized companies, in the context of organisational inertia and path dependency, may become innovation-driven organisations. The seminar will analyse the role of different stakeholders, which role the different stakeholders play and how companies may become part of an innovation ecosystems. Based on the core paper, the students will apply the concepts they have learned to selected companies and present the results in class. In addition to a presentation, the students will submit the results in seminar papers.

Organizational issues
Weblink: https://itm.entechnon.kit.edu/192_1281.php

V **Pioneering Leadership in the German Mittelstand**
2500033, SS 2025, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content
Participants
- learn about the particular specifics of management and the cultural constitution of medium-sized and, in particular, family-run companies in Germany.
- understand the core elements of owner strategy and corporate strategy and why both strategies are linked in family businesses.
- gain an overview of the complex challenges facing German SMEs and the entrepreneurial barriers and success factors that significantly determine competitiveness and innovative ability.
- have understood what role leadership skills play in this, what key skills there are, how they are measured and how they are used in business practice.
- have internalized which competencies constitute so-called “pioneering leadership” and can assess these in themselves as well as medium-sized companies - as attractive future employers - with regard to innovative ability and competitiveness.
- consolidate what they have learned using current examples and case studies from business practice in German SMEs as well as management consulting and HR consulting practice.

V	**ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems** 2500056, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

Content
Background: In the ABBA Summer School Seminar hosted at the Karlsruhe Decision & Design Lab (KD^{2}Lab) at KIT, we aim to enable students to explore biosignal sensors for designing user-adaptive systems. This comprehensive three-day program is designed for both bachelor's and master's students who want to gain an understanding of biosignal and the development of user-adaptive systems. The learning objective is to design human-centered biosignal-adaptive systems to address user needs in learning scenarios.

Course Content: Throughout the summer school, students will learn the foundations of biosignal-adaptive systems through a series of lectures and apply the knowledge in practical group work. For the group work, we offer students two contexts for their research topics: literature research during thesis writing and programming with LLM. Aiming to address user challenges in these two contexts, we provide two biosignal sensors: EEG or eye-tracking sensors. By collecting biosignal data with the sensors, we encourage students to integrate cutting-edge AI algorithms for their design and implementation. In the end, students should present their results to showcase the functionality, innovation, and a prototype of their biosignal-adaptive systems.

Learning Outcome: By successfully achieving the learning objective, students will receive a certificate from KIT and will have the opportunity to apply their acquired skills and knowledge for further research.

The seminar will be held in a three-day format from 23th to 25th September with 3 ECTS. For any questions, please ask Luke (shi.liu@kit.edu) for more information!

V	**Human-Centered Systems Seminar: Engineering** 2500125, SS 2025, 3 SWS, Language: English, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

Content
Formerly known as "Current Topics in Digital Transformation"

With this seminar, we aim to provide students with the possibility to independently work on state-of-the-art research topics in addition to the knowledge gained in the lectures of the human-centered systems lab (Prof. Mädche). Students will work on a dedicated topic in the context of human-centered systems and apply a pre-defined research method. A broad spectrum of topics is offered every semester, topics may range from creating an experimental design, analyzing collected data, or systematically comparing existing software prototypes in a specific field of interest.

V	**Master Seminar: Trustworthy AI** 2540469, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content
Artificial Intelligence is shaping critical areas of society, but ensuring fairness, transparency, and trust remains a challenge. Our master seminar, "Trustworthy AI," explores key issues such as bias detection, intersectional fairness, and explainability in AI systems. We address bias in AI-driven decision-making, particularly in critical areas like credit scoring, which is classified as a high-risk application context by the AI Act, and examine methods to enhance fairness. A crucial focus is on developing transparent AI models and understanding how explanations influence trust in automated systems. Additionally, we analyze large language models, their limitations, and innovative retrieval methods such as GraphRAG, which enhance knowledge representation in AI.

This seminar is offered by the newly established Information Systems III research group headed by Prof. Dr. Jella Pfeiffer at the Institute for Information Systems (WIN). To learn more about us, please visit our website (WIN - Information Systems III).

V	**Data Science for Industrial Applications** 2540493, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content

Learning Objectives

This seminar will require you to screen, select, and apply information systems theories and methodologies to solve contemporary challenges in the manufacturing and adjacent industries. This will include both critical reviews of the literature state-of-the-art [1-2] as well as the systematic conduct of design science research and machine learning methods [3-4]. You will identify key problems in real-world use cases, derive relevant research questions, and systematically gather, choose, and apply academic knowledge to develop solutions in the form of proof-of-concepts or prototypes.

Course Credits

The seminar can be credited as Seminar Betriebswirtschaftslehre A [T-WIWI-103474], Seminar Betriebswirtschaftslehre B [T-WIWI-103476] or Seminar Wirtschaftsinformatik [T-WIWI-109827] (3 ECTS). Other courses may be credited upon request.

Seminar Description

The Internet of Things (IoT) is significantly transforming industries such as automotive, healthcare, and energy. With the rise of ubiquitous computing power, connectivity/internet access, and the economic application of sensors [5], physical products are providing vast amounts of data, enabling the development of smart services [6]. While such IoT use cases are projected to open a market potential valued at $3.3 billion in 2030 [7], the industry is still far from exploiting its full capabilities. To solve this challenge, cutting-edge academic knowledge in information systems and machine learning is key to generating valuable insights from machine data.

The seminar is held in cooperation with international industry partners, who provide real-world datasets and ongoing access to subject matter experts. Students will work in teams of 2-4 on different topics and datasets. The assignments will be handed out in a joint kick-off event – to be scheduled once participating students have been selected. Attendance at this kick-off event is mandatory and a prerequisite for participation. Students are required to submit a seminar paper of 12-15 pages on an individual basis.

Expertise in Python and Data Science / Machine Learning as well as successful participation in the course "Artificial Intelligence in Service Systems" (T-WIWI-108715) are strongly recommended.

Contact

Daniel Hendricks – daniel.hendriks@kit.edu

Philipp Spitzer - philipp.spitzer@kit.edu

Joshua Holstein – joshua.holstein@kit.edu

The practical seminar will be held in English. Application documents can be handed in in English or German.

[1] Webster, J., Watson, R. T. (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. MIS Quarterly, 26 (2) xiii-xxiii.

[2] Brocke, J. v. et al. (2009), Reconstructing the Giant: On the Importance of Rigour in Documenting the Literature Search Process. *Proceedings of the European Conference on Information Systems*, paper 161.

[3] Wirth, R., Hipp, J. (2000). CRISP-DM: Towards a Standard Process Model for Data Mining. Proceedings of the 4th International Conference on the Practical Applications of Knowledge Discovery and Data Mining, 29-40.

[4] Peffers, K., Tuunanen, T., Rothenberger, M., Chatterjee, S. (2008). A Design Science Research Methodology for Information Systems Research. Journal of Management Information Systems, 24 (3) 45–78.

[5] Martin, D.; Kühl, N.; Satzger, G. (2021). Virtual Sensors. Business & Information Systems Engineering, 63 (3) 315-323.

[6] Hunke, F., Heinz, D. Satzger, G. (2022). Creating customer value from data: foundations and archetypes of analytics-based services. Electronic Markets, 32, 503–521.

[7] Chui, M., Collins, M., Patel, M. (2021). IoT value set to accelerate through 2030: Where and how to capture it. McKinsey & Company. URL: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/iot-value-set-to-accelerate-through-2030-where-and-how-to-capture-it

V **Master Seminar in Data Science and Machine Learning** — **Seminar (S)**
2540510, SS 2025, 2 SWS, Language: German/English, Open in study portal

V **User-Adaptive Systems Seminar** — **Seminar (S)**, **Blended (On-Site/Online)**
2540553, SS 2025, 2 SWS, Language: English, Open in study portal

Content

User-adaptive systems collect and analyze biosignals from users to recognize user states as a basis for adaptation. Thermic, mechanical, electric, acoustic, and optical signals are collected using sensors which are integrated in wearables, e.g. glasses, earphones, belts, or bracelets. The collected data is processed with analytics and machine learning techniques in order to determine short-term, evolving over time, and long-term user states in the form of user characteristics, affective-cognitive states, or behavior. Finally, the recognized user states are leveraged for realizing user-centric adaptations.

In this seminar, interdisciplinary teams of students design, develop, and evaluate a user-adaptive system prototype leveraging state-of-the-art hard- and software. This seminar follows an interdisciplinary approach. Students from the fields of computer science, information systems and industrial engineering & management collaborate in the prototype design, development, and evaluation.

The seminar is carried out in cooperation between Teco/Chair of Pervasive Computing Systems (Prof. Beigl) and the Institute of Information Systems and Marketing (h-lab, Prof. Mädche). It is offered as part of the DFG-funded graduate school “KD2School: Designing Adaptive Systems for Economic Decisions“ (https://kd2school.info/)

Learning objectives of the seminar

- Explain what a user-adaptive system is and how it can be conceptualized
- Suggest and evaluate different design solutions for addressing the identified problem
- Build a user-adaptive system prototype using state-of-the-art hard- and software
- Perform a user-centric evaluation of the user-adaptive system prototype

Prerequisites

Strong analytical abilities and profound software development skills are required.

Organizational issues

Termine werden bekannt gegeben

Literature

Required literature will be made available in the seminar.

V **Human-Centered Systems Seminar: Research**
2540557, SS 2025, 3 SWS, Language: English, Open in study portal

Seminar (S)
Blended (On-Site/Online)

Content

Formerly known as "Information Systems and Service Design Seminar"

With this seminar, we aim to provide students with the possibility to independently work on state-of-the-art research topics in addition to the knowledge gained in the lectures of the research group IS I (Prof. Mädche). The research group “Information Systems I” (IS I) headed by Prof. Mädche focuses in research, education, and innovation on designing interactive intelligent systems. It is positioned at the intersection of Information Systems and Human-Computer Interaction (HCI).

In the seminar, participants will get deeper insights in a contemporary research topic in the field of information systems, specifically interactive intelligent systems.

The actual seminar topics will be derived from current research activities of the research group. Our research assistants offer a rich set of topics from our research clusters (digital experience and participation, intelligent enterprise systems, or digital services design & innovation). Students can select among these topics individually depending on their personal interests. The seminar is carried out in the form of a literature-based thesis project. In the seminar, students will acquire the important methodological skills of running a systematic literature review.

Learning Objectives

- focus on a contemporary topic at the intersection of Information Systems and Human-Computer Interaction (HCI), specifically interactive intelligent systems
- carry out a structured literature search for a given topic
- aggregate the collected information in a suitable way to present and extract knowledge
- write a seminar thesis following academic writing standards
- deliver a presentation in a scientific context in front of an auditorium

Prerequisites

No specific prerequisites are required for the seminar.

Literature

Further literature will be made available in the seminar.

Organizational issues

Termine werden bekannt gegeben

V	**Entrepreneurship Research** 2545002, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content

Content

In this course, the students choose from various relevant and current research topics in entrepreneurship and independently develop a topic that suits them in small teams. Initially, there is an introduction to standard methods such as systematic literature review, design science, qualitative and quantitative data analysis, and more. The seminar topic must be scientifically prepared and presented in 15-20 pages as part of a written elaboration. The seminar results are presented in a block event at the end of the semester (20 min + 10 min open discussion).

Learning Objectives

The foundations of independent scholarly work (literature review, argumentation + discussion, citation of literature sources, application of qualitative, quantitative, and simulation methods) are developed as part of the written elaboration. The competencies acquired in the seminar can be utilized in preparing for a potential master's thesis. Therefore, the seminar is mainly aimed at students who intend to write their thesis at the Chair of Entrepreneurship and Technology Management and wish to gain substantial experience in entrepreneurship research.

Organizational issues

Thursday, 08.05.2025, 10.00-16.00

Thursday, 05.06.2025, 10.00-16.00

Thursday, 10.07.2025, 09.00-12.00

Registration is via the Wiwi-Portal.

Literature

Will be announced in the seminar.

V Hospital Management

2550493, SS 2025, 2 SWS, Language: German, Open in study portal

Block (B)
Online

Content

The "Hospital Management" seminar is intended to help students in higher semesters to simulate some of the organizational and management tasks that arise in a medium-sized service company using a specific example (here: management of a medium-sized hospital). The seminar thus represents a kind of "bracket" for a large number of individual skills that the students have acquired during their studies. The seminar takes place as a webinar.

Students will be asked about the typical interaction of a medium-sized hospital with its environment in 5 thematic blocks: Interaction with the customer (patients) / Interaction with employees* / Interaction with business partners / Interaction with stakeholders / Summarizing opportunities and risks.

Organizational issues

Das Seminar wird als Blockveranstaltung stattfinden. Die Termine werden bei der Bewerbung über das Wiwi-Portal bekanntgegeben.

V Seminar Human Resource Management (Master)

2573012, SS 2025, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content

The topics are redefined each semester on basis of current research topics. The topics will be announced on the website of the Wiwi-Portal.

Aim

The student

- looks critically into current research topics in the fields of Human Resource Management and Personnel Economics.
- trains his / her presentation skills.
- learns to get his / her ideas and insights across in a focused and concise way, both in oral and written form, and to sum up the crucial facts.
- cultivates the discussion of research approaches.

Workload

The total workload for this course is: approximately 90 hours.

Lecture: 30h
Preparation of lecture: 45h
Exam preparation: 15h

Literature

Selected journal articles and books.

Organizational issues

Geb. 05.20, Raum 2A-12.1, Termine werden bekannt gegeben

V Seminar Human Resources and Organizations (Master)

2573013, SS 2025, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content
The topics are redefined each semester on basis of current research topics. The topics will be announced on the website of the Wiwi-Portal.

Aim

The student

- looks critically into current research topics in the fields of human resources and organizations.
- trains his / her presentation skills.
- learns to get his / her ideas and insights across in a focused and concise way, both in oral and written form, and to sum up the crucial facts.
- cultivates the discussion of research approaches.

Workload

The total workload for this course is: approximately 90 hours.

Lecture: 30h
Preparation of lecture: 45h
Exam preparation: 15h

Literature

Selected journal articles and books.

Organizational issues
Geb. 05.20, Raum 2A-12.1, Termine werden bekannt gegeben

V	**Seminar Management Accounting - Sustainability Topics** 2579919, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S) On-Site**

Content
The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. Topics are selectively prediscibed. The seminar course is concentrated in several meetings that are spread throughout the semester.

Learning objectives:

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources.

Workload:

- The total workload for this course is approximately 90 hours. For further information see German version.

Examination:

- The performance review is carried out in the form of a “Prüfungsleistung anderer Art” (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

Required prior Courses:

- The course requires a basic knowledge of finance and accounting.

Note:

- Maximum of 8 students.

Organizational issues
Geb.05.20, 2A-12.1; Termine werden bekannt gegeben

Literature
Will be announced in the course.

T 4.241 Course: Seminar in Business Administration B (Master) [T-WIWI-103476]

Responsible: Professorenschaft des Fachbereichs Betriebswirtschaftslehre
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102972 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	00063	Seminar Social Sentiment in Times of Crises	2 SWS	Seminar	Fegert
WT 24/25	2500006	Digital Citizen Science	2 SWS	Seminar /	Greif-Winzrieth
WT 24/25	2500043	Development of Sustainable Digital Business Models	2 SWS	Seminar /	Weissenberger-Eibl
WT 24/25	2500045	Digital Democracy - Challenges and Opportunities of the Digital Society	2 SWS	Seminar /	Fegert, Stein, Bezzaoui, Pekkip
WT 24/25	2500049	AI Innovation Ecosystems	2 SWS	Seminar /	Beyer, Weissenberger-Eibl
WT 24/25	2500125	Human-Centered Systems Seminar: Engineering	2 SWS	Seminar /	Mädche
WT 24/25	2530293		2 SWS	Seminar /	Ruckes, Benz, Luedecke, Kohl, Sarac
WT 24/25	2530586			Seminar /	Uhrig-Homburg, Molnar
WT 24/25	2540473	Business Data Analytics	2 SWS	Seminar /	Grote, Schulz, Motz
WT 24/25	2540475	Positive Information Systems	2 SWS	Seminar /	Knierim, del Puppo
WT 24/25	2540478	Smart Grids and Energy Markets	2 SWS	Seminar /	Weinhardt, Semmelmann, Miskiw
WT 24/25	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar /	Geyer-Schulz, Nazemi
WT 24/25	2540557	Human-Centered Systems Seminar: Research	2 SWS	Seminar /	Mädche
WT 24/25	2545105	Case studies seminar: Innovation management	2 SWS	Seminar /	Weissenberger-Eibl
WT 24/25	2550493	Hospital Management	2 SWS	Block /	Hansis
WT 24/25	2571181	Seminar Digital Marketing (Master)	2 SWS	Seminar /	Kupfer
WT 24/25	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter
WT 24/25	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter
WT 24/25	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar /	Wouters, Dickemann
WT 24/25	2581030	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Sloot
WT 24/25	2581976	Seminar in Production and Operations Management I	2 SWS	Seminar /	Schultmann, Rudi
WT 24/25	2581977	Seminar in Production and Operations Management II	2 SWS	Seminar /	Volk, Schultmann
WT 24/25	2581978	Seminar in Production and Operations Management	2 SWS	Seminar /	Schultmann, Rosenberg
WT 24/25	2581979	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Kleinebrahm
WT 24/25	2581980	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Sandmeier
WT 24/25	2581981	Seminar in Energy Economics	2 SWS	Seminar /	Ardone, Fichtner, Sledney

ST 2025	00063	Seminar Social Sentiment in Times of Crises	2 SWS	Seminar	Fegert
ST 2025	2500018	Successful transformation through innovation	2 SWS	Seminar /	Busch
ST 2025	2500020	Digital Democracy - Challenges and opportunities of the digital society	2 SWS	Seminar /	Fegert
ST 2025	2500032	ERPSim Seminar	2 SWS	Seminar /	Mädche
ST 2025	2500033	Pioneering Leadership in the German Mittelstand	2 SWS	Seminar /	Weissenberger-Eibl
ST 2025	2500056	ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems	2 SWS	Seminar /	Mädche
ST 2025	2500125	Human-Centered Systems Seminar: Engineering	3 SWS	Seminar /	Mädche
ST 2025	2530580	Seminar in Finance (Master)	2 SWS	Seminar /	Uhrig-Homburg, Müller, Thimme, Walter
ST 2025	2540469	Master Seminar: Trustworthy AI	2 SWS	Seminar /	Gutschow
ST 2025	2540473	Business Data Analytics	2 SWS	Seminar	Hariharan
ST 2025	2540475	Positive Information Systems	2 SWS	Seminar	Knierim
ST 2025	2540478	Smart Grid Economics & Energy Markets	2 SWS	Seminar	Weinhardt
ST 2025	2540493	Data Science for Industrial Applications	2 SWS	Seminar /	Spitzer, Holstein, Hendriks
ST 2025	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar	Geyer-Schulz
ST 2025	2540553	User-Adaptive Systems Seminar	2 SWS	Seminar /	Mädche, Beigl
ST 2025	2540557	Human-Centered Systems Seminar: Research	3 SWS	Seminar /	Mädche
ST 2025	2545002	Entrepreneurship Research	2 SWS	Seminar /	Malik
ST 2025	2550493	Hospital Management	2 SWS	Block /	Hansis
ST 2025	2571180	Seminar in Marketing and Sales (Master)	2 SWS	Seminar /	Klarmann, Mitarbeiter
ST 2025	2571182	Seminar “The Future of Marketing” (Master)	2 SWS	Seminar /	Kupfer
ST 2025	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter, Gorny
ST 2025	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter, Walther
ST 2025	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar /	Letmathe
ST 2025	2581030	Seminar Energiewirtschaft IV	2 SWS	Seminar /	Fichtner, Sloot
ST 2025	2581031	Seminar Energiewirtschaft V	2 SWS	Seminar /	Plötz
ST 2025	2581032	Seminar Energiewirtschaft VI	2 SWS	Seminar /	Slednev, Fichtner
ST 2025	2581976	Seminar Produktionswirtschaft und Logistik I	2 SWS	Seminar /	Schultmann, Rudi
ST 2025	2581977	Seminar Produktionswirtschaft und Logistik II	2 SWS	Seminar /	Volk, Schultmann
ST 2025	2581978	Seminar Produktionswirtschaft und Logistik III	2 SWS	Seminar /	Schultmann
ST 2025	2581979	Seminar Energiewirtschaft I	2 SWS	Seminar /	Fichtner, Kleinebrahm
ST 2025	2581981	Seminar Energiewirtschaft III	2 SWS	Seminar /	Ardone, Fichtner
Exams					
WT 24/25	00064	Seminar Social Sentiment in Times of Crises			Weinhardt
WT 24/25	00072	Seminar Positive Information Systems			Weinhardt
WT 24/25	00074	Seminar Business Data Analytics			Weinhardt
WT 24/25	7900017	Seminar Smart Grid and Energy Markets			Weinhardt

WT 24/25	7900050	Development of Sustainable Business Models	Weissenberger-Eibl
WT 24/25	7900069	Human-Centered Systems Seminar: Engineering	Mädche
WT 24/25	7900106	Hospital Management	Hansis
WT 24/25	7900151	Master Seminar in Data Science and Machine Learning	Geyer-Schulz
WT 24/25	7900163	Seminar Human Resource Management (Master)	Nieken
WT 24/25	7900164	Seminar Human Resources and Organizations (Master)	Nieken
WT 24/25	7900184	Seminar in Finance (Master)	Ruckes
WT 24/25	7900203	Seminar "Finance in a nutshell"	Uhrig-Homburg
WT 24/25	7900233	Human-Centered Systems Seminar: Research	Mädche
WT 24/25	7900237	Case Studies Seminar: Innovation Management	Weissenberger-Eibl
WT 24/25	7900318	Bond Markets - Models & Derivatives	Uhrig-Homburg
WT 24/25	7900333	Seminar Digital Marketing (Master)	Kupfer
WT 24/25	7900335	Seminar Energy Economics IV	Fichtner
WT 24/25	7900355	AI Innovation Ecosystems	Weissenberger-Eibl, Beyer
WT 24/25	7900364	Connecting the Challenges of Servitization with Circular Economy: A Literature Review	Satzger
WT 24/25	79-2579919-M	Seminar Management Accounting - Sustainability Topics (Master)	Wouters
WT 24/25	7981976	Seminar in Production and Operations Management I	Schultmann
WT 24/25	7981977	Seminar in Production and Operations Management II	Schultmann
WT 24/25	7981978	Seminar in Production and Operations Management III	Schultmann
WT 24/25	7981979	Seminar Energy Economics I	Fichtner
WT 24/25	7981980	Seminar Energy Economics II	Fichtner
WT 24/25	7981981	Seminar Energy Economics III	Fichtner
ST 2025	7900008	Hospital Management	Hansis
ST 2025	7900025	Successful Transformation Through Innovation	Busch
ST 2025	7900050	Language Models for Structured Literature Reviews	Satzger
ST 2025	7900101	Seminar Human Resource Management (Master)	Nieken
ST 2025	7900127	Seminar in Finance (Master)	Uhrig-Homburg
ST 2025	7900231	Seminar Human Resources and Organizations (Master)	Nieken
ST 2025	7900233	Seminar in Marketing and Sales (Master)	Klarmann
ST 2025	7900318	Practical Seminar: Data Science for Industrial Applications	Satzger
ST 2025	7900319	Service Design Thinking	Satzger
ST 2025	7900320	Practical Seminar Service Innovation	Satzger
ST 2025	792581030	Seminar Energy Economics IV	Fichtner
ST 2025	792581031	Seminar Energy Economics V	Plötz
ST 2025	7981976	Seminar in Production and Operations Management I	Schultmann
ST 2025	7981977	Seminar in Production and Operations Management II	Schultmann
ST 2025	7981979	Seminar Energy Economics I	Fichtner
ST 2025	7981981	Seminar Energy Economics III	Fichtner

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V	**Development of Sustainable Digital Business Models** 2500043, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
The topic of sustainability is becoming increasingly important for companies in Europe. For example, the demand for sustainable products has risen sharply in many sectors. More and more companies are obliged by guidelines and standards to report on the sustainability of their activities. At the same time, the digital transformation is progressing and offers companies opportunities to implement or communicate their plans digitally. The seminar examines how the topic of sustainability is anchored in the digital business modelling of companies.

Students first learn about the dimensions of business models and sustainability. The seminar then discusses various concepts from the literature that take sustainability into account in business modelling. Students develop their own approach to sustainable digital business modelling and apply it to selected company examples from different sectors. The results are 1) presented and discussed in presentations and 2) recorded in seminar papers.

V	**AI Innovation Ecosystems** 2500049, WS 24/25, 2 SWS, Language: German/English, Open in study portal	**Seminar (S)** **Online**

Content
This research seminar uses the example of three innovation clusters in Baden-Württemberg to analyse innovation ecosystems and their potential special features in the field of artificial intelligence. The practical seminar benefits from expert input, but also places a clear focus on research methods and scientific work. A toolbox will be developed together, including literature reviews and interview techniques, which will later facilitate the work on the Master's thesis.
Firstly, the concept of innovation ecosystems is examined. Despite the frequently used term, the state of the art is still relatively open and an overview can be developed together. Then, using the example of the AI Health Innovation Cluster, a cluster is presented and its political history, structure and goal (achievement) are analysed. In the following two sessions, the IPAI and Cyber Valley will be analysed by experts and groups of students.
Since the students will be responsible for much of the seminar themselves, in addition to practical and methodological inputs, a preliminary meeting will take place on 31 October (6-7 pm) to allow sufficient preparation time. The seminar will take place virtually.

V	2530586, WS 24/25, SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
Within this seminar eLearning videos are produced to different topics out of the contents of our lectures. The student gets in touch with scientific work. Through profound working on a specific scientific topic the student is meant to learn the foundations of scientific research and reasoning in particular in finance.Through conduction of the video the student becomes familiar with the fundamental techniques for presentations and foundations of scientific reasoning. In addition, the student earns rhetorical skills.

The success is monitored by the development of an eLearning video and by the writing of a project report (according to §4(2), 3 SPO).

The overall grade is made up of these partial performances.

Recommendations:

Knowledge of the content of the modules *Essentials of Finance* [WW3BWLFBV1] (for bachelor students) and *F1 (Finance)* [WW4BWLFBV1] (for master students) is assumed.

The total workload for this course is approximately 90 hours. For further information see German version.

Organizational issues
Kickoff am 21.10.24 um 16 Uhr, Zwischenpräsentation am 10.12.24, 16 Uhr und Abschlusspräsentation am 21.01.25, 17:45 Uhr am Campus B (Geb. 09.21), Raum 209

V	**Business Data Analytics** 2540473, WS 24/25, 2 SWS, Language: German/English, Open in study portal	**Seminar (S)** **On-Site**

Content
wird auf deutsch und englisch gehalten

Organizational issues
Blockveranstaltung, siehe WWW

V	**Master Seminar in Data Science and Machine Learning** 2540510, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

V	**Case studies seminar: Innovation management** 2545105, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
The objective of the seminar is to master selected concepts and methods of innovation management and then to apply these practically. Working in groups, the students apply the described concepts and methods of innovation management to a case study from the industry to answer specific questions. Accordingly, the block seminar involves a switch from input to the application of this input. At the end, the results of the group work are presented in the form of a seminar paper and discussed by the whole course. A short introduction to presentation techniques is planned to help students prepare the seminar papers.

Literature
Werden in der ersten Veranstaltung bekannt gegeben.

V	**Hospital Management** 2550493, WS 24/25, 2 SWS, Language: German, Open in study portal	**Block (B)** **Online**

V	**Seminar Human Resource Management (Master)** 2573012, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
The topics are redefined each semester on basis of current research topics. The topics will be announced on the website of the Wiwi-Portal.

Aim

The student

- looks critically into current research topics in the fields of Human Resource Management and Personnel Economics.
- trains his / her presentation skills.
- learns to get his / her ideas and insights across in a focused and concise way, both in oral and written form, and to sum up the crucial facts.
- cultivates the discussion of research approaches.

Workload

The total workload for this course is: approximately 90 hours.

Lecture: 30h
Preparation of lecture: 45h
Exam preparation: 15h

Literature

Selected journal articles and books.

Organizational issues
Blockveranstaltung siehe Homepage

V Seminar Human Resources and Organizations (Master)

2573013, WS 24/25, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content
The topics are redefined each semester on basis of current research topics. The topics will be announced on the website of the Wiwi-Portal.

Aim

The student

- looks critically into current research topics in the fields of human resources and organizations.
- trains his / her presentation skills.
- learns to get his / her ideas and insights across in a focused and concise way, both in oral and written form, and to sum up the crucial facts.
- cultivates the discussion of research approaches.

Workload

The total workload for this course is: approximately 90 hours.

Lecture: 30h
Preparation of lecture: 45h
Exam preparation: 15h

Literature

Selected journal articles and books.

Organizational issues
Blockveranstaltung siehe Homepage

V Seminar Management Accounting - Sustainability Topics

2579919, WS 24/25, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content
The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. Topics are selectively prediscibed. The seminar course is concentrated in several meetings that are spread throughout the semester.

Learning objectives:

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources.

Examination:

- The performance review is carried out in the form of a "Prüfungsleistung anderer Art" (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

Required prior Courses:

- The course requires a basic knowledge of finance and accounting.

Workload:

- The total workload for this course is approximately 90 hours. For further information see German version.

Note:

- Maximum of 8 students.

Organizational issues
Ort und Zeit werden noch bekannt gegeben bzw. über ILIAS

Literature
Will be announced in the course.

V	**Successful transformation through innovation** 2500018, SS 2025, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
This seminar uses strategic innovation management theory and concepts such as organisational ambidexterity, boundary spanning and stakeholder approaches how companies can increase their innovative increase their innovative capacity through innovation. The students will use a core paper to illustrate the steps towards becoming an innovative organisation. The aim is to understand how -with the help of the concepts mentioned above - medium-sized companies, in the context of organisational inertia and path dependency, may become innovation-driven organisations. The seminar will analyse the role of different stakeholders, which role the different stakeholders play and how companies may become part of an innovation ecosystems. Based on the core paper, the students will apply the concepts they have learned to selected companies and present the results in class. In addition to a presentation, the students will submit the results in seminar papers.

Organizational issues
Weblink: https://itm.entechnon.kit.edu/192_1281.php

V	**Pioneering Leadership in the German Mittelstand** 2500033, SS 2025, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
Participants
- learn about the particular specifics of management and the cultural constitution of medium-sized and, in particular, family-run companies in Germany.
- understand the core elements of owner strategy and corporate strategy and why both strategies are linked in family businesses.
- gain an overview of the complex challenges facing German SMEs and the entrepreneurial barriers and success factors that significantly determine competitiveness and innovative ability.
- have understood what role leadership skills play in this, what key skills there are, how they are measured and how they are used in business practice.
- have internalized which competencies constitute so-called “pioneering leadership” and can assess these in themselves as well as medium-sized companies - as attractive future employers - with regard to innovative ability and competitiveness.
- consolidate what they have learned using current examples and case studies from business practice in German SMEs as well as management consulting and HR consulting practice.

V	**ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems** 2500056, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

Content
Background: In the ABBA Summer School Seminar hosted at the Karlsruhe Decision & Design Lab (KD²Lab) at KIT, we aim to enable students to explore biosignal sensors for designing user-adaptive systems. This comprehensive three-day program is designed for both bachelor's and master's students who want to gain an understanding of biosignal and the development of user-adaptive systems. The learning objective is to design human-centered biosignal-adaptive systems to address user needs in learning scenarios.

Course Content: Throughout the summer school, students will learn the foundations of biosignal-adaptive systems through a series of lectures and apply the knowledge in practical group work. For the group work, we offer students two contexts for their research topics: literature research during thesis writing and programming with LLM. Aiming to address user challenges in these two contexts, we provide two biosignal sensors: EEG or eye-tracking sensors. By collecting biosignal data with the sensors, we encourage students to integrate cutting-edge AI algorithms for their design and implementation. In the end, students should present their results to showcase the functionality, innovation, and a prototype of their biosignal-adaptive systems.

Learning Outcome: By successfully achieving the learning objective, students will receive a certificate from KIT and will have the opportunity to apply their acquired skills and knowledge for further research.

The seminar will be held in a three-day format from 23th to 25th September with 3 ECTS. For any questions, please ask Luke (shi.liu@kit.edu) for more information!

V	**Human-Centered Systems Seminar: Engineering** 2500125, SS 2025, 3 SWS, Language: English, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

Content

Formerly known as "Current Topics in Digital Transformation"

With this seminar, we aim to provide students with the possibility to independently work on state-of-the-art research topics in addition to the knowledge gained in the lectures of the human-centered systems lab (Prof. Mädche). Students will work on a dedicated topic in the context of human-centered systems and apply a pre-defined research method. A broad spectrum of topics is offered every semester, topics may range from creating an experimental design, analyzing collected data, or systematically comparing existing software prototypes in a specific field of interest.

V	**Master Seminar: Trustworthy AI** 2540469, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content

Artificial Intelligence is shaping critical areas of society, but ensuring fairness, transparency, and trust remains a challenge. Our master seminar, "Trustworthy AI," explores key issues such as bias detection, intersectional fairness, and explainability in AI systems. We address bias in AI-driven decision-making, particularly in critical areas like credit scoring, which is classified as a high-risk application context by the AI Act, and examine methods to enhance fairness. A crucial focus is on developing transparent AI models and understanding how explanations influence trust in automated systems. Additionally, we analyze large language models, their limitations, and innovative retrieval methods such as GraphRAG, which enhance knowledge representation in AI.

This seminar is offered by the newly established Information Systems III research group headed by Prof. Dr. Jella Pfeiffer at the Institute for Information Systems (WIN). To learn more about us, please visit our website (WIN - Information Systems III).

V	**Data Science for Industrial Applications** 2540493, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content

Learning Objectives

This seminar will require you to screen, select, and apply information systems theories and methodologies to solve contemporary challenges in the manufacturing and adjacent industries. This will include both critical reviews of the literature state-of-the-art [1-2] as well as the systematic conduct of design science research and machine learning methods [3-4]. You will identify key problems in real-world use cases, derive relevant research questions, and systematically gather, choose, and apply academic knowledge to develop solutions in the form of proof-of-concepts or prototypes.

Course Credits

The seminar can be credited as Seminar Betriebswirtschaftslehre A [T-WIWI-103474], Seminar Betriebswirtschaftslehre B [T-WIWI-103476] or Seminar Wirtschaftsinformatik [T-WIWI-109827] (3 ECTS). Other courses may be credited upon request.

Seminar Description

The Internet of Things (IoT) is significantly transforming industries such as automotive, healthcare, and energy. With the rise of ubiquitous computing power, connectivity/internet access, and the economic application of sensors [5], physical products are providing vast amounts of data, enabling the development of smart services [6]. While such IoT use cases are projected to open a market potential valued at $3.3 billion in 2030 [7], the industry is still far from exploiting its full capabilities. To solve this challenge, cutting-edge academic knowledge in information systems and machine learning is key to generating valuable insights from machine data.

The seminar is held in cooperation with international industry partners, who provide real-world datasets and ongoing access to subject matter experts. Students will work in teams of 2-4 on different topics and datasets. The assignments will be handed out in a joint kick-off event – to be scheduled once participating students have been selected. Attendance at this kick-off event is mandatory and a prerequisite for participation. Students are required to submit a seminar paper of 12-15 pages on an individual basis.

Expertise in Python and Data Science / Machine Learning as well as successful participation in the course “Artificial Intelligence in Service Systems” (T-WIWI-108715) are strongly recommended.

Contact

Daniel Hendricks – daniel.hendriks@kit.edu

Philipp Spitzer - philipp.spitzer@kit.edu

Joshua Holstein – joshua.holstein@kit.edu

The practical seminar will be held in English. Application documents can be handed in in English or German.

[1] Webster, J., Watson, R. T. (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. MIS Quarterly, 26 (2) xiii-xxiii.

[2] Brocke, J. v. et al. (2009), Reconstructing the Giant: On the Importance of Rigour in Documenting the Literature Search Process. *Proceedings of the European Conference on Information Systems*, paper 161.

[3] Wirth, R., Hipp, J. (2000). CRISP-DM: Towards a Standard Process Model for Data Mining. Proceedings of the 4th International Conference on the Practical Applications of Knowledge Discovery and Data Mining, 29-40.

[4] Peffers, K., Tuunanen, T., Rothenberger, M., Chatterjee, S. (2008). A Design Science Research Methodology for Information Systems Research. Journal of Management Information Systems, 24 (3) 45–78.

[5] Martin, D.; Kühl, N.; Satzger, G. (2021). Virtual Sensors. Business & Information Systems Engineering, 63 (3) 315-323.

[6] Hunke, F., Heinz, D. Satzger, G. (2022). Creating customer value from data: foundations and archetypes of analytics-based services. Electronic Markets, 32, 503–521.

[7] Chui, M., Collins, M., Patel, M. (2021). IoT value set to accelerate through 2030: Where and how to capture it. McKinsey & Company. URL: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/iot-value-set-to-accelerate-through-2030-where-and-how-to-capture-it

V **Master Seminar in Data Science and Machine Learning** — Seminar (S)

2540510, SS 2025, 2 SWS, Language: German/English, Open in study portal

V **User-Adaptive Systems Seminar** — Seminar (S), Blended (On-Site/Online)

2540553, SS 2025, 2 SWS, Language: English, Open in study portal

Content

User-adaptive systems collect and analyze biosignals from users to recognize user states as a basis for adaptation. Thermic, mechanical, electric, acoustic, and optical signals are collected using sensors which are integrated in wearables, e.g. glasses, earphones, belts, or bracelets. The collected data is processed with analytics and machine learning techniques in order to determine short-term, evolving over time, and long-term user states in the form of user characteristics, affective-cognitive states, or behavior. Finally, the recognized user states are leveraged for realizing user-centric adaptations.

In this seminar, interdisciplinary teams of students design, develop, and evaluate a user-adaptive system prototype leveraging state-of-the-art hard- and software. This seminar follows an interdisciplinary approach. Students from the fields of computer science, information systems and industrial engineering & management collaborate in the prototype design, development, and evaluation.

The seminar is carried out in cooperation between Teco/Chair of Pervasive Computing Systems (Prof. Beigl) and the Institute of Information Systems and Marketing (h-lab, Prof. Mädche). It is offered as part of the DFG-funded graduate school “KD2School: Designing Adaptive Systems for Economic Decisions“ (https://kd2school.info/)

Learning objectives of the seminar

- Explain what a user-adaptive system is and how it can be conceptualized
- Suggest and evaluate different design solutions for addressing the identified problem
- Build a user-adaptive system prototype using state-of-the-art hard- and software
- Perform a user-centric evaluation of the user-adaptive system prototype

Prerequisites

Strong analytical abilities and profound software development skills are required.

Organizational issues

Termine werden bekannt gegeben

Literature

Required literature will be made available in the seminar.

V **Human-Centered Systems Seminar: Research**

2540557, SS 2025, 3 SWS, Language: English, Open in study portal

Seminar (S)
Blended (On-Site/Online)

Content
Formerly known as "Information Systems and Service Design Seminar"

With this seminar, we aim to provide students with the possibility to independently work on state-of-the-art research topics in addition to the knowledge gained in the lectures of the research group IS I (Prof. Mädche). The research group “Information Systems I” (IS I) headed by Prof. Mädche focuses in research, education, and innovation on designing interactive intelligent systems. It is positioned at the intersection of Information Systems and Human-Computer Interaction (HCI).

In the seminar, participants will get deeper insights in a contemporary research topic in the field of information systems, specifically interactive intelligent systems.

The actual seminar topics will be derived from current research activities of the research group. Our research assistants offer a rich set of topics from our research clusters (digital experience and participation, intelligent enterprise systems, or digital services design & innovation). Students can select among these topics individually depending on their personal interests. The seminar is carried out in the form of a literature-based thesis project. In the seminar, students will acquire the important methodological skills of running a systematic literature review.

Learning Objectives

- focus on a contemporary topic at the intersection of Information Systems and Human-Computer Interaction (HCI), specifically interactive intelligent systems
- carry out a structured literature search for a given topic
- aggregate the collected information in a suitable way to present and extract knowledge
- write a seminar thesis following academic writing standards
- deliver a presentation in a scientific context in front of an auditorium

Prerequisites
No specific prerequisites are required for the seminar.

Literature
Further literature will be made available in the seminar.

Organizational issues
Termine werden bekannt gegeben

V **Entrepreneurship Research** — **Seminar (S) On-Site**
2545002, SS 2025, 2 SWS, Language: English, Open in study portal

Content
Content

In this course, the students choose from various relevant and current research topics in entrepreneurship and independently develop a topic that suits them in small teams. Initially, there is an introduction to standard methods such as systematic literature review, design science, qualitative and quantitative data analysis, and more. The seminar topic must be scientifically prepared and presented in 15-20 pages as part of a written elaboration. The seminar results are presented in a block event at the end of the semester (20 min + 10 min open discussion).

Learning Objectives
The foundations of independent scholarly work (literature review, argumentation + discussion, citation of literature sources, application of qualitative, quantitative, and simulation methods) are developed as part of the written elaboration. The competencies acquired in the seminar can be utilized in preparing for a potential master's thesis. Therefore, the seminar is mainly aimed at students who intend to write their thesis at the Chair of Entrepreneurship and Technology Management and wish to gain substantial experience in entrepreneurship research.

Organizational issues
Thursday, 08.05.2025, 10.00-16.00
Thursday, 05.06.2025, 10.00-16.00
Thursday, 10.07.2025, 09.00-12.00

Registration is via the Wiwi-Portal.

Literature
Will be announced in the seminar.

V **Hospital Management** — Block (B) Online
2550493, SS 2025, 2 SWS, Language: German, Open in study portal

Content
The "Hospital Management" seminar is intended to help students in higher semesters to simulate some of the organizational and management tasks that arise in a medium-sized service company using a specific example (here: management of a medium-sized hospital). The seminar thus represents a kind of "bracket" for a large number of individual skills that the students have acquired during their studies. The seminar takes place as a webinar.

Students will be asked about the typical interaction of a medium-sized hospital with its environment in 5 thematic blocks: Interaction with the customer (patients) / Interaction with employees* / Interaction with business partners / Interaction with stakeholders / Summarizing opportunities and risks.

Organizational issues
Das Seminar wird als Blockveranstaltung stattfinden. Die Termine werden bei der Bewerbung über das Wiwi-Portal bekanntgegeben.

V **Seminar Human Resource Management (Master)** — Seminar (S) On-Site
2573012, SS 2025, 2 SWS, Language: German, Open in study portal

Content
The topics are redefined each semester on basis of current research topics. The topics will be announced on the website of the Wiwi-Portal.

Aim

The student

- looks critically into current research topics in the fields of Human Resource Management and Personnel Economics.
- trains his / her presentation skills.
- learns to get his / her ideas and insights across in a focused and concise way, both in oral and written form, and to sum up the crucial facts.
- cultivates the discussion of research approaches.

Workload

The total workload for this course is: approximately 90 hours.

Lecture: 30h
Preparation of lecture: 45h
Exam preparation: 15h

Literature

Selected journal articles and books.

Organizational issues
Geb. 05.20, Raum 2A-12.1, Termine werden bekannt gegeben

V **Seminar Human Resources and Organizations (Master)** — Seminar (S) On-Site
2573013, SS 2025, 2 SWS, Language: German, Open in study portal

Content
The topics are redefined each semester on basis of current research topics. The topics will be announced on the website of the Wiwi-Portal.

Aim

The student

- looks critically into current research topics in the fields of human resources and organizations.
- trains his / her presentation skills.
- learns to get his / her ideas and insights across in a focused and concise way, both in oral and written form, and to sum up the crucial facts.
- cultivates the discussion of research approaches.

Workload

The total workload for this course is: approximately 90 hours.

Lecture: 30h
Preparation of lecture: 45h
Exam preparation: 15h

Literature

Selected journal articles and books.

Organizational issues
Geb. 05.20, Raum 2A-12.1, Termine werden bekannt gegeben

V Seminar Management Accounting - Sustainability Topics

2579919, SS 2025, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content
The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. Topics are selectively prediscibed. The seminar course is concentrated in several meetings that are spread throughout the semester.

Learning objectives:

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources.

Workload:

- The total workload for this course is approximately 90 hours. For further information see German version.

Examination:

- The performance review is carried out in the form of a "Prüfungsleistung anderer Art" (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

Required prior Courses:

- The course requires a basic knowledge of finance and accounting.

Note:

- Maximum of 8 students.

Organizational issues
Geb.05.20, 2A-12.1; Termine werden bekannt gegeben

Literature
Will be announced in the course.

T 4.242 Course: Seminar in Economics A (Master) [T-WIWI-103478]

Responsible: Professorenschaft des Fachbereichs Volkswirtschaftslehre
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102971 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	25000111	Statistics and Epidemics		Seminar / 🗣	Bracher
WT 24/25	2500024	Wirtschaftstheoretisches Seminar IV (Master)	2 SWS	Seminar / 🧩	Puppe, Kretz, Ammann, Okulicz
WT 24/25	2500047	Advanced Topics in Econometrics, Statistics and Data Science	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher, Sobolová
WT 24/25	2520405	Topics in Experimental Economics		Seminar / 🗣	Reiß, Peters
WT 24/25	2520500	Workshop on Economics, Finance and Statistics	2 SWS	Seminar	Puppe, Brumm, Nieken, Ott, Reiß, Ruckes, Schienle, Uhrig-Homburg, Wigger, Krüger
WT 24/25	2520563	Wirtschaftstheoretisches Seminar III (Master)	2 SWS	Seminar / 🗣	Ammann, Kretz
WT 24/25	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Rüter
WT 24/25	2560130	Seminar Public Finance	2 SWS	Seminar / 🧩	Wigger, Schmelzer
WT 24/25	2560142	Seminar Game Theory and Behavioral Economics (Master)	2 SWS	Seminar / 🗣	Rau, Rosar
WT 24/25	2560143	AI and Digitization for Society (Master)	2 SWS	Seminar / 🧩	Zhao
WT 24/25	2560282	Seminar in Economic Policy	2 SWS	Seminar / 🗣	Ott, Assistenten
WT 24/25	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🧩	Brumm, Pegorari, Frank
WT 24/25	2561208	Selected aspects of European transport planning and -modelling	2 SWS	Seminar	Szimba, Mitusch
ST 2025	2500040	Seminar zur Bahnökonomie und -politik	2 SWS	Seminar / 🗣	Krenn, Mitusch
ST 2025	2520367	Strategische Entscheidungen	2 SWS	Seminar / 🧩	Ehrhart
ST 2025	2520536	Seminar in Economic Theory II	2 SWS	Seminar / 🗣	Ammann, Kretz, Okulicz
ST 2025	2520563	Wirtschaftstheoretisches Seminar III	2 SWS	Seminar / 🗣	Ammann, Kretz, Okulicz
ST 2025	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Buse, Rüter, Bracher, Eberl
ST 2025	2560130	Seminar Public Finance	2 SWS	Block / 🧩	Wigger, Schmelzer
ST 2025	2560282	Seminar in economic policy	2 SWS	Seminar / 🗣	Ott, Assistenten
ST 2025	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🧩	Brumm, Kissling, Frank
ST 2025	2560552	Seminar Co-opetition: A Practical Perspective on Game Theory in the Digital Economy (Master)	2 SWS	Seminar / 🗣	Rosar
ST 2025	2560554	Seminar Lying and Cheating in Economic Decision Situations (Master)	2 SWS	Seminar / 🗣	Rau
Exams					

WT 24/25	79000111	Statistics and Epidemics	Bracher
WT 24/25	7900021	Seminar: How to Make Democracy Work? Voting Methods in Theory and Practice (Master)	Puppe
WT 24/25	7900090	Advanced Topics in Econometrics, Statistics and Data Science	Schienle
WT 24/25	7900139	Selected Aspects of European Transport Planning and Modelling	Mitusch
WT 24/25	7900140	Seminar Game Theory and Behavioral Economics (Master)	Puppe
WT 24/25	7900212	Seminar in Economic Policy	Ott
WT 24/25	7900296	Seminar AI and Digitization for Society (Master)	Puppe
WT 24/25	79100005	Topics in Experimental Economics	Reiß
WT 24/25	79sefi2	Seminar Public Finance A (Master)	Wigger
ST 2025	7900051	Seminar in Economic Policy	Ott
ST 2025	7900164	Seminar in Economics (Bachelor)	Mitusch

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V **Statistics and Epidemics**
25000111, WS 24/25, SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content

Motivation

Infectious disease epidemiology gives rise to a large variety of real-time data streams. During the COVID-19 pandemic, the interpretation and statistical analysis of these data has proven crucial, but also highly challenging. In this seminar, students will get to know central concepts of infectious disease surveillance and modelling from a statistical perspective. Following an overview of various aspects in the form of blocked lectures, students will choose a more specific topic for their seminar thesis.

Learning Goals

Students develop an understanding of central modeling tasks and methods, including

- estimation of reproductive numbers
- compartment models of disease spread
- nowcasting and short-term forecasting of disease spread
- detection of outbreaks
- diagnostic testing

Moreover, they get to know various data types commonly used in the analysis of disease spread.

Logistics

The project seminar is worth 4.5 credit points (Leistungspunkte). There will be three blocked lectures (approx. 135 minutes each) in the beginning of the lecture period. For the various topics covered, subjects for seminar theses will be proposed (and students are allowed to propose their own topics). Towards the end of the semester, students present their progress on the chosen topics to the group. Grades will be based on this presentation (25%) and the final report (75%).

Organizational issues

Prerequisites

Students should have a very good working knowledge of statistics, including proficiency in a programming language for applied data analysis. The lecture VWL3 Introduction to Econometrics is a prerequisite for the project seminar. Most available software in the field is in R, but in principle Python can be used as well. Advanced knowledge of biology, medicine or epidemiology is not required.

Application Procedure

Please submit a transcript of records as well as a short letter of motivation (roughly 200 words) via WIWI-Portal: https://portal.wiwi.kit.edu/ys/8223

Application time frame: July 20th, 2024 to September, 30th, 2024.

V	**Advanced Topics in Econometrics, Statistics and Data Science** 2500047, WS 24/25, 2 SWS, Language: German/English, Open in study portal	**Seminar (S)**

Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben

V	**Topics in Experimental Economics** 2520405, WS 24/25, SWS, Language: German/English, Open in study portal	**Seminar (S)** **On-Site**

Organizational issues

Blockseminar; Blücherstraße 17; Termine werden separat bekannt gegeben

Literature

Als Pflichtliteratur dienen ausgewählte Paper.

V	**Topics in Econometrics** 2521310, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)**

Organizational issues
Blockveranstaltung, Termine werden auf Homepage und über Ilias bekannt gegeben

V	**Seminar Game Theory and Behavioral Economics (Master)** 2560142, WS 24/25, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content
For Master students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Economathematics.

Objective: The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see http://polit.econ.kit.edu or https://portal.wiwi.kit.edu/Seminare

Seminar Papers of 8–10 pages are to be handed in.

Recommendation: Knowledge in the field of experimental economic research or behavioral economics as well as in the field of microeconomics and game theory may be helpful.

Organizational issues
Application is possible via https://portal.wiwi.kit.edu/Seminare

Kick-off: 23.10.24, 14.00 - 15.30 h, Bdg. 01.85, KD2Lab (1. floor über Außentreppe), Team Room

Presentations: 13.01.2025, 14.00 - 18.00 h, Bdg. 01.85, KD2Lab (1. floor über Außentreppe), Team Room

V	**AI and Digitization for Society (Master)** 2560143, WS 24/25, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

Content
For Master students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Economathematics.

The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see http://polit.econ.kit.edu or https://portal.wiwi.kit.edu/Seminare

Seminar Papers of 8–10 pages are to be handed in.

Recommendation: Knowledge in the field of experimental economic research or behavioral economics as well as in the field of microeconomics and game theory may be helpful.

Organizational issues
Application is possible via https://portal.wiwi.kit.edu/Seminare

Kick-off: 23.10.2024, 11.00 - 12.00 (online)

Presentations: 17.01.2025, 14.00 - 18.00 h, Geb. 01.85, KD2Lab Team room

V	**Advanced Topics in Econometrics** 2521310, SS 2025, 2 SWS, Language: German/English, Open in study portal	**Seminar (S)**

Organizational issues
Blockveranstaltung, Termine werden bekannt gegeben

V	**Seminar Public Finance** 2560130, SS 2025, 2 SWS, Language: German, Open in study portal	**Block (B)** **Blended (On-Site/Online)**

Content
See German version.

Organizational issues
Termine werden bekannt gegeben.

Literature
Literatur wird zu Beginn des jeweiligen Seminars vorgestellt.

V	**Seminar Co-opetition: A Practical Perspective on Game Theory in the Digital Economy (Master)** 2560552, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content

5 Seminar Co-opetition: A Practical Perspective on Game Theory in the Digital Economy

This seminar offers an alternative perspective on game theory that is more applied, complementing the more mathematical approach taught in standard university courses (e.g., "Einführung in die Spieltheorie").

Traditional game theory focuses on abstract mathematical models. The insights from these models are useful in real-life situations, particularly in business contexts. However, strategic interactions in such contexts are often complex, and it is not always obvious what *the 'right game'* looks like. Moreover, effectively communicating game-theoretical principles to colleagues, subordinates, and stakeholders is just as important as the analysis itself.

In their 1996 book "Co-opetition", Nalebuff and Brandenburger address these issues by explaining game-theoretic principles using real-world business examples rather than mathematical models. The authors argue rigorously but '*hide*' the underlying mathematical models. While many of the book's stories now seem outdated, the lessons remain valuable for anyone interested in *applying* game theory.

5.1 Seminar Objectives

In this seminar, students will either work alone or in small groups. Each group will be assigned one chapter of the book and will address three key tasks:

1. **Presentation of Ideas**: Each group will demonstrate their understanding of the assigned chapter by clearly communicating its key insights in their own words.
2. **Application to Modern Contexts**: Each group will transfer the chapter's ideas to examples from today's digital economy, such as platform markets, AI-driven business models, digital advertising strategies, and data-driven competition.
3. **Linking to Game Theory**: Each group will demonstrate their ability to engage with academic literature by identifying literature related to their book chapter and discussing these connections.

5.2 Seminar Organization

Introductory Meeting: The seminar will start with a kick-off meeting on April 24, 2024, at 14:00. In this meeting, students will be assigned to groups and chapters of the book and receive further guidance on expectations. The meeting will last approximately one hour.

Presentations: Each group will give a 30-minute presentation, followed by a discussion, in a blocked event on June 27. Attendance at all presentations is mandatory for successful completion of the seminar.

Seminar paper: Each group must submit a 12-page seminar paper by August 3. The seminar paper is a polished version of the presentation, incorporating useful feedback from the discussion on the seminar presentation day.

For further questions, don't hesitate to get in touch with **Dr. Frank Rosar** (rosar@kit.edu).

5.3 References

Nalebuff, Barry J., Brandenburger, A. (1996). Co-opetition. Currency.

Organizational issues

Registration via WiWi-Portal

Kick-off Meeting: 24.04.2025

Seminar Presentations: 27.06.2025

V	**Seminar Lying and Cheating in Economic Decision Situations (Master)** 2560554, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content

Objective of the seminar: The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see http://polit.econ.kit.edu or https://portal.wiwi.kit.edu/Seminare

The acceptance of students for the seminar is based on preferences and suitability for the topics. This includes theoretical and practical experience with Behavioral Economics as well as English skills.

Seminar Papers of 12–15 pages are to be handed in.

Students' grades will be based on the quality of presentations in the seminar (40%) and the seminar paper (60%). There may be a bonus on the grade for actively participating in the discussions of the presentations.

Recommendation: Knowledge in the field of experimental economic research or behavioral economics as well as in the field of microeconomics and game theory may be helpful.

Organizational issues

Obligatory: Application via WiWi-Portal during the seminar registration period

Introduction: 23.04.2025, 14.45 - 15.30, KD2Lab Teamraum

Presentations: 02.07.2025, KD2Lab Teamraum

Seminar Topics in Political Economy

T 5.243 Course: Seminar in Economics B (Master) [T-WIWI-103477]

Responsible: Professorenschaft des Fachbereichs Volkswirtschaftslehre
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102972 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	25000111	Statistics and Epidemics		Seminar / 🗣	Bracher
WT 24/25	2500024	Wirtschaftstheoretisches Seminar IV (Master)	2 SWS	Seminar / 🧩	Puppe, Kretz, Ammann, Okulicz
WT 24/25	2500047	Advanced Topics in Econometrics, Statistics and Data Science	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher, Sobolová
WT 24/25	2520405	Topics in Experimental Economics		Seminar / 🗣	Reiß, Peters
WT 24/25	2520500	Workshop on Economics, Finance and Statistics	2 SWS	Seminar	Puppe, Brumm, Nieken, Ott, Reiß, Ruckes, Schienle, Uhrig-Homburg, Wigger, Krüger
WT 24/25	2520563	Wirtschaftstheoretisches Seminar III (Master)	2 SWS	Seminar / 🗣	Ammann, Kretz
WT 24/25	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Rüter
WT 24/25	2560130	Seminar Public Finance	2 SWS	Seminar / 🧩	Wigger, Schmelzer
WT 24/25	2560142	Seminar Game Theory and Behavioral Economics (Master)	2 SWS	Seminar / 🗣	Rau, Rosar
WT 24/25	2560282	Seminar in Economic Policy	2 SWS	Seminar / 🗣	Ott, Assistenten
WT 24/25	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🧩	Brumm, Pegorari, Frank
WT 24/25	2561208	Selected aspects of European transport planning and -modelling	2 SWS	Seminar	Szimba, Mitusch
ST 2025	2500040	Seminar zur Bahnökonomie und -politik	2 SWS	Seminar / 🗣	Krenn, Mitusch
ST 2025	2520367	Strategische Entscheidungen	2 SWS	Seminar / 🧩	Ehrhart
ST 2025	2520536	Seminar in Economic Theory II	2 SWS	Seminar / 🗣	Ammann, Kretz, Okulicz
ST 2025	2520563	Wirtschaftstheoretisches Seminar III	2 SWS	Seminar / 🗣	Ammann, Kretz, Okulicz
ST 2025	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Buse, Rüter, Bracher, Eberl
ST 2025	2560130	Seminar Public Finance	2 SWS	Block / 🧩	Wigger, Schmelzer
ST 2025	2560259	Organisation and Management of Development Projects	2 SWS	Seminar / 🧩	Sieber
ST 2025	2560282	Seminar in economic policy	2 SWS	Seminar / 🗣	Ott, Assistenten
ST 2025	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🧩	Brumm, Kissling, Frank
ST 2025	2560552	Seminar Co-opetition: A Practical Perspective on Game Theory in the Digital Economy (Master)	2 SWS	Seminar / 🗣	Rosar
ST 2025	2560554	Seminar Lying and Cheating in Economic Decision Situations (Master)	2 SWS	Seminar / 🗣	Rau
Exams					

WT 24/25	79000111	Statistics and Epidemics	Bracher
WT 24/25	7900090	Advanced Topics in Econometrics, Statistics and Data Science	Schienle
WT 24/25	7900139	Selected Aspects of European Transport Planning and Modelling	Mitusch
WT 24/25	7900140	Seminar Game Theory and Behavioral Economics (Master)	Puppe
WT 24/25	7900212	Seminar in Economic Policy	Ott
WT 24/25	7900296	Seminar AI and Digitization for Society (Master)	Puppe
WT 24/25	79100005	Topics in Experimental Economics	Reiß
WT 24/25	79sefi3	Seminar Public Finance B (Master)	Wigger
ST 2025	7900051	Seminar in Economic Policy	Ott
ST 2025	7900164	Seminar in Economics (Bachelor)	Mitusch

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V **Statistics and Epidemics**
25000111, WS 24/25, SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content

Motivation

Infectious disease epidemiology gives rise to a large variety of real-time data streams. During the COVID-19 pandemic, the interpretation and statistical analysis of these data has proven crucial, but also highly challenging. In this seminar, students will get to know central concepts of infectious disease surveillance and modelling from a statistical perspective. Following an overview of various aspects in the form of blocked lectures, students will choose a more specific topic for their seminar thesis.

Learning Goals

Students develop an understanding of central modeling tasks and methods, including

- estimation of reproductive numbers
- compartment models of disease spread
- nowcasting and short-term forecasting of disease spread
- detection of outbreaks
- diagnostic testing

Moreover, they get to know various data types commonly used in the analysis of disease spread.

Logistics

The project seminar is worth 4.5 credit points (Leistungspunkte). There will be three blocked lectures (approx. 135 minutes each) in the beginning of the lecture period. For the various topics covered, subjects for seminar theses will be proposed (and students are allowed to propose their own topics). Towards the end of the semester, students present their progress on the chosen topics to the group. Grades will be based on this presentation (25%) and the final report (75%).

Organizational issues

Prerequisites

Students should have a very good working knowledge of statistics, including proficiency in a programming language for applied data analysis. The lecture VWL3 Introduction to Econometrics is a prerequisite for the project seminar. Most available software in the field is in R, but in principle Python can be used as well. Advanced knowledge of biology, medicine or epidemiology is not required.

Application Procedure

Please submit a transcript of records as well as a short letter of motivation (roughly 200 words) via WIWI-Portal: https://portal.wiwi.kit.edu/ys/8223

Application time frame: July 20th, 2024 to September, 30th, 2024.

V	**Advanced Topics in Econometrics, Statistics and Data Science** 2500047, WS 24/25, 2 SWS, Language: German/English, Open in study portal	**Seminar (S)**

Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben

V	**Topics in Experimental Economics** 2520405, WS 24/25, SWS, Language: German/English, Open in study portal	**Seminar (S)** **On-Site**

Organizational issues

Blockseminar; Blücherstraße 17; Termine werden separat bekannt gegeben

Literature

Als Pflichtliteratur dienen ausgewählte Paper.

V	**Topics in Econometrics** 2521310, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)**

Organizational issues
Blockveranstaltung, Termine werden auf Homepage und über Ilias bekannt gegeben

V	**Seminar Game Theory and Behavioral Economics (Master)** 2560142, WS 24/25, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content
For Master students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Economathematics.

Objective: The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see http://polit.econ.kit.edu or https://portal.wiwi.kit.edu/Seminare

Seminar Papers of 8–10 pages are to be handed in.

Recommendation: Knowledge in the field of experimental economic research or behavioral economics as well as in the field of microeconomics and game theory may be helpful.

Organizational issues
Application is possible via https://portal.wiwi.kit.edu/Seminare

Kick-off: 23.10.24, 14.00 - 15.30 h, Bdg. 01.85, KD2Lab (1. floor über Außentreppe), Team Room

Presentations: 13.01.2025, 14.00 - 18.00 h, Bdg. 01.85, KD2Lab (1. floor über Außentreppe), Team Room

V	**Advanced Topics in Econometrics** 2521310, SS 2025, 2 SWS, Language: German/English, Open in study portal	**Seminar (S)**

Organizational issues
Blockveranstaltung, Termine werden bekannt gegeben

V	**Seminar Public Finance** 2560130, SS 2025, 2 SWS, Language: German, Open in study portal	**Block (B)** **Blended (On-Site/Online)**

Content
See German version.

Organizational issues
Termine werden bekannt gegeben.

Literature
Literatur wird zu Beginn des jeweiligen Seminars vorgestellt.

V	**Seminar Co-opetition: A Practical Perspective on Game Theory in the Digital Economy (Master)** 2560552, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content

6 Seminar Co-opetition: A Practical Perspective on Game Theory in the Digital Economy

This seminar offers an alternative perspective on game theory that is more applied, complementing the more mathematical approach taught in standard university courses (e.g., “Einführung in die Spieltheorie”).

Traditional game theory focuses on abstract mathematical models. The insights from these models are useful in real-life situations, particularly in business contexts. However, strategic interactions in such contexts are often complex, and it is not always obvious what *the ‘right game’* looks like. Moreover, effectively communicating game-theoretical principles to colleagues, subordinates, and stakeholders is just as important as the analysis itself.

In their 1996 book “Co-opetition”, Nalebuff and Brandenburger address these issues by explaining game-theoretic principles using real-world business examples rather than mathematical models. The authors argue rigorously but ‘*hide*’ the underlying mathematical models. While many of the book’s stories now seem outdated, the lessons remain valuable for anyone interested in *applying* game theory.

6.1 Seminar Objectives

In this seminar, students will either work alone or in small groups. Each group will be assigned one chapter of the book and will address three key tasks:

1. **Presentation of Ideas**: Each group will demonstrate their understanding of the assigned chapter by clearly communicating its key insights in their own words.

2. **Application to Modern Contexts**: Each group will transfer the chapter’s ideas to examples from today's digital economy, such as platform markets, AI-driven business models, digital advertising strategies, and data-driven competition.

3. **Linking to Game Theory**: Each group will demonstrate their ability to engage with academic literature by identifying literature related to their book chapter and discussing these connections.

6.2 Seminar Organization

Introductory Meeting: The seminar will start with a kick-off meeting on April 24, 2024, at 14:00. In this meeting, students will be assigned to groups and chapters of the book and receive further guidance on expectations. The meeting will last approximately one hour.

Presentations: Each group will give a 30-minute presentation, followed by a discussion, in a blocked event on June 27. Attendance at all presentations is mandatory for successful completion of the seminar.

Seminar paper: Each group must submit a 12-page seminar paper by August 3. The seminar paper is a polished version of the presentation, incorporating useful feedback from the discussion on the seminar presentation day.

For further questions, don't hesitate to get in touch with **Dr. Frank Rosar** (rosar@kit.edu).

6.3 References

Nalebuff, Barry J., Brandenburger, A. (1996). Co-opetition. Currency.

Organizational issues

Registration via WiWi-Portal

Kick-off Meeting: 24.04.2025

Seminar Presentations: 27.06.2025

V	**Seminar Lying and Cheating in Economic Decision Situations (Master)** 2560554, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **On-Site**

Content

Objective of the seminar: The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see http://polit.econ.kit.edu or https://portal.wiwi.kit.edu/Seminare

The acceptance of students for the seminar is based on preferences and suitability for the topics. This includes theoretical and practical experience with Behavioral Economics as well as English skills.

Seminar Papers of 12–15 pages are to be handed in.

Students' grades will be based on the quality of presentations in the seminar (40%) and the seminar paper (60%). There may be a bonus on the grade for actively participating in the discussions of the presentations.

Recommendation: Knowledge in the field of experimental economic research or behavioral economics as well as in the field of microeconomics and game theory may be helpful.

Organizational issues

Obligatory: Application via WiWi-Portal during the seminar registration period

Introduction: 23.04.2025, 14.45 - 15.30, KD2Lab Teamraum

Presentations: 02.07.2025, KD2Lab Teamraum

Seminar Topics in Political Economy

T 6.244 Course: Seminar in Informatics A (Master) [T-WIWI-103479]

Responsible: Professorenschaft des Instituts AIFB
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102973 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	2400125	Security and Privacy Awareness	2 SWS	Seminar /	Seidel-Saul, Volkamer, Boehm, Aldag, Veit
WT 24/25	2513105	Seminar Advanced Analytics for Road Traffic Noise (Master)	2 SWS	Seminar /	Lazarova-Molnar, Demetgül
WT 24/25	2513107	Seminar Modeling and Simulation for Energy Systems (Master)	2 SWS	Seminar	Lazarova-Molnar, Mostafa
WT 24/25	2513313	Seminar Linked Data and the Semantic Web (Master)	3 SWS	Seminar /	Käfer, Braun
WT 24/25	2513314	Seminar Real-World Challenges in Data Science and Analytics (Bachelor)	3 SWS	/	Hoellig, Käfer, Thoma
WT 24/25	2513315	Seminar Real-World Challenges in Data Science and Analytics (Master)	3 SWS	/	Hoellig, Käfer, Thoma
WT 24/25	2513451	Seminar Cooperative Autonomous Vehicles (Master)	2 SWS	Seminar /	Vinel
WT 24/25	2513457	Seminar Collective Perception in Autonomous Driving (Master)	2 SWS	Seminar /	Vinel
WT 24/25	2513458	Seminar Artificial Intelligence for Autonomous Driving (Master)	2 SWS	Seminar /	Vinel, Zhao
WT 24/25	2513500	Seminar Cognitive Automobiles and Robots (Master)	2 SWS	Seminar /	Zöllner, Daaboul
WT 24/25	2513607	Seminar Knowledge Graphs and Large Language Models (Master)	2 SWS	Seminar /	Sack, Gesese, Norouzi, Vafaie, Tan
ST 2025	2512101	Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Seminar/ Master)	2 SWS	Seminar /	Lazarova-Molnar, Khodadadi, Mostafa
ST 2025	2513103	Seminar: Applications of Digital Twins (Master)	2 SWS	Seminar /	Lazarova-Molnar, Lee
ST 2025	2513108	Seminar: New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)	2 SWS	Seminar /	Demetgül, Lazarova-Molnar
ST 2025	2513109	Seminar: Agent-based Modeling and Simulation (Master)	2 SWS	Seminar	Lazarova-Molnar, Ghasemi
ST 2025	2513211	Seminar Business Information Systems (Master)	2 SWS	Seminar /	Oberweis, Forell, Frister, Fritsch, Rybinski, Schreiber, Schüler, Ullrich
ST 2025	2513309	Seminar Knowledge Discovery and Data Mining (Master)	2 SWS	Seminar /	Käfer, Noullet, Popovic, Qu , Shao, Kinder
ST 2025	2513311	Seminar Data Science & Real-time Big Data Analytics (Master)	2 SWS	Seminar /	Käfer, Thoma, Hoellig
ST 2025	2513455	Seminar Machine Learning in Autonomous Driving (Master)	2 SWS	Seminar /	Zhao , Vinel
ST 2025	2513459	Seminar Vulnerable Road User Technologies (Master)	2 SWS	Seminar /	Schrapel, Vinel

ST 2025	2513500	Cognitive Automobiles and Robots	2 SWS	Seminar / 🗣	Schneider, Zöllner, Daaboul
ST 2025	2513553	Seminar E-Voting (Master)	2 SWS	Seminar / 🗣	Beckert, Müller-Quade, Volkamer, Kirsten, Hilt, Dörre
ST 2025	2513607	Large Language Model-Enhanced Representation Learning for Knowledge Graphs (Master)	2 SWS	Seminar / 🧩	Sack, Gesese, Tan
Exams					
WT 24/25	7900069	Human-Centered Systems Seminar: Engineering			Mädche
WT 24/25	7900102	Advanced Lab Information Service Engineering (Master)			Sack
WT 24/25	7900119	Seminar Cognitive Automobiles and Robots			Zöllner
WT 24/25	7900121	Security and Privacy Awareness			Volkamer
WT 24/25	7900209	Seminar Digital Twins with Lego: Hands-on Workshop in Data-driven Simulation (Master)			Lazarova-Molnar
WT 24/25	7900215	Seminar Knowledge Graphs and Large Language Models (Master)			Käfer
WT 24/25	7900226	Seminar Modeling and Simulation for Energy Systems (Master)			Lazarova-Molnar
WT 24/25	7900233	Human-Centered Systems Seminar: Research			Mädche
WT 24/25	7900236	Seminar Advanced Analytics for Road Traffic Noise (Master)			Lazarova-Molnar
WT 24/25	7900245	Seminar Cooperative Autonomous Vehicles (Master)			Vinel
WT 24/25	7900279	Seminar Collective Perception in Autonomous Driving (Master)			Vinel
WT 24/25	7900304	Seminar Linked Data and the Semantic Web (Master)			Färber
WT 24/25	7900356	Seminar Real-World Challenges in Data Science and Analytics (Master)			Sure-Vetter, Färber
WT 24/25	79AIFB_AIAD_C4	Seminar Artificial Intelligence for Autonomous Driving (Master)			Vinel

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
Placeholder for seminars offered by the Institute AIFB.

Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V **Security and Privacy Awareness**
2400125, WS 24/25, 2 SWS, Language: German/English, Open in study portal

Seminar (S)
Blended (On-Site/Online)

Content

Within the framework of this interdisciplinary seminar, the topics security awareness and privacy awareness are to be considered from different perspectives. It deals with legal, information technology, psychological, social as well as philosophical aspects.

Important notes:

- Consider that legal-focused topics require you to speak and understand German legal texts
- The seminar is only for MASTER students (or Mastervorzug)
- The link to enrol is for every student, regardless of the study background

Dates (not final):

- Kick-Off: Tue, 22.10.2024, 11:30 Uhr, Raum 1C-03, Gebäude 5.20
- First version: 05.01.2025
- Final version: 23.02.2025
- Presentation: CW 12

Topics:

The advertised topics can be found in the wiwi portal [https://portal.wiwi.kit.edu/ys/8308]. They will be assigned after the kick-off.

V

Seminar Advanced Analytics for Road Traffic Noise (Master)

2513105, WS 24/25, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content

Road traffic noise (RTN) stands as a significant environmental pollutant encountered in daily life, profoundly impacting human health. Extensive research has empirically validated its detrimental effects on well-being, encompassing cardiovascular and mental health implications (Stansfeld et al., 2021; Lan et al., 2020). Moreover, regulatory bodies have proposed guidelines and regulations (WHO, 2018; EU, 2019) to mitigate environmental noise exposure, prompting stakeholders like vehicle manufacturers to integrate measures addressing road traffic noise into their design frameworks.

In this seminar, we diverge from the regulatory perspective on RTN and instead delve into its comprehension through data analytics and other techniques. Specifically, we present a guideline for understanding this societal concern and discuss existing road traffic noise modeling (RTNM) approaches, in particular, their formulation and considerations.

Topics:

1. Introduction to RTN
2. Overview on RTNM
3. Time series analysis
4. Data exploration and visualization
5. Machine learning for RTNM
6. Sound feature extraction and analysis

Literature

- Stansfeld, S., Clark, C., Smuk, M., Gallacher, J., & Babisch, W. (2021). Road traffic noise, noise sensitivity, noise annoyance, psychological and physical health and mortality. Environmental Health, 20, 1-15.
- Lan, Y., Roberts, H., Kwan, M. P., & Helbich, M. (2020). Transportation noise exposure and anxiety: A systematic review and meta-analysis. Environmental research, 191, 110118.
- WHO. (2018) Environmental Noise Guidelines for the European Region.
- EU. (2019) Regulation (EU) No 540/2014 of the European Parliament and of the Council of 16 April 2014 on the Sound Level of Motor Vehicles and of Replacement Silencing Systems, and Amending Directive 2007/46/EC and Repealing Directive 70/157/EEC.

V

Seminar Linked Data and the Semantic Web (Master)

2513313, WS 24/25, 3 SWS, Language: German/English, Open in study portal

Seminar (S)
On-Site

Content

Linked Data is a way of publishing data on the web in a machine-understandable fashion. The aim of this practical seminar is to build applications and devise algorithms that consume, provide, or analyse Linked Data.

The Linked Data principles are a set of practices for data publishing on the web. Linked Data builds on the web architecture and uses HTTP for data access, and RDF for describing data, thus aiming towards web-scale data integration. There is a vast amount of data available published according to those principles: recently, 4.5 billion facts have been counted with information about various domains, including music, movies, geography, natural sciences. Linked Data is also used to make web-pages machine-understandable, corresponding annotations are considered by the big search engine providers. On a smaller scale, devices on the Internet of Things can also be accessed using Linked Data which makes the unified processing of device data and data from the web easy.

In this practical seminar, students will build prototypical applications and devise algorithms that consume, provide, or analyse Linked Data. Those applications and algorithms can also extend existing applications ranging from databases to mobile apps.

For the seminar, programming skills or knowledge about web development tools/technologies are highly recommended. Basic knowledge of RDF and SPARQL are also recommended, but may be acquired during the seminar. Students will work in groups. Seminar meetings will take place as 'Block-Seminar'.

Topics of interest include, but are not limited to:

- Travel Security
- Geo data
- Linked News
- Social Media

The exact dates and information for registration will be announced at the event page.

V Seminar Real-World Challenges in Data Science and Analytics (Bachelor)

2513314, WS 24/25, 3 SWS, Language: German/English, Open in study portal

On-Site

Content

In the seminar, various Real-World Challenges in Data Science and Analytics will be worked on.

During this seminar, groups of students work on a case challenge with data provided. Here, the typical process of a data science project is depicted: integration of data, analysis of these, modeling of the decisions and visualization of the results.

During the seminar, solution concepts are worked out, implemented as a software solution and presented in an intermediate and final presentation. The seminar "Real-World Challenges in Data Science and Analytics" is aimed at students in master's programs.

The exact dates and information for registration will be announced at the course page.

V Seminar Real-World Challenges in Data Science and Analytics (Master)

2513315, WS 24/25, 3 SWS, Language: German/English, Open in study portal

On-Site

Content

In the seminar, various Real-World Challenges in Data Science and Analytics will be worked on.

During this seminar, groups of students work on a case challenge with data provided. Here, the typical process of a data science project is depicted: integration of data, analysis of these, modeling of the decisions and visualization of the results.

During the seminar, solution concepts are worked out, implemented as a software solution and presented in an intermediate and final presentation. The seminar "Real-World Challenges in Data Science and Analytics" is aimed at students in master's programs.

The exact dates and information for registration will be announced at the course page.

V Seminar Cognitive Automobiles and Robots (Master)

2513500, WS 24/25, 2 SWS, Language: German/English, Open in study portal

Seminar (S)
Blended (On-Site/Online)

Content

The seminar is intended as a theoretical supplement to lectures such as "Machine Learning". The theoretical basics will be deepened in the seminar. The aim of the seminar is that the participants work individually to analyze a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and theoretical evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

Learning objectives:

- Students can apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles for theoretical analysis.
- Students can evaluate, document and present their concepts and results.

Recommendations:

Attendance of the lecture machine learning

Workload:

The workload of 3 credit points consists of the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

Organizational issues

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

V **Seminar Knowledge Graphs and Large Language Models (Master)**
2513607, WS 24/25, 2 SWS, Language: English, Open in study portal

Seminar (S)
Blended (On-Site/Online)

Content

Large language models (LLMs) such as GPT-3 have shown remarkable capabilities in transforming various natural language processing (NLP) tasks across different domains. However, LLMs often generate incorrect answers, known as hallucinations, posing significant challenges to their usability and reliability. Additionally, LLMs operate as black boxes, making it difficult to understand how they arrive at specific conclusions, leading to transparency and explainability issues. Combining LLMs with KGs creates a powerful synergy that significantly enhances the capabilities of artificial intelligence across various tasks. This integration leverages the strengths of both technologies, with LLMs excelling at understanding and generating human-like text, and KGs providing structured, reliable information about entities and their relationships. Together, they offer a robust approach to problem-solving across diverse domains.

This seminar will focus on the intersection of LLMs and KGs, covering areas of interest including, but not limited to:

- KG completion using LLMs
- Question answering with KGs and LLMs
- Explainability of LLMs with KG integration
- Reasoning with LLMs and KGs
- Enhanced prompt engineering using KGs

Contributions of the students:

Each student will be assigned one paper on the topic, which could be a research paper discussing a novel approach or a resource paper presenting datasets, tools, etc. The student will be responsible for the following tasks:

1. **Report Writing**: Read the assigned paper thoroughly and write a 15-page seminar report explaining the methods and findings in their own words.
2. **Presenting**: Prepare and deliver a seminar presentation to share insights from the paper with other seminar participants.
3. **Conducting Experiments**: If the authors provide code, re-implement it for small-scale experiments using Google Colab or make the implementation available via GitHub.

V **Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Seminar/Master)**
2512101, SS 2025, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content

This seminar focuses on the data-driven discovery of simulation models in industrial settings, providing a hands-on approach to understanding and optimizing production processes.

Students will start by designing and constructing production lines using Lego Spike and similar modular systems. This activity will include developing comprehensive data-capturing pipelines to collect detailed event-logging raw data from their production lines.

Next, the seminar will explore advanced techniques for transforming this raw data into simulation models, e.g., Petri nets. Participants will learn and apply data-driven model extraction methods, such as process mining to extract workflow processes; statistical methods to fit probability distributions and analyze trends, and machine learning algorithms to model complex behaviors within the production process. Through these techniques, students will extract simulation models that reflect the real-world dynamics of their production lines. The seminar will then guide participants on how to validate the extracted simulation models to ensure their accuracy.

By the end of the seminar, students will be equipped with the skills to build model production lines, collect event logging data from them, transform event log data into actionable simulation models and use these models to drive efficiency and innovation in industrial production settings.

Grading Scheme:

Report - 50%

Presentations - 40%

Implementation - 10%

V

Seminar: Applications of Digital Twins (Master)

2513103, SS 2025, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content

Seminar Name: Applications of Digital Twins

Size: 10 students (with 10 different topics)

Workload:

- 2 Lectures:
  - Introduction to Digital Twins and topic distribution
  - "How to Give Effective Presentations" lecture
- 10 student presentations (each 45 minutes in total)
- 10 student reports

Responsible Person: Hui Min Lee, Sanja Lazarova-Molnar

Deliverables for Grade:

- 1 Report per student and topic (8 pages, including references, IEEE Template, compulsory usage of Reference Manager – Zotero or EndNote)
- 25 mins presentation per student plus 20 min discussion (focus on the presentation topic + presentation skills) = 45 minutes for each student

Credits: 3 credits = 90 hours

Format/ Structure of the Seminar (Draft):

- 2 Lectures at the beginning of the semester
- Students have 1 week time to provide a priority list of 5 topics, distribution will be decided based on first come – first serve, ensuring that core topics are covered
- Q&As can be asked and answered over mails or ad-hoc appointments
- Students have time to work on the report and presentation during the semester
- Submission of all reports will be required 2 months after the intro lecture for ensuring fairness
- Presentations are done in blocks of 2 students per class, starting mid-June, presentations will be submitted at the day of the scheduled presentation

Approximate Time Consumption for Students (Draft):

- Lectures: 3 hours
- Student Presentations: 7.5 hours
- Topic Subscription: 1 hour
- Presentation Preparation: 15 hours
- Paper Writing and Literature Review: 63.5 hours

Description:

The seminar focuses on applications of Digital Twins and data-driven modeling, with an additional goal of improving scientific research and presentation skills for Master students. The seminar covers the diverse applications and use cases of Digital Twins in different domains such as manufacturing, energy systems, healthcare and many more, offering students an in-depth understanding of the role of Digital Twins in transforming the industries.

The seminar is structured as a literature review seminar. Each student can select a topic out of a predefined set, conduct further research and then write a comprehensive research paper. Students will also deliver presentations, synthesizing insights from both the provided starting reference literature and their own additional research.

By the end of the course, students will not only have a solid understanding of the current applications of Digital Twins and emerging trends but also be well-prepared to present their findings in an academic setting.

Topics:

1. Digital Twins for Manufacturing Systems

References:

- Zhang, Chenyuan, et al. "A reconfigurable modeling approach for digital twin-based manufacturing system." *Procedia Cirp* 83 (2019): 118-125. (96 citations)
- Kritzinger, Werner, et al. "Digital Twin in manufacturing: A categorical literature review and classification." *Ifac-PapersOnline* 51.11 (2018): 1016-1022. (1934 citations)
- Jaensch, Florian, et al. "Digital twins of manufacturing systems as a base for machine learning." *2018 25th International conference on mechatronics and machine vision in practice (M2VIP)*. IEEE, 2018. (73 citations)

2. Digital Twins for Energy Systems

References:

- Steindl, Gernot, et al. "Generic digital twin architecture for industrial energy systems." *Applied Sciences* 10.24 (2020): 8903. (78 citations)
- Granacher, Julia, et al. "Overcoming decision paralysis—A digital twin for decision making in energy system design." *Applied Energy* 306 (2022): 117954. (33 citations) -> focus on interactive digital twins
- Palensky, Peter, et al. "Digital twins and their use in future power systems." *Digital Twin* 1 (2022): 4. (37 citations)

3. Digital Twins in Healthcare

References:

- Alazab, Mamoun, et al. "Digital twins for healthcare 4.0-recent advances, architecture, and open challenges." *IEEE Consumer Electronics Magazine* (2022). (26 citations)
- Croatti, Angelo, et al. "On the integration of agents and digital twins in healthcare." *Journal of Medical Systems* 44 (2020): 1-8. (163 citations)
- Erol, Tolga, Arif Furkan Mendi, and Dilara Doğan. "The digital twin revolution in healthcare." *2020 4th international symposium on multidisciplinary studies and innovative technologies (ISMSIT)*. IEEE, 2020. (106 citations)

4. Digital Twins of City Infrastructures (in Smart Cities)

References:

- Deren, Li, Yu Wenbo, and Shao Zhenfeng. "Smart city based on digital twins." *Computational Urban Science* 1 (2021): 1-11. (110 citations)
- Deng, Tianhu, Keren Zhang, and Zuo-Jun Max Shen. "A systematic review of a digital twin city: A new pattern of urban governance toward smart cities." *Journal of Management Science and Engineering* 6.2 (2021): 125-134. (192 citations)
- Mylonas, Georgios, et al. "Digital twins from smart manufacturing to smart cities: A survey." *Ieee Access* 9 (2021): 143222-143249. (99 citations)

5. Digital Twins in Logistics

References:

- Moshood, Taofeeq D., et al. "Digital twins driven supply chain visibility within logistics: A new paradigm for future logistics." *Applied System Innovation* 4.2 (2021): 29. (71 citations)
- Agalianos, K., et al. "Discrete event simulation and digital twins: review and challenges for logistics." *Procedia Manufacturing* 51 (2020): 1636-1641. (74 citations)
- Korth, Benjamin, Christian Schwede, and Markus Zajac. "Simulation-ready digital twin for realtime management of logistics systems." *2018 IEEE international conference on big data (big data)*. IEEE, 2018. (64 citations)

6. Cognitive Digital Twins

References:

- Al Faruque, Mohammad Abdullah, et al. "Cognitive digital twin for manufacturing systems." *2021 Design, Automation & Test in Europe Conference & Exhibition (DATE)*. IEEE, 2021. (28 citations)
- Zhang, Nan, Rami Bahsoon, and Georgios Theodoropoulos. "Towards engineering cognitive digital twins with self-awareness." *2020 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*. IEEE, 2020. (22 citations)
- Zheng, Xiaochen, Jinzhi Lu, and Dimitris Kiritsis. "The emergence of cognitive digital twin: vision, challenges and opportunities." *International Journal of Production Research* 60.24 (2022): 7610-7632. (92 citations)

7. Fusing Data and Human Expert Knowledge in Digital Twins

References:

- Kulkarni, Vinay, Souvik Barat, and Tony Clark. "Towards adaptive enterprises using digital twins." *2019 winter simulation conference (WSC)*. IEEE, 2019. (22 citations)
- Vogel-Heuser, Birgit, et al. "Potential for combining semantics and data analysis in the context of digital twins." *Philosophical Transactions of the Royal Society A* 379.2207 (2021): 20200368. (16 citations)

- Todorovski, Ljupčo, and Sašo Džeroski. "Integrating knowledge-driven and data-driven approaches to modeling." *ecological modelling* 194.1-3 (2006): 3-13. (80 citations)

8. Digital Twins for Multi-agent / Complex Systems

References:

- Pretel, Elena, Alejandro Moya, Elena Navarro, Víctor López-Jaquero, and Pascual González. "Analysing the synergies between Multi-agent Systems and Digital Twins: A systematic literature review." *Information and Software Technology* (2024): 107503. (2 citations)
- Mariani, S., Picone, M., Ricci, A. (2022). About Digital Twins, Agents, and Multiagent Systems: A Cross-Fertilisation Journey. In: Melo, F.S., Fang, F. (eds) *Autonomous Agents and Multiagent Systems. Best and Visionary Papers. AAMAS 2022*. Lecture Notes in Computer Science, vol 13441. (11 citations)
- Marah H, Challenger M. Adaptive hybrid reasoning for agent-based digital twins of distributed multi-robot systems. *SIMULATION.* 2024;100(9):931-957. (0 citations – new articles)

9. Digital Twins for Energy Systems

References:

- Kabir, Md Rafiul, Dipal Halder, and Sandip Ray. "Digital Twins for IoT-driven Energy Systems: A Survey." *IEEE Access* (2024). (0 citations – new articles)
- Brosinsky, Christoph, Rainer Krebs, and Dirk Westermann. "Embedded Digital Twins in future energy management systems: paving the way for automated grid control." *at-Automatisierungstechnik* 68, no. 9 (2020): 750-764.(21 citations)
- Song, Zhao, Christoph M. Hackl, Abhinav Anand, Andre Thommessen, Jonas Petzschmann, Omar Kamel, Robert Braunbehrens, Anton Kaifel, Christian Roos, and Stefan Hauptmann. "Digital twins for the future power system: An overview and a future perspective." *Sustainability* 15, no. 6 (2023): 5259. .(32 citations)
- Mostafa, Omar & Lazarova-Molnar, Sanja. (2024). Enhancing Reliability of Energy Systems with Digital Twins: Challenges and Opportunities. (0 citations – new articles)

10. Digital Twins in Transportation and Automotive

References:

- Schwarz, Chris, and Ziran Wang. "The role of digital twins in connected and automated vehicles." *IEEE Intelligent Transportation Systems Magazine* 14, no. 6 (2022): 41-51. (91 citations)
- Bhatti, Ghanishtha, Harshit Mohan, and R. Raja Singh. "Towards the future of smart electric vehicles: Digital twin technology." *Renewable and Sustainable Energy Reviews* 141 (2021): 110801. (422 citations)
- Almeaibed, Sadeq, Saba Al-Rubaye, Antonios Tsourdos, and Nicolas P. Avdelidis. "Digital twin analysis to promote safety and security in autonomous vehicles." *IEEE Communications Standards Magazine* 5, no. 1 (2021): 40-46. (135 citations)

11. Digital Twins for Environment and Sustainability

References:

- Tzachor, Asaf, Soheil Sabri, Catherine E. Richards, Abbas Rajabifard, and Michele Acuto. "Potential and limitations of digital twins to achieve the sustainable development goals." *Nature Sustainability* 5, no. 10 (2022): 822-829. (110 citations)
- Corrado, Casey R., Suzanne M. DeLong, Emily G. Holt, Edward Y. Hua, and Andreas Tolk. "Combining green metrics and digital twins for sustainability planning and governance of smart buildings and cities." *Sustainability* 14, no. 20 (2022): 12988. (36 citations)
- Kim, Byungmo, Jaewon Oh, and Cheonhong Min. "Development of a simulation model for digital twin of an oscillating water column wave power generator structure with ocean environmental effect." *Sensors* 23, no. 23 (2023): 9472. (3 citations)

12. Digital Twins in Agriculture

References:

- Peladarinos, Nikolaos, Dimitrios Piromalis, Vasileios Cheimaras, Efthymios Tserepas, Radu Adrian Munteanu, and Panagiotis Papageorgas. "Enhancing smart agriculture by implementing digital twins: A comprehensive review." *Sensors* 23, no. 16 (2023): 7128. (60 citations)
- Escribà-Gelonch, Marc, Shu Liang, Pieter van Schalkwyk, Ian Fisk, Nguyen Van Duc Long, and Volker Hessel. "Digital Twins in Agriculture: Orchestration and Applications." *Journal of Agricultural and Food Chemistry* 72, no. 19 (2024): 10737-10752. (12 citations)
- Verdouw, Cor, Bedir Tekinerdogan, Adrie Beulens, and Sjaak Wolfert. "Digital twins in smart farming." *Agricultural Systems* 189 (2021): 103046. (494 citations)

V **Seminar: New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)** **Seminar (S) On-Site**
2513108, SS 2025, 2 SWS, Language: English, Open in study portal

Content
Noise, especially in urban areas, is a major environmental issue that impacts quality of life and health, contributing to stress, sleep disturbances, and cardiovascular problems. Traffic noise, primarily from tire-road interactions, has become more prominent as electric vehicles reduce engine noise. Tackling this issue involves both passive methods, like noise barriers, and active solutions such as noise cancellation technologies.

In recent years, artificial intelligence (AI) has emerged as a powerful tool for managing noise. AI-based systems can classify noise sources, create noise maps, and develop control strategies. Advanced AI techniques, including Generative Adversarial Networks (GANs), AutoEncoders, Bi-Long Short-Term Memory (LSTM), and Bi-Gated Recurrent Units (GRUs), Graphical Convolutional Networks (GCN), Physics-informed neural networks, YOLO, Transformer, show great potential for reducing noise. Additionally, many computer vision techniques are used to improve noise conditions. This seminar will explore these AI methods and their role in enhancing conditions safety, minimizing environmental noise, and supporting intelligent transportation systems.

In this seminar, we try to understand Noise through data analysis and other techniques. We discuss current approaches to noise prediction and innovative AI approaches based on data science and machine learning.

Topics:

Introduction to Noise and Tire-Road Noise

Overview on Noise and Tire-Road Noise

Time Series Analysis and Image Analysis

Data Exploration and Visualization

Noise Feature Extraction and Analysis

Machine learning and Deep Learning Approach for Tire-Road Noise

Who are we looking for:

We are looking for students who want to expand their specialist knowledge and practical experience in artificial intelligence, signal processing, computer vision and road-tire noise. Participation provides the opportunity to actively participate in shaping the future of using artificial intelligence, computer vision and signal processing to reduce road-tire and traffic noise.

What we offer:

We provide you with tyre-road noise data. With this data, you can apply many signal processing, computer vision and artificial intelligence algorithms. This is where you can let your creativity run free and implement innovative solutions with our guidance.

Organizational:

- Kickoff meeting **on April 24, 2025**: Introduction to topics, information about data, clarification of organizational questions. In the Kickoff Meeting, Groups come together and each group has a theme.
- Interim presentation **29 May 2025**: Presentation of the current situation and information sharing.
- Final presentation on **July 17, 2025**: Presentation of results and submission of documents

Registration: Please briefly state your motivation for taking this course. Optionally you can attach your Transcript of Records and CV.

Deliverables (per team): 1 Report (min 10 pages, scientific paper format, including references) + Presentations (2) + Implementation Files(codes)

Grading relevant Parts: Written Report, Presentations and Implementation

V **Seminar Knowledge Discovery and Data Mining (Master)** **Seminar (S) On-Site**
2513309, SS 2025, 2 SWS, Language: English, Open in study portal

Content
In this seminar different machine learning and data mining methods are implemented.

The seminar includes different methods of machine learning and data mining. Participants of the seminar should have basic knowledge of machine learning and programming skills.

Domains of interest include, but are not limited to:

- Medicine
- Social Media
- Finance Market
- Scientific Publications

Further Information: https://aifb.kit.edu/web/Lehre/Praktikum_Knowledge_Discovery_and_Data_Science

The exact dates and information for registration will be announced at the event page.

Organizational issues
Die Anmeldung erfolgt über das WiWi-Portal https://portal.wiwi.kit.edu/ .

Literature
Detaillierte Referenzen werden zusammen mit den jeweiligenThemen angegeben. Allgemeine Hintergrundinformationen ergeben sich z.B.aus den folgenden Lehrbüchern:

- Mitchell, T.; Machine Learning
- McGraw Hill, Cook, D.J. and Holder, L.B. (Editors) Mining Graph Data, ISBN:0-471-73190-0
- Wiley, Manning, C. and Schütze, H.; Foundations of Statistical NLP, MIT Press, 1999.

V **Seminar Data Science & Real-time Big Data Analytics (Master)**
2513311, SS 2025, 2 SWS, Language: English, Open in study portal
Seminar (S)
On-Site

Content
In this seminar, students will design applications in teams that use meaningful and creative Event Processing methods. Thereby, students have access to an existing record.

Event processing and real-time data are everywhere: financial market data, sensors, business intelligence, social media analytics, logistics. Many applications collect large volumes of data in real time and are increasingly faced with the challenge of being able to process them quickly and react promptly. The challenges of this real-time processing are currently also receiving a great deal of attention under the term "Big Data". The complex processing of real-time data requires both knowledge of methods for data analysis (data science) and their processing (real-time analytics). Seminar papers are offered on both of these areas as well as on interface topics, the input of own ideas is explicitly desired.

Further information to the practical seminar is given under the following Link:
http://seminar-cep.fzi.de

Questions are answered via the e-mail address sem-ep@fzi.de.

Organizational issues
Die Anmeldung erfolgt über das WiWi-Portal https://portal.wiwi.kit.edu/ .

V **Cognitive Automobiles and Robots**
2513500, SS 2025, 2 SWS, Language: German/English, Open in study portal
Seminar (S)
On-Site

Content

The seminar is intended as a theoretical supplement to lectures such as "Machine Learning". The theoretical basics will be deepened in the seminar. The aim of the seminar is that the participants work individually to analyze a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and theoretical evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

Learning objectives:

- Students can apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles for theoretical analysis.
- Students can evaluate, document and present their concepts and results.

Recommendations:

Attendance of the lecture machine learning

Workload:

The workload of 3 credit points consists of the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

Organizational issues

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

V	**Seminar E-Voting (Master)** 2513553, SS 2025, 2 SWS, Language: German/English, Open in study portal	**Seminar (S)** **On-Site**

Content

What should a voting procedure fulfill? When is a voting procedure secure? Which components need to be examined? Which methods can be used to investigate this?

Cryptographic voting procedures and algorithmic voting (counting) procedures are examined from different perspectives (cryptographic methods, formal correctness, human factors).

This course can also be credited for the KASTEL certificate. Further information about obtaining the certificate can be found on the SECUSO website (https://secuso.aifb.kit.edu/Studium_und_Lehre.php).

Organizational issues

Die Anmeldung für das Seminar ist bis zum t.b.a. über https://portal.wiwi.kit.edu/ys/TODO möglich.

V	**Large Language Model-Enhanced Representation Learning for Knowledge Graphs (Master)** 2513607, SS 2025, 2 SWS, Language: English, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

Content

Effective feature representation is critical for optimizing the performances of machine learning algorithms. Recently, Representation Learning (RL) has advanced significantly, focusing on embedding words and Knowledge Graphs (KGs) into low-dimensional vector spaces. Word embeddings encode words as vectors, capturing context, semantic similarity, and relationships. Similarly, KG representation learning (KGRL) algorithms (a.k.a. KG embedding (KGE) models) are used to represent entities and relations as vectors in a low-dimensional vector space, preserving structure and semantic connections.

KGE models can be unimodal, using a single source of information, or multimodal, integrating multiple sources such as relations between entities, text literals, numeric literals, images, etc. Capturing information from these sources ensures semantically rich representations. Multimodal KGE models either create separate representations for each source in non-unified spaces or a unified representation for KG elements. These embeddings are commonly used for KG completion tasks such as link prediction and entity classification.

Emerging methodologies for KGRL leverage LLMs such as LLaMA, GPT 3.5, and PaLM2. The integration of LLMs with KG KGRL signifies a pivotal advancement in the field of artificial intelligence, enhancing the ability to capture and utilize complex knowledge structures.

In this seminar, we aim to explore state-of-the-art approaches that utilize LLMs for Knowledge Graph representation learning.

Contributions of the students:

Each student will be assigned one paper on the topic, which could be a research paper discussing a novel approach or a resource paper presenting datasets, tools, etc. The student will be responsible for the following tasks:

1. **Report Writing**: Read the assigned paper thoroughly and write a 15-page seminar report explaining the methods and findings in their own words.
2. **Presenting**: Prepare and deliver a seminar presentation to share insights from the paper with other seminar participants.
3. **Conducting Experiments**: If the authors provide code, re-implement it for small-scale experiments using Google Colab or make the implementation available via GitHub.

T 6.245 Course: Seminar in Informatics B (Master) [T-WIWI-103480]

Responsible: Professorenschaft des Instituts AIFB
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102974 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	2400125	Security and Privacy Awareness	2 SWS	Seminar /	Seidel-Saul, Volkamer, Boehm, Aldag, Veit
WT 24/25	2513105	Seminar Advanced Analytics for Road Traffic Noise (Master)	2 SWS	Seminar /	Lazarova-Molnar, Demetgül
WT 24/25	2513107	Seminar Modeling and Simulation for Energy Systems (Master)	2 SWS	Seminar	Lazarova-Molnar, Mostafa
WT 24/25	2513313	Seminar Linked Data and the Semantic Web (Master)	3 SWS	Seminar /	Käfer, Braun
WT 24/25	2513314	Seminar Real-World Challenges in Data Science and Analytics (Bachelor)	3 SWS	/	Hoellig, Käfer, Thoma
WT 24/25	2513315	Seminar Real-World Challenges in Data Science and Analytics (Master)	3 SWS	/	Hoellig, Käfer, Thoma
WT 24/25	2513451	Seminar Cooperative Autonomous Vehicles (Master)	2 SWS	Seminar /	Vinel
WT 24/25	2513457	Seminar Collective Perception in Autonomous Driving (Master)	2 SWS	Seminar /	Vinel
WT 24/25	2513458	Seminar Artificial Intelligence for Autonomous Driving (Master)	2 SWS	Seminar /	Vinel, Zhao
WT 24/25	2513500	Seminar Cognitive Automobiles and Robots (Master)	2 SWS	Seminar /	Zöllner, Daaboul
WT 24/25	2513607	Seminar Knowledge Graphs and Large Language Models (Master)	2 SWS	Seminar /	Sack, Gesese, Norouzi, Vafaie, Tan
ST 2025	2512101	Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Seminar/ Master)	2 SWS	Seminar /	Lazarova-Molnar, Khodadadi, Mostafa
ST 2025	2513103	Seminar: Applications of Digital Twins (Master)	2 SWS	Seminar /	Lazarova-Molnar, Lee
ST 2025	2513108	Seminar: New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)	2 SWS	Seminar /	Demetgül, Lazarova-Molnar
ST 2025	2513109	Seminar: Agent-based Modeling and Simulation (Master)	2 SWS	Seminar	Lazarova-Molnar, Ghasemi
ST 2025	2513211	Seminar Business Information Systems (Master)	2 SWS	Seminar /	Oberweis, Forell, Frister, Fritsch, Rybinski, Schreiber, Schüler, Ullrich
ST 2025	2513309	Seminar Knowledge Discovery and Data Mining (Master)	2 SWS	Seminar /	Käfer, Noullet, Popovic, Qu , Shao, Kinder
ST 2025	2513311	Seminar Data Science & Real-time Big Data Analytics (Master)	2 SWS	Seminar /	Käfer, Thoma, Hoellig
ST 2025	2513455	Seminar Machine Learning in Autonomous Driving (Master)	2 SWS	Seminar /	Zhao , Vinel
ST 2025	2513459	Seminar Vulnerable Road User Technologies (Master)	2 SWS	Seminar /	Schrapel, Vinel

ST 2025	2513500	Cognitive Automobiles and Robots	2 SWS	Seminar /	Schneider, Zöllner, Daaboul
ST 2025	2513553	Seminar E-Voting (Master)	2 SWS	Seminar /	Beckert, Müller-Quade, Volkamer, Kirsten, Hilt, Dörre
ST 2025	2513607	Large Language Model-Enhanced Representation Learning for Knowledge Graphs (Master)	2 SWS	Seminar /	Sack, Gesese, Tan
Exams					
WT 24/25	7500175	Seminar: Energy Informatics			Hagenmeyer, Bläsius
WT 24/25	7500220	Seminar Ubiquitous Computing			Beigl
WT 24/25	7900102	Advanced Lab Information Service Engineering (Master)			Sack
WT 24/25	7900119	Seminar Cognitive Automobiles and Robots			Zöllner
WT 24/25	7900121	Security and Privacy Awareness			Volkamer
WT 24/25	7900209	Seminar Digital Twins with Lego: Hands-on Workshop in Data-driven Simulation (Master)			Lazarova-Molnar
WT 24/25	7900215	Seminar Knowledge Graphs and Large Language Models (Master)			Käfer
WT 24/25	7900226	Seminar Modeling and Simulation for Energy Systems (Master)			Lazarova-Molnar
WT 24/25	7900236	Seminar Advanced Analytics for Road Traffic Noise (Master)			Lazarova-Molnar
WT 24/25	7900245	Seminar Cooperative Autonomous Vehicles (Master)			Vinel
WT 24/25	7900279	Seminar Collective Perception in Autonomous Driving (Master)			Vinel
WT 24/25	7900304	Seminar Linked Data and the Semantic Web (Master)			Färber
WT 24/25	7900356	Seminar Real-World Challenges in Data Science and Analytics (Master)			Sure-Vetter, Färber
WT 24/25	79AIFB_AIAD_C4	Seminar Artificial Intelligence for Autonomous Driving (Master)			Vinel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
Placeholder for seminars offered by the Institute AIFB.

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V **Security and Privacy Awareness**
2400125, WS 24/25, 2 SWS, Language: German/English, Open in study portal

Seminar (S)
Blended (On-Site/Online)

Content

Within the framework of this interdisciplinary seminar, the topics security awareness and privacy awareness are to be considered from different perspectives. It deals with legal, information technology, psychological, social as well as philosophical aspects.

Important notes:

- Consider that legal-focused topics require you to speak and understand German legal texts
- The seminar is only for MASTER students (or Mastervorzug)
- The link to enrol is for every student, regardless of the study background

Dates (not final):

- Kick-Off: Tue, 22.10.2024, 11:30 Uhr, Raum 1C-03, Gebäude 5.20
- First version: 05.01.2025
- Final version: 23.02.2025
- Presentation: CW 12

Topics:

The advertised topics can be found in the wiwi portal [https://portal.wiwi.kit.edu/ys/8308]. They will be assigned after the kick-off.

V Seminar Advanced Analytics for Road Traffic Noise (Master)

2513105, WS 24/25, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content

Road traffic noise (RTN) stands as a significant environmental pollutant encountered in daily life, profoundly impacting human health. Extensive research has empirically validated its detrimental effects on well-being, encompassing cardiovascular and mental health implications (Stansfeld et al., 2021; Lan et al., 2020). Moreover, regulatory bodies have proposed guidelines and regulations (WHO, 2018; EU, 2019) to mitigate environmental noise exposure, prompting stakeholders like vehicle manufacturers to integrate measures addressing road traffic noise into their design frameworks.

In this seminar, we diverge from the regulatory perspective on RTN and instead delve into its comprehension through data analytics and other techniques. Specifically, we present a guideline for understanding this societal concern and discuss existing road traffic noise modeling (RTNM) approaches, in particular, their formulation and considerations.

Topics:

1. Introduction to RTN
2. Overview on RTNM
3. Time series analysis
4. Data exploration and visualization
5. Machine learning for RTNM
6. Sound feature extraction and analysis

Literature

- Stansfeld, S., Clark, C., Smuk, M., Gallacher, J., & Babisch, W. (2021). Road traffic noise, noise sensitivity, noise annoyance, psychological and physical health and mortality. Environmental Health, 20, 1-15.
- Lan, Y., Roberts, H., Kwan, M. P., & Helbich, M. (2020). Transportation noise exposure and anxiety: A systematic review and meta-analysis. Environmental research, 191, 110118.
- WHO. (2018) Environmental Noise Guidelines for the European Region.
- EU. (2019) Regulation (EU) No 540/2014 of the European Parliament and of the Council of 16 April 2014 on the Sound Level of Motor Vehicles and of Replacement Silencing Systems, and Amending Directive 2007/46/EC and Repealing Directive 70/157/EEC.

V Seminar Linked Data and the Semantic Web (Master)

2513313, WS 24/25, 3 SWS, Language: German/English, Open in study portal

Seminar (S)
On-Site

Content
Linked Data is a way of publishing data on the web in a machine-understandable fashion. The aim of this practical seminar is to build applications and devise algorithms that consume, provide, or analyse Linked Data.

The Linked Data principles are a set of practices for data publishing on the web. Linked Data builds on the web architecture and uses HTTP for data access, and RDF for describing data, thus aiming towards web-scale data integration. There is a vast amount of data available published according to those principles: recently, 4.5 billion facts have been counted with information about various domains, including music, movies, geography, natural sciences. Linked Data is also used to make web-pages machine-understandable, corresponding annotations are considered by the big search engine providers. On a smaller scale, devices on the Internet of Things can also be accessed using Linked Data which makes the unified processing of device data and data from the web easy.

In this practical seminar, students will build prototypical applications and devise algorithms that consume, provide, or analyse Linked Data. Those applications and algorithms can also extend existing applications ranging from databases to mobile apps.

For the seminar, programming skills or knowledge about web development tools/technologies are highly recommended. Basic knowledge of RDF and SPARQL are also recommended, but may be acquired during the seminar. Students will work in groups. Seminar meetings will take place as 'Block-Seminar'.

Topics of interest include, but are not limited to:

- Travel Security
- Geo data
- Linked News
- Social Media

The exact dates and information for registration will be announced at the event page.

V Seminar Real-World Challenges in Data Science and Analytics (Bachelor)
2513314, WS 24/25, 3 SWS, Language: German/English, Open in study portal
On-Site

Content
In the seminar, various Real-World Challenges in Data Science and Analytics will be worked on.

During this seminar, groups of students work on a case challenge with data provided. Here, the typical process of a data science project is depicted: integration of data, analysis of these, modeling of the decisions and visualization of the results.

During the seminar, solution concepts are worked out, implemented as a software solution and presented in an intermediate and final presentation. The seminar "Real-World Challenges in Data Science and Analytics" is aimed at students in master's programs.

The exact dates and information for registration will be announced at the course page.

V Seminar Real-World Challenges in Data Science and Analytics (Master)
2513315, WS 24/25, 3 SWS, Language: German/English, Open in study portal
On-Site

Content
In the seminar, various Real-World Challenges in Data Science and Analytics will be worked on.

During this seminar, groups of students work on a case challenge with data provided. Here, the typical process of a data science project is depicted: integration of data, analysis of these, modeling of the decisions and visualization of the results.

During the seminar, solution concepts are worked out, implemented as a software solution and presented in an intermediate and final presentation. The seminar "Real-World Challenges in Data Science and Analytics" is aimed at students in master's programs.

The exact dates and information for registration will be announced at the course page.

V Seminar Cognitive Automobiles and Robots (Master)
2513500, WS 24/25, 2 SWS, Language: German/English, Open in study portal
Seminar (S)
Blended (On-Site/Online)

Content

The seminar is intended as a theoretical supplement to lectures such as "Machine Learning". The theoretical basics will be deepened in the seminar. The aim of the seminar is that the participants work individually to analyze a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and theoretical evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

Learning objectives:

- Students can apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles for theoretical analysis.
- Students can evaluate, document and present their concepts and results.

Recommendations:

Attendance of the lecture machine learning

Workload:

The workload of 3 credit points consists of the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

Organizational issues

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

V **Seminar Knowledge Graphs and Large Language Models (Master)**
2513607, WS 24/25, 2 SWS, Language: English, Open in study portal

Seminar (S)
Blended (On-Site/Online)

Content

Large language models (LLMs) such as GPT-3 have shown remarkable capabilities in transforming various natural language processing (NLP) tasks across different domains. However, LLMs often generate incorrect answers, known as hallucinations, posing significant challenges to their usability and reliability. Additionally, LLMs operate as black boxes, making it difficult to understand how they arrive at specific conclusions, leading to transparency and explainability issues. Combining LLMs with KGs creates a powerful synergy that significantly enhances the capabilities of artificial intelligence across various tasks. This integration leverages the strengths of both technologies, with LLMs excelling at understanding and generating human-like text, and KGs providing structured, reliable information about entities and their relationships. Together, they offer a robust approach to problem-solving across diverse domains.

This seminar will focus on the intersection of LLMs and KGs, covering areas of interest including, but not limited to:

- KG completion using LLMs
- Question answering with KGs and LLMs
- Explainability of LLMs with KG integration
- Reasoning with LLMs and KGs
- Enhanced prompt engineering using KGs

Contributions of the students:

Each student will be assigned one paper on the topic, which could be a research paper discussing a novel approach or a resource paper presenting datasets, tools, etc. The student will be responsible for the following tasks:

1. **Report Writing**: Read the assigned paper thoroughly and write a 15-page seminar report explaining the methods and findings in their own words.
2. **Presenting**: Prepare and deliver a seminar presentation to share insights from the paper with other seminar participants.
3. **Conducting Experiments**: If the authors provide code, re-implement it for small-scale experiments using Google Colab or make the implementation available via GitHub.

V **Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Seminar/Master)**
2512101, SS 2025, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content

This seminar focuses on the data-driven discovery of simulation models in industrial settings, providing a hands-on approach to understanding and optimizing production processes.
Students will start by designing and constructing production lines using Lego Spike and similar modular systems. This activity will include developing comprehensive data-capturing pipelines to collect detailed event-logging raw data from their production lines.
Next, the seminar will explore advanced techniques for transforming this raw data into simulation models, e.g., Petri nets. Participants will learn and apply data-driven model extraction methods, such as process mining to extract workflow processes; statistical methods to fit probability distributions and analyze trends, and machine learning algorithms to model complex behaviors within the production process. Through these techniques, students will extract simulation models that reflect the real-world dynamics of their production lines. The seminar will then guide participants on how to validate the extracted simulation models to ensure their accuracy.
By the end of the seminar, students will be equipped with the skills to build model production lines, collect event logging data from them, transform event log data into actionable simulation models and use these models to drive efficiency and innovation in industrial production settings.

Grading Scheme:

Report - 50%

Presentations - 40%

Implementation - 10%

V **Seminar: Applications of Digital Twins (Master)**
2513103, SS 2025, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content

Seminar Name: Applications of Digital Twins

Size: 10 students (with 10 different topics)

Workload:

- 2 Lectures:
  - Introduction to Digital Twins and topic distribution
  - "How to Give Effective Presentations" lecture
- 10 student presentations (each 45 minutes in total)
- 10 student reports

Responsible Person: Hui Min Lee, Sanja Lazarova-Molnar

Deliverables for Grade:

- 1 Report per student and topic (8 pages, including references, IEEE Template, compulsory usage of Reference Manager – Zotero or EndNote)
- 25 mins presentation per student plus 20 min discussion (focus on the presentation topic + presentation skills) = 45 minutes for each student

Credits: 3 credits = 90 hours

Format/ Structure of the Seminar (Draft):

- 2 Lectures at the beginning of the semester
- Students have 1 week time to provide a priority list of 5 topics, distribution will be decided based on first come – first serve, ensuring that core topics are covered
- Q&As can be asked and answered over mails or ad-hoc appointments
- Students have time to work on the report and presentation during the semester
- Submission of all reports will be required 2 months after the intro lecture for ensuring fairness
- Presentations are done in blocks of 2 students per class, starting mid-June, presentations will be submitted at the day of the scheduled presentation

Approximate Time Consumption for Students (Draft):

- Lectures: 3 hours
- Student Presentations: 7.5 hours
- Topic Subscription: 1 hour
- Presentation Preparation: 15 hours
- Paper Writing and Literature Review: 63.5 hours

Description:

The seminar focuses on applications of Digital Twins and data-driven modeling, with an additional goal of improving scientific research and presentation skills for Master students. The seminar covers the diverse applications and use cases of Digital Twins in different domains such as manufacturing, energy systems, healthcare and many more, offering students an in-depth understanding of the role of Digital Twins in transforming the industries.

The seminar is structured as a literature review seminar. Each student can select a topic out of a predefined set, conduct further research and then write a comprehensive research paper. Students will also deliver presentations, synthesizing insights from both the provided starting reference literature and their own additional research.

By the end of the course, students will not only have a solid understanding of the current applications of Digital Twins and emerging trends but also be well-prepared to present their findings in an academic setting.

Topics:

1. **Digital Twins for Manufacturing Systems**

References:

- Zhang, Chenyuan, et al. "A reconfigurable modeling approach for digital twin-based manufacturing system." *Procedia Cirp* 83 (2019): 118-125. (96 citations)
- Kritzinger, Werner, et al. "Digital Twin in manufacturing: A categorical literature review and classification." *Ifac-PapersOnline* 51.11 (2018): 1016-1022. (1934 citations)
- Jaensch, Florian, et al. "Digital twins of manufacturing systems as a base for machine learning." *2018 25th International conference on mechatronics and machine vision in practice (M2VIP)*. IEEE, 2018. (73 citations)

2. Digital Twins for Energy Systems

References:

- Steindl, Gernot, et al. "Generic digital twin architecture for industrial energy systems." *Applied Sciences* 10.24 (2020): 8903. (78 citations)
- Granacher, Julia, et al. "Overcoming decision paralysis—A digital twin for decision making in energy system design." *Applied Energy* 306 (2022): 117954. (33 citations) -> focus on interactive digital twins
- Palensky, Peter, et al. "Digital twins and their use in future power systems." *Digital Twin* 1 (2022): 4. (37 citations)

3. Digital Twins in Healthcare

References:

- Alazab, Mamoun, et al. "Digital twins for healthcare 4.0-recent advances, architecture, and open challenges." *IEEE Consumer Electronics Magazine* (2022). (26 citations)
- Croatti, Angelo, et al. "On the integration of agents and digital twins in healthcare." *Journal of Medical Systems* 44 (2020): 1-8. (163 citations)
- Erol, Tolga, Arif Furkan Mendi, and Dilara Doğan. "The digital twin revolution in healthcare." *2020 4th international symposium on multidisciplinary studies and innovative technologies (ISMSIT)*. IEEE, 2020. (106 citations)

4. Digital Twins of City Infrastructures (in Smart Cities)

References:

- Deren, Li, Yu Wenbo, and Shao Zhenfeng. "Smart city based on digital twins." *Computational Urban Science* 1 (2021): 1-11. (110 citations)
- Deng, Tianhu, Keren Zhang, and Zuo-Jun Max Shen. "A systematic review of a digital twin city: A new pattern of urban governance toward smart cities." *Journal of Management Science and Engineering* 6.2 (2021): 125-134. (192 citations)
- Mylonas, Georgios, et al. "Digital twins from smart manufacturing to smart cities: A survey." *Ieee Access* 9 (2021): 143222-143249. (99 citations)

5. Digital Twins in Logistics

References:

- Moshood, Taofeeq D., et al. "Digital twins driven supply chain visibility within logistics: A new paradigm for future logistics." *Applied System Innovation* 4.2 (2021): 29. (71 citations)
- Agalianos, K., et al. "Discrete event simulation and digital twins: review and challenges for logistics." *Procedia Manufacturing* 51 (2020): 1636-1641. (74 citations)
- Korth, Benjamin, Christian Schwede, and Markus Zajac. "Simulation-ready digital twin for realtime management of logistics systems." *2018 IEEE international conference on big data (big data)*. IEEE, 2018. (64 citations)

6. Cognitive Digital Twins

References:

- Al Faruque, Mohammad Abdullah, et al. "Cognitive digital twin for manufacturing systems." *2021 Design, Automation & Test in Europe Conference & Exhibition (DATE)*. IEEE, 2021. (28 citations)
- Zhang, Nan, Rami Bahsoon, and Georgios Theodoropoulos. "Towards engineering cognitive digital twins with self-awareness." *2020 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*. IEEE, 2020. (22 citations)
- Zheng, Xiaochen, Jinzhi Lu, and Dimitris Kiritsis. "The emergence of cognitive digital twin: vision, challenges and opportunities." *International Journal of Production Research* 60.24 (2022): 7610-7632. (92 citations)

7. Fusing Data and Human Expert Knowledge in Digital Twins

References:

- Kulkarni, Vinay, Souvik Barat, and Tony Clark. "Towards adaptive enterprises using digital twins." *2019 winter simulation conference (WSC)*. IEEE, 2019. (22 citations)
- Vogel-Heuser, Birgit, et al. "Potential for combining semantics and data analysis in the context of digital twins." *Philosophical Transactions of the Royal Society A* 379.2207 (2021): 20200368. (16 citations)

- Todorovski, Ljupčo, and Sašo Džeroski. "Integrating knowledge-driven and data-driven approaches to modeling." *ecological modelling* 194.1-3 (2006): 3-13. (80 citations)

8. Digital Twins for Multi-agent / Complex Systems

References:

- Pretel, Elena, Alejandro Moya, Elena Navarro, Víctor López-Jaquero, and Pascual González. "Analysing the synergies between Multi-agent Systems and Digital Twins: A systematic literature review." *Information and Software Technology* (2024): 107503. (2 citations)
- Mariani, S., Picone, M., Ricci, A. (2022). About Digital Twins, Agents, and Multiagent Systems: A Cross-Fertilisation Journey. In: Melo, F.S., Fang, F. (eds) *Autonomous Agents and Multiagent Systems. Best and Visionary Papers. AAMAS 2022*. Lecture Notes in Computer Science, vol 13441. (11 citations)
- Marah H, Challenger M. Adaptive hybrid reasoning for agent-based digital twins of distributed multi-robot systems. *SIMULATION.* 2024;100(9):931-957. (0 citations – new articles)

9. Digital Twins for Energy Systems

References:

- Kabir, Md Rafiul, Dipal Halder, and Sandip Ray. "Digital Twins for IoT-driven Energy Systems: A Survey." *IEEE Access* (2024). (0 citations – new articles)
- Brosinsky, Christoph, Rainer Krebs, and Dirk Westermann. "Embedded Digital Twins in future energy management systems: paving the way for automated grid control." *at-Automatisierungstechnik* 68, no. 9 (2020): 750-764.(21 citations)
- Song, Zhao, Christoph M. Hackl, Abhinav Anand, Andre Thommessen, Jonas Petzschmann, Omar Kamel, Robert Braunbehrens, Anton Kaifel, Christian Roos, and Stefan Hauptmann. "Digital twins for the future power system: An overview and a future perspective." *Sustainability* 15, no. 6 (2023): 5259. .(32 citations)
- Mostafa, Omar & Lazarova-Molnar, Sanja. (2024). Enhancing Reliability of Energy Systems with Digital Twins: Challenges and Opportunities. (0 citations – new articles)

10. Digital Twins in Transportation and Automotive

References:

- Schwarz, Chris, and Ziran Wang. "The role of digital twins in connected and automated vehicles." *IEEE Intelligent Transportation Systems Magazine* 14, no. 6 (2022): 41-51. (91 citations)
- Bhatti, Ghanishtha, Harshit Mohan, and R. Raja Singh. "Towards the future of smart electric vehicles: Digital twin technology." *Renewable and Sustainable Energy Reviews* 141 (2021): 110801. (422 citations)
- Almeaibed, Sadeq, Saba Al-Rubaye, Antonios Tsourdos, and Nicolas P. Avdelidis. "Digital twin analysis to promote safety and security in autonomous vehicles." *IEEE Communications Standards Magazine* 5, no. 1 (2021): 40-46. (135 citations)

11. Digital Twins for Environment and Sustainability

References:

- Tzachor, Asaf, Soheil Sabri, Catherine E. Richards, Abbas Rajabifard, and Michele Acuto. "Potential and limitations of digital twins to achieve the sustainable development goals." *Nature Sustainability* 5, no. 10 (2022): 822-829. (110 citations)
- Corrado, Casey R., Suzanne M. DeLong, Emily G. Holt, Edward Y. Hua, and Andreas Tolk. "Combining green metrics and digital twins for sustainability planning and governance of smart buildings and cities." *Sustainability* 14, no. 20 (2022): 12988. (36 citations)
- Kim, Byungmo, Jaewon Oh, and Cheonhong Min. "Development of a simulation model for digital twin of an oscillating water column wave power generator structure with ocean environmental effect." *Sensors* 23, no. 23 (2023): 9472. (3 citations)

12. Digital Twins in Agriculture

References:

- Peladarinos, Nikolaos, Dimitrios Piromalis, Vasileios Cheimaras, Efthymios Tserepas, Radu Adrian Munteanu, and Panagiotis Papageorgas. "Enhancing smart agriculture by implementing digital twins: A comprehensive review." *Sensors* 23, no. 16 (2023): 7128. (60 citations)
- Escribà-Gelonch, Marc, Shu Liang, Pieter van Schalkwyk, Ian Fisk, Nguyen Van Duc Long, and Volker Hessel. "Digital Twins in Agriculture: Orchestration and Applications." *Journal of Agricultural and Food Chemistry* 72, no. 19 (2024): 10737-10752. (12 citations)
- Verdouw, Cor, Bedir Tekinerdogan, Adrie Beulens, and Sjaak Wolfert. "Digital twins in smart farming." *Agricultural Systems* 189 (2021): 103046. (494 citations)

V **Seminar: New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)** **Seminar (S) On-Site**
2513108, SS 2025, 2 SWS, Language: English, Open in study portal

Content
Noise, especially in urban areas, is a major environmental issue that impacts quality of life and health, contributing to stress, sleep disturbances, and cardiovascular problems. Traffic noise, primarily from tire-road interactions, has become more prominent as electric vehicles reduce engine noise. Tackling this issue involves both passive methods, like noise barriers, and active solutions such as noise cancellation technologies.

In recent years, artificial intelligence (AI) has emerged as a powerful tool for managing noise. AI-based systems can classify noise sources, create noise maps, and develop control strategies. Advanced AI techniques, including Generative Adversarial Networks (GANs), AutoEncoders, Bi-Long Short-Term Memory (LSTM), and Bi-Gated Recurrent Units (GRUs), Graphical Convolutional Networks (GCN), Physics-informed neural networks, YOLO, Transformer, show great potential for reducing noise. Additionally, many computer vision techniques are used to improve noise conditions. This seminar will explore these AI methods and their role in enhancing conditions safety, minimizing environmental noise, and supporting intelligent transportation systems.

In this seminar, we try to understand Noise through data analysis and other techniques. We discuss current approaches to noise prediction and innovative AI approaches based on data science and machine learning.

Topics:

Introduction to Noise and Tire-Road Noise

Overview on Noise and Tire-Road Noise

Time Series Analysis and Image Analysis

Data Exploration and Visualization

Noise Feature Extraction and Analysis

Machine learning and Deep Learning Approach for Tire-Road Noise

Who are we looking for:

We are looking for students who want to expand their specialist knowledge and practical experience in artificial intelligence, signal processing, computer vision and road-tire noise. Participation provides the opportunity to actively participate in shaping the future of using artificial intelligence, computer vision and signal processing to reduce road-tire and traffic noise.

What we offer:

We provide you with tyre-road noise data. With this data, you can apply many signal processing, computer vision and artificial intelligence algorithms. This is where you can let your creativity run free and implement innovative solutions with our guidance.

Organizational:

- Kickoff meeting **on April 24, 2025**: Introduction to topics, information about data, clarification of organizational questions. In the Kickoff Meeting, Groups come together and each group has a theme.
- Interim presentation **29 May 2025**: Presentation of the current situation and information sharing.
- Final presentation on **July 17, 2025**: Presentation of results and submission of documents

Registration: Please briefly state your motivation for taking this course. Optionally you can attach your Transcript of Records and CV.

Deliverables (per team): 1 Report (min 10 pages, scientific paper format, including references) + Presentations (2) + Implementation Files(codes)

Grading relevant Parts: Written Report, Presentations and Implementation

V **Seminar Knowledge Discovery and Data Mining (Master)** **Seminar (S) On-Site**
2513309, SS 2025, 2 SWS, Language: English, Open in study portal

Content
In this seminar different machine learning and data mining methods are implemented.

The seminar includes different methods of machine learning and data mining. Participants of the seminar should have basic knowledge of machine learning and programming skills.

Domains of interest include, but are not limited to:

- Medicine
- Social Media
- Finance Market
- Scientific Publications

Further Information: https://aifb.kit.edu/web/Lehre/Praktikum_Knowledge_Discovery_and_Data_Science

The exact dates and information for registration will be announced at the event page.

Organizational issues
Die Anmeldung erfolgt über das WiWi-Portal https://portal.wiwi.kit.edu/ .

Literature
Detaillierte Referenzen werden zusammen mit den jeweiligenThemen angegeben. Allgemeine Hintergrundinformationen ergeben sich z.B.aus den folgenden Lehrbüchern:

- Mitchell, T.; Machine Learning
- McGraw Hill, Cook, D.J. and Holder, L.B. (Editors) Mining Graph Data, ISBN:0-471-73190-0
- Wiley, Manning, C. and Schütze, H.; Foundations of Statistical NLP, MIT Press, 1999.

V **Seminar Data Science & Real-time Big Data Analytics (Master)**
2513311, SS 2025, 2 SWS, Language: English, Open in study portal
Seminar (S)
On-Site

Content
In this seminar, students will design applications in teams that use meaningful and creative Event Processing methods. Thereby, students have access to an existing record.

Event processing and real-time data are everywhere: financial market data, sensors, business intelligence, social media analytics, logistics. Many applications collect large volumes of data in real time and are increasingly faced with the challenge of being able to process them quickly and react promptly. The challenges of this real-time processing are currently also receiving a great deal of attention under the term "Big Data". The complex processing of real-time data requires both knowledge of methods for data analysis (data science) and their processing (real-time analytics). Seminar papers are offered on both of these areas as well as on interface topics, the input of own ideas is explicitly desired.

Further information to the practical seminar is given under the following Link:
http://seminar-cep.fzi.de

Questions are answered via the e-mail address sem-ep@fzi.de.

Organizational issues
Die Anmeldung erfolgt über das WiWi-Portal https://portal.wiwi.kit.edu/ .

V **Cognitive Automobiles and Robots**
2513500, SS 2025, 2 SWS, Language: German/English, Open in study portal
Seminar (S)
On-Site

Content

The seminar is intended as a theoretical supplement to lectures such as "Machine Learning". The theoretical basics will be deepened in the seminar. The aim of the seminar is that the participants work individually to analyze a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and theoretical evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

Learning objectives:

- Students can apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles for theoretical analysis.
- Students can evaluate, document and present their concepts and results.

Recommendations:

Attendance of the lecture machine learning

Workload:

The workload of 3 credit points consists of the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

Organizational issues

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

V **Seminar E-Voting (Master)**
2513553, SS 2025, 2 SWS, Language: German/English, Open in study portal

Seminar (S)
On-Site

Content

What should a voting procedure fulfill? When is a voting procedure secure? Which components need to be examined? Which methods can be used to investigate this?

Cryptographic voting procedures and algorithmic voting (counting) procedures are examined from different perspectives (cryptographic methods, formal correctness, human factors).

This course can also be credited for the KASTEL certificate. Further information about obtaining the certificate can be found on the SECUSO website (https://secuso.aifb.kit.edu/Studium_und_Lehre.php).

Organizational issues

Die Anmeldung für das Seminar ist bis zum t.b.a. über https://portal.wiwi.kit.edu/ys/TODO möglich.

V **Large Language Model-Enhanced Representation Learning for Knowledge Graphs (Master)**
2513607, SS 2025, 2 SWS, Language: English, Open in study portal

Seminar (S)
Blended (On-Site/Online)

Content

Effective feature representation is critical for optimizing the performances of machine learning algorithms. Recently, Representation Learning (RL) has advanced significantly, focusing on embedding words and Knowledge Graphs (KGs) into low-dimensional vector spaces. Word embeddings encode words as vectors, capturing context, semantic similarity, and relationships. Similarly, KG representation learning (KGRL) algorithms (a.k.a. KG embedding (KGE) models) are used to represent entities and relations as vectors in a low-dimensional vector space, preserving structure and semantic connections.

KGE models can be unimodal, using a single source of information, or multimodal, integrating multiple sources such as relations between entities, text literals, numeric literals, images, etc. Capturing information from these sources ensures semantically rich representations. Multimodal KGE models either create separate representations for each source in non-unified spaces or a unified representation for KG elements. These embeddings are commonly used for KG completion tasks such as link prediction and entity classification.

Emerging methodologies for KGRL leverage LLMs such as LLaMA, GPT 3.5, and PaLM2. The integration of LLMs with KG KGRL signifies a pivotal advancement in the field of artificial intelligence, enhancing the ability to capture and utilize complex knowledge structures.

In this seminar, we aim to explore state-of-the-art approaches that utilize LLMs for Knowledge Graph representation learning.

Contributions of the students:

Each student will be assigned one paper on the topic, which could be a research paper discussing a novel approach or a resource paper presenting datasets, tools, etc. The student will be responsible for the following tasks:

1. **Report Writing**: Read the assigned paper thoroughly and write a 15-page seminar report explaining the methods and findings in their own words.
2. **Presenting**: Prepare and deliver a seminar presentation to share insights from the paper with other seminar participants.
3. **Conducting Experiments**: If the authors provide code, re-implement it for small-scale experiments using Google Colab or make the implementation available via GitHub.

T 6.246 Course: Seminar in Operations Research A (Master) [T-WIWI-103481]

Responsible: Prof. Dr. Stefan Nickel
Prof. Dr. Steffen Rebennack
Prof. Dr. Oliver Stein

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-102973 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	2550131	Seminar on Methodical Foundations of Operations Research (B)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze
WT 24/25	2550132	Seminar zur Mathematischen Optimierung (MA)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze
WT 24/25	2550462	Seminar on Trending Topics in Optimization and Machine Learning (Master)	2 SWS	Seminar / 🧩	Rebennack, Warwicker, Kandora
WT 24/25	2550473	Seminar on Energy and Power Systems Optimization (Master)	2 SWS	Seminar / 🧩	Rebennack, Warwicker, Kandora
WT 24/25	2550491	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / 🧩	Nickel, Mitarbeiter
ST 2025	2500028	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / 🧩	Nickel, Mitarbeiter, Pomes
ST 2025	2550131	Seminar on Methodical Foundations of Operations Research (BA)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
ST 2025	2550132	Seminar on Mathematical Optimization (MA)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
ST 2025	2550462	Seminar: Trending Topics in Machine Learning and Optimization (Master)	2 SWS	Seminar / 🧩	Rebennack, Warwicker, Kandora
ST 2025	2550473	Seminar: Energy and Power Systems Optimization (Master)	2 SWS	Seminar / 🧩	Rebennack, Warwicker, Kandora
ST 2025	2550491	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / 🧩	Nickel, Mitarbeiter

Exams			
WT 24/25	7900011_WS2425	Seminar in Operations Research B (Bachelor)	Stein
WT 24/25	7900012_WS2425	Seminar in Operations Research A (Master)	Stein
WT 24/25	7900169	Seminar Trending Topics in Optimization and Machine Learning (Master)	Rebennack
WT 24/25	7900314	Seminar on Power Systems Optimization (Master)	Rebennack
WT 24/25	7900342	Seminar Modern OR and Innovative Logistics	Nickel
ST 2025	7900295	Seminar Trending Topics in Machine Learning and Opt. - Operations Research A (Master)	Rebennack
ST 2025	7900349	Seminar on Power Systems Optimization (Master)	Rebennack

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V	**Seminar on Methodical Foundations of Operations Research (B)** 2550131, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
The seminar aims at describing, evaluating, and discussing recent as well as classical topics in continuous optimization. The focus is on the treatment of optimization models and algorithms, also with respect to their practical application.

Bachelor studenst are introduced to the style of scientific work. By focussed treatment of a scientific topic they deal with the basics of scientific investigation and reasoning.

For further development of a scientific work style, master students are particularly expected to critically question the seminar topics.

With regard to the oral presentations the students become acquainted with presentation techniques and basics of scientifc reasoning. Also rethoric abilities may be improved.

Remarks:

Attendance at all oral presentations is compulsory.

Preferably at least one module offered by the Institute of Operations Research should have been chosen before attending this seminar.

Assessment:

The assessment is composed of a 15-20 page paper as well as a 40-60 minute oral presentation according to §4(2), 3 of the examination regulation.The grade is composed of the equally weighted assessments of the paper and the oral presentation.

The seminar is appropriate for bachelor as well as for master students. Their differentiation results from different assessment criteria for the seminar paper and the oral presentation.

Workload:

The total workload for this course is approximately 90 hours. For further information see German version.

Literature
Die Literaur und die relevanten Quellen werden gegen Ende des vorausgehenden Semesters im Wiwi-Portal und in einer Seminarvorbesprechung bekannt gegeben.

References and relevant sources are announced at the end of the preceding semester in the Wiwi-Portal and in a prepatory meeting.

V	**Seminar: Modern OR and Innovative Logistics** 2550491, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

Content
The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

Organizational issues
Anmeldezeitraum: 11.09.24 bis 30.09.24 im Wiwi Portal

Literature
Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

V **Seminar: Modern OR and Innovative Logistics**
2500028, SS 2025, 2 SWS, Language: German, Open in study portal
Seminar (S)
Blended (On-Site/Online)

Content
The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

Organizational issues
Anmeldung erfolgt über das Wiwi-Portal. Nähere Informationen hierzu finden Sie hier zu einem späteren Zeitpunkt.

Literature
Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

V **Seminar on Methodical Foundations of Operations Research (BA)**
2550131, SS 2025, 2 SWS, Language: German, Open in study portal
Seminar (S)
On-Site

Content
The seminar aims at describing, evaluating, and discussing recent as well as classical topics in continuous optimization. The focus is on the treatment of optimization models and algorithms, also with respect to their practical application.

Bachelor studenst are introduced to the style of scientific work. By focussed treatment of a scientific topic they deal with the basics of scientific investigation and reasoning.

For further development of a scientific work style, master students are particularly expected to critically question the seminar topics.

With regard to the oral presentations the students become acquainted with presentation techniques and basics of scientifc reasoning. Also rethoric abilities may be improved.

Remarks:

Attendance at all oral presentations is compulsory.

Preferably at least one module offered by the Institute of Operations Research should have been chosen before attending this seminar.

Assessment:

The assessment is composed of a 15-20 page paper as well as a 40-60 minute oral presentation according to §4(2), 3 of the examination regulation.The grade is composed of the equally weighted assessments of the paper and the oral presentation.

The seminar is appropriate for bachelor as well as for master students. Their differentiation results from different assessment criteria for the seminar paper and the oral presentation.

Workload:

The total workload for this course is approximately 90 hours. For further information see German version.

Literature
Die Literaur und die relevanten Quellen werden gegen Ende des vorausgehenden Semesters im Wiwi-Portal und in einer Seminarvorbesprechung bekannt gegeben.

References and relevant sources are announced at the end of the preceding semester in the Wiwi-Portal and in a prepatory meeting.

V **Seminar: Modern OR and Innovative Logistics**
2550491, SS 2025, 2 SWS, Language: German, Open in study portal

Seminar (S)
Blended (On-Site/Online)

Content
The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

The topics of the seminar will be announced at the beginning of the term in a preliminary meeting. Attendance is compulsory for the preliminary meeting as well for all seminar presentations.

Exam:

The assessment consists of a written seminar thesis of 20-25 pages and a presentation of 35-40 minutes (according to §4(2), 3 of the examination regulation).

The final mark for the seminar consists of the seminar thesis, the seminar presentation, the handout, and if applicable further material such as programming code.

The seminar can be attended both by Bachelor and Master students. A differentiation will be achieved by different valuation standards for the seminar thesis and presentation.

Requirements:

If possible, at least one module of the institute should be taken before attending the seminar.

Objectives:

The student

- illustrates and evaluates classic and current research questions in discrete optimization,
- applies optimization models and algorithms in discrete optimization, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management),
- successfully gets in touch with scientific working by an in-depth working on a special scientific topic which makes the student familiar with scientific literature research and argumentation methods,
- acquires good rhetorical and presentation skills.

As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic.

Organizational issues
wird auf der Homepage dol.ior.kit.edu bzw. auf dem WiWi-Portal bekannt gegeben

Literature
Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

T 6.247 Course: Seminar in Operations Research B (Master) [T-WIWI-103482]

Responsible: Prof. Dr. Stefan Nickel
Prof. Dr. Steffen Rebennack
Prof. Dr. Oliver Stein

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-102974 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	2550131	Seminar on Methodical Foundations of Operations Research (B)	2 SWS	Seminar / On-Site	Stein, Beck, Schwarze
WT 24/25	2550132	Seminar zur Mathematischen Optimierung (MA)	2 SWS	Seminar / On-Site	Stein, Beck, Schwarze
WT 24/25	2550462	Seminar on Trending Topics in Optimization and Machine Learning (Master)	2 SWS	Seminar / Blended	Rebennack, Warwicker, Kandora
WT 24/25	2550473	Seminar on Energy and Power Systems Optimization (Master)	2 SWS	Seminar / Blended	Rebennack, Warwicker, Kandora
WT 24/25	2550491	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / Blended	Nickel, Mitarbeiter
ST 2025	2500028	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / Blended	Nickel, Mitarbeiter, Pomes
ST 2025	2550131	Seminar on Methodical Foundations of Operations Research (BA)	2 SWS	Seminar / On-Site	Stein, Beck, Schwarze, Neussel
ST 2025	2550132	Seminar on Mathematical Optimization (MA)	2 SWS	Seminar / On-Site	Stein, Beck, Schwarze, Neussel
ST 2025	2550462	Seminar: Trending Topics in Machine Learning and Optimization (Master)	2 SWS	Seminar / Blended	Rebennack, Warwicker, Kandora
ST 2025	2550473	Seminar: Energy and Power Systems Optimization (Master)	2 SWS	Seminar / Blended	Rebennack, Warwicker, Kandora
ST 2025	2550491	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / Blended	Nickel, Mitarbeiter
Exams					
WT 24/25	7900011_WS2425	Seminar in Operations Research B (Bachelor)			Stein
WT 24/25	7900012_WS2425	Seminar in Operations Research A (Master)			Stein
WT 24/25	7900314	Seminar on Power Systems Optimization (Master)			Rebennack
WT 24/25	7900342	Seminar Modern OR and Innovative Logistics			Nickel
ST 2025	7900296	Seminar in Operations Research B (Master)			Rebennack

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V	**Seminar on Methodical Foundations of Operations Research (B)** 2550131, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **On-Site**

Content
The seminar aims at describing, evaluating, and discussing recent as well as classical topics in continuous optimization. The focus is on the treatment of optimization models and algorithms, also with respect to their practical application.

Bachelor studenst are introduced to the style of scientific work. By focussed treatment of a scientific topic they deal with the basics of scientific investigation and reasoning.

For further development of a scientific work style, master students are particularly expected to critically question the seminar topics.

With regard to the oral presentations the students become acquainted with presentation techniques and basics of scientifc reasoning. Also rethoric abilities may be improved.

Remarks:

Attendance at all oral presentations is compulsory.

Preferably at least one module offered by the Institute of Operations Research should have been chosen before attending this seminar.

Assessment:

The assessment is composed of a 15-20 page paper as well as a 40-60 minute oral presentation according to §4(2), 3 of the examination regulation.The grade is composed of the equally weighted assessments of the paper and the oral presentation.

The seminar is appropriate for bachelor as well as for master students. Their differentiation results from different assessment criteria for the seminar paper and the oral presentation.

Workload:

The total workload for this course is approximately 90 hours. For further information see German version.

Literature
Die Literaur und die relevanten Quellen werden gegen Ende des vorausgehenden Semesters im Wiwi-Portal und in einer Seminarvorbesprechung bekannt gegeben.

References and relevant sources are announced at the end of the preceding semester in the Wiwi-Portal and in a prepatory meeting.

V	**Seminar: Modern OR and Innovative Logistics** 2550491, WS 24/25, 2 SWS, Language: German, Open in study portal	**Seminar (S)** **Blended (On-Site/Online)**

Content
The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

Organizational issues
Anmeldezeitraum: 11.09.24 bis 30.09.24 im Wiwi Portal

Literature
Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

V **Seminar: Modern OR and Innovative Logistics**
2500028, SS 2025, 2 SWS, Language: German, Open in study portal
Seminar (S)
Blended (On-Site/Online)

Content
The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

Organizational issues
Anmeldung erfolgt über das Wiwi-Portal. Nähere Informationen hierzu finden Sie hier zu einem späteren Zeitpunkt.

Literature
Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

V **Seminar on Methodical Foundations of Operations Research (BA)**
2550131, SS 2025, 2 SWS, Language: German, Open in study portal
Seminar (S)
On-Site

Content
The seminar aims at describing, evaluating, and discussing recent as well as classical topics in continuous optimization. The focus is on the treatment of optimization models and algorithms, also with respect to their practical application.

Bachelor studenst are introduced to the style of scientific work. By focussed treatment of a scientific topic they deal with the basics of scientific investigation and reasoning.

For further development of a scientific work style, master students are particularly expected to critically question the seminar topics.

With regard to the oral presentations the students become acquainted with presentation techniques and basics of scientifc reasoning. Also rethoric abilities may be improved.

Remarks:

Attendance at all oral presentations is compulsory.

Preferably at least one module offered by the Institute of Operations Research should have been chosen before attending this seminar.

Assessment:

The assessment is composed of a 15-20 page paper as well as a 40-60 minute oral presentation according to §4(2), 3 of the examination regulation.The grade is composed of the equally weighted assessments of the paper and the oral presentation.

The seminar is appropriate for bachelor as well as for master students. Their differentiation results from different assessment criteria for the seminar paper and the oral presentation.

Workload:

The total workload for this course is approximately 90 hours. For further information see German version.

Literature
Die Literaur und die relevanten Quellen werden gegen Ende des vorausgehenden Semesters im Wiwi-Portal und in einer Seminarvorbesprechung bekannt gegeben.

References and relevant sources are announced at the end of the preceding semester in the Wiwi-Portal and in a prepatory meeting.

V **Seminar: Modern OR and Innovative Logistics**
2550491, SS 2025, 2 SWS, Language: German, Open in study portal
Seminar (S)
Blended (On-Site/Online)

Content
The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

The topics of the seminar will be announced at the beginning of the term in a preliminary meeting. Attendance is compulsory for the preliminary meeting as well for all seminar presentations.

Exam:

The assessment consists of a written seminar thesis of 20-25 pages and a presentation of 35-40 minutes (according to §4(2), 3 of the examination regulation).

The final mark for the seminar consists of the seminar thesis, the seminar presentation, the handout, and if applicable further material such as programming code.

The seminar can be attended both by Bachelor and Master students. A differentiation will be achieved by different valuation standards for the seminar thesis and presentation.

Requirements:

If possible, at least one module of the institute should be taken before attending the seminar.

Objectives:

The student

- illustrates and evaluates classic and current research questions in discrete optimization,
- applies optimization models and algorithms in discrete optimization, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management),
- successfully gets in touch with scientific working by an in-depth working on a special scientific topic which makes the student familiar with scientific literature research and argumentation methods,
- acquires good rhetorical and presentation skills.

As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic.

Organizational issues
wird auf der Homepage dol.ior.kit.edu bzw. auf dem WiWi-Portal bekannt gegeben

Literature
Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

T 6.248 Course: Seminar in Statistics A (Master) [T-WIWI-103483]

Responsible: Prof. Dr. Oliver Grothe
Prof. Dr. Melanie Schienle

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-102971 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	25000111	Statistics and Epidemics		Seminar / 🗣	Bracher
WT 24/25	2500012		2 SWS	Seminar / 🗣	Grothe, Kaplan, Liu
WT 24/25	2500047	Advanced Topics in Econometrics, Statistics and Data Science	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher, Sobolová
WT 24/25	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Rüter
ST 2025	2500208	Statistics and Large Language Models	2 SWS	Seminar	Krüger, Eberl
ST 2025	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Buse, Rüter, Bracher, Eberl
ST 2025	2550561	Fortgeschrittene Themen zu Statistik, Datenanalyse und maschinellem Lernen (Master)	2 SWS	Seminar / 🗣	Grothe, Liu
Exams					
WT 24/25	79000111	Statistics and Epidemics			Bracher
WT 24/25	7900090	Advanced Topics in Econometrics, Statistics and Data Science			Schienle
WT 24/25	7900144	Topics in Econometrics			Schienle
WT 24/25	7900216	Seminar in Statistics A (Master)			Grothe

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V **Statistics and Epidemics**
25000111, WS 24/25, SWS, Language: English, Open in study portal
Seminar (S)
On-Site

Content

Motivation

Infectious disease epidemiology gives rise to a large variety of real-time data streams. During the COVID-19 pandemic, the interpretation and statistical analysis of these data has proven crucial, but also highly challenging. In this seminar, students will get to know central concepts of infectious disease surveillance and modelling from a statistical perspective. Following an overview of various aspects in the form of blocked lectures, students will choose a more specific topic for their seminar thesis.

Learning Goals

Students develop an understanding of central modeling tasks and methods, including

- estimation of reproductive numbers
- compartment models of disease spread
- nowcasting and short-term forecasting of disease spread
- detection of outbreaks
- diagnostic testing

Moreover, they get to know various data types commonly used in the analysis of disease spread.

Logistics

The project seminar is worth 4.5 credit points (Leistungspunkte). There will be three blocked lectures (approx. 135 minutes each) in the beginning of the lecture period. For the various topics covered, subjects for seminar theses will be proposed (and students are allowed to propose their own topics). Towards the end of the semester, students present their progress on the chosen topics to the group. Grades will be based on this presentation (25%) and the final report (75%).

Organizational issues

Prerequisites

Students should have a very good working knowledge of statistics, including proficiency in a programming language for applied data analysis. The lecture VWL3 Introduction to Econometrics is a prerequisite for the project seminar. Most available software in the field is in R, but in principle Python can be used as well. Advanced knowledge of biology, medicine or epidemiology is not required.

Application Procedure

Please submit a transcript of records as well as a short letter of motivation (roughly 200 words) via WIWI-Portal: https://portal.wiwi.kit.edu/ys/8223

Application time frame: July 20th, 2024 to September, 30th, 2024.

V **Advanced Topics in Econometrics, Statistics and Data Science**
2500047, WS 24/25, 2 SWS, Language: German/English, Open in study portal
Seminar (S)

Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben

V **Topics in Econometrics**
2521310, WS 24/25, 2 SWS, Language: German, Open in study portal
Seminar (S)

Organizational issues

Blockveranstaltung, Termine werden auf Homepage und über Ilias bekannt gegeben

V

Advanced Topics in Econometrics

2521310, SS 2025, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben

T 6.249 Course: Seminar in Statistics B (Master) [T-WIWI-103484]

Responsible: Prof. Dr. Oliver Grothe
Prof. Dr. Melanie Schienle

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-102972 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
WT 24/25	25000111	Statistics and Epidemics		Seminar / 🗣	Bracher
WT 24/25	2500012		2 SWS	Seminar / 🗣	Grothe, Kaplan, Liu
WT 24/25	2500047	Advanced Topics in Econometrics, Statistics and Data Science	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher, Sobolová
WT 24/25	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Rüter
ST 2025	2500208	Statistics and Large Language Models	2 SWS	Seminar	Krüger, Eberl
ST 2025	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Buse, Rüter, Bracher, Eberl
ST 2025	2550561	Fortgeschrittene Themen zu Statistik, Datenanalyse und maschinellem Lernen (Master)	2 SWS	Seminar / 🗣	Grothe, Liu
Exams					
WT 24/25	79000111	Statistics and Epidemics			Bracher
WT 24/25	7900089	Seminar in Statistics B (Master)			Schienle
WT 24/25	7900090	Advanced Topics in Econometrics, Statistics and Data Science			Schienle
WT 24/25	7900241	Seminar in Statistics B (Master)			Grothe

Legend: 🖥 Online, ♲ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

Prerequisites
None.

Recommendation
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Annotation
The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: https://portal.wiwi.kit.edu.

Workload
90 hours

Below you will find excerpts from events related to this course:

V **Statistics and Epidemics**
25000111, WS 24/25, SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content

Motivation

Infectious disease epidemiology gives rise to a large variety of real-time data streams. During the COVID-19 pandemic, the interpretation and statistical analysis of these data has proven crucial, but also highly challenging. In this seminar, students will get to know central concepts of infectious disease surveillance and modelling from a statistical perspective. Following an overview of various aspects in the form of blocked lectures, students will choose a more specific topic for their seminar thesis.

Learning Goals

Students develop an understanding of central modeling tasks and methods, including

- estimation of reproductive numbers
- compartment models of disease spread
- nowcasting and short-term forecasting of disease spread
- detection of outbreaks
- diagnostic testing

Moreover, they get to know various data types commonly used in the analysis of disease spread.

Logistics

The project seminar is worth 4.5 credit points (Leistungspunkte). There will be three blocked lectures (approx. 135 minutes each) in the beginning of the lecture period. For the various topics covered, subjects for seminar theses will be proposed (and students are allowed to propose their own topics). Towards the end of the semester, students present their progress on the chosen topics to the group. Grades will be based on this presentation (25%) and the final report (75%).

Organizational issues

Prerequisites

Students should have a very good working knowledge of statistics, including proficiency in a programming language for applied data analysis. The lecture VWL3 Introduction to Econometrics is a prerequisite for the project seminar. Most available software in the field is in R, but in principle Python can be used as well. Advanced knowledge of biology, medicine or epidemiology is not required.

Application Procedure

Please submit a transcript of records as well as a short letter of motivation (roughly 200 words) via WIWI-Portal: https://portal.wiwi.kit.edu/ys/8223

Application time frame: July 20th, 2024 to September, 30th, 2024.

V **Advanced Topics in Econometrics, Statistics and Data Science**
2500047, WS 24/25, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Organizational issues
Blockveranstaltung, Termine werden bekannt gegeben

V **Topics in Econometrics**
2521310, WS 24/25, 2 SWS, Language: German, Open in study portal

Seminar (S)

Organizational issues
Blockveranstaltung, Termine werden auf Homepage und über Ilias bekannt gegeben

V

Advanced Topics in Econometrics

2521310, SS 2025, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben

T 6.250 Course: Seminar Mathematics [T-MATH-105686]

Responsible: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: M-MATH-102730 - Seminar

Type	Credits	Grading scale	Version
Completed coursework	3	pass/fail	1

Exams			
WT 24/25	7700048	Seminar Mathematics	Kühnlein

T 6.251 Course: Service Operations and Cyber Security [T-WIWI-114109]

Responsible: Esther Mohr
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-102805 - Service Operations

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	1

Exams			
ST 2025	00030	Service Operations and Cyber Security	Nickel

Competence Certificate
The assessment consists of a written paper and an oral exam of ca. 30-40 min.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-WIWI-102872 - Challenges in Supply Chain Management must not have been started.

Recommendation
Basic knowledge as conveyed in the module "Introduction to Operations Research" is assumed.

Annotation
The number of course participants is limited to 12 due to the collaborative work in project teams. As a result of this limitation, registration is required before the course begins. Further information can be found on the course's website.
The event takes place irregularly. The planned lectures and courses for the next three years will be announced online.

T 6.252 Course: Simulation Game in Energy Economics [T-WIWI-108016]

Responsible: Dr. Massimo Genoese
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3,5	Grade to a third	Each summer term	2

Events					
ST 2025	2581025	Simulation Game in Energy Economics	3 SWS	Lecture / Practice (/ 🗣	Genoese, Zimmermann

Legend: 🖥 Online, ✧ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Examination as written assignment and oral presentation (§4 (2), 1 SPO).

Prerequisites
None

Recommendation
Visiting the course "Introduction to Energy Economics"

Annotation
The number of participants is limited.
There is a registration procedure via CAS followed by a selection of the participants.

Below you will find excerpts from events related to this course:

V Simulation Game in Energy Economics
2581025, SS 2025, 3 SWS, Language: German, Open in study portal

Lecture / Practice (VÜ)
On-Site

Content

- Introduction
- Agents and market places in the electricity industry
- Selected planning tasks of energy service companies
- Methods of modelling in the energy sector
- Agent-based simulation: The PowerACE model
- Simulation game: Simulation in energy economics (electricity and emission trading, investment decisions)

The lecture is structured in a theoretical and a practical part. In the theoretical part, the students are taught the basics to carry out simulations themselves in the practical part which comprises amongst others the simulation of the power exchange. The participants of the simulation game take a role as a power trader in the power market. Based on various sources of information (e.g. prognosis of power prices, available power plants, fuel prices), they can launch bids in the power exchange.

Assessment: presentation and written summary

Prerequisites: Basics in Energy economics ad markets are advantageous.

Organizational issues
CIP-Pool West, Raum 102, Geb. 06.41 - siehe Institutsaushang

Literature
Weiterführende Literatur:

Möst, D. und Genoese, M. (2009): Market power in the German wholesale electricity market. The Journal of Energy Markets (47–74). Volume 2/Number 2, Summer 2009

T 6.253 Course: Smart Energy Infrastructure [T-WIWI-107464]

Responsible: Dr. Armin Ardone
Dr. Dr. Andrej Marko Pustisek

Organisation: KIT Department of Economics and Management

Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading scale	Recurrence	Version
Written examination	5,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2581023	(Smart) Energy Infrastructure	4 SWS	Lecture / 🗣	Ardone, Pustisek
Exams					
WT 24/25	7900178	Smart Energy Infrastructure NEW			Fichtner

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 minutes). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Workload
165 hours

Below you will find excerpts from events related to this course:

V (Smart) Energy Infrastructure
2581023, WS 24/25, 4 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
The lecture provides a techno-economic overview of different infrastructures of the energy system and their importance regarding the future energy system ("Energiewende") – in particular

- for electricity:
  - the supply side (e.g. power plants)
  - the demand side (e.g. load structures of appliances, flexibilities) as well as
  - transport infrastructures (electricity grids)
- for fuel transportation:
  - pipeline infrastructures (focus on natural gas)
  - shipping of LNG
  - crude oil and oil product transportation
  - hydrogen transportation
  - comparison of potential energy carriers for global trade of renewable energy (e.g., hydrogen and its derivates, e-fuels, reactive metals)
- storage systems (e.g. batteries)

Additionally, the lecture provides a toolbox for energy system analysis such as an overview and classification of energy systems modelling approaches as well as the usage of scenario techniques for energy systems analysis.

The lecture also provides practical examples for the relevant methods presented.

Organizational issues
Blockveranstaltung am 14.11., 15.11., 28.11., 29.11., 05.12., 06.12., 12.12., 13.12.24

T 6.254 Course: Smart Grid Applications [T-WIWI-107504]

Responsible: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-103720 - eEnergy: Markets, Services and Systems

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	see Annotations	2

Competence Certificate
The assessment consists of a written exam (60 min) (according to §4(2), 1 of the examination regulations). By successful completion of the exercises (§4 (2), 3 SPO 2007 respectively §4 (3) SPO 2015) a bonus can be obtained. If the grade of the written exam is at least 4.0 and at most 1.3, the bonus will improve it by one grade level (i.e. by 0.3 or 0.4).

Prerequisites
None

Recommendation
None

Annotation
The lecture will no longer be offered from the coming winter semester 2023/24. It is only possible to take part in the main exam (first-time writer) and follow-up exam (repeater).

T 6.255 Course: Sobolev Spaces [T-MATH-105896]

Responsible: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: M-MATH-102926 - Sobolev Spaces

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

Events					
ST 2025	0161150	Sobolev spaces	4 SWS	Lecture	Schnaubelt

Recommendation
Some basic knowledge of (elementary) linear functional analysis is strongly recommended.

Below you will find excerpts from events related to this course:

V Sobolev spaces
0161150 , SS 2025, 4 SWS, Language: English, Open in study portal

Lecture (V)

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.

T 6.256 Course: Social Choice Theory [T-WIWI-102859]

Responsible: Prof. Dr. Clemens Puppe
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101500 - Microeconomic Theory
M-WIWI-101504 - Collective Decision Making

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2025	2520537	Social Choice Theory	2 SWS	Lecture / 🗣	Puppe, Kretz
ST 2025	2520539	Übung zu Social Choice Theory	1 SWS	Practice / 🗣	Puppe, Kretz
Exams					
ST 2025	7900039	Social Choice Theory (main date)			Puppe
ST 2025	7900045	Social Choice Theory (make-up date)			Puppe

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The assessment consists of a written exam (60 min.). The examination is offered every summer semester.

Prerequisites
None

Below you will find excerpts from events related to this course:

V Social Choice Theory
2520537, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
How should (political) candidates be elected? What are good ways of merging individual judgments into collective judgments? Social Choice Theory is the systematic study and comparison of how groups and societies can come to collective decisions.

The course offers a rigorous and comprehensive treatment of judgment and preference aggregation as well as voting theory. It is divided into two parts. The first part deals with (general binary) aggregation theory and builds towards a general impossibility result that has the famous Arrow theorem as a corollary. The second part treats voting theory. Among other things, it includes prooving the Gibbard-Satterthwaite theorem.

Workload:
Total workload for 4.5 credit points: approx. 135 hours
Attendance: 30 hours
Self-study: 105 hours

Literature
Main texts:

- Moulin, H. 1988. *Axioms of Cooperative Decision Making*. Cambridge University Press.
- List, C. and Puppe, C. 2009. Judgement Aggregation. A survey. In: *The Handbook of rational & social choice*. P. Anand, P. Pattanaik, C. Puppe (Eds.). Oxford University Press.

Secondary texts:

- Sen, A. K. 1970. *Collective Choice and Social Welfare*. Holden-Day.
- Gaertner, W. 2009. *A Primer in Social Choice Theory*. Revised edition. Oxford University Press.
- Gaertner, W. 2001. *Domain Conditions in Social Choice Theory*. Cambridge University Press.

6.257 Course: Social Dimensions of Energy Transitions [T-WIWI-113935]

Responsible: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each summer term	1

Events					
ST 2025	2581051	Social Dimensions of Energy Transitions	2 SWS	Lecture / 🗣	Fichtner, Sloot

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
Written examination (60 minutes). The examination is offered every semester and can be repeated at any regular examination date.

Workload
105 hours

Below you will find excerpts from events related to this course:

Social Dimensions of Energy Transitions

2581051, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
Course topics:

Part I: Household energy use

1. Introduction: Energy use and human behavior
2. Bounded rationality and bias in decision-making
3. Identifying and measuring sustainable energy behavior
4. Financial incentives and demand response
5. Energy feedback
6. Social influence and energy behavior

Part II: Energy technology acceptance

7. Social acceptance of energy technologies
8. Efficacy and energy policy support
9. NIMBYism and local support for energy technologies
10. Framing, moral hazard and geoengineering
11. Political orientation
12. Public perceptions of energy security

T 6.258 Course: Sociotechnical Information Systems Development [T-WIWI-109249]

Responsible: Prof. Dr. Ali Sunyaev
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	2

Exams			
WT 24/25	7900080	Advanced Lab Development of Sociotechnical Information Systems (Bachelor)	Sunyaev
WT 24/25	7900143	Advanced Lab Development of Sociotechnical Information Systems (Master)	Sunyaev

Competence Certificate
The alternative exam assessment consists of an implementation and a final thesis documenting the development and use of the application.

Prerequisites
None.

Workload
135 hours

T 6.259 Course: Software Quality Management [T-WIWI-102895]

Responsible: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2025	2511208	Software Quality Management	2 SWS	Lecture / 🗣	Oberweis
ST 2025	2511209	Übungen zu Software-Qualitätsmanagement	1 SWS	Practice / 🗣	Oberweis
Exams					
WT 24/25	79AIFB_STQM_C1	Software Quality Management			Oberweis
ST 2025	79AIFB_STQM_A5	Software Quality Management (Registration until 21.07.2025)			Oberweis

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✗ Cancelled

Competence Certificate
The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation in the first week after lecture period.

Prerequisites
None

Below you will find excerpts from events related to this course:

V Software Quality Management
2511208, SS 2025, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
This lecture imparts fundamentals of active software quality management (quality planning, quality testing, quality control, quality assurance) and illustrates them with concrete examples, as currently applied in industrial software development. Keywords of the lecture content are: software and software quality, process models, software process quality, ISO 9000-3, CMM(I), BOOTSTRAP, SPICE, software tests.

Learning objectives:

Students

- explain the relevant quality models,
- apply methods to evaluate the software quality and evaluate the results,
- know the mail models of sofware certification, compare and evaluate these models,
- write scientific theses in the area of software quality management and find own solutions for given problems.

Recommendations:

Programming knowledge in Java and basic knowledge of computer science are expected.

Workload:

- Lecture 30h
- Exercise 15h
- Preparation of lecture 24h
- Preparation of exercises 25h
- Exam preparation 40h
- Exam 1h

Literature

- Helmut Balzert: Lehrbuch der Software-Technik. Spektrum-Verlag 2008
- Peter Liggesmeyer: Software-Qualität, Testen, Analysieren und Verifizieren von Software. Spektrum Akademischer Verlag 2002
- Mauro Pezzè, Michal Young: Software testen und analysieren. Oldenbourg Verlag 2009

Weitere Literatur wird in der Vorlesung bekanntgegeben.

T 6.260 Course: Space and Time Discretization of Nonlinear Wave Equations [T-MATH-112120]

Responsible: Prof. Dr. Marlis Hochbruck
Organisation: KIT Department of Mathematics
Part of: M-MATH-105966 - Space and Time Discretization of Nonlinear Wave Equations

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	6	Grade to a third	Irregular	1 terms	1

Prerequisites
none

Workload
180 hours

T 6.261 Course: Spatial Stochastics [T-MATH-105867]

Responsible: Prof. Dr. Daniel Hug
Prof. Dr. Günter Last
PD Dr. Steffen Winter

Organisation: KIT Department of Mathematics

Part of: M-MATH-102903 - Spatial Stochastics

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0105600	Spatial Stochastics	4 SWS	Lecture	Hug
WT 24/25	0105610	Tutorial for 0105600 (Spatial Stochastics)	2 SWS	Practice	Hug
Exams					
WT 24/25	7700052	Spatial Stochastics			Last, Hug

Prerequisites
none

Workload
240 hours

Below you will find excerpts from events related to this course:

V Spatial Stochastics

0105600, WS 24/25, 4 SWS, Language: English, Open in study portal

Lecture (V)

Content
Competence Goal:
The students are familiar with some basic spatial stochastic processes. They do not only understand how to deal with general properties of distributions, but also know how to describe and apply specific models (Poisson process, Gaussian random fields). They know how to work self-organised and self-reflexive.

Content:
Random sets
Point processes
Random measures
Palm distributions
Random fields
Gaussian fields
Spectral theory of random fields
Spatial ergodic theorem

Literature
Skriptum/Lectures Notes

T 6.262 Course: Special Topics in Information Systems [T-WIWI-113726]

Responsible: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-103720 - eEnergy: Markets, Services and Systems

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Competence Certificate
The assessment of this course is in form of a written documentation, a presentation of the outcome of the conducted practical components and an active participation in class.
Please take into account that, beside the written documentation, also a practical component (such as a survey or an implementation of an application) is part of the course. Please examine the course description for the particular tasks.

The overall grade is composed as follows:

A total of 60 points can be achieved, of which

- A maximum of 30 points for the written documentation
- A maximum of 30 points for the practical component

In order to pass the success control, at least 15 points (written documentation / practical component) must be achieved.

Prerequisites
see below

Recommendation
None

Annotation
All the practical seminars offered at the chair of Prof. Dr. Weinhardt can be chosen in the Special Topics in Information Systems course. The current topics of the practical seminars are available at the following homepage: www.iism.kit.edu/im/lehre.

The Special Topics Information Systems is equivalent to the practical seminar, as it was only offered for the major in “Information Systems” so far. With this course students majoring in “Industrial Engineering and Management“ and “Economics Engineering” also have the chance of getting practical experience and enhance their scientific capabilities.

The Special Topics Information Systems can be chosen instead of a regular lecture (see module description). Please take into account, that this course can only be accounted once per module.

T 6.263 Course: Special Topics of Numerical Linear Algebra [T-MATH-105891]

Responsible: PD Dr. Volker Grimm
Prof. Dr. Marlis Hochbruck
PD Dr. Markus Neher

Organisation: KIT Department of Mathematics

Part of: M-MATH-102920 - Special Topics of Numerical Linear Algebra

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2025	0160400	Topics in Numerical Linear Algebra	4 SWS	Lecture	Neher

Prerequisites
none

Workload
240 hours

Below you will find excerpts from events related to this course:

V Topics in Numerical Linear Algebra

0160400, SS 2025, 4 SWS, Language: English, Open in study portal

Lecture (V)

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

T 6.264 Course: Spectral Theory - Exam [T-MATH-103414]

Responsible: Prof. Dr. Dorothee Frey
PD Dr. Gerd Herzog
apl. Prof. Dr. Peer Kunstmann
Prof. Dr. Roland Schnaubelt
Dr. rer. nat. Patrick Tolksdorf

Organisation: KIT Department of Mathematics

Part of: M-MATH-101768 - Spectral Theory

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2025	0163700	Spectral Theory	4 SWS	Lecture	Reichel
ST 2025	0163710	Tutorial for 0163700 (Spectral Theory)	2 SWS	Practice	Reichel
Exams					
WT 24/25	0100017	Spectral Theory - Exam			Schnaubelt

Competence Certificate
Oral examination of approx. 30 minutes.

Prerequisites
none

Workload
240 hours

Below you will find excerpts from events related to this course:

V Spectral Theory

0163700, SS 2025, 4 SWS, Open in study portal

Lecture (V)

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.

T 6.265 Course: Splitting Methods for Evolution Equations [T-MATH-110805]

Responsible: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: M-MATH-105325 - Splitting Methods for Evolution Equations

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Events					
ST 2025	0160800	Splitting methods for evolution equations	3 SWS	Lecture / 🗣	Jahnke

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

Workload
180 hours

Below you will find excerpts from events related to this course:

V Splitting methods for evolution equations

0160800, SS 2025, 3 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

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).

T 6.266 Course: Statistical Learning [T-MATH-111726]

Responsible: Prof. Dr. Mathias Trabs
Organisation: KIT Department of Mathematics
Part of: M-MATH-105840 - Statistical Learning

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
WT 24/25	7700153	Statistical Learning	Ebner

Competence Certificate
The module will be completed with an oral exam (approx. 30 min).

Prerequisites
none

Recommendation
The module "Introduction to Stochastics" is recommended. The module "Probability theory" is preferable.

T 6.267 Course: Statistical Modeling of Generalized Regression Models [T-WIWI-103065]

Responsible: apl. Prof. Dr. Wolf-Dieter Heller
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2521350	Statistical Modeling of Generalized Regression Models	2 SWS	Lecture	Heller
Exams					
WT 24/25	7900011	Statistical Modeling of Generalized Regression Models			Heller
WT 24/25	7900146 (WS23/24)	Statistical Modeling of generalized regression models			Heller

Competence Certificate
The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation.

Prerequisites
The course T-MATH-105870 "Generalized Regression Models" must not have been selected.

Recommendation
Knowledge of the contents covered by the course "Economics III: Introduction in Econometrics" [2520016]

Below you will find excerpts from events related to this course:

V Statistical Modeling of Generalized Regression Models

2521350, WS 24/25, 2 SWS, Open in study portal

Lecture (V)

Content
Learning objectives:

The student has profound knowledge of generalized regression models.

Requirements:

Knowledge of the contents covered by the course *Economics III: Introduction in Econometrics" [2520016].*

Workload:

Total workload for 4.5 CP: approx. 135 hours

Attendance: 30 hours

Preparation and follow-up: 65 hours

T 6.268 Course: Steins Method with Applications in Statistics [T-MATH-111187]

Responsible: Dr. rer. nat. Bruno Ebner
Prof. Dr. Daniel Hug

Organisation: KIT Department of Mathematics

Part of: M-MATH-105579 - Steins Method with Applications in Statistics

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Exams			
WT 24/25	7700117	Steins Method with Applications in Statistics	Ebner

Prerequisites
none

T 6.269 Course: Stochastic Calculus and Finance [T-WIWI-103129]

Responsible: Dr. Mher Safarian
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2521331	Stochastic Calculus and Finance	2 SWS	Lecture	Safarian
WT 24/25	2521332	Übungen zu Stochastic Calculus and Finance	2 SWS	Practice	Safarian
Exams					
WT 24/25	7900225	Stochastic Calculus and Finance			Safarian

Competence Certificate
The assessment of this course consists of a written examination (§4(2), 1 SPOs, 180 min.).

Prerequisites
None

Annotation
For more information see http://statistik.econ.kit.edu/

Below you will find excerpts from events related to this course:

V Stochastic Calculus and Finance

2521331, WS 24/25, 2 SWS, Language: English, Open in study portal

Lecture (V)

Content
Learning objectives:

After successful completion of the course students will be familiar with many common methods of pricing and portfolio models in finance. Emphasis we be put on both finance and the theory behind it.

Content:

The course will provide rigorous yet focused training in stochastic calculus and mathematical finance. Topics to be covered:

1. Stochastic Calculus: Stochastic Processes, Brownian Motion and Martingales, Entropy, Stopping Times, Local martingales, Doob-Meyer Decomposition, Quadratic Variation, Stochastic Integration, Ito Formula, Girsanov Theorem, Jump-diffusion Processes, Stable and Levy processes.
2. Mathematical Finance: Pricing Models, The Black-Scholes Model, State prices and Equivalent Martingale Measure, Complete Markets and Redundant Security Prices, Arbitrage Pricing with Dividends, Term-Structure Models (One Factor Models, Cox-Ingersoll-Ross Model, Affine Models), Term-Structure Derivatives and Hedging, Mortgage-Backed Securities, Derivative Assets (Forward Prices, Future Contracts, American Options, Look-back Options), Incomplete Markets, Markets with Transaction Costs, Optimal Portfolio and Consumption Choice (Stochastic Control and Merton continuous time optimization problem, CAPM), Equilibrium models, Numerical Methods.

Workload:

Total workload for 4.5 CP: approx. 135 hours
Attendance: 30 hours
Preparation and follow-up: 65 hours

Organizational issues
Blockveranstaltung, Termine werden über Ilias bekannt gegeben

Literature

- Dynamic Asset Pricing Theory, Third Edition by D. Duffie, Princeton University Press, 1996
- Stochastic Calculus for Finance II: Continuous-Time Models by S. E. Shreve, Springer, 2003
- Stochastic Finance: An Introduction in Discrete Time by H. Föllmer, A. Schied, de Gruyter, 2011
- Methods of Mathematical Finance by I. Karatzas, S. E. Shreve, Springer, 1998
- Markets with Transaction Costs by Yu. Kabanov, M. Safarian, Springer, 2010
- Introduction to Stochastic Calculus Applied to Finance by D.Lamberton, B. Lapeyre, Chapman&Hall,1996

T 6.270 Course: Stochastic Control [T-MATH-105871]

Responsible: Prof. Dr. Nicole Bäuerle
Organisation: KIT Department of Mathematics
Part of: M-MATH-102908 - Stochastic Control

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Prerequisites
none

Workload
120 hours

T 6.271 Course: Stochastic Differential Equations [T-MATH-105852]

Responsible: Prof. Dr. Dorothee Frey
Prof. Dr. Roland Schnaubelt

Organisation: KIT Department of Mathematics

Part of: M-MATH-102881 - Stochastic Differential Equations

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T 6.272 Course: Stochastic Geometry [T-MATH-105840]

Responsible: Prof. Dr. Daniel Hug
Prof. Dr. Günter Last
PD Dr. Steffen Winter

Organisation: KIT Department of Mathematics

Part of: M-MATH-102865 - Stochastic Geometry

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2025	0152600	Stochastic Geometry	4 SWS	Lecture	Hug
ST 2025	0152610	Tutorial for 0152600 (Stochastic Geometry)	2 SWS	Practice	Hug

Below you will find excerpts from events related to this course:

V Stochastic Geometry

0152600, SS 2025, 4 SWS, Open in study portal

Lecture (V)

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.

T 6.273 Course: Stochastic Simulation [T-MATH-112242]

Responsible: TT-Prof. Dr. Sebastian Krumscheid
Organisation: KIT Department of Mathematics
Part of: M-MATH-106053 - Stochastic Simulation

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	1

Events					
WT 24/25	0100027	Stochastic Simulation	2 SWS	Lecture	Krumscheid
Exams					
WT 24/25	7700109	Stochastic Simulation			Krumscheid

Competence Certificate
oral exam of ca. 30 min

Prerequisites
none

Workload
150 hours

Below you will find excerpts from events related to this course:

V Stochastic Simulation

0100027, WS 24/25, 2 SWS, Open in study portal

Lecture (V)

Content
The course covers mathematical concepts and computational tools used to analyze systems with uncertainty arising across various application domains. First, we will address stochastic modelling strategies to represent uncertainty in such systems. Then we will discuss sampling-based methods to assess uncertain system outputs via stochastic simulation techniques. The focus of this course will be on the theoretical foundations of the discussed techniques, as well as their methodological realization as efficient computational tools.

Topics covered include:

- Random variable generation
- Simulation of random processes
- Simulation of Gaussian random fields
- Monte Carlo method; output analysis
- Variance reduction techniques
- Quasi Monte Carlo methods
- Markov Chain Monte Carlo methods (Metropolis-Hasting, Gibbs sampler)

Other topics that may be addressed if time allows, such as rare event simulations, and stochastic optimization using stochastic approximation or simulated annealing.

T 6.274 Course: Strategy and Management Theory: Developments and "Classics" [T-WIWI-106190]

Responsible: Prof. Dr. Hagen Lindstädt
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-103119 - Advanced Topics in Strategy and Management

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Irregular	1

Events					
WT 24/25	2577921	Strategy and Management Theory: Developments and "Classics" (Master)	2 SWS	Seminar / 🗣	Lindstädt
Exams					
WT 24/25	7900120	Strategy and Management Theory: Developments and "Classics"			Lindstädt

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The control of success according to § 4(2), 3 SPO takes place by writing a scientific work and a presentation of the results of the work in the context of a conclusion meeting. Details on the design of the performance review will be announced during the lecture.

Prerequisites
None

Recommendation
Basic knowledge as conveyed in the bachelor module „Strategy and Organization" is recommended.

Annotation
This course is admission restricted. If you were already admitted to another course in the module "Advanced Topics in Strategy and Management" the participation at this course will be guaranteed.

The course is planned to be held for the first time in the winter term 2017/18.

Workload
90 hours

Below you will find excerpts from events related to this course:

V Strategy and Management Theory: Developments and "Classics" (Master)
2577921, WS 24/25, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content

This course covers highly topical issues of great relevance to the management of organizations. Students will be enabled to take strategic management positions. By applying appropriate models from the fields of strategy and management - or models developed in-house - participants will learn to evaluate the strategic starting position of an organization and derive precise and well-founded recommendations for action based on this.

This course offers students the opportunity to explore current management issues and sharpen their skills in strategic analysis and evaluation. Through intensive collaboration and practical application of the knowledge learned, students are optimally prepared for the demands and challenges of modern business management.

Structure

The course begins with an overarching theme, based on which students are divided into groups of two. The core of the course consists of the preparation of a written paper as well as the presentation and discussion of the results.

Learning Objectives

Upon completion of the course, students will be able to,

- analyze complex business situations, think strategically and derive sound management decisions.
- compose clear and convincing written papers that accurately present the analyses and recommendations developed.
- present results in an engaging manner and actively participate in substantive discussions.

Recommendations:

Prior attendance of the Bachelor's module "Strategy and Organization" or another module with comparable content at another university is recommended.

Workload:

Total effort approx. 90 hours

Attendance time: 15 hours

Preparation and follow-up: 75 hours

Examination and preparation: not applicable

Verification:

The success control according to § 4(2), 3 SPO is done by writing a scientific paper and a presentation of the results of the paper in the context of a final event. Details on the design of the performance review will be announced during the lecture.

Annotation:

The course is admission restricted. In case of prior admission to another course in the module "Strategy and Management: Advanced Topics" [M-WIWI-103119], participation in this course is guaranteed. For more information on the application process, see the IBU website.

Exams are offered at least every other semester, so the entire module can be completed in two semesters.

Organizational issues

Termin am 22. Januar 2025 findet im Raum 2A-12.1 im Gebäude 05.20 am IBU statt.

6.275 Course: Structural Graph Theory [T-MATH-111004]

Responsible: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-105463 - Structural Graph Theory

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Prerequisites
none

T 6.276 Course: Supplement Enterprise Information Systems [T-WIWI-110346]

Responsible: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each term	1

Competence Certificate
The assessment of this course is a written or (if necessary) oral examination.

Prerequisites
None

Annotation
This course can be used in particular for the acceptance of external courses whose content is in the broader area of applied informatics, but is not equivalent to another course of this topic.

Workload
135 hours

T 6.277 Course: Supplement Software- and Systemsengineering [T-WIWI-110372]

Responsible: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each term	1

Competence Certificate
The assessment of this course is a written or (if necessary) oral examination.

Prerequisites
None

Annotation
This course can be used in particular for the acceptance of external courses whose content is in the broader area of software and systems engineering, but cannot assigned to another course of this topic.

T 6.278 Course: Tactical and Operational Supply Chain Management [T-WIWI-102714]

Responsible: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101413 - Applications of Operations Research

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2025	2550486	Tactical and operational SCM	3 SWS	Lecture / 🗣	Nickel
ST 2025	2550487	Übungen zu Taktisches und operatives SCM	1.5 SWS	Practice / 🗣	Pomes, Hoffmann
Exams					
WT 24/25	7900104	Tactical and Operational Supply Chain Management			Nickel

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
Depending on further pandemic developments, the exam will be offered either as an open-book exam, or as a written exam (60 min).

The exam takes place in every semester.

Prerequisite for admission to examination is the successful completion of the online assessments.

Prerequisites
Prerequisite for admission to examination is the succesful completion of the online assessments.

Recommendation
None

Annotation
The lecture is held in every summer term. The planned lectures and courses for the next three years are announced online.

Below you will find excerpts from events related to this course:

V Tactical and operational SCM
2550486, SS 2025, 3 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
The planning of material transport is an essential element of Supply Chain Management. By linking transport connections across different facilities, the material source (production plant) is connected with the material sink (customer). The general supply task can be formulated as follows (cf. Gudehus): For given material flows or shipments, choose the optimal (in terms of minimal costs) distribution and transportation chain from the set of possible logistics chains, which asserts the compliance of delivery times and further constraints. The main goal of the inventory management is the optimal determination of order quantities in terms of minimization of fixed and variable costs subject to resource constraints, supply availability and service level requirements. Similarly, the problem of lot sizing in production considers the determination of the optimal amount of products to be produced in a time slot. The course includes an introduction to basic terms and definitions of Supply Chain Management and a presentation of fundamental quantitative planning models for distribution, vehicle routing, inventory management and lot sizing. Furthermore, case
studies from practice will be discussed in detail.

Passing the online exercise is a prerequisite for admission to the exam.

Literature
Weiterführende Literatur

- Domschke: Logistik: Transporte, 5. Auflage, Oldenbourg, 2005
- Domschke: Logistik: Rundreisen und Touren, 4. Auflage, Oldenbourg, 1997
- Ghiani, Laporte, Musmanno: Introduction to Logistics Systems Planning and Control, Wiley, 2004
- Gudehus: Logistik, 3. Auflage, Springer, 2005
- Simchi-Levi, Kaminsky, Simchi-Levi: Designing and Managing the Supply Chain, 3rd edition, McGraw-Hill, 2008
- Silver, Pyke, Peterson: Inventory management and production planning and scheduling, 3rd edition, Wiley, 1998

T 6.279 Course: Time Series Analysis [T-MATH-105874]

Responsible: Dr. rer. nat. Bruno Ebner
Prof. Dr. Vicky Fasen-Hartmann
Prof. Dr. Tilmann Gneiting
PD Dr. Bernhard Klar
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: M-MATH-102911 - Time Series Analysis

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	3

Events					
ST 2025	0161100	Time Series Analysis	2 SWS	Lecture	Fasen-Hartmann
ST 2025	0161110	Tutorial for 0161100 (Time Series Analysis)	1 SWS	Practice	Fasen-Hartmann
Exams					
ST 2025	7700097	Time Series Analysis			Fasen-Hartmann
ST 2025	7700099	Time Series Analysis			Fasen-Hartmann
ST 2025	7700108	Time Series Analysis			Fasen-Hartmann

Workload
120 hours

Below you will find excerpts from events related to this course:

V Time Series Analysis

0161100, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)

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

T 6.280 Course: Topics in Algebraic Topology [T-MATH-114063]

Responsible: TT-Prof. Dr. Manuel Krannich
Organisation: KIT Department of Mathematics
Part of: M-MATH-107017 - Topics in Algebraic Topology

Type	Credits	Grading scale	Recurrence	Expansion	Version
Written examination	6	Grade to a third	Irregular	1 terms	1

Competence Certificate
written exam (120 min.)

Prerequisites
none

Workload
180 hours

T 6.281 Course: Topics in Experimental Economics [T-WIWI-102863]

Responsible: Prof. Dr. Johannes Philipp Reiß
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101505 - Experimental Economics

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Competence Certificate
The assessment consists of a written exam (following §4(2), 1 of the examination regulation).

Prerequisites
None

Recommendation
Basic knowledge of Experimental Economics is assumed. Therefore, it is strongly recommended to attend the course Experimental Economics beforehand.

Annotation
The course is offered in summer 2020 for the next time, not in summer 2018.

T 6.282 Course: Topics in Stochastic Optimization [T-WIWI-112109]

Responsible: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-101637 - Analytics and Statistics
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	1

Competence Certificate
Students will be given problem sets on which they work in groups. The problem sets will involve the implementation of the models presented in the course, and exploring features of these models. The groups will present their findings in front of the class. The grading will be based on the presentation.

Recommendation
A solid understanding of Stochastic Optimization and/or Optimization under Uncertainty as well as optimization in general is highly recommended, since we will heavily build upon basics of these areas.

Annotation
Teaching and learning format: Lecture and exercise

Workload
135 hours

T 6.283 Course: Topological Data Analysis [T-MATH-111031]

Responsible: Prof. Dr. Tobias Hartnick
Prof. Dr. Roman Sauer
Organisation: KIT Department of Mathematics
Part of: M-MATH-105487 - Topological Data Analysis

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Exams			
WT 24/25	7700079	Topological Data Analysis	Sauer

Prerequisites
none

T 6.284 Course: Translation Surfaces [T-MATH-112128]

Responsible: Prof. Dr. Frank Herrlich
Organisation: KIT Department of Mathematics
Part of: M-MATH-105973 - Translation Surfaces

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Prerequisites
none

Workload
240 hours

T 6.285 Course: Traveling Waves [T-MATH-105897]

Responsible: Dr. Björn de Rijk
Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-102927 - Traveling Waves

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	2

Competence Certificate
The module examination takes place in form of an oral exam of about 30 minutes. Please see under "Modulnote" for more information about the bonus regulation.

Prerequisites
none

Recommendation
The following background is strongly recommended: Analysis 1-4.

Workload
180 hours

T 6.286 Course: Trustworthy Emerging Technologies [T-WIWI-113026]

Responsible: Prof. Dr. Ali Sunyaev
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	1

Competence Certificate
Alternative exam assessment (§ 4(2), 3 SPO). Details will be announced in the respective course.

Workload
135 hours

T 6.287 Course: Uncertainty Quantification [T-MATH-108399]

Responsible: Prof. Dr. Martin Frank
Organisation: KIT Department of Mathematics
Part of: M-MATH-104054 - Uncertainty Quantification

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Events					
ST 2025	0164400	Uncertainty Quantification	2 SWS	Lecture	Frank
ST 2025	0164410	Tutorial for 0164400 (Uncertainty quantification)	1 SWS	Practice	Frank

Prerequisites
none

Below you will find excerpts from events related to this course:

V Uncertainty Quantification
0164400, SS 2025, 2 SWS, Language: English, Open in study portal

Lecture (V)

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.

Organizational issues
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.

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.

T 6.288 Course: Valuation [T-WIWI-102621]

Responsible: Prof. Dr. Martin Ruckes
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101482 - Finance 1
M-WIWI-101483 - Finance 2

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2530212	Valuation	2 SWS	Lecture / 🗣	Ruckes
WT 24/25	2530213	Übungen zu Valuation	1 SWS	Practice / 🗣	Ruckes, Luedecke
Exams					
WT 24/25	7900057	Valuation			Ruckes
ST 2025	7900072	Valuation			Ruckes

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
See German version.

Prerequisites
None

Recommendation
None

Below you will find excerpts from events related to this course:

V Valuation
Lecture (V)
On-Site

2530212, WS 24/25, 2 SWS, Language: English, Open in study portal

Literature
Weiterführende Literatur

Titman/Martin (2013): *Valuation - The Art and Science of Corporate Investment Decisions*, 2nd. ed. Pearson International.

T 6.289 Course: Variational Methods [T-MATH-110302]

Responsible: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-105093 - Variational Methods

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
WT 24/25	7700104	Variational Methods	Lamm, Lewintan

T 6.290 Course: Wavelets [T-MATH-105838]

Responsible: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-102895 - Wavelets

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Competence Certificate
Mündliche Prüfung im Umfang von ca. 30 Minuten.

Prerequisites
none

Workload
240 hours

T 6.291 Course: Web App Programming for Finance [T-WIWI-110933]

Responsible: TT-Prof. Dr. Julian Thimme
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-101480 - Finance 3

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Once	1

Competence Certificate
Non exam assessment according to § 4 paragraph 3 of the examination regulation. (Anmerkung: gilt nur für SPO 2015). The grade is made up as follows: 50% result of the project (R-code), 50% presentation of the project.

Prerequisites
None

Recommendation
The content of the bachelor course Investments is assumed to be known and necessary to follow the course.

Workload
135 hours

T 6.292 Course: Workshop Business Wargaming – Analyzing Strategic Interactions [T-WIWI-106189]

Responsible: Prof. Dr. Hagen Lindstädt
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-103119 - Advanced Topics in Strategy and Management

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Irregular	1

Events					
WT 24/25	2577922	Workshop Business Wargaming - Analyse strategischer Interaktionen (Master)	2 SWS	Seminar / 🗣	Lindstädt
ST 2025	2577922	Workshop Business Wargaming - Analyse strategischer Interaktionen (Master)	2 SWS	Seminar / 🗣	Lindstädt
Exams					
WT 24/25	7900172	Workshop Business Wargaming – Analyzing Strategic Interactions			Lindstädt

Legend: 🖥 Online, Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Competence Certificate
In this course, real conflict situations are simulated and analyzed using various methods from business wargaming. Details on the design of the performance review will be announced during the lecture.

Prerequisites
None

Recommendation
Basic knowledge as conveyed in the bachelor module „Strategy and Organization“ is recommended.

Annotation
This course is admission restricted. If you were already admitted to another course in the module “Advanced Topics in Strategy and Management” the participation at this course will be guaranteed.

The course is planned to be held for the first time in the summer term 2018.

Workload
90 hours

Below you will find excerpts from events related to this course:

V Workshop Business Wargaming - Analyse strategischer Interaktionen (Master)
2577922, WS 24/25, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content

This course enables the simulation of strategic conflicts in which the participants assume the roles of selected actors. With the help of specially programmed wargaming software, strategic conflicts are simulated interactively and then reflected upon and discussed.

The course focuses on the simulation and analysis of real conflict situations with strategic interaction. Students gain a better understanding of the structural characteristics of strategic conflicts in the fields of economics and politics as well as the ability to derive their own strategies for action.

Through a combination of group work, simulation, and reflection, the seminar provides a learning experience that both strengthens team skills and develops analytical skills in strategic conflict. Join this seminar to gain sound insights into conflict dynamics and develop effective action strategies for complex situations.

Learning Objectives

Upon completion of the course, students will be able to,

- learn the basic methodologies, features and benefits of business wargaming
- improve their understanding of conflict dynamics by reflecting on strategic conflicts
- Strengthen analytical skills by processing a variety of courses of action and deriving strategies for action

Recommendations:

Prior attendance of the Bachelor's module "Strategy and Organization" or another module with comparable content at another university is recommended.

Workload:

- Total workload: approx. 90 hours
- Attendance time: 15 hours
- Preparation and follow-up: 75 hours
- Examination and preparation: not applicable

Evidence:

In this course, real conflict situations are simulated and analyzed with the help of various methods from business wargaming. Details on the design of the performance review will be announced during the lecture.

Annotation:

The course is admission restricted. In case of prior admission to another course in the module "Strategy and Management: Advanced Topics" [M-WIWI-103119], participation in this course is guaranteed. For more information on the application process, see the IBU website.

Exams are offered at least every other semester, so the entire module can be completed in two semesters.

Organizational issues

IBU-Seminarraum, Geb. 05.20, Raum 2A-12.1

V **Workshop Business Wargaming - Analyse strategischer Interaktionen (Master)**
2577922, SS 2025, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content

This course enables the simulation of strategic conflicts in which the participants assume the roles of selected actors. With the help of specially programmed wargaming software, strategic conflicts are simulated interactively and then reflected upon and discussed.

The course focuses on the simulation and analysis of real conflict situations with strategic interaction. Students gain a better understanding of the structural characteristics of strategic conflicts in the fields of economics and politics as well as the ability to derive their own strategies for action.

Through a combination of group work, simulation, and reflection, the seminar provides a learning experience that both strengthens team skills and develops analytical skills in strategic conflict. Join this seminar to gain sound insights into conflict dynamics and develop effective action strategies for complex situations.

Learning Objectives

Upon completion of the course, students will be able to,

- learn the basic methodologies, features and benefits of business wargaming
- improve their understanding of conflict dynamics by reflecting on strategic conflicts
- Strengthen analytical skills by processing a variety of courses of action and deriving strategies for action

Recommendations:

Prior attendance of the Bachelor's module "Strategy and Organization" or another module with comparable content at another university is recommended.

Workload:

- Total workload: approx. 90 hours
- Attendance time: 15 hours
- Preparation and follow-up: 75 hours
- Examination and preparation: not applicable

Evidence:

In this course, real conflict situations are simulated and analyzed with the help of various methods from business wargaming. Details on the design of the performance review will be announced during the lecture.

Annotation:

The course is admission restricted. In case of prior admission to another course in the module "Strategy and Management: Advanced Topics" [M-WIWI-103119], participation in this course is guaranteed. For more information on the application process, see the IBU website.

Exams are offered at least every other semester, so the entire module can be completed in two semesters.

Organizational issues

IBU-Seminarraum, Geb. 05.20, Raum 2A-12.1

T 6.293 Course: Workshop Current Topics in Strategy and Management [T-WIWI-106188]

Responsible: Prof. Dr. Hagen Lindstädt
Organisation: KIT Department of Economics and Management
Part of: M-WIWI-103119 - Advanced Topics in Strategy and Management

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Irregular	1

Events					
ST 2025	2577923	Workshop aktuelle Themen Strategie und Management (Master)	2 SWS	Seminar / 🗣	Lindstädt

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Competence Certificate
The evaluation of the performance takes place through the active participation in the discussion rounds; an appropriate preparation is expressed here and a clear understanding of the topic and framework becomes recognizable. Further details on the design of the performance review will be announced during the lecture.

Prerequisites
None

Recommendation
Basic knowledge as conveyed in the bachelor module „Strategy and Organization" is recommended.

Annotation
This course is admission restricted. If you were already admitted to another course in the module "Advanced Topics in Strategy and Management" the participation at this course will be guaranteed.

The course is planned to be held for the first time in the winter term 2017/18.

Workload
90 hours

Below you will find excerpts from events related to this course:

V Workshop aktuelle Themen Strategie und Management (Master)

Seminar (S)
On-Site

2577923, SS 2025, 2 SWS, Language: German, Open in study portal

Content

Aspects of strategic management can be found in a variety of daily events. In this course, current strategic and industrial policy issues are discussed and the exchange of ideas on current management topics is promoted.

For this purpose, practice-relevant case studies and dedicated questions are communicated to the students in advance so that they can prepare themselves individually for the discussion. The chair team actively moderates the discussion and creates typical discussion situations such as pro/con discussions and conflicting interests of different groups in order to bring opposing opinions into an exchange and to promote the power of argumentation. In this way, the discussion not only imparts knowledge about the content, but also strengthens the participants' skills by simulating real discussion situations in a management team.

In addition, company representatives and managers participate in individual case studies to strengthen the context of the content and experience the daily dynamics of discussion in strategic business areas.

Learning Objectives:

Students will

- are able to evaluate strategic decisions using appropriate models of strategic business management,
- are able to present and critically evaluate theoretical approaches and models in the field of strategic business management and illustrate them using practical examples, and
- have the ability to present their position convincingly through a reasoned argumentation in structured discussions.

Recommendations:

Previous attendance of the Bachelor's module "Strategy and Organization" or another module with comparable content at another university is recommended.

Workload:

Total effort approx. 90 hours

Attendance time: 15 hours

Preparation and follow-up: 75 hours

Examination and preparation: not applicable

Evidence:

Performance will be assessed through active discussion participation in the discussion rounds; here, adequate preparation will be expressed and a clear understanding of the topic and framework will be evident. Further details on the design of the performance assessment will be announced during the lecture.

Annotation:

This course is admission restricted. In case of prior admission to another course in the module "Strategy and Management: Advanced Topics"[M-WIWI-103119], participation in this course is guaranteed. For more information on the application process, see the IBU website.

Exams are offered at least every other semester so that the entire module can be completed in two semesters.