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Module Handbook Economathematics M.Sc.

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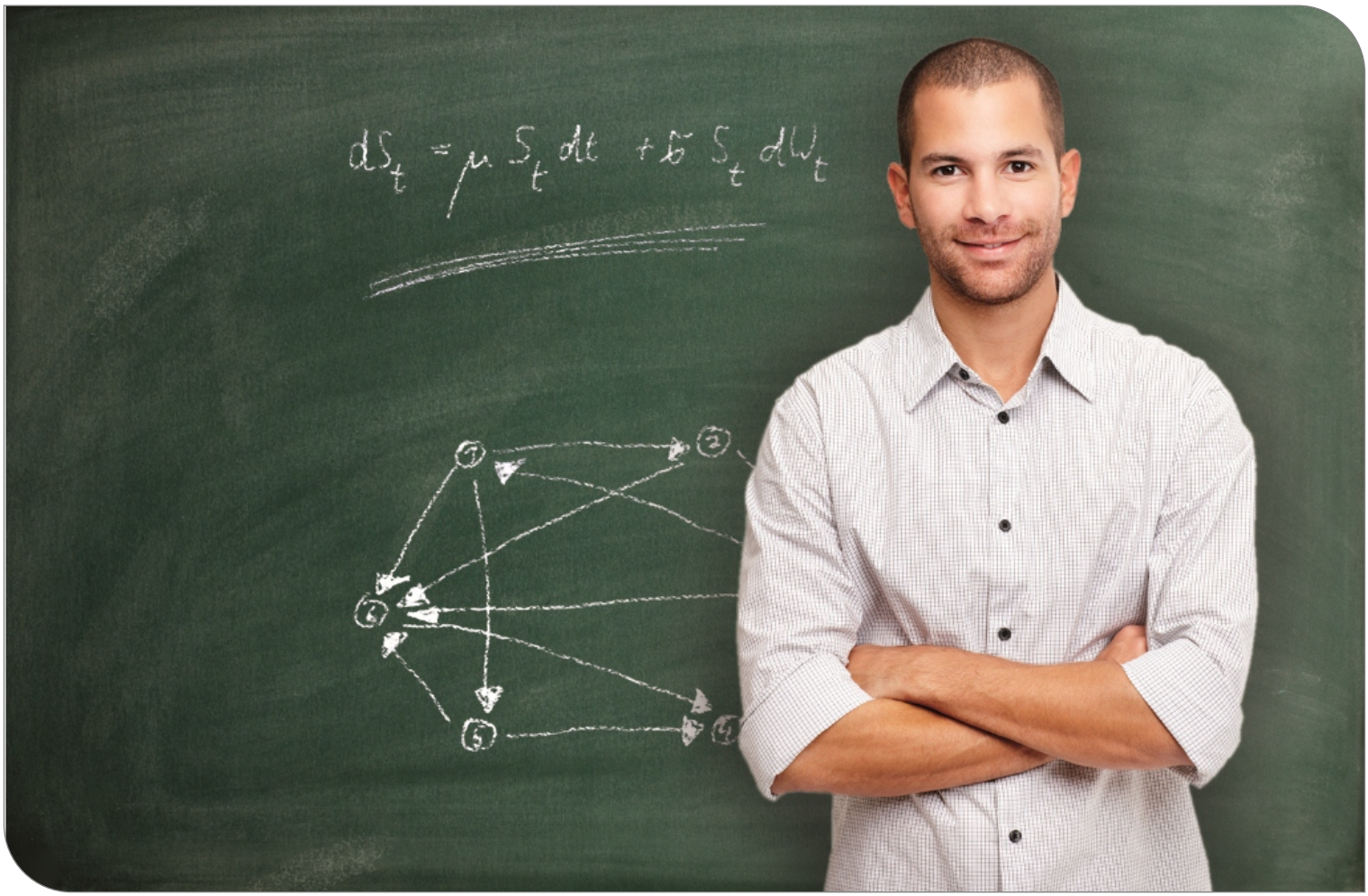
KIT DEPARTMENT OF BUSINESS AND ECONOMICS / KIT DEPARTMENT OF MATHEMATICS



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4.255. Statistical Learning - T-MATH-111726 603
4.256. Statistical Modeling of Generalized Regression Models - T-WIWI-103065 604
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1 The Module Handbook: Your Guide Through Your Studies

Welcome to the **Module Handbook** for your study program at the KIT Department of Economics and Management. We are delighted to have you join us and wish you a successful start to the new semester! This handbook provides an essential introduction to the key terms and regulations governing the selection of modules, courses, and examinations within your program.

Your study program is structured around several disciplines (e.g., Business Administration, Economics, Operations Research). Each discipline is further divided into **modules**, with each module comprising one or more interrelated components that often lead to an examination. The scope of each module is defined by **Credit Points (CP)**, which are awarded upon successful completion. While some modules are compulsory, the program's interdisciplinary nature offers a wide range of individual specialization and deepening opportunities within many modules. This flexibility allows you to tailor the content and timeline of your studies according to your personal interests, career aspirations, and needs.

This module handbook serves as a comprehensive guide to the modules within your program. Specifically, it details:

- The **structure** of the modules
- Their **scope** (in CP)
- Module **dependencies**
- Expected **learning outcomes**
- **Assessment methods** and examinations

This handbook is an essential orientation and a helpful guide throughout your studies. Please note that it **complements, but does not replace, the course catalog**, which provides semester-specific and variable course details such as timetables and locations.

1.1 Module Selection and Completion

Each module and each examination can only be selected once. If an examination is selectable within multiple modules, the student's decision on its assignment to a specific module is made at the moment of registration for that examination.

A module is considered completed and passed when its module examination is successfully passed (achieving a grade of 4.0 or better). For modules where the module examination is subdivided into several partial examinations, the module is completed only when all necessary partial examinations have been successfully passed. If a module offers alternative partial examinations, the module examination is considered concluded with the examination that leads to or exceeds the required total credit points. The module grade, reflecting the weight of its predefined credit points, is then included in the overall grade calculation for the study program.

1.2 Module Versions and Revisions

Modules are periodically revised, for instance, due to the introduction of new courses or the cancellation of existing examinations. As a rule, a new module version is created, which applies to all students who are newly starting the module. Students who have already commenced a module, however, are generally "grandfathered" and remain subject to the conditions of the module version valid at the time they began. These students can complete the module under the same conditions as at the beginning (exceptions are regulated by the Examination Board). The decisive date for this is the student's "binding declaration" regarding the choice of the module, as defined by §5(2) of the Study and Examination Regulations. This binding declaration is established by registering for the first examination within that module.

1.3 Accessing Module Handbook Versions

All modules in this handbook are presented in their current version, with the version number indicated in each module description. Older module versions can be accessed via previous module handbooks in the archive at: http://www.wiwi.kit.edu/Archiv_MHB.php.

1.4 Examination Formats and Registration

Module examinations can be taken either as a comprehensive general examination or as partial examinations. If offered as a general examination, the entire learning content of the module will be assessed in a single examination. If the module examination is subdivided, the content of each constituent course will be examined in corresponding partial examinations.

Registration for examinations can be done online via the campus management portal. The following functions are available at https://campus.studium.kit.edu/:

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

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

1.5 Grading, Repetition Rules, and Types of Assessment

Examinations are categorized into written examinations, oral examinations, and alternative assessment types ("Prüfungsleistungen anderer Art"). All examinations are graded. Ungraded coursework ("Studienleistungen"), on the other hand, can be repeated multiple times and do not receive a grade.

Generally, a failed written exam, oral exam, or alternative assessment can be repeated only once. Should this repeat examination (including any provided oral repeat examination) also be failed, the right to take the examination is forfeited. A request for a second repetition must be submitted in writing to the Examination Board two months after forfeiting the examination right. For more information, please see: http://www.wiwi.kit.edu/hinweiseZweitwdh.php.

1.6 Examiners

The Examination Board has appointed the KIT examiners and lecturers listed in this module handbook for the modules and their respective courses as official examiners for the courses they offer.

1.7 Additional Achievements

Additional achievements are voluntarily undertaken graded assessments that do not impact the student's overall grade. They can pertain to single courses or entire modules. It is mandatory to declare an additional achievement as such at the time of registration for the respective assessment. Additional achievements totaling at most 30 CP may be listed on the final certificate.

1.8 Important Resources and Legal Framework

For current information regarding your studies at the KIT Department of Economics and Management, please visit our website www.wiwi.kit.edu, as well as our channels on Instagram, LinkedIn, and YouTube. Please also consult the current notices and announcements for students at: https://www.wiwi.kit.edu/studium.php.

Comprehensive information regarding the legal and regulatory framework of your study program can be found in the respective study and examination regulations. These documents are available under the Official Announcements of KIT at: http://www.sle.kit.edu/amtlicheBekanntmachungen.php.

1.9 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
Sophie Wieczorek
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:

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Editorial responsibility:

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

2 Study Program Structure

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

2.1 Master's Thesis

Credits
30

Mandatory				
M-MATH-102917	Master's Thesis		WS+SS	30 CP

2.2 Mathematical Methods

Credits
36

Stochastics (Election: at least 8 credits)				
M-MATH-102860	Continuous Time Finance		SS	8 CP
M-MATH-102865	Stochastic Geometry		SS	8 CP
M-MATH-102903	Spatial Stochastics		WS	8 CP
M-MATH-102904	Brownian Motion		Irreg.	4 CP
M-MATH-102905	Percolation	DE/EN	Irreg.	5 CP
M-MATH-102906	Generalized Regression Models		Irreg.	4 CP
M-MATH-102907	Markov Decision Processes		Irreg.	5 CP
M-MATH-102908	Stochastic Control		Irreg.	4 CP
M-MATH-102909	Mathematical Statistics		WS	8 CP
M-MATH-102910	Nonparametric Statistics		Irreg.	4 CP
M-MATH-102911	Time Series Analysis		SS	4 CP
M-MATH-102919	Discrete Time Finance		WS	8 CP
M-MATH-102922	Poisson Processes		Irreg.	5 CP
M-MATH-102939	Extreme Value Theory		Irreg.	4 CP
M-MATH-102947	Probability Theory and Combinatorial Optimization		Irreg.	8 CP
M-MATH-102956	Forecasting: Theory and Practice	EN	Irreg.	8 CP
M-MATH-104055	Ruin Theory		Irreg.	4 CP
M-MATH-105101	Introduction to Homogeneous Dynamics		Irreg.	6 CP
M-MATH-105487	Topological Data Analysis		Irreg.	6 CP
M-MATH-105579	Steins Method with Applications in Statistics	DE/EN	Irreg.	4 CP
M-MATH-105649	Fractal Geometry	DE/EN	Irreg.	6 CP
M-MATH-102864	Convex Geometry		Irreg.	8 CP
M-MATH-105840	Statistical Learning		SS	8 CP
M-MATH-106045	Introduction to Stochastic Differential Equations	EN	Irreg.	4 CP
M-MATH-106052	Random Graphs and Networks	EN	Irreg.	8 CP
M-MATH-106485	Functional Data Analysis	EN	Irreg.	4 CP
Analysis or Applied and Numerical Mathematics, Optimization (Election: at least 8 credits)				
M-MATH-101320	Functional Analysis	DE	WS	8 CP
M-MATH-101768	Spectral Theory	DE	SS	8 CP
M-MATH-102870	Classical Methods for Partial Differential Equations		WS	8 CP
M-MATH-102871	Boundary and Eigenvalue Problems		SS	8 CP
M-MATH-102872	Evolution Equations	DE/EN	see notes	8 CP
M-MATH-102874	Integral Equations		Irreg.	8 CP
M-MATH-102878	Complex Analysis		Irreg.	8 CP
M-MATH-102879	Potential Theory		Irreg.	8 CP
M-MATH-102883	Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems	DE/EN	Irreg.	8 CP
M-MATH-102885	Maxwell's Equations		Irreg.	8 CP
M-MATH-102890	Inverse Problems		WS	8 CP
M-MATH-102924	Optimization in Banach Spaces		Irreg.	5 CP
M-MATH-102926	Sobolev Spaces	DE/EN	Irreg.	8 CP
M-MATH-102927	Traveling Waves	EN	Irreg.	6 CP
M-MATH-102941	Control Theory	DE/EN	Irreg.	6 CP
M-MATH-103080	Dynamical Systems	DE	Irreg.	8 CP
M-MATH-103259	Bifurcation Theory		Irreg.	5 CP
M-MATH-103539	Nonlinear Analysis		Irreg.	8 CP
M-MATH-102884	Scattering Theory		Irreg.	8 CP
M-MATH-104059	Mathematical Topics in Kinetic Theory		Irreg.	4 CP
M-MATH-104425	Dispersive Equations		Irreg.	6 CP
M-MATH-104435	Selected Topics in Harmonic Analysis		Irreg.	3 CP

M-MATH-101338	Parallel Computing	DE/EN	Irreg.	5 CP
M-MATH-102888	Numerical Methods for Differential Equations	DE	WS	8 CP
M-MATH-102889	Introduction to Scientific Computing		SS	8 CP
M-MATH-102891	Finite Element Methods	EN	WS	8 CP
M-MATH-102892	Numerical Optimisation Methods		Irreg.	8 CP
M-MATH-102894	Numerical Methods in Computational Electrodynamics	DE	Irreg.	6 CP
M-MATH-102895	Wavelets		Irreg.	8 CP
M-MATH-102897	Mathematical Methods in Signal and Image Processing		Irreg.	8 CP
M-MATH-102899	Optimisation and Optimal Control for Differential Equations		Irreg.	4 CP
M-MATH-102900	Adaptive Finite Elemente Methods		Irreg.	8 CP
M-MATH-102901	Numerical Methods in Mathematical Finance	DE/EN	see notes	8 CP
M-MATH-102915	Numerical Methods for Hyperbolic Equations	DE/EN	Irreg.	6 CP
M-MATH-102920	Special Topics of Numerical Linear Algebra	EN	see notes	8 CP
M-MATH-102921	Geometric Numerical Integration		Irreg.	6 CP
M-MATH-102928	Numerical Methods for Time-Dependent Partial Differential Equations		Irreg.	8 CP
M-MATH-102929	Mathematical Modelling and Simulation in Practise	EN	Irreg.	4 CP
M-MATH-102930	Numerical Methods for Integral Equations		Irreg.	8 CP
M-MATH-102931	Numerical Methods for Maxwell's Equations		Irreg.	6 CP
M-MATH-102932	Numerical Methods in Fluid Mechanics	EN	SS	4 CP
M-MATH-102935	Compressive Sensing		Irreg.	5 CP
M-MATH-102936	Functions of Operators		Irreg.	6 CP
M-MATH-102937	Functions of Matrices		Irreg.	8 CP
M-MATH-106634	Computational Fluid Dynamics and Simulation Lab	DE/EN	SS	4 CP
M-MATH-102943	Introduction into Particulate Flows		Once	3 CP
M-MATH-102955	Advanced Inverse Problems: Nonlinearity and Banach Spaces		Irreg.	5 CP
M-MATH-103260	Mathematical Methods of Imaging		Irreg.	5 CP
M-MATH-103527	Foundations of Continuum Mechanics		Once	4 CP
M-MATH-103700	Exponential Integrators		Irreg.	6 CP
M-MATH-103919	Introduction to Kinetic Theory	EN	WS	4 CP
M-MATH-104054	Uncertainty Quantification	EN	SS	4 CP
M-MATH-104058	Numerical Linear Algebra in Image Processing		Irreg.	6 CP
M-MATH-103540	Boundary Element Methods		Irreg.	8 CP
M-MATH-102887	Monotonicity Methods in Analysis		Irreg.	3 CP
M-MATH-105066	Nonlinear Maxwell Equations	DE/EN	Irreg.	8 CP
M-MATH-105101	Introduction to Homogeneous Dynamics		Irreg.	6 CP
M-MATH-105093	Variational Methods		Irreg.	8 CP
M-MATH-105324	Harmonic Analysis	DE/EN	Irreg.	8 CP
M-MATH-105325	Splitting Methods for Evolution Equations		Irreg.	6 CP
M-MATH-105326	Nonlinear Wave Equations	DE/EN	Irreg.	4 CP
M-MATH-105327	Numerical Simulation in Molecular Dynamics	DE	Irreg.	8 CP
M-MATH-105432	Discrete Dynamical Systems	DE	Irreg.	3 CP
M-MATH-105487	Topological Data Analysis		Irreg.	6 CP
M-MATH-105636	Analytical and Numerical Homogenization	EN	Irreg.	6 CP
M-MATH-105650	Introduction to Fluid Dynamics		Irreg.	3 CP
M-MATH-105837	Introduction to Kinetic Equations	EN	Irreg.	3 CP
M-MATH-105838	Introduction to Microlocal Analysis	EN	Irreg.	3 CP
M-MATH-105897	Selected Methods in Fluids and Kinetic Equations	EN	Irreg.	3 CP
M-MATH-105964	Introduction to Convex Integration	EN	Irreg.	3 CP
M-MATH-105966	Space and Time Discretization of Nonlinear Wave Equations	EN	Irreg.	6 CP
M-MATH-106053	Stochastic Simulation	EN	WS	5 CP

M-MATH-106063	Numerical Complex Analysis	DE	Irreg.	6 CP
M-MATH-106328	Bayesian Inverse Problems with Connections to Machine Learning	EN	SS	4 CP
M-MATH-106401	Introduction to Fluid Mechanics	EN	Irreg.	6 CP
M-MATH-106486	Harmonic Analysis 2	EN	Irreg.	8 CP
M-MATH-106591	Introduction to Dynamical Systems	DE/EN	Irreg.	6 CP
M-MATH-106640	Modelling and Simulation of Lithium-Ion Batteries	EN	Irreg.	4 CP
M-MATH-106664	Scattering Theory for Time-dependent Waves	DE/EN	Irreg.	6 CP
M-MATH-106667	Geometric Variational Problems	DE/EN	Irreg.	8 CP
M-MATH-106666	Minimal Surfaces	DE	Irreg.	3 CP
M-MATH-106663	Semigroup Theory for the Navier-Stokes Equations	EN	Irreg.	6 CP
M-MATH-106696	Regularity for Elliptic Operators	EN	Irreg.	6 CP
M-MATH-106695	Numerical Analysis of Neural Networks	EN	Irreg.	6 CP
M-MATH-106682	Numerical Methods for Oscillatory Differential Equations	DE/EN	see notes	8 CP
M-MATH-106822	Advanced Methods in Nonlinear Partial Differential Equations	EN	Irreg.	3 CP
M-MATH-106836	MathSEE Modeling Week	EN	WS	3 CP
M-MATH-107456	Interpolation Spaces	DE/EN	Irreg.	6 CP
M-MATH-107646	Numerical Analysis on Quantum Computers neu	EN	Irreg.	6 CP
M-MATH-107647	Galerkin Methods for Time-dependent PDEs neu	EN	Irreg.	5 CP
Algebra and Geometry (Election: at most 20 credits)				
M-MATH-101315	Algebra		see notes	8 CP
M-MATH-101317	Differential Geometry	DE/EN	Irreg.	8 CP
M-MATH-101336	Graph Theory	EN	see notes	8 CP
M-MATH-101724	Algebraic Geometry		Irreg.	8 CP
M-MATH-101725	Algebraic Number Theory		Irreg.	8 CP
M-MATH-102864	Convex Geometry		Irreg.	8 CP
M-MATH-102867	Geometric Group Theory	EN	see notes	8 CP
M-MATH-102948	Algebraic Topology	DE/EN	see notes	8 CP
M-MATH-102949	Introduction to Geometric Measure Theory	DE/EN	Irreg.	6 CP
M-MATH-102950	Combinatorics	EN	see notes	8 CP
M-MATH-102957	Extremal Graph Theory	EN	Irreg.	8 CP
M-MATH-102865	Stochastic Geometry		SS	8 CP
M-MATH-102866	Geometry of Schemes		Irreg.	8 CP
M-MATH-102912	Global Differential Geometry	DE/EN	Irreg.	8 CP
M-MATH-102953	Algebraic Topology II	DE/EN	Irreg.	8 CP
M-MATH-104261	Lie Groups and Lie Algebras	DE	see notes	8 CP
M-MATH-105101	Introduction to Homogeneous Dynamics		Irreg.	6 CP
M-MATH-105463	Structural Graph Theory	EN	Irreg.	4 CP
M-MATH-105487	Topological Data Analysis		Irreg.	6 CP
M-MATH-105649	Fractal Geometry	DE/EN	Irreg.	6 CP
M-MATH-106950	Lie-Algebras	DE	see notes	8 CP
M-MATH-105931	Metric Geometry	DE	see notes	8 CP
M-MATH-105973	Translation Surfaces	DE	Irreg.	8 CP
M-MATH-106466	Riemann Surfaces	DE	Irreg.	8 CP
M-MATH-106473	Ergodic Theory	DE	Irreg.	8 CP
M-MATH-106632	Curves on Surfaces	EN	Irreg.	3 CP
M-MATH-106776	Complex Geometry	EN	Irreg.	6 CP
M-MATH-106957	Modern Methods in Combinatorics	EN	Irreg.	6 CP
M-MATH-107017	Topics in Algebraic Topology	EN	Irreg.	6 CP
M-MATH-107387	Class Field Theory	DE	Irreg.	8 CP
M-MATH-107484	Topics in Homotopy Theory	EN	Irreg.	6 CP

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	EN	WS+SS	9 CP
M-WIWI-101637	Analytics and Statistics	DE	WS+SS	9 CP
M-WIWI-101504	Collective Decision Making	EN	WS+SS	9 CP
M-WIWI-105032	Data Science for Finance	EN	WS	9 CP
M-WIWI-101647	Data Science: Evidence-based Marketing	EN	WS+SS	9 CP
M-WIWI-106258	Digital Marketing	EN	WS+SS	9 CP
M-WIWI-103720	eEnergy: Markets, Services and Systems	DE	WS+SS	9 CP
M-WIWI-102970	Decision and Game Theory	DE	WS	9 CP
M-WIWI-101505	Experimental Economics	DE/EN	WS+SS	9 CP
M-WIWI-101482	Finance 1	DE/EN	WS+SS	9 CP
M-WIWI-101483	Finance 2	DE/EN	WS+SS	9 CP
M-WIWI-101480	Finance 3	DE/EN	WS+SS	9 CP
M-WIWI-105894	Foundations for Advanced Financial -Quant and -Machine Learning Research	EN	see notes	9 CP
M-WIWI-104068	Information Systems in Organizations	EN	WS+SS	9 CP
M-WIWI-101500	Microeconomic Theory	EN	WS+SS	9 CP
M-WIWI-106660	Modeling the Dynamics of Financial Markets	EN	SS	9 CP
M-WIWI-101638	Econometrics and Statistics I	DE/EN	WS+SS	9 CP
M-WIWI-101639	Econometrics and Statistics II	DE/EN	WS+SS	9 CP
M-WIWI-101502	Economic Theory and its Application in Finance	EN	WS+SS	9 CP
M-WIWI-103119	Advanced Topics in Strategy and Management	DE	WS+SS	9 CP
M-WIWI-107649	Sustainable Information Systems neu	EN	WS+SS	9 CP

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	DE	WS+SS	9 CP
M-WIWI-101414	Methodical Foundations of OR	DE	WS+SS	9 CP
M-WIWI-101452	Energy Economics and Technology	DE/EN	WS+SS	9 CP
M-WIWI-101472	Informatics	DE/EN	WS+SS	9 CP
M-WIWI-101473	Mathematical Programming	DE/EN	WS+SS	9 CP
M-WIWI-102832	Operations Research in Supply Chain Management	DE/EN	WS+SS	9 CP
M-WIWI-102805	Service Operations	DE/EN	WS+SS	9 CP
M-WIWI-103289	Stochastic Optimization	DE/EN	WS+SS	9 CP
M-WIWI-105312	Marketing and Sales Management	EN	SS	9 CP
M-WIWI-101451	Energy Economics and Energy Markets	DE/EN	WS+SS	9 CP

2.5 Seminar in Economics and Management

Credits
3

Seminar in Economics and Management (Election: at least 3 credits)				
M-WIWI-102971	Seminar	DE	WS+SS	3 CP
M-WIWI-102973	Seminar	DE	WS+SS	3 CP

2.6 Mathematical Seminar

Credits
3

Mandatory				
M-MATH-102730	Seminar	DE/EN	WS+SS	3 CP

2.7 Elective Field

Credits
12

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

M-MATH-102926	Sobolev Spaces	DE/EN	Irreg.	8 CP
M-MATH-102928	Numerical Methods for Time-Dependent Partial Differential Equations		Irreg.	8 CP
M-MATH-102929	Mathematical Modelling and Simulation in Practise	EN	Irreg.	4 CP
M-MATH-102932	Numerical Methods in Fluid Mechanics	EN	SS	4 CP
M-MATH-102935	Compressive Sensing		Irreg.	5 CP
M-MATH-102937	Functions of Matrices		Irreg.	8 CP
M-MATH-102939	Extreme Value Theory		Irreg.	4 CP
M-MATH-102943	Introduction into Particulate Flows		Once	3 CP
M-MATH-102948	Algebraic Topology	DE/EN	see notes	8 CP
M-MATH-102949	Introduction to Geometric Measure Theory	DE/EN	Irreg.	6 CP
M-MATH-102865	Stochastic Geometry		SS	8 CP
M-MATH-102870	Classical Methods for Partial Differential Equations		WS	8 CP
M-MATH-102871	Boundary and Eigenvalue Problems		SS	8 CP
M-MATH-102900	Adaptive Finite Elemente Methods		Irreg.	8 CP
M-MATH-102903	Spatial Stochastics		WS	8 CP
M-MATH-102921	Geometric Numerical Integration		Irreg.	6 CP
M-MATH-106634	Computational Fluid Dynamics and Simulation Lab	DE/EN	SS	4 CP
M-MATH-102950	Combinatorics	EN	see notes	8 CP
M-MATH-102953	Algebraic Topology II	DE/EN	Irreg.	8 CP
M-MATH-102955	Advanced Inverse Problems: Nonlinearity and Banach Spaces		Irreg.	5 CP
M-MATH-102957	Extremal Graph Theory	EN	Irreg.	8 CP
M-WIWI-101413	Applications of Operations Research	DE	WS+SS	9 CP
M-WIWI-101414	Methodical Foundations of OR	DE	WS+SS	9 CP
M-WIWI-101452	Energy Economics and Technology	DE/EN	WS+SS	9 CP
M-WIWI-101472	Informatics	DE/EN	WS+SS	9 CP
M-WIWI-101473	Mathematical Programming	DE/EN	WS+SS	9 CP
M-WIWI-101480	Finance 3	DE/EN	WS+SS	9 CP
M-WIWI-101482	Finance 1	DE/EN	WS+SS	9 CP
M-WIWI-101483	Finance 2	DE/EN	WS+SS	9 CP
M-WIWI-101500	Microeconomic Theory	EN	WS+SS	9 CP
M-WIWI-101502	Economic Theory and its Application in Finance	EN	WS+SS	9 CP
M-WIWI-101504	Collective Decision Making	EN	WS+SS	9 CP
M-WIWI-101505	Experimental Economics	DE/EN	WS+SS	9 CP
M-WIWI-101637	Analytics and Statistics	DE	WS+SS	9 CP
M-WIWI-101638	Econometrics and Statistics I	DE/EN	WS+SS	9 CP
M-WIWI-101639	Econometrics and Statistics II	DE/EN	WS+SS	9 CP
M-WIWI-102832	Operations Research in Supply Chain Management	DE/EN	WS+SS	9 CP
M-WIWI-102970	Decision and Game Theory	DE	WS	9 CP
M-WIWI-102971	Seminar	DE	WS+SS	3 CP
M-WIWI-102972	Seminar	DE/EN	WS+SS	3 CP
M-WIWI-102973	Seminar	DE	WS+SS	3 CP
M-WIWI-102974	Seminar	DE/EN	WS+SS	3 CP
M-MATH-103080	Dynamical Systems	DE	Irreg.	8 CP
M-MATH-103259	Bifurcation Theory		Irreg.	5 CP
M-MATH-103260	Mathematical Methods of Imaging		Irreg.	5 CP
M-WIWI-103289	Stochastic Optimization	DE/EN	WS+SS	9 CP
M-WIWI-103119	Advanced Topics in Strategy and Management	DE	WS+SS	9 CP
M-WIWI-103720	eEnergy: Markets, Services and Systems	DE	WS+SS	9 CP
M-MATH-103527	Foundations of Continuum Mechanics		Once	4 CP
M-MATH-103539	Nonlinear Analysis		Irreg.	8 CP

M-MATH-103700	Exponential Integrators		Irreg.	6 CP
M-MATH-103919	Introduction to Kinetic Theory	EN	WS	4 CP
M-WIWI-104068	Information Systems in Organizations	EN	WS+SS	9 CP
M-MATH-104054	Uncertainty Quantification	EN	SS	4 CP
M-MATH-104055	Ruin Theory		Irreg.	4 CP
M-MATH-104058	Numerical Linear Algebra in Image Processing		Irreg.	6 CP
M-MATH-104059	Mathematical Topics in Kinetic Theory		Irreg.	4 CP
M-MATH-102884	Scattering Theory		Irreg.	8 CP
M-MATH-104261	Lie Groups and Lie Algebras	DE	see notes	8 CP
M-MATH-104425	Dispersive Equations		Irreg.	6 CP
M-MATH-104435	Selected Topics in Harmonic Analysis		Irreg.	3 CP
M-MATH-103540	Boundary Element Methods		Irreg.	8 CP
M-MATH-102887	Monotonicity Methods in Analysis		Irreg.	3 CP
M-MATH-105066	Nonlinear Maxwell Equations	DE/EN	Irreg.	8 CP
M-MATH-105101	Introduction to Homogeneous Dynamics		Irreg.	6 CP
M-MATH-105093	Variational Methods		Irreg.	8 CP
M-WIWI-105312	Marketing and Sales Management	EN	SS	9 CP
M-MATH-105324	Harmonic Analysis	DE/EN	Irreg.	8 CP
M-MATH-105325	Splitting Methods for Evolution Equations		Irreg.	6 CP
M-MATH-105326	Nonlinear Wave Equations	DE/EN	Irreg.	4 CP
M-MATH-105327	Numerical Simulation in Molecular Dynamics	DE	Irreg.	8 CP
M-MATH-105432	Discrete Dynamical Systems	DE	Irreg.	3 CP
M-MATH-105463	Structural Graph Theory	EN	Irreg.	4 CP
M-MATH-105487	Topological Data Analysis		Irreg.	6 CP
M-MATH-105579	Steins Method with Applications in Statistics	DE/EN	Irreg.	4 CP
M-MATH-105636	Analytical and Numerical Homogenization	EN	Irreg.	6 CP
M-MATH-105649	Fractal Geometry	DE/EN	Irreg.	6 CP
M-MATH-105650	Introduction to Fluid Dynamics		Irreg.	3 CP
M-MATH-105837	Introduction to Kinetic Equations	EN	Irreg.	3 CP
M-MATH-105838	Introduction to Microlocal Analysis	EN	Irreg.	3 CP
M-MATH-106950	Lie-Algebras	DE	see notes	8 CP
M-MATH-105840	Statistical Learning		SS	8 CP
M-MATH-105897	Selected Methods in Fluids and Kinetic Equations	EN	Irreg.	3 CP
M-MATH-105931	Metric Geometry	DE	see notes	8 CP
M-MATH-105964	Introduction to Convex Integration	EN	Irreg.	3 CP
M-MATH-105966	Space and Time Discretization of Nonlinear Wave Equations	EN	Irreg.	6 CP
M-MATH-105973	Translation Surfaces	DE	Irreg.	8 CP
M-MATH-106045	Introduction to Stochastic Differential Equations	EN	Irreg.	4 CP
M-MATH-106052	Random Graphs and Networks	EN	Irreg.	8 CP
M-MATH-106053	Stochastic Simulation	EN	WS	5 CP
M-MATH-106063	Numerical Complex Analysis	DE	Irreg.	6 CP
M-MATH-106328	Bayesian Inverse Problems with Connections to Machine Learning	EN	SS	4 CP
M-MATH-106401	Introduction to Fluid Mechanics	EN	Irreg.	6 CP
M-MATH-106466	Riemann Surfaces	DE	Irreg.	8 CP
M-MATH-106473	Ergodic Theory	DE	Irreg.	8 CP
M-MATH-106485	Functional Data Analysis	EN	Irreg.	4 CP
M-MATH-106486	Harmonic Analysis 2	EN	Irreg.	8 CP
M-MATH-106591	Introduction to Dynamical Systems	DE/EN	Irreg.	6 CP
M-MATH-106632	Curves on Surfaces	EN	Irreg.	3 CP
M-MATH-106640	Modelling and Simulation of Lithium-Ion Batteries	EN	Irreg.	4 CP

M-MATH-106664	Scattering Theory for Time-dependent Waves	DE/EN	Irreg.	6 CP
M-MATH-106667	Geometric Variational Problems	DE/EN	Irreg.	8 CP
M-MATH-106666	Minimal Surfaces	DE	Irreg.	3 CP
M-MATH-106663	Semigroup Theory for the Navier-Stokes Equations	EN	Irreg.	6 CP
M-MATH-106696	Regularity for Elliptic Operators	EN	Irreg.	6 CP
M-MATH-106695	Numerical Analysis of Neural Networks	EN	Irreg.	6 CP
M-MATH-106682	Numerical Methods for Oscillatory Differential Equations	DE/EN	see notes	8 CP
M-MATH-106776	Complex Geometry	EN	Irreg.	6 CP
M-MATH-106822	Advanced Methods in Nonlinear Partial Differential Equations	EN	Irreg.	3 CP
M-WIWI-101647	Data Science: Evidence-based Marketing	EN	WS+SS	9 CP
M-MATH-106957	Modern Methods in Combinatorics	EN	Irreg.	6 CP
M-MATH-107017	Topics in Algebraic Topology	EN	Irreg.	6 CP
M-MATH-106836	MathSEE Modeling Week	EN	WS	3 CP
M-MATH-107387	Class Field Theory	DE	Irreg.	8 CP
M-MATH-107484	Topics in Homotopy Theory	EN	Irreg.	6 CP
M-MATH-107456	Interpolation Spaces	DE/EN	Irreg.	6 CP
M-MATH-107646	Numerical Analysis on Quantum Computers neu	EN	Irreg.	6 CP
M-MATH-107647	Galerkin Methods for Time-dependent PDEs neu	EN	Irreg.	5 CP

3 Modules

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

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	2

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

Assessment
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

Recommendations
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]

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

Credits	Grading	Recurrence	Duration	Level	Version
5 CP	graded	Irregular	1 term	5	1

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

Assessment
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

Recommendations
Inverse problems, Functional analysis

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

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	English	4	3

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

Assessment
The assessment is carried out in an alternative form. The 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.

Recommendations
None

Teaching and Learning Methods
Project

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

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Irregular	1 term	English	4	1

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

Assessment
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

Recommendations
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]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	2 terms	German	4	1

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

Assessment
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
After completing the module, students will be able to

- independently analyze strategic issues and derive recommendations in a structured manner using suitable models and reference frameworks of management theory.
- present their position convincingly in structured discussions using a well-thought-out line of argument.
- deal independently with a current, research-oriented question from strategic management.
- draw his/her own conclusions from the less structured information, drawing on his/her interdisciplinary knowledge and selectively developing current research findings.
- apply and discuss theoretical contents of management theory to real-life situations by intensively dealing with a large number of practice-relevant case studies.

Content
The content will focus on three areas. Firstly, 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 are developed in a written paper.

Additional Information
The module is admission-restricted. Once you have been admitted to a course, you are guaranteed the opportunity to complete the module. The examinations are offered at least every second 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]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	see Annotations	1 term	4	2

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

Assessment
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.

Additional Information
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

Recommendations
Basic knowledge on groups and rings is benefitial.

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

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

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

Assessment
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

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

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

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

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

Assessment
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

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

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

Coordinators: TT-Prof. Dr. Manuel Krannich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	German/English	4	2

Mandatory			
T-MATH-105915	Algebraic Topology	8 CP	Krannich, Llosa Isenrich, Sauer

Assessment
Written exam of 120 min.

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)

Module Grade Calculation
The module grade is the grade of the written exam.

Additional Information
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: 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

Recommendations
The content of the course "Elementare Geometrie" is recommended.

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

Coordinators: TT-Prof. Dr. Manuel Krannich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German/English	5	2

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

Assessment
Written exam of 120 min.

Prerequisites
none

Competence Goal
Students

- are able to compute cohomology rings of basic examples
- are able to apply basic techniques of homological algebra
- are able to work in a self-organized and reflective manner.

Content

- Singular cohomology
- Product structures in cohomology
- Universal coefficient theorems in homological algebra
- Poincaré duality

Module Grade Calculation
The module grade is the grade of the 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

Recommendations
The content of the courses "Elementare Geometrie" and "Algebraic Topology" is recommended.

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

Coordinators: 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	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

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

Assessment
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.

Additional Information
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.

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

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	2 terms	German	4	5

Mandatory			
T-WIWI-103123	Advanced Statistics	4,5 CP	Grothe
Supplementary Courses (Election: between 4,5 and 5 credits)			
T-WIWI-114746	Selected Topics in Statistics and Analytics: Seminal Papers in Theory and Methods	4,5 CP	Grothe
T-WIWI-106341	Machine Learning 2 - Advanced Methods	4,5 CP	Zöllner
T-WIWI-111247	Mathematics for High Dimensional Statistics	4,5 CP	Grothe
T-WIWI-103124	Multivariate Statistical Methods	4,5 CP	Grothe
T-WIWI-112109	Topics in Stochastic Optimization	4,5 CP	Rebennack

Assessment
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
For all students, the course "Advanced Statistics" within this module is compulsory and must be taken.

Exception for Students of Economathematics: Students enrolled in the Economathematics degree program are exempt from the compulsory requirement to take the "Advanced Statistics" course. Instead, they are permitted to choose any two courses offered within this module. As the technical registration of this choice cannot be performed independently in the Campus system, students of Economathematics are kindly requested to contact the Examination Office of the Department of Economics and Management directly for correct module registration and exam enrollment.

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

Additional Information
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]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	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 CP	Nickel
T-WIWI-102714	Tactical and Operational Supply Chain Management	4,5 CP	Nickel
Supplementary Courses (Election: at most 1 item)			
T-WIWI-102726	Global Optimization I	4,5 CP	Stein
T-WIWI-106199	Modeling and OR-Software: Introduction	4,5 CP	Nickel
T-WIWI-106545	Optimization under Uncertainty	4,5 CP	Rebennack

Assessment
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.

Additional Information
The planned lectures and courses for the next three years are announced online at https://dol.ior.kit.edu/Lehrveranstaltungen.php.

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

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

M 3.14 Module: Bayesian Inverse Problems with Connections to Machine Learning [M-MATH-106328]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	1

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

Assessment
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

Recommendations
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 3.15 Module: Bifurcation Theory [M-MATH-103259]

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

Credits	Grading	Recurrence	Duration	Level	Version
5 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-106487	Bifurcation Theory	5 CP	Mandel

Prerequisites
None

Additional Information
Course is held in English

M 3.16 Module: Boundary and Eigenvalue Problems [M-MATH-102871]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Each summer term	1 term	4	1

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

Assessment
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 3.17 Module: Boundary Element Methods [M-MATH-103540]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

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

Assessment
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

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

M 3.18 Module: Brownian Motion [M-MATH-102904]

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	Irregular	1 term	4	1

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

Assessment
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

Recommendations
The course 'Probability Theory' is strongly recommended.

M 3.19 Module: Class Field Theory [M-MATH-107387]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German	4	1

Mandatory			
T-MATH-114500	Class Field Theory	8 CP	Herrlich, Kühnlein

Assessment
The module examination takes the form of an oral examination lasting approx. 30 minutes.

Prerequisites
none

Competence Goal
Graduates

- are familiar with the issues and concepts of class field theory,
- know the basic results of class field theory and can relate them to each other,
- are prepared to write a thesis in the field of algebraic number theory

Content

- Abelian extensions of number fields, Kronecker-Weber theorem,
- Hilbert class fields, class fields for a group of ideal classes,
- Existence, completeness and isomorphism theorem for class fields,
- Dirichlet's L-series and generalization of the theorem on prime numbers in an arithmetic progression,
- Artin map and Artin's reciprocity law

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

Recommendations
The modules "Algebra" and "Algebraic Number Theory" are strongly recommended.

M 3.20 Module: Classical Methods for Partial Differential Equations [M-MATH-102870]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Each winter term	1 term	4	1

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

M 3.21 Module: Collective Decision Making [M-WIWI-101504]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	English	4	4

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

Assessment
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.

M 3.22 Module: Combinatorics [M-MATH-102950]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	English	4	4

Mandatory			
T-MATH-105916	Combinatorics	8 CP	Aksenovich

Assessment
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.

Additional Information

- 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

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

M 3.23 Module: Complex Analysis [M-MATH-102878]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	5	1

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

Assessment
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

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

M 3.24 Module: Complex Geometry [M-MATH-106776]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

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

Assessment
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

Recommendations
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 3.25 Module: Compressive Sensing [M-MATH-102935]

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

Credits	Grading	Recurrence	Duration	Level	Version
5 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105894	Compressive Sensing	5 CP	Rieder

Assessment
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

Recommendations
The course "Introduction to stochastics" is recommended.

M 3.26 Module: Computational Fluid Dynamics and Simulation Lab [M-MATH-106634]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German/English	4	2

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

Assessment
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

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

Coordinators: Prof. Dr. Michael Plum
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization) Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German/English	4	2

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

Assessment
The module examination takes the form of an oral examination (approx. 20 min).

Prerequisites
None.

Competence Goal
At the end of the module, students know the basics of computer-assisted analytical methods for proving the existence and enclosures of solutions of boundary value and eigenvalue problems, as well as the importance of such methods as a supplement to other (purely analytical) methods.

Content
Formulation of nonlinear boundary value problems as zero-finding and fixed-point problems; verification of the assumptions of a suitable fixed-point theorem using computer-assisted methods: explicit Sobolev inequalities, eigenvalue bounds using variational characterizations, interval arithmetic

Module Grade Calculation
The module grade is the grade of the oral examination.

Workload
Total workload: 240 hours

Attendance time: 90 hours

- Course including module examination

Self-study: 150 hours

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

Recommendations

- Classical methods for partial differential equations
- Boundary and eigenvalue problems
- Functional analysis

M 3.28 Module: Continuous Time Finance [M-MATH-102860]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Each summer term	1 term	4	1

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

Assessment
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

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

M 3.29 Module: Control Theory [M-MATH-102941]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-105909	Control Theory	6 CP	Schnaubelt

Assessment
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

Recommendations
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 3.30 Module: Convex Geometry [M-MATH-102864]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105831	Convex Geometry	8 CP	Hug

Assessment
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 3.31 Module: Curves on Surfaces [M-MATH-106632]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Irregular	1 term	English	4	1

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

Assessment
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

Recommendations
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.

M 3.32 Module: Data Science for Finance [M-WIWI-105032]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each winter term	1 term	English	4	1

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

Assessment
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.

Recommendations
Basic knowledge of capital markt theory.

Teaching and Learning Methods
Lectures and Exercises

M 3.33 Module: Data Science: Evidence-based Marketing [M-WIWI-101647]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	2 terms	English	4	5

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

Assessment
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.

Recommendations
None

M 3.34 Module: Decision and Game Theory [M-WIWI-102970]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each winter term	1 term	German	4	1

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

Assessment
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 3.35 Module: Differential Geometry [M-MATH-101317]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German/English	4	2

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

Assessment
Performance will be assessed in the form of an oral examination lasting approximately 30 minutes. If the examination requires an unreasonable amount of preparation, the oral examination may be replaced by a written examination lasting 120 minutes. The decision will be announced at least six weeks before the examination.

Prerequisites
None.

Competence Goal
Participating students

- can discuss and apply fundamental concepts and techniques of modern differential geometry in detail,
- are familiar with exemplary applications of differential geometry,
- can attend advanced seminars and lectures in the field of differential geometry and topology.

Content

- Manifolds
- Tensors
- Riemannian metrics
- Linear relationships
- Covariant derivative
- Parallel translation
- Geodesics
- Curvature tensor and curvature notions

Optional:

- Fiber Bundles
- Differential forms
- Theorems of Stokes, Bonnet-Myers, and Hadamard-Cartan

Module Grade Calculation
The module grade is the grade for the written or oral exam.

Additional Information
This course is one of the 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, by attending

- Course including module examination

Self-study: 150 hours

- Consolidation of course content through follow-up work on lecture content at home
- Completion of exercises
- Consolidation of course content using appropriate literature and internet research
- Preparation for the exam

Recommendations
In addition to the introductory lectures in calculus and linear algebra, ideally the module “Elementary Geometry” or a comparable course should also have been already completed.

M 3.36 Module: Digital Marketing [M-WIWI-106258]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	2 terms	English	4	2

Mandatory			
T-WIWI-112693	Digital Marketing	4,5 CP	Kupfer
Supplementary Courses (Election: 4,5 credits)			
T-WIWI-106981	Digital Marketing and Sales in B2B	1,5 CP	Klarmann, Konhäuser
T-WIWI-114174	Economic Decision Making	4,5 CP	Scheibehenne
T-WIWI-114893	International Entrepreneurship and Brand Development	6 CP	Kupfer, Terzidis
T-WIWI-107720	Market Research	4,5 CP	Klarmann
T-WIWI-112711	Media Management	4,5 CP	Kupfer
T-WIWI-111848	Online Concepts for Karlsruhe City Retailers	3 CP	Kupfer

Assessment
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 "Digital Marketing" module explores advanced marketing strategies within the context of digital transformation. Students develop a deep understanding of digital consumer behavior, the digital environment, and digital marketing strategies:

- **Principles of Digital Marketing:** In this mandatory course of the module, students learn about practices and strategies like search engine optimization, word-of-mouth, and influencer marketing.
- **Performance Analytics and Practical Applications:** Practical applications of SEO, SEA, and Content Management Systems. Students learn to monitor performance using Key Performance Indicators (KPIs), dashboards, and Return on Investment (RoI) calculations and apply their knowledge to real-world cases.
- **Contextualization:** Via course selections, students can learn about specific requirements for B2B digital strategies, media industries, and retailing.
- **Decision Psychology:** Students can decide to deepen their knowledge on consumer psychology, including heuristics, nudging, and risk perception.
- **Market Research & Methods:** Students can learn about advanced empirical techniques to interpret customer attitudes and prepare for scientific research.

By integrating these multidisciplinary perspectives, the module enables students to implement sophisticated marketing instruments and critically evaluate current practices in digital business environments.

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.

M 3.37 Module: Discrete Dynamical Systems [M-MATH-105432]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Irregular	1 term	German	4	1

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

Assessment
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

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

M 3.38 Module: Discrete Time Finance [M-MATH-102919]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Each winter term	1 term	4	1

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

Assessment
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

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

M 3.39 Module: Dispersive Equations [M-MATH-104425]

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

Credits	Grading	Recurrence	Duration	Level	Version
6 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-109001	Dispersive Equations	6 CP	Reichel

Assessment
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

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

M 3.40 Module: Dynamical Systems [M-MATH-103080]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German	4	1

Mandatory			
T-MATH-106114	Dynamical Systems	8 CP	Reichel

Assessment
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

Recommendations
The module 'Functional Analysis' is recommended.

M 3.41 Module: Econometrics and Statistics I [M-WIWI-101638]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German/English	4	6

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

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

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German/English	4	7

Election Notes
Special note on elective regulations: The partial achievement T-WIWI-111388 "Applied Econometrics" is generally a mandatory requirement for this module.

Exception: If this partial achievement has already been successfully completed as part of the module M-WIWI-101638 "Econometrics and Statistics I", the requirement for this module is waived. In this case, any other partial achievements from the module's offering may be selected instead to reach the required number of credits (LP).

Important note on registration: As the automated verification in the Campus System cannot account for this specific exception, students are unable to register for alternative partial achievements independently. In this case, please contact the **Examination Office of the KIT Department of Economics and Management** directly for manual registration.

Mandatory			
T-WIWI-111388	Applied Econometrics	4,5 CP	Krüger
Compulsory Elective Courses (Election: at least 1 item)			
T-WIWI-103064	Financial Econometrics	4,5 CP	Schienle
T-WIWI-110939	Financial Econometrics II	4,5 CP	Schienle
T-WIWI-103124	Multivariate Statistical Methods	4,5 CP	Grothe
T-WIWI-103126	Non- and Semiparametrics	4,5 CP	Schienle
T-WIWI-103127	Panel Data	4,5 CP	Heller
T-WIWI-103128	Portfolio and Asset Liability Management	4,5 CP	Safarian
T-WIWI-110868	Predictive Modeling	4,5 CP	Krüger
T-WIWI-111387	Probabilistic Time Series Forecasting Challenge	4,5 CP	Krüger
T-WIWI-103123	Advanced Statistics	4,5 CP	Grothe
T-WIWI-103065	Statistical Modeling of Generalized Regression Models	4,5 CP	Heller
T-WIWI-103129	Stochastic Calculus and Finance	4,5 CP	Safarian

Assessment
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 partial achievement *T-WIWI-111388 "Applied Econometrics"* is generally a mandatory requirement for this module.

Exception: If this partial achievement has already been successfully completed as part of the module *M-WIWI-101638 "Econometrics and Statistics I"*, the requirement for this module is waived. In this case, any other partial achievements from the module's offering may be selected instead to reach the required number of credits (LP).

Important note on registration: As the automated verification in the Campus System cannot account for this specific exception, students are unable to register for alternative partial achievements independently. In this case, please contact the **Examination Office of the KIT Department of Economics and Management** directly for manual registration.

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

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	English	4	6

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

Assessment
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.

M 3.44 Module: eEnergy: Markets, Services and Systems [M-WIWI-103720]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German	4	3

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

Assessment
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.

Additional Information
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.

M 3.45 Module: Energy Economics and Energy Markets [M-WIWI-101451]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German/English	4	9

Mandatory			
T-WIWI-107043	Liberalised Power Markets	5,5 CP	Fichtner
Supplementary Courses (Election:)			
T-WIWI-114980	Behavioral Dimensions of Energy Transitions	3,5 CP	Fichtner
T-WIWI-107501	Energy Market Engineering	4,5 CP	Weinhardt
T-WIWI-112151	Energy Trading and Risk Management	3,5 CP	N.N.
T-WIWI-108016	Simulation Game in Energy Economics	3,5 CP	Genoese
T-WIWI-107446	Quantitative Methods in Energy Economics	3,5 CP	Plötz
T-WIWI-102712	Regulation Theory and Practice	4,5 CP	Mitusch

Assessment
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 Trading and Risk Management:* trade centres, trade products, market mechanisms, position and risk management
- *Simulation Game in Energy Economics*: Simulation of the German electricity system
- *Behavioral Dimensions of Energy Transitions*: Explores how energy consumers make decisions regarding their energy use and how these decisions can be influenced by psychological and economic factors, such as financial incentives; examines the social acceptance of energy technologies and policies, and what determines different levels of acceptance.
- *Quantitative Methods in Energy Economics*: The aim of the course is to help the students understand real-world usage of quantitative methods of energy economics and apply these methods

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.

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

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	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 CP	Jochem
T-WIWI-102650	Energy and Environment	3,5 CP	Karl
T-WIWI-113073	Machine Learning and Optimization in Energy Systems	3,5 CP	Fichtner
T-WIWI-107464	Smart Energy Infrastructure	5,5 CP	Ardone, Pustisek
T-WIWI-102695	Heat Economy	3,5 CP	Fichtner

Assessment
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 and Environment**: emission factors, emission reduction measures, environmental impact
- **Machine Learning and Optimization in Energy Systems**: Understanding and Applying the core principles of the most commonly used machine learning and optimization techniques within the energy sector

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.

M 3.47 Module: Ergodic Theory [M-MATH-106473]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German	4	1

Mandatory			
T-MATH-113086	Ergodic Theory	8 CP	Link

Assessment
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

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

M 3.48 Module: Evolution Equations [M-MATH-102872]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	German/English	4	1

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

Assessment
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.

Additional Information
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

Recommendations
The module “Functional Analysis” is strongly recommended.

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

M 3.49 Module: Experimental Economics [M-WIWI-101505]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	2 terms	German/English	4	6

Compulsory Elective Courses (Election: 2 items)			
T-WIWI-115061	Experimental Research in Economics and Information Systems	4,5 CP	Weinhardt
T-WIWI-105781	Incentives in Organizations	4,5 CP	Nieken
T-WIWI-102862	Predictive Mechanism and Market Design	4,5 CP	Reiß
T-WIWI-102863	Topics in Experimental Economics	4,5 CP	Reiß

Assessment
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.

Additional Information
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.

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

M 3.50 Module: Exponential Integrators [M-MATH-103700]

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

Credits	Grading	Recurrence	Duration	Level	Version
6 CP	graded	Irregular	1 term	4	1

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

Assessment
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.

Recommendations
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 3.51 Module: Extremal Graph Theory [M-MATH-102957]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	English	4	3

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

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

Prerequisites
None.

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.

Module Grade Calculation
The module grade is the grade of the exam.

Additional Information
Course is held in English

Workload
Total workload: 240 hours

Attendance time: 90 hours

- Course including module examination

Self-study: 150 hours

- Consolidation 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

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

M 3.52 Module: Extreme Value Theory [M-MATH-102939]

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	Irregular	1 term	4	2

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

Assessment
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

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

M 3.53 Module: Finance 1 [M-WIWI-101482]

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

Organisation: KIT Department of Business and Economics

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German/English	4	1

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

Assessment
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.

M 3.54 Module: Finance 2 [M-WIWI-101483]

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

Organisation: KIT Department of Business and Economics

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German/English	4	11

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-113469	Advanced Corporate Finance	4,5 CP	Ruckes
T-WIWI-114979	Advanced Quantitative Finance	4,5 CP	Thimme
T-WIWI-102647	Asset Pricing	4,5 CP	Ruckes, Uhrig-Homburg
T-WIWI-110995	Bond Markets	4,5 CP	Uhrig-Homburg
T-WIWI-110997	Bond Markets - Models & Derivatives	3 CP	Uhrig-Homburg
T-WIWI-110996	Bond Markets - Tools & Applications	1,5 CP	Uhrig-Homburg
T-WIWI-109050	Corporate Risk Management	4,5 CP	Ruckes
T-WIWI-102643	Derivatives	4,5 CP	Uhrig-Homburg
T-WIWI-110797	eFinance: Information Systems for Securities Trading	4,5 CP	Weinhardt
T-WIWI-102900	Financial Analysis	4,5 CP	Luedecke
T-WIWI-102623	Financial Intermediation	4,5 CP	Ruckes
T-WIWI-102646	International Finance	3 CP	Uhrig-Homburg
T-WIWI-102621	Valuation	4,5 CP	Ruckes

Assessment
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
Students may only start the module *Finance 2* after they have successfully completed the module *Finance 1*. Exceptions are subject to approval by the examination committee; for this purpose, students must contact the examination office of the KIT Faculty of Economics and Management.

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.

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

M 3.55 Module: Finance 3 [M-WIWI-101480]

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

Organisation: KIT Department of Business and Economics

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German/English	4	11

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-113469	Advanced Corporate Finance	4,5 CP	Ruckes
T-WIWI-114979	Advanced Quantitative Finance	4,5 CP	Thimme
T-WIWI-102647	Asset Pricing	4,5 CP	Ruckes, Uhrig-Homburg
T-WIWI-110995	Bond Markets	4,5 CP	Uhrig-Homburg
T-WIWI-110997	Bond Markets - Models & Derivatives	3 CP	Uhrig-Homburg
T-WIWI-110996	Bond Markets - Tools & Applications	1,5 CP	Uhrig-Homburg
T-WIWI-109050	Corporate Risk Management	4,5 CP	Ruckes
T-WIWI-102643	Derivatives	4,5 CP	Uhrig-Homburg
T-WIWI-110797	eFinance: Information Systems for Securities Trading	4,5 CP	Weinhardt
T-WIWI-102900	Financial Analysis	4,5 CP	Luedecke
T-WIWI-102623	Financial Intermediation	4,5 CP	Ruckes
T-WIWI-102646	International Finance	3 CP	Uhrig-Homburg
T-WIWI-102621	Valuation	4,5 CP	Ruckes
T-WIWI-110933	Web App Programming for Finance	4,5 CP	Thimme

Assessment
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
Students may only start the module *Finance 3* after they have successfully completed the modules *Finance 1* and *Finance 2*. Exceptions are subject to approval by the examination committee; for this purpose, students must contact the examination office of the KIT Faculty of Economics and Management.

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

Coordinators: 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	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each winter term	1 term	English	4	2

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

Assessment
Success is assessed in the form of an oral examination lasting approx. 30 minutes. If the examination is unreasonably time-consuming, the oral examination may be replaced by a written examination lasting 120 minutes. The decision will be announced at least six weeks before the examination.

Prerequisites
None.

Competence Goal
At the end of the course, students

- know the basic methods, techniques and algorithms for the numerical solution of elliptic boundary value problems with finite elements (especially stability, convergence and complexity of the discretisation)
- can explain concepts of modelling with differential equations
- are able to solve numerically boundary value problems with finite elements

Content

- Theory of finite element methods for elliptic boundary value problems of second order
- Basic concepts for the implementation
- Special topis like, e.g., elliptic eigenvalue problems
- Mixed methods

Module Grade Calculation
The module grade is the grade of the 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

Recommendations
Basic knowledge of numerical methods and the analysis for differential equations is strongly recommended. Knowledge in functional analysis is helpful.

M 3.57 Module: Forecasting: Theory and Practice [M-MATH-102956]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	2 terms	English	4	3

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

Assessment
The examination takes the form of an oral exam (30 min).

Prerequisites
None

Competence Goal
At the end of the course, students

- can explain the measure theoretic and probabilistic foundations of the theory of forecasting and are able to apply this knowledge in examples
- can explain the decision theoretic foundations of forecast evaluation and are able to apply key concepts and key tools in examples
- can explain, adapt, interpret, and implement regression methods for forecasting
- can explain basic concepts of the generation and evaluation of meteorological and economic forecasts
- can develop and code simulation and real data studies for the generation and evaluation of forecasts in a self-organized and reflective manner
- are prepared to work on a thesis in the field of the theory and practice of forecasting

Content

- case studies from meteorology and economics
- point forecasts and probabilistic forecasts
- prediction spaces, calibration, and sharpness
- proper scoring rules and consistent scoring functions
- forecast aggregation
- predictive facets of regression

Module Grade Calculation
The module grade is the grade of the oral exam.

Additional Information

- regular cycle: every 2nd year, next offering winter semester 26/27

Workload
Total workload: 240 hours
Attendance time: 90 hours

- course including lectures, problem classes, and 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 for the module examinaton

Recommendations
Familiarity with the contents of the module "Probability theory" is strongly recommended. Furthermore, familiarity with the contents of the module "Statistics" is recommended.

Literature
Gneiting, T, Katzfuss, M (2014). Probabilistic forecasting. Annual Review of Statistics and Its Application, 1, 125-151.

Further literature will be recommended in the course.

M 3.58 Module: Foundations for Advanced Financial -Quant and -Machine Learning Research [M-WIWI-105894]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	see Annotations	1 term	English	4	1

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

Assessment
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.

Additional Information

- 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.

Teaching and Learning Methods
Lecture and exercise.

M 3.59 Module: Foundations of Continuum Mechanics [M-MATH-103527]

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	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 CP	Wieners

Assessment
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

Recommendations
optimization theory

M 3.60 Module: Fractal Geometry [M-MATH-105649]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	German/English	4	2

Mandatory			
T-MATH-111296	Fractal Geometry	6 CP	Winter

Assessment
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

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

M 3.61 Module: Functional Analysis [M-MATH-101320]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each winter term	1 term	German	4	2

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

Assessment
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 3.62 Module: Functional Data Analysis [M-MATH-106485]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Irregular	1 term	English	4	2

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

Assessment
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

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

M 3.63 Module: Functions of Matrices [M-MATH-102937]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

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

Assessment
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

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

M 3.64 Module: Functions of Operators [M-MATH-102936]

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

Credits	Grading	Recurrence	Duration	Level	Version
6 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105905	Functions of Operators	6 CP	

Assessment
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

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

M 3.65 Module: Galerkin Methods for Time-dependent PDEs [M-MATH-107647]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-114992	Galerkin Methods for Time-dependent PDEs	5 CP	Dörfler

Assessment
Success is assessed in form of an oral examination.

Prerequisites
None.

Competence Goal
At the end of the course, students

- know the basic methods, techniques and algorithms for the numerical solution of parabolic boundary value problems with finite elements (especially stability, convergence and complexity of the discretisation),
- can explain concepts of modelling with time-dependend differential equations,
- are able to solve numerically initial boundary value problems with finite elements.

Content

- Theory of the solution for parabolic boundary value problems with continuous or discontinuous finite element methods,
- Basic concepts for the implementation,
- Adaptive time-stepping and adaptive finite elements in space.

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

Recommendations
Basic knowledge of numerical methods and the analysis for differential equations is strongly recommended. Knowlegde in functional analysis is helpful.

M 3.66 Module: Generalized Regression Models [M-MATH-102906]

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	Irregular	1 term	4	2

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

Assessment
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

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

M 3.67 Module: Geometric Group Theory [M-MATH-102867]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	English	4	2

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

Assessment
The module examination takes the form of a written examination lasting 120 minutes.

Prerequisites
None.

Competence Goal
Graduates

- recognize the interplay between geometry and group theory,
- understand fundamental structures and techniques of geometric group theory and are able to identify, discuss, and apply them,
- are familiar with and understand concepts and results from coarse geometry,
- are prepared to read and engage with current research literature in geometric group theory.

Content

- Finitely generated groups and group presentations
- Cayley graphs and group actions
- Quasi-isometries of metric spaces, quasi-isometric invariants, and the Schwarz–Milnor Lemma
- Classes of groups, for example: hyperbolic groups, Fuchsian groups, amenable groups, braid groups, Thompson's group

Module Grade Calculation
The module grade is the grade of the examination.

Additional Information
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

Recommendations
The contents of the modules "Introduction to Geometry and Topology" or "Elementary Geometry" and "Introduction to Algebra and Number Theory" are recommended.

M 3.68 Module: Geometric Numerical Integration [M-MATH-102921]

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

Credits	Grading	Recurrence	Duration	Level	Version
6 CP	graded	Irregular	1 term	4	2

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

Assessment
The module will be completed by an oral exam (about 25 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.

Additional Information
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

Recommendations
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 Python or MATLAB are strongly recommended.

M 3.69 Module: Geometric Variational Problems [M-MATH-106667]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German/English	4	1

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

Assessment
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

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

M 3.70 Module: Geometry of Schemes [M-MATH-102866]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	5	1

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

Assessment
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

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

M 3.71 Module: Global Differential Geometry [M-MATH-102912]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German/English	5	2

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

Assessment
The module examination takes the form of an oral examination lasting approximately 30 minutes.

Prerequisites
None.

Competence Goal
Graduates

- have acquired a deeper understanding of exemplary concepts and methods of global differential geometry and Riemannian geometry,
- are prepared for independent research and advanced seminars in the field of differential geometry.

Content

- Existence and obstacle theorems for metrics with special properties
- Geometric finiteness and classification results
- Geometric limits
- Gromov-Hausdorff and Lipschitz convergence of Riemannian manifolds
- Moduli Spaces of Riemannian Metrics

Module Grade Calculation
The module grade is the grade for the oral examination.

Workload
Total workload: 240 hours

Attendance time: 90 hours

- Course including examination

Self-study: 150 hours

- Consolidation of course content through follow-up work on lecture content at home
- Completion of exercises
- Consolidation of course content using appropriate literature and internet research
- Preparation for the module examination

Recommendations
Prior knowledge gained in the lecture “Differential Geometry” is recommended.

M 3.72 Module: Graph Theory [M-MATH-101336]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	English	4	3

Mandatory			
T-MATH-102273	Graph Theory	8 CP	Aksenovich

Assessment
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.

Additional Information

- 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

M 3.73 Module: Harmonic Analysis [M-MATH-105324]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German/English	4	3

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

Assessment
The module will be completed by an oral exam of approx. 30 min.

Prerequisites
None.

Competence Goal
Students are familiar with the representation of (square-)integrable functions by Fourier series, the convergence theory of these series and the relationship between the smoothness of a function and the decay of the Fourier coefficients. They are able to apply the results to simple examples. They master the properties of the Fourier transform in the context of Lebesgue spaces and distributions. They recognize the importance of Fourier analysis for applied mathematics, based on explicit solutions for the heat equation, the wave equation and the Schrödinger equation. They master the basic statements on the boundedness singular integrals, e.g., for the Hilbert transform. They recognize the importance and applicability of interpolation methods and Fourier multiplier theorems.

Content

- Fourier series
- Fourier transform on L^1 and L^2
- Tempered distributions and their Fourier transform
- Explicit solutions of the Heat-, Schrödinger- and Wave equation on R^n
- the Hilbert transform
- the interpolation theorem of Marcinkiewicz
- Singular integral operators
- the Fourier multiplier theorem of Mihlin

Module Grade Calculation
The module grade is the grade of the oral exam.

Additional Information
Every two years.

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

Recommendations
The contents of the course "Functional Analysis" are recommended.

M 3.74 Module: Harmonic Analysis 2 [M-MATH-106486]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	English	4	1

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

Assessment
Oral examination of ca. 30 minutes.

Prerequisites
None

Competence Goal
The students

- can explain basic results on Riesz tranforms and in the Littlewood-Paley theory.
- can explain the basic results on Hardy spaces and BMO and put them into context.
- can describe fundamental results on oscillatory integrals and apply them to examples.
- can describe fundamental results for the study of dispersive equations and discuss them.
- master important techniques of proofs for singular integral operators and oscillatory integrals and can sketch central proofs.
- are prepared to write a thesis in the field of Harmonic Analysis or dispersive equations.

Content

- Riesz transforms and related singular integral operators
- Littlewood-Paley theory
- Hardy space H^1 and the space BMO
- sharp maximal functions and good-lambda inequalities
- oscillatory integrals, dispersive estimates, Strichartz estimates
- applications to various 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

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

M 3.75 Module: Informatics [M-WIWI-101472]

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

Organisation: KIT Department of Business and Economics

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German/English	4	22

Compulsory Elective Area (Election:)			
T-WIWI-113363	Collective Perception in Autonomous Driving	4,5 CP	Vinel
T-WIWI-102680	Computational Economics	4,5 CP	Shukla
T-WIWI-112690	Cooperative Autonomous Vehicles	4,5 CP	Vinel
T-WIWI-110346	Supplement Enterprise Information Systems	4,5 CP	Oberweis
T-WIWI-110372	Supplement Software- and Systemsengineering	4,5 CP	Oberweis
T-WIWI-114951	Advanced Topics in Digital Twins	4,5 CP	Lazarova-Molnar
T-WIWI-113059	Human Factors in Autonomous Driving	4,5 CP	Vinel
T-WIWI-109270	Human Factors in Security and Privacy	4,5 CP	Volkamer
T-WIWI-113968	Management of IT-Projects	4,5 CP	Alpers
T-WIWI-102666	Knowledge Discovery	4,5 CP	Käfer
T-WIWI-114863	Knowledge-Driven Artificial Intelligence	4,5 CP	Sack
T-WIWI-106340	Machine Learning 1 - Basic Methods	4,5 CP	Zöllner
T-WIWI-106341	Machine Learning 2 - Advanced Methods	4,5 CP	Zöllner
T-WIWI-112685	Modeling and Simulation	4,5 CP	Lazarova-Molnar
T-WIWI-102697	Business Process Modelling	4,5 CP	Oberweis
T-WIWI-102679	Nature-Inspired Optimization Methods	4,5 CP	Shukla
T-WIWI-109799	Process Mining	4,5 CP	Schreiber
T-WIWI-110848	Semantic Web Technologies	4,5 CP	Käfer
T-WIWI-102895	Software Quality Management	4,5 CP	Oberweis
Seminars and Advanced Labs (Election: between 0 and 1 items)			
T-WIWI-110548	Advanced Lab Informatics (Master)	4,5 CP	Professorenschaft des Instituts AIFB
T-WIWI-112914	Advanced Lab Realization of Innovative Services (Master)	4,5 CP	Oberweis
T-WIWI-108439	Advanced Lab Security, Usability and Society	4,5 CP	Volkamer
T-WIWI-109985	Project Lab Cognitive Automobiles and Robots	5 CP	Zöllner
T-WIWI-109983	Project Lab Machine Learning	5 CP	Zöllner

Assessment

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

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	2 terms	English	4	5

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

Assessment
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.

Additional Information
New module starting summer term 2018.

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

M 3.77 Module: Integral Equations [M-MATH-102874]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

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

Assessment
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 3.78 Module: Interpolation Spaces [M-MATH-107456]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-114639	Interpolation Spaces	6 CP	Kunstmann, Lamm

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

Prerequisites
none

Competence Goal
Graduates

- are able to state and discuss essential results on interpolation theory and maximum L^p regularity,
- can state and discuss basic results on Besov spaces and relate them to each other,
- can state basic results in the treatment of partial differential equations and relate them to each other,
- can outline central proofs,
- are prepared to write a thesis in the field of harmonic analysis or global analysis.

Content

- Real and complex interpolation,
- function spaces,
- maximal L^p regularity,
- applications to partial differential equations.

Module Grade Calculation
The module grade is the grade of the oral examination.

Workload
Attendance time: 60 hours

- Course including module examination during the course of study

Self-study: 120 hours

- Consolidation of the course 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

Recommendations
The modules 'Functional Analysis' and 'Classical Methods in PDE's' are strongly recommended.

M 3.79 Module: Introduction into Particulate Flows [M-MATH-102943]

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

Credits	Grading	Recurrence	Duration	Level	Version
3 CP	graded	Once	1 term	4	2

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

Assessment
Oral exam of ca. 20 minutes

Prerequisites
none

Competence Goal
Participants

- can explain the basic mathematical models of fluid flows
- can explain the modeling of particulate fluid flows
- understand the numerical methods to compute particulate fluid flows

Content

- Mathematical description of fluid flows
- Models to describe particles in fluids
- Movement of rigid bodies in a flow
- Movement of rigid bodies in a viscous flow
- Different forces acting between fluid and particle, e.g. ionic flows

Module Grade Calculation
The grade of the module is the grade of the oral exam.

Workload
Total workload: 90 hours

Attendance: 30 h

- lectures, problem classes and examination

Self studies: 60 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

Recommendations
Basic knowledge in numerics of differential equations und numerical fluid dynamics is strongly recommended.

M 3.80 Module: Introduction to Convex Integration [M-MATH-105964]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Irregular	1 term	English	4	1

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

Assessment
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

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

M 3.81 Module: Introduction to Dynamical Systems [M-MATH-106591]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	German/English	4	1

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

Assessment
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

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

M 3.82 Module: Introduction to Fluid Dynamics [M-MATH-105650]

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

Credits	Grading	Recurrence	Duration	Level	Version
3 CP	graded	Irregular	1 term	4	2

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

Assessment
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

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

M 3.83 Module: Introduction to Fluid Mechanics [M-MATH-106401]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

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

Assessment
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

Recommendations
The module *Functional Analysis* is strongly recommended.

M 3.84 Module: Introduction to Geometric Measure Theory [M-MATH-102949]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	German/English	4	2

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

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

Prerequisites
None.

Competence Goal
Graduates

- know basic statements and proof techniques of geometric measure theory,
- are familiar with exemplary applications of methods of geometric measure theory and apply them,
- are able to work in a reflective and self-organized manner.

Content

- measure and integral
- Covering theorems
- Hausdorff measures
- Differentiation of measures
- Lipschitz functions and rectifiability
- Area and coarea formula
- Currents
- Applications

Workload
Total workload: 180 hours

Attendance time: 60 hours

- Course including module examination during the course of study

Self-study: 120 hours

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

M 3.85 Module: Introduction to Homogeneous Dynamics [M-MATH-105101]

Coordinators: 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	Recurrence	Duration	Level	Version
6 CP	graded	Irregular	1 term	4	1

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

Prerequisites
None

M 3.86 Module: Introduction to Kinetic Equations [M-MATH-105837]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Irregular	1 term	English	4	2

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

Assessment
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

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

M 3.87 Module: Introduction to Kinetic Theory [M-MATH-103919]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-MATH-108013	Introduction to Kinetic Theory	4 CP	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

Recommendations
Partial Differential Equations, Functional Analysis

M 3.88 Module: Introduction to Microlocal Analysis [M-MATH-105838]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
3 CP	graded	Irregular	1 term	English	4	1

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

Assessment
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

Recommendations
The following courses should be studied beforehand: "Classical Methods for Partial Differential Equations" und "Functional Analysis".

M 3.89 Module: Introduction to Scientific Computing [M-MATH-102889]

Coordinators: 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	Recurrence	Duration	Level	Version
8 CP	graded	Each summer term	1 term	4	3

Mandatory			
T-MATH-105837	Introduction to Scientific Computing	8 CP	Dörfler, Hochbruck, Jahnke, Rieder, Wieners
T-MATH-114059	Project Lab Scientific Computing	0 CP	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

Assessment
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.

Additional Information
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

Recommendations
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 3.90 Module: Introduction to Stochastic Differential Equations [M-MATH-106045]

Coordinators: Prof. Dr. Mathias Trabs
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-112234	Introduction to Stochastic Differential Equations	4 CP	Janák, Trabs

Assessment
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

Recommendations
The contents of the course "Probability Theory" are strongly recommended. The contents of the course "Continuous Time Finance" are recommended.

M 3.91 Module: Inverse Problems [M-MATH-102890]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Each winter term	1 term	4	1

Mandatory			
T-MATH-105835	Inverse Problems	8 CP	Arens, Griesmaier, Hettlich, Rieder

Assessment
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

Recommendations
The course "Functional Analysis" or "Integral Equations" is recommended as a prerequisite.

M 3.92 Module: Lie Groups and Lie Algebras [M-MATH-104261]

Coordinators: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	German	4	1

Mandatory			
T-MATH-108799	Lie Groups and Lie Algebras	8 CP	Hartnick

Additional Information
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 3.93 Module: Lie-Algebras [M-MATH-106950]

Coordinators: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	German	4	1

Mandatory			
T-MATH-113907	Lie-Algebras	8 CP	Hartnick

Additional Information
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 3.94 Module: Marketing and Sales Management [M-WIWI-105312]

Coordinators: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Business and Economics
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each summer term	1 term	English	4	10

Compulsory Elective Courses (Election:)			
T-WIWI-112693	Digital Marketing	4,5 CP	Kupfer
T-WIWI-106981	Digital Marketing and Sales in B2B	1,5 CP	Klarmann, Konhäuser
T-WIWI-114174	Economic Decision Making	4,5 CP	Scheibehenne
T-WIWI-107720	Market Research	4,5 CP	Klarmann
T-WIWI-111848	Online Concepts for Karlsruhe City Retailers	3 CP	Kupfer
T-WIWI-102883	Pricing	4,5 CP	Klarmann
T-WIWI-114893	International Entrepreneurship and Brand Development	6 CP	Kupfer, Terzidis

Assessment
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
This module provides students with a profound understanding of key principles and concepts of marketing management and enables them to independently analyze, develop, and critically reflect on marketing and sales strategies. The focus is on combining theoretical knowledge with its practical application in various contexts, from digital markets and B2B environments to international brand development.

Students work on realistic case studies and application-oriented projects, present their ideas in group settings, and receive continuous feedback. Complemented by collaboration with external partners and the use of qualitative and quantitative market research methods, students learn to make data-driven and strategic marketing decisions.

The module consists of the following courses: Digital Marketing, Digital Marketing and Sales in B2B, International Entrepreneurship and Brand Development, Market Research, Online Concepts for Local Retailers in Karlsruhe, and Pricing. The choice of options within the module allows students to set individual priorities.

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

M 3.95 Module: Markov Decision Processes [M-MATH-102907]

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

Credits	Grading	Recurrence	Duration	Level	Version
5 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105921	Markov Decision Processes	5 CP	Bäuerle

Assessment
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

Recommendations
The course 'Probability theory' is strongly recommended and 'Markov chains' is recommended.

M 3.96 Module: Master's Thesis [M-MATH-102917]

Coordinators: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: Master's Thesis

Credits	Grading	Recurrence	Duration	Level	Version
30 CP	graded	Each term	1 term	4	1

Mandatory			
T-MATH-105878	Master's Thesis	30 CP	Kühnlein

Assessment
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 3.97 Module: Mathematical Methods in Signal and Image Processing [M-MATH-102897]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105862	Mathematical Methods in Signal and Image Processing	8 CP	Rieder

Assessment
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

Recommendations
The course "Functional analysis" is recommended.

M 3.98 Module: Mathematical Methods of Imaging [M-MATH-103260]

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

Credits	Grading	Recurrence	Duration	Level	Version
5 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-106488	Mathematical Methods of Imaging	5 CP	Rieder

Assessment
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

Recommendations
The course „Functional Analysis“ is recommended.

M 3.99 Module: Mathematical Modelling and Simulation in Practise [M-MATH-102929]

Coordinators: PD Dr. Gudrun Thäter
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Irregular	1 term	English	4	2

Mandatory			
T-MATH-105889	Mathematical Modelling and Simulation in Practise	4 CP	Thäter

Assessment
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.

Additional Information
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

Recommendations
Some basic knowledge of numerical mathematics is recommended.

Literature
Hans-Joachim Bungartz e.a.: Modeling and Simulation: An Application-Oriented Introduction,
Springer, 2013

M 3.100 Module: Mathematical Programming [M-WIWI-101473]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	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 CP	Stein
T-WIWI-102726	Global Optimization I	4,5 CP	Stein
T-WIWI-103638	Global Optimization I and II	9 CP	Stein
T-WIWI-102856	Convex Analysis	4,5 CP	Stein
T-WIWI-111587	Multicriteria Optimization	4,5 CP	Stein
T-WIWI-102724	Nonlinear Optimization I	4,5 CP	Stein
T-WIWI-103637	Nonlinear Optimization I and II	9 CP	Stein
T-WIWI-102855	Parametric Optimization	4,5 CP	Stein
Supplementary Courses (Election: at most 2 items)			
T-WIWI-106548	Advanced Stochastic Optimization	4,5 CP	Rebennack
T-WIWI-102720	Mixed Integer Programming II	4,5 CP	Stein
T-WIWI-102727	Global Optimization II	4,5 CP	Stein
T-WIWI-102723	Graph Theory and Advanced Location Models	4,5 CP	Nickel
T-WIWI-106549	Large-scale Optimization	4,5 CP	Rebennack
T-WIWI-111247	Mathematics for High Dimensional Statistics	4,5 CP	Grothe
T-WIWI-103124	Multivariate Statistical Methods	4,5 CP	Grothe
T-WIWI-102725	Nonlinear Optimization II	4,5 CP	Stein
T-WIWI-102715	Operations Research in Supply Chain Management	4,5 CP	Nickel
T-WIWI-112109	Topics in Stochastic Optimization	4,5 CP	Rebennack

Assessment
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
This module provides an advanced education in mathematical foundations and sophisticated methods of optimization. It addresses complex decision-making situations where optimal solutions must be found under constraints, covering a wide range of specialized optimization classes.

The core content includes:

- **Global and Nonlinear Optimization**: Handling problems with non-convex structures where local optima are not necessarily global solutions. Teaching of methods for determining global optima.
- **Mixed-Integer Optimizatio**n: Modeling and solving problems where both continuous and integer (discrete) variables occur, which is essential for many applications from engineering and economics.
- **Multicriteria Optimization**: Methods for solving problems with multiple, often conflicting objectives (Pareto optimization).

Students learn both the mathematical modeling of complex systems and the application and implementation of modern solution algorithms to efficiently handle real-world optimization problems.

Additional Information
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.

M 3.101 Module: Mathematical Statistics [M-MATH-102909]

Coordinators: PD Dr. Bernhard Klar
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Each winter term	1 term	4	2

Mandatory			
T-MATH-105872	Mathematical Statistics	8 CP	Ebner, Fasen-Hartmann, Klar, Trabs

Assessment
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

Recommendations
The contents of the courses "Probability theory" and "Statistics" are strongly recommended.

M 3.102 Module: Mathematical Topics in Kinetic Theory [M-MATH-104059]

Coordinators: PD Dr. Ioannis Anapolitanos
Prof. Dr. Dirk Hundertmark

Organisation: KIT Department of Mathematics

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-108403	Mathematical Topics in Kinetic Theory	4 CP	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

M 3.103 Module: MathSEE Modeling Week [M-MATH-106836]

Coordinators: Prof. Dr. Sebastian Krumscheid
PD Dr. Stefan Kühnlein

Organisation: KIT Department of Informatics
KIT Department of Mathematics

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-MATH-113711	MathSEE Modeling Week	3 CP	Krumscheid, Kühnlein

Assessment
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 3.104 Module: Maxwell's Equations [M-MATH-102885]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105856	Maxwell's Equations	8 CP	Arens, Griesmaier, Hettlich

Assessment
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

Recommendations
Desirable is basic knowledge from functional analysis

M 3.105 Module: Methodical Foundations of OR [M-WIWI-101414]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German	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 CP	Stein
T-WIWI-103638	Global Optimization I and II	9 CP	Stein
T-WIWI-102724	Nonlinear Optimization I	4,5 CP	Stein
T-WIWI-103637	Nonlinear Optimization I and II	9 CP	Stein
Supplementary Courses (Election:)			
T-WIWI-106546	Introduction to Stochastic Optimization	4,5 CP	Rebennack
T-WIWI-102727	Global Optimization II	4,5 CP	Stein
T-WIWI-102725	Nonlinear Optimization II	4,5 CP	Stein
T-WIWI-102704	Facility Location and Strategic Supply Chain Management	4,5 CP	Nickel

Assessment
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.

Additional Information
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.

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

M 3.106 Module: Metric Geometry [M-MATH-105931]

Coordinators: Prof. Dr. Alexander Lytchak
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	German	4	2

Mandatory			
T-MATH-111933	Metric Geometry	8 CP	Lytchak, Nepechiy

Assessment
Oral examination of circa 20 minutes.

Prerequisites
None.

Competence Goal
Understanding of fundamental concepts of metric geometry

Preparation for a thesis in the area of metric geometry

Content
Convergence of metric spaces, Spaces of metric spaces, comparison geometry, curvature-free geometry of manifolds

Module Grade Calculation
The module grade is the grade of the final oral exam.

Additional Information
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

Contact hours: 90 hours

Course, including the accompanying module examination

Independent study: 150 hours

- Consolidation of course content through at-home review of the lecture material
- Completion of exercise assignments
- Further study of course content using appropriate literature and online research
- Preparation for the accompanying module examination

Recommendations
Basic knowledge of set-theoretical topology and elementary geometry, as taught in the module "M-MATH-103152 - Elementary Geometry", is recommended.

M 3.107 Module: Microeconomic Theory [M-WIWI-101500]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	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 CP	Brumm, Mitusch
T-WIWI-102861	Advanced Game Theory	4,5 CP	Ehrhart, Puppe, Reiß
T-WIWI-102613	Auction Theory	4,5 CP	Ehrhart
T-WIWI-105781	Incentives in Organizations	4,5 CP	Nieken
T-WIWI-113264	Matching Theory	4,5 CP	Puppe
T-WIWI-102859	Social Choice Theory	4,5 CP	Puppe

Assessment
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
Attendance time: 90 h

Self-study: approx. 100 h

Exam preparation: approx. 80 h

Total: 270 h

M 3.108 Module: Minimal Surfaces [M-MATH-106666]

Coordinators: Dr. Peter Lewintan
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Analysis or Applied and Numerical Mathematics, Optimization) Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Irregular	1 term	German	4	1

Mandatory			
T-MATH-113417	Minimal Surfaces	3 CP	Lewintan

Assessment
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

Recommendations
The course "Classical Methods for Partial Differential Equations" is recommended.

M 3.109 Module: Modeling the Dynamics of Financial Markets [M-WIWI-106660]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-WIWI-113414	Modeling the Dynamics of Financial Markets	9 CP	Ulrich

Assessment
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.

Recommendations
Recommendation: Knowledge in the fields of Advanced Statistics, Deep Learning, Financial Economics, Differential Equations, Optimization.

Teaching and Learning Methods
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 3.110 Module: Modelling and Simulation of Lithium-Ion Batteries [M-MATH-106640]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113382	Modelling and Simulation of Lithium-Ion Batteries	4 CP	Dörfler

Assessment
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

Recommendations
Basic knowledge in the numerical treatment of differential equations, such as boundary value problems or initial value problems is strongly recommended.

M 3.111 Module: Modern Methods in Combinatorics [M-MATH-106957]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113911	Modern Methods in Combinatorics	6 CP	Aksenovich

Assessment
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

Recommendations
Some knowledge of linear algebra and probability theory is strongly recommended. The courses *Graph Theory* and *Combinatorics* are recommended but not required.

M 3.112 Module: Monotonicity Methods in Analysis [M-MATH-102887]

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

Credits	Grading	Recurrence	Duration	Level	Version
3 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105877	Monotonicity Methods in Analysis	3 CP	Herzog

Assessment
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

Recommendations
The course "Functional Analysis" is recommended.

M 3.113 Module: Nonlinear Analysis [M-MATH-103539]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-107065	Nonlinear Analysis	8 CP	Lamm

Prerequisites
None

M 3.114 Module: Nonlinear Maxwell Equations [M-MATH-105066]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-110283	Nonlinear Maxwell Equations	8 CP	Schnaubelt

Assessment
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

Recommendations
The contents of the module "Functional Analysis" are strongly recommended.

M 3.115 Module: Nonlinear Wave Equations [M-MATH-105326]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
4 CP	graded	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-110806	Nonlinear Wave Equations	4 CP	Reichel, Schnaubelt

Assessment
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

Recommendations
The contents of the module "Functional Analysis" are strongly recommended.

M 3.116 Module: Nonparametric Statistics [M-MATH-102910]

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	Irregular	1 term	4	2

Mandatory			
T-MATH-105873	Nonparametric Statistics	4 CP	Ebner, Fasen-Hartmann, Klar, Trabs

Assessment
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

Recommendations
The contents of the module 'Probability Theory' are strongly recommended. The module 'Mathematical Statistics' is recommended.

M 3.117 Module: Numerical Analysis of Neural Networks [M-MATH-106695]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113470	Numerical Analysis of Neural Networks	6 CP	Maier

Assessment
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.

Additional Information
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

Recommendations
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.

M 3.118 Module: Numerical Analysis on Quantum Computers [M-MATH-107646]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-114990	Numerical Analysis on Quantum Computers	6 CP	Maier

Assessment
Oral examination of approximately 30 minutes.

Prerequisites
None.

Competence Goal
This lecture introduces a purely mathematical view on quantum computing. Students learn elementary concepts that describe operations on quantum computers. They are able to combine them and to implement numerical algorithms, e.g., to solve linear systems or differential equations. Students can also theoretically analyze the errors of the algorithms.

Content

- Basics of quantum computers
- Classical quantum algorithms
- Solving linear systems
- Solving linear differential equations

Module Grade Calculation
The grade of the module is the grade of the oral exam.

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

Recommendations
A solid background in numerical mathematics is recommended.

M 3.119 Module: Numerical Complex Analysis [M-MATH-106063]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	German	4	1

Mandatory			
T-MATH-112280	Numerical Complex Analysis	6 CP	Hochbruck

Assessment
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.

Recommendations
Basic knowledge of complex analysis is highly recommended.

Literature
Lecture notes with references.

M 3.120 Module: Numerical Linear Algebra in Image Processing [M-MATH-104058]

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

Credits	Grading	Recurrence	Duration	Level	Version
6 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-108402	Numerical Linear Algebra in Image Processing	6 CP	Grimm

Assessment
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 3.121 Module: Numerical Methods for Differential Equations [M-MATH-102888]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-MATH-105836	Numerical Methods for Differential Equations	8 CP	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

Assessment
The module will be completed by an oral examination with a duration of approximately 30 minutes. If this would require an unreasonable amount of time, the oral examination may be replaced by a written exam with a duration of approximately 120 minutes. The decision will be announced at least six weeks before the examination.

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

Recommendations
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".

M 3.122 Module: Numerical Methods for Hyperbolic Equations [M-MATH-102915]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	German/English	4	2

Mandatory			
T-MATH-105900	Numerical Methods for Hyperbolic Equations	6 CP	Dörfler

Assessment
Oral exam of ca. 25 minutes

Prerequisites
none

Competence Goal
Absolventinnen und Absolventen können

- die grundlegenden Methoden, Techniken und Algorithmen der Behandlung hyperbolischer Anfangswertprobleme erklären
- Konzepte der Modellierung mit hyperbolischen Differentialgleichungen wiedergeben
- Einfache skalare oder vektorwertige hyperbolische Gleichungen numerisch lösen

Content

- Modelling with conservation laws
- Shocks, Rarefaction waves and weak solutions
- Aspects of existence and regularity theorie of scalar problems
- Discretisation of conservation laws in space and time
- Properties and discretisation of hyperbolic systems

Module Grade Calculation
The grade of the module is the grade of the oral exam.

Workload
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

Recommendations
Basic knowledge in numerics of differential equations is strongly recommended. Knowledge in functional analysis is recommended.

M 3.123 Module: Numerical Methods for Integral Equations [M-MATH-102930]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	5	1

Mandatory			
T-MATH-105901	Numerical Methods for Integral Equations	8 CP	Arens, Hettlich

Assessment
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

Recommendations
Numerical Analysis I

Integral Equations

M 3.124 Module: Numerical Methods for Maxwell's Equations [M-MATH-102931]

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

Credits	Grading	Recurrence	Duration	Level	Version
6 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105920	Numerical Methods for Maxwell's Equations	6 CP	Hochbruck, Jahnke

Assessment
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.

Recommendations
Basic knowledge of ordinary and/or partial differential equations is recommended.

The module "Numerical Methods for Differential Equations" is strongly recommended.

Teaching and Learning Methods
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 3.125 Module: Numerical Methods for Oscillatory Differential Equations [M-MATH-106682]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	German/English	4	1

Mandatory			
T-MATH-113437	Numerical Methods for Oscillatory Differential Equations	8 CP	Jahnke

Assessment
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.

Additional Information
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

Recommendations
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.).

M 3.126 Module: Numerical Methods for Time-Dependent Partial Differential Equations [M-MATH-102928]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	5	1

Mandatory			
T-MATH-105899	Numerical Methods for Time-Dependent Partial Differential Equations	8 CP	Hochbruck, Jahnke

Assessment
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.

Recommendations
Numerical methods for differential equations, finite element methods, functional analysis.

M 3.127 Module: Numerical Methods in Computational Electrodynamics [M-MATH-102894]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	German	4	2

Mandatory			
T-MATH-105860	Numerical Methods in Computational Electrodynamics	6 CP	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

Assessment
Oral exam of ca. 25 minutes

Prerequisites
None

Competence Goal
Participants

- are able to explain electrostatic or electrodynamic effects with mathematical models,
- know the basic problems to construct correct approximations,
- are able to describe stable discretisations of Maxwell equations.

Content

- Maxwell equations, special cases
- Boundary and transmission conditions
- Analytical tools
- The electromagnetic source problem
- The eigenvalue problem
- Finite elements for the Maxwell equations
- Interpolation estimates

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

Recommendations
Basic knowledge in analysis of boundary value problems and the finite element method is strongly recommended.

M 3.128 Module: Numerical Methods in Fluid Mechanics [M-MATH-102932]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-MATH-105902	Numerical Methods in Fluid Mechanics	4 CP	Dörfler, Thäter

Assessment
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.

Recommendations
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.

M 3.129 Module: Numerical Methods in Mathematical Finance [M-MATH-102901]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	German/English	4	1

Mandatory			
T-MATH-105865	Numerical Methods in Mathematical Finance	8 CP	Jahnke

Assessment
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.

Additional Information
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

Recommendations
Familiarity with stochastic differential equations, the Ito integral, and the Ito formula is strongly recommended. MATLAB skills are strongly recommended for the programming exercises.

M 3.130 Module: Numerical Optimisation Methods [M-MATH-102892]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105858	Numerical Optimisation Methods	8 CP	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

M 3.131 Module: Numerical Simulation in Molecular Dynamics [M-MATH-105327]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German	4	1

Mandatory			
T-MATH-110807	Numerical Simulation in Molecular Dynamics	8 CP	Grimm

Assessment
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

Recommendations
The module M-MATH-102888 (Numerical Methods for Differential Equations) and some programming skills in C (or C++) are recommended.

M 3.132 Module: Operations Research in Supply Chain Management [M-WIWI-102832]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	2 terms	German/English	4	10

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 CP	Nickel
T-WIWI-106200	Modeling and OR-Software: Advanced Topics	4,5 CP	Nickel
T-WIWI-102715	Operations Research in Supply Chain Management	4,5 CP	Nickel
Supplementary Courses (Election: at most 1 item)			
T-MACH-112213	Applied material flow simulation	4,5 CP	Baumann
T-WIWI-106546	Introduction to Stochastic Optimization	4,5 CP	Rebennack
T-WIWI-102718	Discrete-Event Simulation in Production and Logistics	4,5 CP	Spieckermann
T-WIWI-102719	Mixed Integer Programming I	4,5 CP	Stein
T-WIWI-102720	Mixed Integer Programming II	4,5 CP	Stein
T-WIWI-106549	Large-scale Optimization	4,5 CP	Rebennack
T-WIWI-111587	Multicriteria Optimization	4,5 CP	Stein
T-WIWI-114747	"Practical Seminar in Discrete Optimization: Implementing and Evaluating Solution Methods (with Python)"	4,5 CP	Bakker
T-WIWI-112109	Topics in Stochastic Optimization	4,5 CP	Rebennack

Assessment
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.

Additional Information
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

Recommendations
Basic knowledge as conveyed in the module *Introduction to Operations Research* is assumed.

M 3.133 Module: Optimisation and Optimal Control for Differential Equations [M-MATH-102899]

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105864	Optimisation and Optimal Control for Differential Equations	4 CP	

Prerequisites
none

M 3.134 Module: Optimization in Banach Spaces [M-MATH-102924]

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

Credits	Grading	Recurrence	Duration	Level	Version
5 CP	graded	Irregular	1 term	4	2

Mandatory			
T-MATH-105893	Optimization in Banach Spaces	5 CP	Griesmaier, Hettlich

Assessment
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

Recommendations
Some basic knowledge of finite dimensional optimization theory and functional analysis is desirable.

M 3.135 Module: Parallel Computing [M-MATH-101338]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
5 CP	graded	Irregular	1 term	German/English	4	2

Mandatory			
T-MATH-102271	Parallel Computing	5 CP	Krause, Wieners

Assessment
Examination prerequisite: passed computer lab

Success is assessed in the form of an oral examination lasting approx. 20 minutes.

Prerequisites
None

Competence Goal
Graduates

- know the fundamentals of parallel computing,
- have an overview of scientific computing concepts on parallel computers,
- have theoretical and practical experience with parallel programming models and parallel solution methods,
- can independently implement simple practical tasks in a scalable manner

Content

- Parallel programming models
- Parallel solving of linear equation systems
- Parallel finite differences, finite elements, finite volumes methods
- Domain decomposition methods
- Parallel matrix-matrix and matrix-vector operations
- Convergence and performance analysis
- Load balance techniques
- Applications from the natural sciences and engineering

Module Grade Calculation
The module grade is the grade for the oral examination.

Workload
Total workload: 150 hours

Attendance time: 60 hours

- Course including module examination during the course of study

Self-study: 90 hours

- Consolidation of course content through follow-up work on lecture content at home
- Completion of exercises
- Consolidation of course content using appropriate literature and internet research
- Preparation for the module examination during the course of study

Recommendations
Knowledge of a higher-level programming language (C++, Java, Fortran) and basic knowledge of the numerical treatment of differential equations (finite differences or finite elements) are recommended.

M 3.136 Module: Percolation [M-MATH-102905]

Coordinators: PD Dr. Steffen Winter
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Irregular	1 term	German/English	4	2

Mandatory			
T-MATH-105869	Percolation	5 CP	Hug, Winter

Assessment
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

Recommendations
The contents of the module *Probability Theory* are recommended.

M 3.137 Module: Poisson Processes [M-MATH-102922]

Coordinators: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading	Recurrence	Duration	Level	Version
5 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105922	Poisson Processes	5 CP	Fasen-Hartmann, Hug, Nestmann, Winter

Assessment
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

Recommendations
The contents of the module *Probability Theory* are recommended.

M 3.138 Module: Potential Theory [M-MATH-102879]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105850	Potential Theory	8 CP	Arens, Griesmaier, Hettlich, Reichel

Assessment
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 3.139 Module: Probability Theory and Combinatorial Optimization [M-MATH-102947]

Coordinators: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105923	Probability Theory and Combinatorial Optimization	8 CP	Hug

Assessment
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.

Recommendations
The contents of the module "Probability Theory" are strongly recommended.

M 3.140 Module: Random Graphs and Networks [M-MATH-106052]

Coordinators: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-112241	Random Graphs and Networks	8 CP	Hug

Assessment
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.

Additional Information
can not be completed together with M-MATH-102951 - Random Graphs

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

Recommendations
The contents of the module 'Probability Theory' are strongly recommended.

M 3.141 Module: Regularity for Elliptic Operators [M-MATH-106696]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113472	Regularity for Elliptic Operators	6 CP	Kunstmann

Assessment
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

Recommendations
The modules “Functional Analysis” and "Spectral Theory" are strongly recommended.

M 3.142 Module: Riemann Surfaces [M-MATH-106466]

Coordinators: Prof. Dr. Frank Herrlich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German	4	1

Mandatory			
T-MATH-113081	Riemann Surfaces	8 CP	Herrlich

Assessment
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

Recommendations
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 3.143 Module: Ruin Theory [M-MATH-104055]

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-108400	Ruin Theory	4 CP	Fasen-Hartmann

Assessment
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 time: 45 hours

- Course and exercises including module examination during the course

Self-study: 75 hours

- Consolidation of the course 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

Recommendations
The content of the module "Probability Theory" is recommended.

M 3.144 Module: Scattering Theory [M-MATH-102884]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105855	Scattering Theory	8 CP	Arens, Griesmaier, Hettlich

Assessment
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

Recommendations
One of the following modules should already be covered: functional analysis or integral equations

M 3.145 Module: Scattering Theory for Time-dependent Waves [M-MATH-106664]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	German/English	4	1

Mandatory			
T-MATH-113416	Scattering Theory for Time-dependent Waves	6 CP	Griesmaier

Assessment
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

Recommendations
The modules *Functional Analysis* and/or *Integral Equations* are recommended.

M 3.146 Module: Selected Methods in Fluids and Kinetic Equations [M-MATH-105897]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-111853	Selected Methods in Fluids and Kinetic Equations	3 CP	

Assessment
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

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

M 3.147 Module: Selected Topics in Harmonic Analysis [M-MATH-104435]

Coordinators: PD Dr. Ioannis Anapolitanos
Prof. Dr. Dirk Hundertmark

Organisation: KIT Department of Mathematics

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

Credits	Grading	Recurrence	Duration	Level	Version
3 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-109065	Selected Topics in Harmonic Analysis	3 CP	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

M 3.148 Module: Semigroup Theory for the Navier-Stokes Equations [M-MATH-106663]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-113415	Semigroup Theory for the Navier-Stokes Equations	6 CP	Tolksdorf

Assessment
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

Recommendations
The following modules are strongly recommended: *Functional Analysis* and *Classical Methods for Partial Differential Equations.*

M 3.149 Module: Seminar [M-WIWI-102971]

Coordinators: Prof. Dr. Hagen Lindstädt
Prof. Dr. Oliver Stein

Organisation: KIT Department of Business and Economics

Part of: Seminar in Economics and Management
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each term	1 term	German	4	1

Wahlpflichtangebot (Election: 3 credits)			
T-WIWI-103474	Seminar in Business Administration A (Master)	3 CP	Professorenschaft des Fachbereichs Betriebswirtschaftslehre
T-WIWI-103478	Seminar in Economics A (Master)	3 CP	Professorenschaft des Fachbereichs Volkswirtschaftslehre
T-WIWI-103483	Seminar in Statistics A (Master)	3 CP	Grothe, Schienle

Assessment
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.

Additional Information
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.

Recommendations
None.

M 3.150 Module: Seminar [M-WIWI-102973]

Coordinators: Prof. Dr. Hagen Lindstädt
Prof. Dr. Oliver Stein

Organisation: KIT Department of Business and Economics

Part of: Seminar in Economics and Management
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each term	1 term	German	4	1

Wahlpflichtangebot (Election: 3 credits)			
T-WIWI-103479	Seminar in Informatics A (Master)	3 CP	Professorenschaft des Instituts AIFB
T-WIWI-103481	Seminar in Operations Research A (Master)	3 CP	Nickel, Rebennack, Stein

Assessment
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.

Additional Information
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.

Recommendations
None.

M 3.151 Module: Seminar [M-MATH-102730]

Coordinators: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: Mathematical Seminar

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	pass/fail	Each term	1 term	German/English	4	3

Elective Seminar (Election: 1 item)			
T-MATH-105686	Seminar Mathematics	3 CP	Kühnlein

Assessment
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 3.152 Module: Seminar [M-WIWI-102972]

Coordinators: Prof. Dr. Hagen Lindstädt
Prof. Dr. Oliver Stein

Organisation: KIT Department of Business and Economics

Part of: Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each term	1 term	German/English	4	1

Wahlplfichtangebot (Election: 1 item)			
T-WIWI-103476	Seminar in Business Administration B (Master)	3 CP	Professorenschaft des Fachbereichs Betriebswirtschaftslehre
T-WIWI-103477	Seminar in Economics B (Master)	3 CP	Professorenschaft des Fachbereichs Volkswirtschaftslehre
T-WIWI-103484	Seminar in Statistics B (Master)	3 CP	Grothe, Schienle

Assessment
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.

Additional Information
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 3.153 Module: Seminar [M-WIWI-102974]

Coordinators: Prof. Dr. Hagen Lindstädt
Prof. Dr. Oliver Stein

Organisation: KIT Department of Business and Economics

Part of: Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each term	1 term	German/English	4	1

Wahlplfichtangebot (Election: 1 item)			
T-WIWI-103480	Seminar in Informatics B (Master)	3 CP	Professorenschaft des Instituts AIFB
T-WIWI-103482	Seminar in Operations Research B (Master)	3 CP	Nickel, Rebennack, Stein

Assessment
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.

Additional Information
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 3.154 Module: Service Operations [M-WIWI-102805]

Coordinators: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Business and Economics
Part of: Operations Management - Data Analysis - Informatics

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	1 term	German/English	4	9

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 CP	Spieckermann
T-WIWI-102884	Operations Research in Health Care Management	4,5 CP	Nickel
T-WIWI-102715	Operations Research in Supply Chain Management	4,5 CP	Nickel
T-WIWI-102716	Practical Seminar: Health Care Management (with Case Studies)	4,5 CP	Nickel
Supplementary Courses (Election: at most 1 item)			
T-MACH-112213	Applied material flow simulation	4,5 CP	Baumann
T-WIWI-114109	Service Operations and Cyber Security	4,5 CP	Mohr

Assessment
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.

Additional Information
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.

Recommendations
The course Practical Seminar Health Care should be combined with the course OR in Health Care Management.

M 3.155 Module: Sobolev Spaces [M-MATH-102926]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German/English	4	2

Mandatory			
T-MATH-105896	Sobolev Spaces	8 CP	Frey, Schnaubelt

Assessment
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

Recommendations
The module "Functional Analysis" is strongly recommended.

M 3.156 Module: Space and Time Discretization of Nonlinear Wave Equations [M-MATH-105966]

Coordinators: 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	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-112120	Space and Time Discretization of Nonlinear Wave Equations	6 CP	Hochbruck

Assessment
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.

Recommendations
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.

M 3.157 Module: Spatial Stochastics [M-MATH-102903]

Coordinators: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Each winter term	1 term	4	1

Mandatory			
T-MATH-105867	Spatial Stochastics	8 CP	Hug, Last, Winter

Assessment
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

Recommendations
The contents of the module *Probability Theory* are recommended.

M 3.158 Module: Special Topics of Numerical Linear Algebra [M-MATH-102920]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	see Annotations	1 term	English	4	1

Mandatory			
T-MATH-105891	Special Topics of Numerical Linear Algebra	8 CP	Grimm, Hochbruck, Neher

Assessment
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.

Additional Information
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.

Recommendations
Numerical analysis 1 and 2.

M 3.159 Module: Spectral Theory [M-MATH-101768]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each summer term	1 term	German	5	1

Mandatory			
T-MATH-103414	Spectral Theory - Exam	8 CP	Frey, Herzog, Kunstmann, Schnaubelt, Tolksdorf

Assessment
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

Recommendations
The module „Functional Analysis“ is strongly recommended.

M 3.160 Module: Splitting Methods for Evolution Equations [M-MATH-105325]

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

Credits	Grading	Recurrence	Duration	Level	Version
6 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-110805	Splitting Methods for Evolution Equations	6 CP	Jahnke

Assessment
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.

Additional Information
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

Recommendations
Familiarity with ordinary differential equations and Runge-Kutta methods (construction, order, stability) is strongly recommended.

M 3.161 Module: Statistical Learning [M-MATH-105840]

Coordinators: Prof. Dr. Mathias Trabs
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Stochastics)
Elective Field

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Each summer term	1 term	4	1

Mandatory			
T-MATH-111726	Statistical Learning	8 CP	Trabs

Assessment
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

Recommendations
The modules "Probability Theory" and "Statistics" (M-MATH-103220) are recommended.

M 3.162 Module: Steins Method with Applications in Statistics [M-MATH-105579]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Irregular	1 term	German/English	4	2

Mandatory			
T-MATH-111187	Steins Method with Applications in Statistics	4 CP	Ebner, Hug

Assessment
The module assessment takes the form of an oral comprehensive examination (approx. 25 minutes).

Prerequisites
None.

Competence Goal
Graduates can

- name and discuss the fundamentals of Stein's method and its applications to selected problems,
- prove central limit theorems and Poisson limit theorems using Stein's method,
- describe applications in statistics,
- work in a self-organized and reflective manner.

Content

- Stein equations for the univariate and multivariate normal distribution as well as for the Poisson distribution,
- local dependencies and dependency graphs,
- application of the above techniques to selected problems such as random graphs,
- Stein operators; characterization of distribution families,
- density and generator approaches,
- application of the above approaches to goodness-of-fit tests and minimum-distance estimators

Module Grade Calculation
The module grade is the grade awarded for the oral examination.

Workload
Total workload: 120 hours

Contact hours: 45 hours

Course, including the exam

Independent study: 75 hours

- Deepening of course content through at-home review of the lecture material,
- Completion of exercise assignments,
- Deepening of course content using suitable literature and online research,
- Preparation for the exam.

Recommendations
The contents of the module "Probability Theory" are strongly recommended. Knowledge of the module "Mathematical Statistics" is recommended.

M 3.163 Module: Stochastic Control [M-MATH-102908]

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105871	Stochastic Control	4 CP	Bäuerle

Assessment
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

Recommendations
The course 'Probably Theory' is strongly recommended. The courses 'Brownian motion' and 'Continuous time finance' are recommended.

M 3.164 Module: Stochastic Geometry [M-MATH-102865]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Each summer term	1 term	5	1

Mandatory			
T-MATH-105840	Stochastic Geometry	8 CP	Hug, Winter

Assessment
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 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

Recommendations
The contents of the module "Spatial Stochastics" are recommended.

M 3.165 Module: Stochastic Optimization [M-WIWI-103289]

Coordinators: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Business and Economics
Part of: Operations Management - Data Analysis - Informatics
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	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 CP	Rebennack
T-WIWI-106548	Advanced Stochastic Optimization	4,5 CP	Rebennack
T-WIWI-106549	Large-scale Optimization	4,5 CP	Rebennack
Supplementary Courses (Election: at most 1 item)			
T-WIWI-102723	Graph Theory and Advanced Location Models	4,5 CP	Nickel
T-WIWI-102719	Mixed Integer Programming I	4,5 CP	Stein
T-WIWI-102720	Mixed Integer Programming II	4,5 CP	Stein
T-WIWI-111247	Mathematics for High Dimensional Statistics	4,5 CP	Grothe
T-WIWI-111587	Multicriteria Optimization	4,5 CP	Stein
T-WIWI-103124	Multivariate Statistical Methods	4,5 CP	Grothe
T-WIWI-102715	Operations Research in Supply Chain Management	4,5 CP	Nickel
T-WIWI-106545	Optimization under Uncertainty	4,5 CP	Rebennack
T-WIWI-112109	Topics in Stochastic Optimization	4,5 CP	Rebennack

Assessment
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.

Additional Information
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.

Recommendations
It is recommended to listen to the lecture "Introduction to Stochastic Optimization" before the lecture "Advanced Stochastic Optimization" is visited.

M 3.166 Module: Stochastic Simulation [M-MATH-106053]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-MATH-112242	Stochastic Simulation	5 CP	Krumscheid

Assessment
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

Recommendations
The contents of the modules 'M-MATH-101321 - Introduction to Stochastics' and 'M-MATH-103214 – Numerical Mathematics 1+2' are recommended.

M 3.167 Module: Structural Graph Theory [M-MATH-105463]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Irregular	1 term	English	4	2

Mandatory			
T-MATH-111004	Structural Graph Theory	4 CP	Aksenovich

Assessment
Success is assessed in an oral examination (approx. 30 minutes).

Prerequisites
None.

Competence Goal
After successful completion of the course, the participants are able to present and analyse main results in Structural Graph Theory. They are 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.

Module Grade Calculation
The module grade is the grade of the oral examination.

Workload
Total workload: 120 hours

Attendance time: 45 hours

- Course including module examination

Self-study: 75 hours

- Consolidation 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

Recommendations
A solid background in the fundamentals of graph theory is recommended.

M 3.168 Module: Sustainable Information Systems [M-WIWI-107649]

Coordinators: TT-Prof. Dr. Philipp Staudt
Organisation: KIT Department of Business and Economics
Part of: Finance - Risk Management - Managerial Economics

Credits	Grading	Recurrence	Duration	Language	Level	Version
9 CP	graded	Each term	2 terms	English	4	1

Mandatory			
T-WIWI-114994	Digital Energy Systems	4,5 CP	Staudt
T-WIWI-114995	Sustainable Information Systems	4,5 CP	Staudt

Assessment
The module examination consists of partial examinations of the selected courses, which together meet the required credit point requirement. Details of the examination can be found in the respective partial performance description. The total grade of the module is formed from the grades of the partial examinations weighted by credit points (cut off after the first decimal place).

Prerequisites
None

Competence Goal
The student

- knows methods for investigating the use of sustainable information systems or information systems for promoting sustainability.
- is aware of the uses of digital technology for sustainability.
- understands how digital technology is changing the energy market and the energy system.
- is able to generate insights into the use of information systems with the help of scientific methods.
- is familiar with the economic and behavioral science theories underlying the digitization of the energy system.
- can make decisions on the use of digital technology for sustainability purposes or in the energy sector.

Content
The module deals with the use of digital technology for sustainability purposes from a general and an energy system perspective. The courses focus on context-specific as well as methodological and theoretical content. While Methods in Sustainable Information Systems focuses on the general perspective on sustainability and methodological knowledge, Digital Energy Systems focuses on the energy system context and economic and behavioral theory fundamentals.

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

- Attendance time: 51 hours
- Preparation and follow-up: 153 hours
- Exam and exam preparation: 66 hours

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

M 3.169 Module: Time Series Analysis [M-MATH-102911]

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

Credits	Grading	Recurrence	Duration	Level	Version
4 CP	graded	Each summer term	1 term	4	3

Mandatory			
T-MATH-105874	Time Series Analysis	4 CP	Ebner, Fasen-Hartmann, Gneiting, Klar, Trabs

Assessment
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

Recommendations
The contents of the course "Probability Theory" are strongly recommended. The contents of the course "Statistics" are recommended.

M 3.170 Module: Topics in Algebraic Topology [M-MATH-107017]

Coordinators: TT-Prof. Dr. Manuel Krannich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-114063	Topics in Algebraic Topology	6 CP	Krannich

Assessment
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

Recommendations
The contents of the modules "Elementary Geometry" and "Algebraic Topology" are recommended.

M 3.171 Module: Topics in Homotopy Theory [M-MATH-107484]

Coordinators: TT-Prof. Dr. Manuel Krannich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	1

Mandatory			
T-MATH-114682	Topics in Homotopy Theory	6 CP	Krannich

Assessment
The module examination takes the form of an oral examination (30 min.)

Prerequisites
None

Competence Goal
Graduates

- are able to calculate the homotopy-theoretic invariants discussed in concrete examples;
- are proficient in advanced techniques of homotopy theory;
- are able to work in a self-organized and reflective manner.

Content

- examples of advanced homotopy-theoretic invariants (e.g. cohomology operations, characteristic classes),
- advanced homotopy-theoretic concepts and methods (e.g. spectral sequences, spectra, obstruction theory, classification of fibrations and fiber bundles, Thom isomorphism),
- applications to the topology of manifolds (e.g. Wu formula, existence of exotic spheres)

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

Recommendations
The contents of the modules "Elementary Geometry", "Algebraic Topology" and "Topics in Algebraic Topology" are recommended.

M 3.172 Module: Topological Data Analysis [M-MATH-105487]

Coordinators: 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	Recurrence	Duration	Level	Version
6 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-111031	Topological Data Analysis	6 CP	Hartnick, Sauer

M 3.173 Module: Translation Surfaces [M-MATH-105973]

Coordinators: Prof. Dr. Frank Herrlich
Organisation: KIT Department of Mathematics
Part of: Mathematical Methods (Algebra and Geometry)
Elective Field

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Irregular	1 term	German	4	1

Mandatory			
T-MATH-112128	Translation Surfaces	8 CP	Herrlich

Assessment
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

Recommendations
Basic knowledge in surface topology and complex analysis is strongly recommended. The module "Algebraic Geometry" is also recommended.

M 3.174 Module: Traveling Waves [M-MATH-102927]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Irregular	1 term	English	4	2

Mandatory			
T-MATH-105897	Traveling Waves	6 CP	de Rijk, Reichel

Assessment
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

Recommendations
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.

M 3.175 Module: Uncertainty Quantification [M-MATH-104054]

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

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-MATH-108399	Uncertainty Quantification	4 CP	Frank

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

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.

Module Grade Calculation
The module grade is the grade of the oral examination.

Workload
Total workload: 120 hours

Attendance time: 45 hours

- Course including module examination during the course of study

Self-study: 75 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

Recommendations
Numerical methods for differential equations

M 3.176 Module: Variational Methods [M-MATH-105093]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-110302	Variational Methods	8 CP	Reichel

Assessment
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

Recommendations
The contents of the courses Functional Analysis, Classical Methods for Partial Differential Equations, or Boundary and Eigenvalue problems are recommended.

M 3.177 Module: Wavelets [M-MATH-102895]

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

Credits	Grading	Recurrence	Duration	Level	Version
8 CP	graded	Irregular	1 term	4	1

Mandatory			
T-MATH-105838	Wavelets	8 CP	Rieder

Assessment
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

Recommendations
The course "Functional analysis" is recommended.

4 Module components

T 4.1 Module component: "Practical Seminar in Discrete Optimization: Implementing and Evaluating Solution Methods (with Python)" [T-WIWI-114747]

Coordinators: Dr.-Ing. Hannah Bakker
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102832 - Operations Research in Supply Chain Management

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Once	1

Courses					
WT 25/26	2500066	Practical Seminar in Discrete Optimization: Implementing and Evaluating Solution Methods (with Python)	3 SWS	Others / 🗣	Bakker
Exams					
WT 25/26	7900067	"Practical Seminar in Discrete Optimization: Implementing and Evaluating Solution Methods (with Python)"			Nickel

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is conducted as an alternative exam assessment in the form of a computational experiment. This includes the submission of a documented code project, a written report (6–8 pages), as well as an interim and a final presentation.

The final grade is composed of the graded and weighted assessment components: the code, the written report, and the interim and final presentations. Details will be announced at the beginning of the course.

Prerequisites
None

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Practical Seminar in Discrete Optimization: Implementing and Evaluating Solution Methods (with Python)

Others (sonst.)
On-Site

2500066, WS 25/26, 3 SWS, Language: German, Open in study portal

Content
This application-oriented seminar provides students with practical skills in working with heuristic methods for discrete optimization. Participants implement a given solution approach in Python and apply it to defined benchmark instances. The focus is not only on technical implementation but also on the systematic setup, execution, and evaluation of a computational experiment. Students practice presenting and assessing results in a structured manner. The aim of the seminar is to develop fundamental competencies in algorithmic implementation and empirical evaluation of heuristic methods, applied to a concrete optimization problem.

Organizational issues
Die Veranstaltung ist teilnahmebeschränkt. Die Anmeldung wird vom 15.08. bis zum 30.09. im Wiwi-Portal freigeschaltet sein.

T 4.2 Module component: (Gen)AI-based Automation in Organizations [T-WIWI-114210]

Coordinators: Prof. Dr. Alexander Mädche
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-104068 - Information Systems in Organizations

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2500015	(Gen)AI-based Automation in Organizations	3 SWS	Lecture /	Mädche, Benke
Exams					
ST 2026	7900308	(Gen)AI-based Automation in Organizations			Mädche

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The alternative exam assessment is a single examination of another type that combines a written examination (duration ≈ 60 minutes) with the implementation of a capstone project. Both components are integrated into one overall assessment; the internal weighting of the two parts is defined by the teaching staff, but only one final grade is awarded for the whole examination. The final grade therefore reflects the total impression of the combined performance

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V **(Gen)AI-based Automation in Organizations**
2500015, SS 2026, 3 SWS, Language: English, Open in study portal
Lecture (V)
Blended (On-Site/Online)

Content
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, Claude or Google Gemini for text and image generation, personal recommendations, or decision support. At the same time, organizations are challenged to leverage GenAI and traditional AI technology 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. This digital transformation process to higher levels of automation, however, must be managed by organizations.

This course will address this organizational challenge and teach concepts about the automation of organizations and their employees leveraging (Gen)AI technologies. The course is not focusing on the technological foundations of GenAI but looks into the economic and social impact of the technology and its management.

Learning Objectives

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 core concepts of automation to drive organizational efficiency and innovation.
- articulate (Gen)AI integration principles for effectively implementing automation in organizations.
- understand and apply automation management strategies and best practices for addressing challenges to ensure adoption of (Gen)AI capabilities for organizational automation from a socio-economic perspective.
- explore and prototype (Gen)AI-based applications to streamline individual tasks and workflows in the context of organizational automation.

Case-studies & No-code exercise
The course contains two applied elements:

- Case-study exercises in which the students apply the theoretical knowledge on integrating (Gen)AI-based services into an organization.
- No-code exercises in which the students will develop a no/low-code application using (Gen)AI services to implement automation.

Organization
The lecture kickoff will take place on **April 24, 2026** from 14:00 - 15:30 at Building 10.11 Room 213 (Plenarsaal).

More information about the schedule of the lecture, the exercises or any organizational aspect will be posted in advance in the ILIAS course of the lecture. For questions regarding the course please use the ILIAS Forum.

The lecture will be held by Dr. Ivo Benke and Till Carlo Schelhorn.

Lecture contact for organizational questions is Till Carlo Schelhorn (till.schelhorn∂kit.edu)

T 4.3 Module component: Adaptive Finite Element Methods [T-MATH-105898]

Coordinators: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: M-MATH-102900 - Adaptive Finite Elemente Methods

Type	Credits	Grading	Version
Oral examination	8 CP	graded	2

Assessment
oral exam of ca. 30 minutes

Prerequisites
none

Recommendations
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

T 4.4 Module component: Advanced Corporate Finance [T-WIWI-113469]

Coordinators: Prof. Dr. Martin Ruckes
Organisation: KIT Department of Business and Economics
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	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2530214	Advanced Corporate Finance	2 SWS	Lecture / 🗣	Ruckes
Exams					
WT 25/26	7900058	Advanced Corporate Finance			Ruckes
ST 2026	7900317	Advanced Corporate Finance			Ruckes

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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 courses related to this module component:

V Advanced Corporate Finance

2530214, SS 2026, 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 4.5 Module component: Advanced Game Theory [T-WIWI-102861]

Coordinators: Prof. Dr. Karl-Martin Ehrhart
Prof. Dr. Clemens Puppe
Prof. Dr. Johannes Philipp Reiß

Organisation: KIT Department of Business and Economics

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	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	2

Courses					
WT 25/26	2521533	Advanced Game Theory	2 SWS	Lecture / 🗣	Reiß
WT 25/26	2521534	Übung zu Advanced Game Theory	1 SWS	Practice / 🗣	Reiß, Peters, Potarca
Exams					
WT 25/26	00076	Advanced Game Theory			Puppe
WT 25/26	7910020	Advanced Game Theory			Reiß

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
It is recommended that students have basic knowledge in mathematics and statistics.

Below you will find excerpts from courses related to this module component:

V Advanced Game Theory

2521533, WS 25/26, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

T 4.6 Module component: Advanced Inverse Problems: Nonlinearity and Banach Spaces [T-MATH-105927]

Coordinators: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-102955 - Advanced Inverse Problems: Nonlinearity and Banach Spaces

Type	Credits	Grading	Version
Oral examination	5 CP	graded	1

Prerequisites
none

T 4.7 Module component: Advanced Lab Informatics (Master) [T-WIWI-110548]

Coordinators: Professorenschaft des Instituts AIFB
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each term	1

Courses					
WT 25/26	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course / 🧩	Schiefer, Toussaint
WT 25/26	2512314	Practical Course Linked Data and the Semantic Web (Master)	3 SWS	Practical course / 🗣	Käfer, Braun, Li, Kubelka
WT 25/26	2512501	Practical Course Cognitive automobiles and robots (Master)	3 SWS	Practical course / 🧩	Zöllner, Schneider
WT 25/26	2512555	Praktikum Security, Usability and Society (Master)	3 SWS	Practical course / 🧩	Volkamer, Strufe, Berens, Fallahi, Ballreich, Hennig, Länge, Mossano, Hilt
WT 25/26	2512600	Project lab Knowledge-driven Artificial Intelligence (Master)	3 SWS	Practical course / 🧩	Sack, Tietz, Vafaie
ST 2026	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course / 🗣	Schiefer, Toussaint, Kruse
ST 2026	2512207	Lab Agentic AI im Smart IoT Office (Master)	3 SWS	Practical course / 🗣	Oberweis, Rybinski, Ullrich
ST 2026	2512500	Project Lab Machine Learning	3 SWS	Practical course / 🧩	Zöllner, Schneider
ST 2026	2512555	Praktikum Security, Usability and Society (Master)	3 SWS	Practical course / 🧩	Volkamer, Strufe, Hennig, Fallahi, Länge, Ballreich, Hilt, Sikra, Algedri, Reimer, Mack
Exams					
WT 25/26	7900102	Advanced Lab Knowledge-driven Artificial Intelligence (Master)			Sack
WT 25/26	7900107	Advanced Lab Cognitive Automobile and Robots (Master)			Zöllner
WT 25/26	7900218	Advanced Lab Linked Data and the Semantic Web (Master)			Käfer
WT 25/26	7900306	Advanced Lab Realization of Innovative Services (Master)			Oberweis
WT 25/26	7900307	Advanced Lab Security, Usability and Society (Master)			Volkamer
ST 2026	7900061	Advanced Lab Agentic AI im Smart IoT Office (Master)			Oberweis
ST 2026	7900086	Project Lab Machine Learning			Zöllner
ST 2026	7900148	Advanced Lab Realization of innovative services (Master)			Oberweis, Schiefer
ST 2026	7900178	Practical Lab Security, Usability and Society (Master)			Volkamer, Strufe

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The alternative exam consists of a single examination of another type that combines three mandatory components:

- Practical work
- Presentation
- Written thesis

All three parts are integrated into one overall assessment. Their individual contributions are weighted according to the course-specific weighting scheme, but only one final grade is awarded for the whole examination. The final grade reflects the total impression of the combined performance.

Prerequisites
None

Additional Information
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 courses related to this module component:

V **Lab Realisation of innovative services (Master)**
2512205, WS 25/26, 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 25/26, 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 25/26, 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 **Praktikum Security, Usability and Society (Master)** — **Practical course (P)** **Blended (On-Site/Online)**
2512555, WS 25/26, 3 SWS, Language: English, Open in study portal

Content
In the lab course “Security, Usability and Society”, students explore practical and interdisciplinary topics in 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 are the work on the respective topic, a final presentation, and a final report. After consultation with the supervisor, all components can be completed in either German or English.

Please note: In-person attendance at the kick-off and final presentation is mandatory to be allocated a topic.

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, are organized via the WiWi Portal. To reserve a place and select 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 Knowledge-driven Artificial Intelligence (Master)** — **Practical course (P)** **Blended (On-Site/Online)**
2512600, WS 25/26, 3 SWS, Language: English, Open in study portal

Content
The **project course Knowledge-driven AI** is based on the summer semester lecture "Information Service Engineering". Goal of the project course is to work on a (real) research problem in small groups related to the ISE lecture topics, including:

- Large Language Models (LLM)
- Natural Language Processing (NLP),
- Knowledge Graphs (KG),
- Machine Learning (ML)

Previous project courses were based on real (funded) research projects and included project tasks, as e.g., leveraging (large) language models for OCR post-processing of scanned historic documents, knowledge extraction and knowledge graph creation from historic documents, entity typing based on knowledge graph embeddings and language models, knowledge graph completion, semantic and exploratory search based on knowledge graphs, and many more.

The project course topics this semester include:

- **"Telling Data Stories with Semantic Technologies and Generative AI"**.
  This topic addresses the challenge that 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, and provide narrative summaries. 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. This topic is part of the currently running project NFDI4Culture. The course results will be published on the NFDI4Culture Portal.
- **"Leveraging Large Language Models to Suggest Heuristics for Ontology Reasoning".**
  Ontology reasoning is a key component of semantic technologies, but traditional reasoning engines often face scalability issues with large or complex ontologies. With the rise of Large Language Models (LLMs), there is growing interest in exploring their potential to support symbolic reasoning. This project presents a preliminary study on using LLMs to suggest simple heuristics for ontology reasoning optimization. Rather than replacing existing reasoners, LLMs will serve as heuristic advisors—for example, by identifying structural patterns or recommending strategies for small ontologies. The project will involve lightweight experiments on selected ontology datasets, comparing reasoning performance with and without LLM-guided heuristics. The goal is to provide an initial exploration of the feasibility of LLM-assisted reasoning, laying the foundation for more advanced research.
- **"Large Language Models for Ontology Alignment with Foundational Ontologies"**
  Ontology alignment with foundational ontologies like BFO is important but often complex and time-consuming. This topic explores how Large Language Models (LLMs) can support or automate this process by interpreting ontology classes, suggesting alignments, and explaining their reasoning.
- **"Information Extraction in the era of Large Language Models"**
  Large Language Models (LLMs) are known to produce inaccurate or even misleading answers. One approach to mitigate this gross limitation is to enhance their responses with verified, structured data from knowledge graphs. The process of extracting structured data from unstructured texts often employs task-specific language models. In this project, students will explore and implement cutting-edge techniques for Named Entity Recognition (NER) using LLMs, comparing different approaches and evaluating their effectiveness in transforming unstructured text into structured data.

In this course you have the chance to combine creativity and practical implementation tasks to develop solutions for real-world projects and problems. The project will be worked on in **teams of 3-4 students** each, guided by a tutor from the teaching staff.

The **kick-off meeting** will take place in person on Wednesday, October 29th in room 05-09 (AIFB building 05.20), 9:45am.

The project course will be held in a **hybrid format**. The kick-off session will take place in person, and the individual group meetings throughout the semester will take place online. Each group can decide together with their tutors on regular meeting times (30min each).

For questions, please reach out to Prof. Harald Sack (harald.sack@kit.edu) or Tabea Tietz (tabea.tietz@kit.edu).

Required coursework for each student team include:

- 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:

- If need be, the ISE project course can also be credited as a seminar.
- The project course will be restricted to overall 16 participants max.
- Participation in the lecture "Information Service Engineering" (summer semester) is not necessarily required, but highly beneficial (the lecture recordings are available on youtube).

Outcomes of previous project course editions:

- Hackathon Coding da Vinci 2022: Winners in the category "most FAIR application"

- Paper publications:
  - M. Li, H. Yang, Z. Liu, M.M. Alam, E. Norouzi, H. Sack and G.A. Gesese: KGMistral: Towards Boosting the Performance of Large Language Models for Question Answering with Knowledge Graph Integration. In Workshop on Deep Learning and Large Language Models for Knowledge Graphs 2024
  - O. Bruns, T. Tietz, M. B. Chaabane, M. Portz, F. Xiong, and H. Sack: The Nuremberg Address Knowledge Graph. In: Proceedings of the 17th Extended Semantic Web Conference, P&D Track 2021 [PDF]

Literature
ISE video channel on youtube: https://www.youtube.com/channel/UCjkkhNSNuXrJpMYZoeSBw6Q/

V Lab Realisation of innovative services (Master)
2512205, SS 2026, 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 bis Mitte März im Wiwi-Portal
https://portal.wiwi.kit.edu/ys

V Lab Agentic AI im Smart IoT Office (Master)
2512207, SS 2026, 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 2026, 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 2026, 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 4.8 Module component: Advanced Lab Realization of Innovative Services (Master) [T-WIWI-112914]

Coordinators: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each term	1

Courses					
WT 25/26	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course /	Schiefer, Toussaint
ST 2026	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course /	Schiefer, Toussaint, Kruse
Exams					
WT 25/26	7900218	Advanced Lab Linked Data and the Semantic Web (Master)			Käfer
WT 25/26	7900306	Advanced Lab Realization of Innovative Services (Master)			Oberweis
ST 2026	7900061	Advanced Lab Agentic AI im Smart IoT Office (Master)			Oberweis
ST 2026	7900148	Advanced Lab Realization of innovative services (Master)			Oberweis, Schiefer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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.

Additional Information
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 courses related to this module component:

V Lab Realisation of innovative services (Master)

2512205, WS 25/26, 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 2026, 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 bis Mitte März im Wiwi-Portal
https://portal.wiwi.kit.edu/ys

T 4.9 Module component: Advanced Lab Security, Usability and Society [T-WIWI-108439]

Coordinators: Prof. Dr. Melanie Volkamer
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each term	3

Courses					
WT 25/26	2512554	Praktikum Security, Usability and Society (Bachelor)	3 SWS	Practical course /	Volkamer, Strufe, Berens, Fallahi, Ballreich, Hennig, Länge, Mossano, Hilt
WT 25/26	2512555	Praktikum Security, Usability and Society (Master)	3 SWS	Practical course /	Volkamer, Strufe, Berens, Fallahi, Ballreich, Hennig, Länge, Mossano, Hilt
ST 2026	2512554	Practical Course: Security, Usability and Society	3 SWS	Practical course /	Volkamer, Strufe, Hennig, Länge, Fallahi, Ballreich, Sikra, Hilt, Reimer, Algedri, Mack
ST 2026	2512555	Praktikum Security, Usability and Society (Master)	3 SWS	Practical course /	Volkamer, Strufe, Hennig, Fallahi, Länge, Ballreich, Hilt, Sikra, Algedri, Reimer, Mack
Exams					
WT 25/26	7900116	Advanced Lab Security, Usability and Society (Bachelor)			Volkamer
WT 25/26	7900307	Advanced Lab Security, Usability and Society (Master)			Volkamer
ST 2026	7900029	Practical lab Security, Usability and Society (Bachelor)			Volkamer, Strufe

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Assessment takes the form of an alternative exam. It consists of a practical assignment, a presentation, and, if required, a written report. The lectures and the presentations will be in English. The written report can be written in either English or German after consultation with the supervisor.
Practical work, presentation, and written thesis are weighted according to the course.

Prerequisites
None

Recommendations
Knowledge from the lecture "Applied Informatics - Cybersecurity" is recommended.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V **Praktikum Security, Usability and Society (Bachelor)** — **Practical course (P)**
2512554, WS 25/26, 3 SWS, Language: English, Open in study portal — **Blended (On-Site/Online)**

Content
In the lab course “Security, Usability and Society”, students explore practical and interdisciplinary topics in 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 are the work on the respective topic, a final presentation, and a final report. After consultation with the supervisor, all components can be completed in either German or English.

Please note: In-person attendance at the kick-off and final presentation is mandatory to be allocated a topic.

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, are organized via the WiWi Portal. To reserve a place and select 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, WS 25/26, 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 explore practical and interdisciplinary topics in 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 are the work on the respective topic, a final presentation, and a final report. After consultation with the supervisor, all components can be completed in either German or English.

Please note: In-person attendance at the kick-off and final presentation is mandatory to be allocated a topic.

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, are organized via the WiWi Portal. To reserve a place and select 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 **Practical Course: Security, Usability and Society**
2512554, SS 2026, 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 2026, 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 4.10 Module component: Advanced Machine Learning and Data Science [T-WIWI-111305]

Coordinators: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-105659 - Advanced Machine Learning and Data Science

Type	Credits	Grading	Term offered	Version
Examination of another type	9 CP	graded	Each term	5

Courses					
ST 2026	2500016	Advanced Machine Learning and Data Science	4 SWS	Project / 🗣	Ulrich

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

Additional Information
The course is aimed at students majoring in data science and/or machine learning. It offers students the opportunity to gain practical knowledge of new developments in the fields of data science and machine learning.

Kick-off Meeting for Winter Term 2025/26:
We will introduce project topics designed for students of computer science, engineering, and mathematics. The meeting will provide an overview of the course structure, project topics, and expectations for the semester.

- **Date**: Tuesday, October 28, 2025, Time: 5:00 PM – 7:00 PM
- **Format**: Online (MS Teams link: Kick-Off (WS-2025)-Tuesday, October 28, 2025 | Meeting-Join | Microsoft Teams)
- **Ms Team Meeting link**: https://teams.microsoft.com/meet/3867172715541?p=GS2swv7ueF5gAClUEs
- **Form link**: https://docs.google.com/forms/d/e/1FAIpQLSek36NGe9I7JyIIlc4iBnd-XEwbhexFS7Wn_P6Wga1-EKU8Qw/viewform?usp=dialog

After the meeting (within 48 hours): Please submit your Priority A and Priority B topic preferences via the form within 48 hours after the kick-off.

If you need more information, please visit https://risk.fbv.kit.edu/2307.php.

Workload
270 hours

Below you will find excerpts from courses related to this module component:

V Advanced Machine Learning and Data Science

2500016, SS 2026, 4 SWS, Language: English, Open in study portal

Project (PRO)
On-Site

Content
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.

Organizational issues
Während des Kick-off Meetings in der ersten Wochen werden Themen vorgestellt.

Wir bereiten Themen für Studenten der Informatik, W-Ing und Wi-Ma vor.

Themen und studentische Bearbeiter werden nach dem Kick-off gematched.

Literature
Literatur und Computerprogramme wird in der ersten Vorlesung bekannt gegeben.

T 4.11 Module component: Advanced Methods in Nonlinear Partial Differential Equations [T-MATH-113691]

Coordinators: 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	Version
Oral examination	3 CP	graded	1

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

Prerequisites
none

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

Workload
90 hours

T 4.12 Module component: Advanced Quantitative Finance [T-WIWI-114979]

Coordinators: Prof. Dr. Julian Thimme
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each summer term	1

Assessment
The assessment of success in this course is carried out as a non exam assessment. The grade is made up as follows:

1. Written elaboration (weighting: 33 %).
2. Working on and presenting data analysis problems in small groups (weighting: 67 %).

Additional Information
New course from summer semester 2026

Workload
135 hours

T 4.13 Module component: Advanced Statistics [T-WIWI-103123]

Coordinators: Prof. Dr. Oliver Grothe
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101637 - Analytics and Statistics
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2550552	Advanced Statistical Techniques, Including Multivariate and Simulation Methods	2 SWS	Lecture / 🗣	Grothe
WT 25/26	2550553	Exercises and Computer Labs in Advanced Statistical Techniques	2 SWS	Practice / 🗣	Grothe
Exams					
WT 25/26	7900289	Advanced Statistical Techniques, Including Multivariate and Simulation Methods			Grothe
ST 2026	7900253	Advanced Statistical Techniques, Including Multivariate and Simulation Methods			Grothe

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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 courses related to this module component:

V Advanced Statistical Techniques, Including Multivariate and Simulation Methods

Lecture (V) On-Site

2550552, WS 25/26, 2 SWS, Language: English, Open in study portal

Literature
Skript zur Vorlesung

T 4.14 Module component: Advanced Stochastic Optimization [T-WIWI-106548]

Coordinators: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading	Term offered	Version
Oral examination	4,5 CP	graded	Irregular	2

Courses					
WT 25/26	2500050	Advanced Stochastic Optimization	2 SWS	Lecture / 💻	Rebennack
WT 25/26	2550468	Übung zu Advanced Stochastic Optimization	1 SWS	Practice / 🧩	Rebennack
Exams					
WT 25/26	7900039	Advanced Stochastic Optimization			Rebennack

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment consists of an oral exam (20 minutes). The exam is offered every semester.

Prerequisites
None.

Recommendations
It is recommended to attend the lecture "Introduction to Stochastic Optimization" before attending the lecture "Advanced Stochastic Optimization".

Additional Information
Lectures and tutorials are offered irregularly.

Workload
135 hours

T 4.15 Module component: Advanced Topics in Digital Twins [T-WIWI-114951]

Coordinators: Prof. Dr.-Ing. Sanja Lazarova-Molnar
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Once	1

Courses					
ST 2026	2511104	Advanced Topics in Digital Twins	2 SWS	Lecture	Lazarova-Molnar
ST 2026	2511105	Exercises Advanced Topics in Digital Twins	1 SWS	Practice	Lazarova-Molnar, Khodadadi, Zare, Götz, Jungmann, Mostafa, Lee, Mahmoud, Daniel, Deufel
Exams					
ST 2026	7900050	Advanced Topics in Digital Twins (Registration until 20.07.2026)			Lazarova-Molnar

Assessment
Written examination (60 minutes).

Prerequisites
None

Recommendations
Basic knowledge of modeling and simulation is helpful but not mandatory.
An interest in interdisciplinary research and applied innovation in cyber-physical systems is advantageous.

Additional Information
The course will be offered once in the summer semester 2026.
The course is conducted in-person only to encourage active participation and hands-on learning.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V **Advanced Topics in Digital Twins** — **Lecture (V)**
2511104, SS 2026, 2 SWS, Language: English, Open in study portal

Content

This lecture series provides an overview of current research in Digital Twins, delivered by members of the SYDSEN research group working on active research topics in the field. Each lecture focuses on a specific topic and covers state-of-the-art methods as well as practical applications. Topics include:

1. Comprehensive Digital Twins
2. Digital Twins for Labor-intensive Manufacturing Systems
3. Integration of Expert Knowledge into Data-Driven Digital Twin Models
4. Human-in-the-Loop Digital Twins
5. Validation of Digital Twins for Production Systems
6. Explainability in Digital Twins
7. Automation of Simulation-Based Decision Support in Data-Driven Digital Twins
8. Digital Twins for Enhanced Reliability in Energy Systems
9. Data-driven Agent-Based Simulation for Digital Twins

By the end of the course, students will understand how Digital Twins are applied in different domains. They will be able to analyze research approaches, identify limitations, and assess the practical relevance of current work. Students will also be able to recognize emerging research directions and innovation opportunities.

Prerequisites

Basic programming experience and foundational knowledge in mathematics, modeling, and data-driven methods.

Learning Objectives

- Conduct critical analysis of Digital Twin research and its practical relevance.
- Evaluate limitations and opportunities for innovation in existing Digital Twin approaches.
- Identify emerging trends across application domains and research areas.
- Connect theoretical knowledge with hands-on experience through demonstrations and tool-based exercises.

Form of Instruction

Lectures covering theoretical foundations and research contributions, complemented by practical sessions including demonstrations, case studies, and tool-based exercises. A detailed course plan will be provided before the start of the semester.

Competence Certificate

The examination will be offered as a written exam (60 minutes).

T 4.16 Module component: Advanced Topics in Economic Theory [T-WIWI-102609]

Coordinators: Prof. Dr. Johannes Brumm
Prof. Dr. Kay Mitusch

Organisation: KIT Department of Business and Economics

Part of: M-WIWI-101500 - Microeconomic Theory
M-WIWI-101502 - Economic Theory and its Application in Finance

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	1

Assessment
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

Recommendations
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.

T 4.17 Module component: Algebra [T-MATH-102253]

Coordinators: PD Dr. Stefan Kühnlein
Prof. Dr. Roman Sauer
Organisation: KIT Department of Mathematics
Part of: M-MATH-101315 - Algebra

Type	Credits	Grading	Version
Oral examination	8 CP	graded	2

Courses					
WT 25/26	0102200	Algebra	4 SWS	Lecture / 🗣	Kühnlein
WT 25/26	0102210	Tutorial for 0102200 (Algebra)	2 SWS	Practice / 🗣	Kühnlein
Exams					
WT 25/26	7700080	Algebra			Kühnlein
ST 2026	7700079	Algebra			Kühnlein

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 4.18 Module component: Algebraic Geometry [T-MATH-103340]

Coordinators: Prof. Dr. Frank Herrlich
PD Dr. Stefan Kühnlein

Organisation: KIT Department of Mathematics

Part of: M-MATH-101724 - Algebraic Geometry

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

T 4.19 Module component: Algebraic Number Theory [T-MATH-103346]

Coordinators: Prof. Dr. Frank Herrlich
PD Dr. Stefan Kühnlein

Organisation: KIT Department of Mathematics

Part of: M-MATH-101725 - Algebraic Number Theory

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Assessment
oral examination of ca. 30 minutes

Prerequisites
none

Workload
240 hours

T 4.20 Module component: Algebraic Topology [T-MATH-105915]

Coordinators: TT-Prof. Dr. Manuel Krannich
Jun.-Prof. Dr. Claudio Llosa Isenrich
Prof. Dr. Roman Sauer

Organisation: KIT Department of Mathematics

Part of: M-MATH-102948 - Algebraic Topology

Type	Credits	Grading	Version
Written examination	8 CP	graded	1

Exams			
WT 25/26	7700140	Algebraic Topology	Llosa Isenrich

Prerequisites
none

T 4.21 Module component: Algebraic Topology II [T-MATH-105926]

Coordinators: 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	Term offered	Version
Written examination	8 CP	graded	Irregular	1

Courses					
ST 2026	0157400	Algebraic Topology II	4 SWS	Lecture	Sauer
ST 2026	0157410	Tutorial for 0157400 (Algebraic Topology II)	2 SWS	Practice	Sauer

Prerequisites
none

Below you will find excerpts from courses related to this module component:

V Algebraic Topology II

0157400, SS 2026, 4 SWS, Language: English, Open in study portal

Lecture (V)

Content
The course deepens the understanding of singular (co-)homology of spaces.

The course covers product structures on the cohomology which are interesting per se but also enable more computations. Fundamental ideas ofhomological algebra will be an important part of the course. A highlight will be the proof of Poincare duality for manifolds and the geometric interpretation of the product structure via intersections of submanifolds.

T 4.22 Module component: Analytical and Numerical Homogenization [T-MATH-111272]

Coordinators: 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	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Prerequisites
none

T 4.23 Module component: Applied Econometrics [T-WIWI-111388]

Coordinators: Prof. Dr. Fabian Krüger
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	2

Courses					
WT 25/26	2520020	Applied Econometrics	2 SWS	Lecture / 🗣	Krüger, N.N.
WT 25/26	2520021	Tutorial in Applied Econometrics	2 SWS	Practice / 🗣	Krüger, N.N.
Exams					
WT 25/26	7900251	Applied Econometrics			Krüger
ST 2026	7900007	Applied Econometrics			Krüger

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of this course is a written examination (90 min).

Prerequisites
None

Below you will find excerpts from courses related to this module component:

V Applied Econometrics

2520020, WS 25/26, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
The course starts with a concise review of 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 4.24 Module component: Applied material flow simulation [T-MACH-112213]

Coordinators: 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	Term offered	Version
Oral examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2117054	Applied material flow simulation	3 SWS	Lecture / Practice / 🗣	Baumann
Exams					
WT 25/26	76-T-MACH-112213	Applied material flow simulation			Baumann, Furmans

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations

- 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

Additional Information
The course is offered in German.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V **Applied material flow simulation** — **Lecture / Practice (VÜ) On-Site**
2117054, WS 25/26, 3 SWS, Language: German, Open in study portal

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 2025/2026 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 01.09.2025 bis zum 30.09.2025 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 4.25 Module component: Asset Pricing [T-WIWI-102647]

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

Organisation: KIT Department of Business and Economics

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	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	2

Courses					
ST 2026	2530555	Asset Pricing	2 SWS	Lecture / 🗣	Uhrig-Homburg, Thimme
ST 2026	2530556	Asset Pricing Exercices	1 SWS	Practice / 🗣	Böll, Uhrig-Homburg, Thimme
Exams					
WT 25/26	7900056	Asset Pricing			Uhrig-Homburg
ST 2026	7900110	Asset Pricing			Uhrig-Homburg, Thimme

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written examination (60 minutes). The examination is offered every semester and can be repeated at any regular examination date.

A bonus can be earned for successful participation in the exercises by submitting correct solutions to at least 50% of the bonus 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

Recommendations
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 courses related to this module component:

V Asset Pricing Exercices

2530556, SS 2026, 1 SWS, Language: German, Open in study portal

Practice (Ü)
On-Site

Organizational issues
Die Übung findet erst ab der 2. Vorlesungswoche statt.

T 4.26 Module component: Auction Theory [T-WIWI-102613]

Coordinators: Prof. Dr. Karl-Martin Ehrhart
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101500 - Microeconomic Theory
M-WIWI-102970 - Decision and Game Theory

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2520408	Auction Theory	2 SWS	Lecture	Ehrhart
WT 25/26	2520409	Auction Theory Exercise	1 SWS	Practice	Ehrhart
Exams					
WT 25/26	7900033	Auction Theory			Ehrhart
ST 2026	7900255	Auction Theory			Ehrhart

Assessment
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 courses related to this module component:

V Auction Theory

2520408, WS 25/26, 2 SWS, Open in study portal **Lecture (V)**

Content
Workload:

- Attendance time lecture (2 SWS × 15 weeks): 30 h
- Exercise attendance time (1 SWS × 15 weeks): 15 h
- Self-study lecture: 45 h
- Self-study exercise: 25 h
- Exam preparation: 20 h
- **Total: 135 h**

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 4.27 Module component: Bayesian Inverse Problems with Connections to Machine Learning [T-MATH-112842]

Coordinators: 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	Term offered	Expansion	Version
Oral examination	4 CP	graded	Each summer term	1 semesters	1

Assessment
oral exam of ca. 30 min

Prerequisites
none

Workload
120 hours

T 4.28 Module component: Behavioral Dimensions of Energy Transitions [T-WIWI-114980]

Coordinators: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading	Term offered	Version
Written examination	3,5 CP	graded	Each summer term	1

Exams			
WT 25/26	7900280	Social Dimensions of Energy Transitions	Fichtner

Assessment
Written examination (60 minutes). The examination is offered every semester and can be repeated at any regular examination date.

Workload
105 hours

T 4.29 Module component: Bifurcation Theory [T-MATH-106487]

Coordinators: Dr. Rainer Mandel
Organisation: KIT Department of Mathematics
Part of: M-MATH-103259 - Bifurcation Theory

Type	Credits	Grading	Term offered	Version
Oral examination	5 CP	graded	Irregular	1

Prerequisites
None

T 4.30 Module component: Bond Markets [T-WIWI-110995]

Coordinators: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2530560	Bond Markets	3 SWS	Lecture / Practice / 🗣	Müller, Uhrig-Homburg, Molnar
Exams					
WT 25/26	7900311	Bond Markets			Uhrig-Homburg
ST 2026	7900280	Bond Markets			Uhrig-Homburg

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Additional Information
This course will be held in English.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Bond Markets
2530560, WS 25/26, 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 bereits im Januar statt.

T 4.31 Module component: Bond Markets - Models & Derivatives [T-WIWI-110997]

Coordinators: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each winter term	1

Courses					
WT 25/26	2530565	Bond Markets - Models & Derivatives	2 SWS	Block / 🗣	Grauer, Uhrig-Homburg, Müller
Exams					
WT 25/26	7900318	Bond Markets - Models & Derivatives			Uhrig-Homburg

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
Knowledge of "Bond Markets" and "Derivatives" courses is very helpful.

Additional Information
This course will be held in English.

Workload
90 hours

Below you will find excerpts from courses related to this module component:

V Bond Markets - Models & Derivatives

2530565, WS 25/26, 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.

T 4.32 Module component: Bond Markets - Tools & Applications [T-WIWI-110996]

Coordinators: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading	Term offered	Version
Examination of another type	1,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2530562	Bond Markets - Tools & Applications	1 SWS	Block / 🗣	Uhrig-Homburg, Grauer, Müller
Exams					
WT 25/26	7900317	Bond Markets - Tools & Applications			Uhrig-Homburg

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
Knowledge of the "Bond Markets" course is very helpful.

Additional Information
This course will be held in English.

Workload
45 hours

Below you will find excerpts from courses related to this module component:

V Bond Markets - Tools & Applications

2530562, WS 25/26, 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 4.33 Module component: Boundary and Eigenvalue Problems [T-MATH-105833]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Courses					
ST 2026	0157500	Boundary and Eigenvalue Problems	4 SWS	Lecture	Knopf
ST 2026	0157510	Tutorial for 0157500 (Boundary and Eigenvalue Problems)	2 SWS	Practice	Knopf
Exams					
WT 25/26	7700153	Boundary and Eigenvalue Problems			Reichel, Liao, Lamm, Hundertmark

Below you will find excerpts from courses related to this module component:

V Boundary and Eigenvalue Problems

0157500, SS 2026, 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 4.34 Module component: Boundary Element Methods [T-MATH-109851]

Coordinators: PD Dr. Tilo Arens
Organisation: KIT Department of Mathematics
Part of: M-MATH-103540 - Boundary Element Methods

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Prerequisites
none

T 4.35 Module component: Brownian Motion [T-MATH-105868]

Coordinators: 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	Version
Oral examination	4 CP	graded	1

Courses					
WT 25/26	0155700	Brownsche Bewegung	2 SWS	Lecture	Last
WT 25/26	0155710	Übungen zu 0155700 (Brownsche Bewegung)	1 SWS	Practice	Last
Exams					
WT 25/26	7700150	Brownian Motion			Last
ST 2026	7700086	Brownian Motion			Last

Prerequisites
none

Workload
120 hours

T 4.36 Module component: Business Intelligence Systems [T-WIWI-105777]

Coordinators: Prof. Dr. Alexander Mädche
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-104068 - Information Systems in Organizations

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each winter term	2

Courses					
WT 25/26	2540422	Business Intelligence Systems	3 SWS	Lecture /	Mädche
Exams					
WT 25/26	7900224	Business Intelligence Systems			Mädche
ST 2026	7900149	Business Intelligence Systems			Mädche

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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

Recommendations
Basic knowledge on database systems is helpful.

Below you will find excerpts from courses related to this module component:

V **Business Intelligence Systems** — **Lecture (V)**
2540422, WS 25/26, 3 SWS, Language: English, Open in study portal — **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.

Workload:

The total workload for this course is approximately 135 hours.

- Attendance Lecture (2 SWS × 15 weeks): 30 h
- Attendance Exercise (1 SWS × 15 weeks): 15 h
- Preparation and Wrap-up of the lecture: 45 h
- Preparation and Wrap-up of the exercise: 25 h
- Exam preparation: 20 h
- Total: 135 h (equivalent to 4.5 CP)

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 4.37 Module component: Business Process Modelling [T-WIWI-102697]

Coordinators: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	2

Courses					
WT 25/26	2511210	Business Process Modelling	2 SWS	Lecture / 🗣	Oberweis
WT 25/26	2511211	Exercise Business Process Modelling	1 SWS	Practice / 🗣	Kruse
Exams					
WT 25/26	79AIFB_MvG_C2	Business Process Modelling (Registration extended until 16.02.2026)			Oberweis
ST 2026	791-AIFB-MvG-NK	Business Process Modelling (Registration until 20.07.2026)			Oberweis

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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 courses related to this module component:

V Business Process Modelling

2511210, WS 25/26, 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 4.38 Module component: Class Field Theory [T-MATH-114500]

Coordinators: Prof. Dr. Frank Herrlich
PD Dr. Stefan Kühnlein

Organisation: KIT Department of Mathematics

Part of: M-MATH-107387 - Class Field Theory

Type	Credits	Grading	Expansion	Version
Oral examination	8 CP	graded	1 semesters	1

Exams			
WT 25/26	7700147	Class Field Theory	Herrlich

Assessment
The module examination takes the form of an oral examination lasting approx. 30 minutes.

Prerequisites
none

Workload
240 hours

T 4.39 Module component: Classical Methods for Partial Differential Equations [T-MATH-105832]

Coordinators: 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	Version
Written examination	8 CP	graded	1

Courses					
WT 25/26	0105300	Classical Methods for Partial Differential Equations	4 SWS	Lecture	Knopf
WT 25/26	0105310	Tutorial for 0105300 (Classical Methods for Partial Differential Equations)	2 SWS	Practice	Knopf
Exams					
WT 25/26	7700045	Classical Methods for Partial Differential Equations			Knopf, Reichel, Lamm, Hundertmark

T 4.40 Module component: Collective Perception in Autonomous Driving [T-WIWI-113363]

Coordinators: Prof. Dr. Alexey Vinel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2511456	Collective Perception in Autonomous Driving	2 SWS	Lecture /	Zhao, Bied, Vinel
ST 2026	2511457	Exercise Collective Perception in Autonomous Driving	1 SWS	Practice /	Flores Comeca, Arockiasamy, Bied, Zhao, Khoshkdahan
Exams					
WT 25/26	79AIFB_CPAD_B3	Collective Perception in Autonomous Driving			Vinel
ST 2026	791-AIFB-CPAD-HK	Collective Perception in Autonomous Driving (Registration until 20.07.2026)			Vinel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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 4.41 Module component: Combinatorics [T-MATH-105916]

Coordinators: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-102950 - Combinatorics

Type	Credits	Grading	Version
Written examination	8 CP	graded	4

Courses					
ST 2026	0150300	Combinatorics	4 SWS	Lecture	Aksenovich, Sagdeev
ST 2026	0150310	Tutorial for Combinatorics (0150300)	2 SWS	Practice	Aksenovich, Sagdeev

Prerequisites
none

Below you will find excerpts from courses related to this module component:

V Combinatorics
0150300, SS 2026, 4 SWS, Open in study portal **Lecture (V)**

Content
Combinatorics is an area of mathematics primarily concerned with counting finite structures such as sets, groups, and graphs. While combinatorial problems are often very basic and easy to describe, solving them requires special knowledge and skills. This course is devoted to main concepts and techniques in combinatorics. These include counting principles such as inclusion-exclusion and bijective mappings, twelvefold way, generating functions, arrangements, Young tableaux, partitions, recursions, partially ordered sets, extremal set theory, and combinatorial designs.

T 4.42 Module component: Complex Analysis [T-MATH-105849]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

T 4.43 Module component: Complex Geometry [T-MATH-113614]

Coordinators: Jun.-Prof. Dr. Claudio Llosa Isenrich
Organisation: KIT Department of Mathematics
Part of: M-MATH-106776 - Complex Geometry

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Assessment
oral exam (ca. 30 min)

Prerequisites
none

Workload
180 hours

T 4.44 Module component: Compressive Sensing [T-MATH-105894]

Coordinators: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-102935 - Compressive Sensing

Type	Credits	Grading	Term offered	Version
Oral examination	5 CP	graded	Irregular	1

Courses					
ST 2026	0154000	Compressive Sensing	2 SWS	Lecture	Rieder

T 4.45 Module component: Computational Economics [T-WIWI-102680]

Coordinators: Prof. Dr. Pradyumn Kumar Shukla
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	3

Courses					
WT 25/26	2590458	Computational Economics	2 SWS	Lecture / 🏵	Shukla
WT 25/26	2590459	Excercises to Computational Economics	1 SWS	Practice / 🏵	Shukla
Exams					
WT 25/26	79AIFB_CE_B1	Computational Economics (Registration extended until 16.02.2026)			Shukla
ST 2026	791-AIFB-CE-NK	Computational Economics (only for repeaters, registration until 20.07.2026)			Shukla

Legend: 🖥 Online, 🏵 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written (60 min) or oral examination.

The examination for this course is offered both in the semester in which the course takes place and in the following semester. In the following semester (summer term), participation in the exam is **exclusively reserved for students who did not pass the first attempt.** This regulation applies from winter semester 2025/2026.

Prerequisites
The prerequisite for admission to the examination "Computational Economics" is the successful completion of a computational assignment issued in mid-December; submissions are due in the third week of January or, alternatively, no later than one week before the examination registration.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Computational Economics

2590458, WS 25/26, 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 4.46 Module component: Computational Fluid Dynamics and Simulation Lab [T-MATH-113373]

Coordinators: 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	Version
Examination of another type	4 CP	graded	1

Courses					
ST 2026	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 courses related to this module component:

V Computational Fluid Dynamics and Simulation Lab

0161700, SS 2026, 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 recommened.

T 4.47 Module component: Computational Risk and Asset Management [T-WIWI-102878]

Coordinators: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-105032 - Data Science for Finance

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Irregular	5

Assessment
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.

Recommendations
Basic knowledge of capital markt theory.

Workload
135 hours

T 4.48 Module component: Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems [T-MATH-105854]

Coordinators: 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	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Assessment
Oral examination lasting approx. 30 minutes.

Prerequisites
None.

Workload
240 hours

T 4.49 Module component: Continuous Time Finance [T-MATH-105930]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Courses					
ST 2026	0159400	Continuous Time Finance	4 SWS	Lecture	Bäuerle
ST 2026	0159410	Tutorial for 0159400 (Continuous Time Finance)	2 SWS	Practice	Bäuerle

Assessment
oral exam of ca. 30 minutes

Prerequisites
none

Workload
240 hours

Below you will find excerpts from courses related to this module component:

V Continuous Time Finance

0159400, SS 2026, 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 4.50 Module component: Control Theory [T-MATH-105909]

Coordinators: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: M-MATH-102941 - Control Theory

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

Prerequisites
none

T 4.51 Module component: Convex Analysis [T-WIWI-102856]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	1

Assessment
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

Recommendations
It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Additional Information
The lecture is offered irregularly. The curriculum of the next three years is available online (www.ior.kit.edu).

T 4.52 Module component: Convex Geometry [T-MATH-105831]

Coordinators: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: M-MATH-102864 - Convex Geometry

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

T 4.53 Module component: Cooperative Autonomous Vehicles [T-WIWI-112690]

Coordinators: Prof. Dr. Alexey Vinel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2511450	Cooperative Autonomous Vehicles	2 SWS	Lecture /	Vinel
ST 2026	2511451	Exercise Cooperative Autonomous Vehicles	1 SWS	Practice /	Vinel
Exams					
WT 25/26	79AIFB_CAV_A3	Cooperative Autonomous Vehicles (Registration extended until 16.02.2026)			Vinel
ST 2026	791-AIFB-CAV-HK	Cooperative Autonomous Vehicles (Registration until 20.07.2026)			Vinel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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 4.54 Module component: Corporate Risk Management [T-WIWI-109050]

Coordinators: Prof. Dr. Martin Ruckes
Organisation: KIT Department of Business and Economics
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	Term offered	Version
Written examination	4,5 CP	graded	Irregular	2

Assessment
The success of the course (lecture and exercise) is assessed in the form of a written examination (60 min.) in accordance with § 4 para. 2 no. 1 SPO. If the number of participants registered for the written examination is low, we reserve the right to hold an oral examination instead of a written examination.
Please note that the examination is only offered in the semester of the lecture and in the following semester.

Prerequisites
None

Recommendations
None

Workload
135 hours

T 4.55 Module component: Curves on Surfaces [T-MATH-113364]

Coordinators: Dr. Elia Fioravanti
Organisation: KIT Department of Mathematics
Part of: M-MATH-106632 - Curves on Surfaces

Type	Credits	Grading	Term offered	Version
Oral examination	3 CP	graded	Irregular	1

Assessment
oral exam (ca. 20-30 min)

Prerequisites
none

Workload
90 hours

T 4.56 Module component: Derivatives [T-WIWI-102643]

Coordinators: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101482 - Finance 1
M-WIWI-101483 - Finance 2

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2530550	Derivatives	2 SWS	Lecture / 🗣	Uhrig-Homburg
ST 2026	2530551	Übung zu Derivate	1 SWS	Practice / 🗣	Dinger, Uhrig-Homburg
Exams					
WT 25/26	7900051	Derivatives			Uhrig-Homburg
ST 2026	7900111	Derivatives			Uhrig-Homburg

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written examination (60 minutes). The examination is offered every semester and can be repeated at any regular examination date.

A bonus can be earned for successful participation in the exercises by submitting correct solutions to at least 50% of the bonus 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

Recommendations
None

Below you will find excerpts from courses related to this module component:

V Derivatives

2530550, SS 2026, 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 4.57 Module component: Designing Interactive Systems: Human-AI Interaction [T-WIWI-113465]

Coordinators: Prof. Dr. Alexander Mädche
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-104068 - Information Systems in Organizations

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2540558	Designing Interactive Systems: Human-AI Interaction	3 SWS	Lecture /	Mädche, Seitz Sänger
Exams					
WT 25/26	7900205	Designing Interactive Systems			Mädche
ST 2026	7900299	Designing Interactive Systems: Human-AI Interaction			Mädche

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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.

Additional Information
The course is held in english.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Designing Interactive Systems: Human-AI Interaction

2540558, SS 2026, 3 SWS, Language: English, Open in study portal

Lecture (V)
Blended (On-Site/Online)

Content
Description

The field of computing has transitioned from traditional batch processing toward the development of highly sophisticated interactive and intelligent systems. As artificial intelligence (AI) continues to advance, these systems have gained the capacity to learn, adapt to environmental stimuli, and simulate human cognitive processes. While the capacity of AI-based information technology to augment and automate human tasks has expanded, it simultaneously creates complex new demands for the design of interactive systems and necessitates a sophisticated understanding of the nuances within human-AI interaction.
This Master's course explores the state-of-the-art scientific knowledge and practical applications required to navigate these complexities, specifically focusing on the design of AI-based interactive systems for personal productivity on the individual level and virtual collaboration on the team level within professional environments.

The course is divided into two phases: The first phase establishes a scientific foundation through a **flipped classroom model**. Students engage with conceptual foundations and theoretical frameworks independently, allowing in-person sessions to be dedicated to analysis and critical discussion of existing knowledge for designing interactive systems enabling effective human-AI interaction. The second phase transitions into the practical application of these concepts through a collaborative **capstone project** conducted in partnership with an industry partner. In this phase, students work in teams to apply knowledge acquired in the first phase culminating in the creation of a prototype of an interactive system. The project emphasizes the intricacies of human-AI interaction, requiring students to synthesize their theoretical knowledge into a functional and sophisticated design solution.

Learning objectives

- Evaluate existing theories and conceptual frameworks of interactive systems to assess their role in modern computing environments.
- Analyze the unique characteristics of human-AI interaction and determine their impact on future interactive systems design.
- Create a functional interactive prototype by following the human-centered design process and applying state-of-the-art knowledge within a collaborative capstone project to solve real-world problems.
- Get hands-on experience by applying lecture content in a design capstone project

Prerequisites

No specific prerequisites are required for the lecture

Literature

Further literature will be made available in the lecture.

Die Erfolgskontrolle erfolgt in Form einer Prüfungsleistung anderer Art (Form) nach § 4 Abs. 2 Nr. 3 SPO. Details zur Ausgestaltung der Erfolgskontrolle werden im Rahmen der Vorlesung bekannt gegeben.

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 4.58 Module component: Differential Geometry [T-MATH-102275]

Coordinators: Prof. Dr. Alexander Lytchak
Prof. Dr. Wilderich Tuschmann

Organisation: KIT Department of Mathematics

Part of: M-MATH-101317 - Differential Geometry

Type	Credits	Grading	Version
Written examination	8 CP	graded	1

Exams			
WT 25/26	7700120	Differential Geometry	Lytchak

Prerequisites
none

T 4.59 Module component: Digital Energy Systems [T-WIWI-114994]

Coordinators: TT-Prof. Dr. Philipp Staudt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-107649 - Sustainable Information Systems

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Assessment
Written examination (60 minutes). The examination is offered every semester and can be repeated at any regular examination date.

Workload
135 hours

T 4.60 Module component: Digital Marketing [T-WIWI-112693]

Coordinators: Prof. Dr. Ann-Kristin Kupfer
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-105312 - Marketing and Sales Management
M-WIWI-106258 - Digital Marketing

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2571185	Digital Marketing	2 SWS	Lecture / 🗣	Kupfer
ST 2026	2571186	Digital Marketing Exercise	1 SWS	Practice / 🗣	Schmitt, Cinar, Kupfer
Exams					
WT 25/26	7900021	Digital Marketing			Kupfer
ST 2026	7900064	Digital Marketing			Kupfer

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
Students are highly encouraged to actively participate in class.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Digital Marketing

2571185, SS 2026, 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 4.61 Module component: Digital Marketing and Sales in B2B [T-WIWI-106981]

Coordinators: Prof. Dr. Martin Klarmann
Anja Konhäuser

Organisation: KIT Department of Business and Economics

Part of: M-WIWI-105312 - Marketing and Sales Management
M-WIWI-106258 - Digital Marketing

Type	Credits	Grading	Term offered	Version
Examination of another type	1,5 CP	graded	Each summer term	1

Courses					
ST 2026	2571156	Digital Marketing and Sales in B2B	1 SWS	Others / 🗣	Konhäuser
Exams					
ST 2026	7900297	Digital Marketing and Sales in B2B			Klarmann

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Additional Information
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 courses related to this module component:

V **Digital Marketing and Sales in B2B** — **Others (sonst.) On-Site**
2571156, SS 2026, 1 SWS, Language: English, Open in study portal

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, Gebäude 01.87

6.5.26 11:00-17:00 Uhr

7.5.26 09:00-14:00 Uhr

Literature

-

T 4.62 Module component: Discrete Dynamical Systems [T-MATH-110952]

Coordinators: PD Dr. Gerd Herzog
Organisation: KIT Department of Mathematics
Part of: M-MATH-105432 - Discrete Dynamical Systems

Type	Credits	Grading	Term offered	Version
Oral examination	3 CP	graded	Irregular	1

Prerequisites
none

Workload
90 hours

T 4.63 Module component: Discrete Time Finance [T-MATH-105839]

Coordinators: 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	Term offered	Version
Written examination	8 CP	graded	Each winter term	1

Courses					
WT 25/26	0108400	Finanzmathematik in diskreter Zeit	4 SWS	Lecture / 🗣	Bäuerle
WT 25/26	0108500	Übungen zu 0108400 (Finanzmathematik in diskreter Zeit)	2 SWS	Practice / 🗣	Bäuerle
Exams					
WT 25/26	0100025	Discrete Time Finance			Bäuerle
WT 25/26	6700054	Discrete Time Finance			Bäuerle

Legend: 📱 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written exam of 2h.

Prerequisites
none

Recommendations
The contents of the module „Probability theory“ are strongly recommended.

Workload
240 hours

T 4.64 Module component: Discrete-Event Simulation in Production and Logistics [T-WIWI-102718]

Coordinators: Hon.-Prof. Dr. Sven Spieckermann
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102805 - Service Operations
M-WIWI-102832 - Operations Research in Supply Chain Management

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each summer term	2

Courses					
ST 2026	2550488	Ereignisdiskrete Simulation in Produktion und Logistik	3 SWS	Lecture / 🗣	Spieckermann
Exams					
ST 2026	7900244	Discrete-Event Simulation in Production and Logistics			Spieckermann

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment consists of a written paper and an oral exam of about 30-40 min (alternative exam assessment).

Prerequisites
None

Recommendations
Basic knowledge as conveyed in the module "Introduction to Operations Research" is assumed.

Additional Information
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 courses related to this module component:

V Ereignisdiskrete Simulation in Produktion und Logistik

2550488, SS 2026, 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 4.65 Module component: Dispersive Equations [T-MATH-109001]

Coordinators: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-104425 - Dispersive Equations

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Prerequisites
none

T 4.66 Module component: Dynamical Systems [T-MATH-106114]

Coordinators: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-103080 - Dynamical Systems

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Prerequisites
none

T 4.67 Module component: Economic Decision Making [T-WIWI-114174]

Coordinators: Prof. Dr. Benjamin Scheibehenne
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-105312 - Marketing and Sales Management
M-WIWI-106258 - Digital Marketing

Type	Credits	Grading	Term offered	Expansion	Version
Examination of another type	4,5 CP	graded	Each winter term	1 semesters	1

Courses					
WT 25/26	2500059	Economic Decision Making	3 SWS	Lecture / Practice / 🗣	Scheibehenne
Exams					
WT 25/26	7900173	Economic Decision Making			Scheibehenne

Legend: 📱 Online, Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Alternative exam assessment. The course format consists of a lecture and a corresponding exercise. The grading includes the following aspects:

- A written exam (60 minutes)
- A presentation during the exercise
- Regular attendance
- In-class assignments

The scoring system for the grading will be announced at the beginning of the course.

Prerequisites
Registration via the WiWi Portal is required for participation in the Übung. The Übung is a prerequisite for the exam.

Additional Information
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

Below you will find excerpts from courses related to this module component:

V **Economic Decision Making** — **Lecture / Practice (VÜ) On-Site**
2500059, WS 25/26, 3 SWS, Language: English, Open in study portal

Content
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

T 4.68 Module component: Efficient Energy Systems and Electric Mobility [T-WIWI-102793]

Coordinators: Prof. Dr. Patrick Jochem
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading	Term offered	Version
Written examination	3,5 CP	graded	Each summer term	1

Courses					
ST 2026	2581006	Efficient Energy Systems and Electric Mobility	2 SWS	Lecture / 🗣	Jochem
Exams					
WT 25/26	7981006	Efficient Energy Systems and Electric Mobility			Fichtner
ST 2026	7981006	Efficient Energy Systems and Electric Mobility			Fichtner

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Prerequisites
None

Recommendations
Literature:

Masters, G. M. & K. F. Hsu (2023). Renewable and efficient electric power systems. John Wiley & Sons. (Chapter 9).
Viral, R., Tomar, A., Asija, D., Rao, U. M., & Sarwar, A. (Eds.). (2024). Smart Grids for Renewable Energy Systems, Electric Vehicles and Energy Storage Systems. CRC Press.

Below you will find excerpts from courses related to this module component:

V Efficient Energy Systems and Electric Mobility

2581006, SS 2026, 2 SWS, Language: German/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: 24.04., 08.05., 22.05., 05.06., 19.06., 03.07., 17.07., 24.07.26

Literature
Wird in der Vorlesung bekanntgegeben.

T 4.69 Module component: eFinance: Information Systems for Securities Trading [T-WIWI-110797]

Coordinators: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	2

Courses					
WT 25/26	2540454	eFinance: Information Systems for Securities Trading	2 SWS	Lecture / 🗣	Weinhardt
WT 25/26	2540455	Übungen zu eFinance: Information Systems for Securities Trading	1 SWS	Practice / 🗣	Motz, Motz
Exams					
WT 25/26	7900182	eFinance: Information Engineering and Management for Securities Trading			Weinhardt
ST 2026	7900269	eFinance: Information Systems for Securities Trading			Weinhardt

Legend: 🖥 Online, 🖥🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Additional Information
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 courses related to this module component:

V eFinance: Information Systems for Securities Trading

Lecture (V)
On-Site

2540454, WS 25/26, 2 SWS, Language: English, Open in study portal

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 4.70 Module component: Energy and Environment [T-WIWI-102650]

Coordinators: Ute Karl
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading	Term offered	Version
Written examination	3,5 CP	graded	Each summer term	2

Courses					
ST 2026	2581003	Energy and Environment	2 SWS	Lecture / 🗣	Karl
Exams					
WT 25/26	7900302	Energy and Environment NEW			Karl
ST 2026	7900294	Energy and Environment NEW			Karl

Legend: 📱 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Prerequisites
None.

Workload
105 hours

Below you will find excerpts from courses related to this module component:

V Energy and Environment

2581003, SS 2026, 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 4.71 Module component: Energy Market Engineering [T-WIWI-107501]

Coordinators: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101451 - Energy Economics and Energy Markets
M-WIWI-103720 - eEnergy: Markets, Services and Systems

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2540464	Energy Market Engineering	2 SWS	Lecture / 🗣	Semmelmann, Miskiw
ST 2026	2540465	Übung zu Energy Market Engineering	1 SWS	Practice / 🗣	Resch
Exams					
WT 25/26	7900127	Energy Market Engineering			Weinhardt

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
None

Additional Information
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 courses related to this module component:

V Energy Market Engineering

2540464, SS 2026, 2 SWS, Language: German/English, Open in study portal

Lecture (V)
On-Site

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 wird als zweiwöchige Blockveranstaltung gehalten. Die genauen Termine und Themenblöcke werden in der Auftaktveranstaltung sowie auf Ilias kommuniziert.

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 4.72 Module component: Energy Networks and Regulation [T-WIWI-107503]

Coordinators: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-103720 - eEnergy: Markets, Services and Systems

Type	Credits	Grading	Term offered	Version
Oral examination	4,5 CP	graded	Each winter term	2

Courses					
WT 25/26	2540494	Energy Networks and Regulation	2 SWS	Lecture / 🗣	Rogat, Miskiw
WT 25/26	2540495	Übung zu Energy Networks and Regulation	1 SWS	Practice / 🗣	Rogat, Miskiw
Exams					
WT 25/26	7900198	Energy Networks and Regulation			Weinhardt

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
None

Below you will find excerpts from courses related to this module component:

V Energy Networks and Regulation

2540494, WS 25/26, 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 4.73 Module component: Energy Trading and Risk Management [T-WIWI-112151]

Coordinators: N.N.
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading	Term offered	Version
Written examination	3,5 CP	graded	Each summer term	2

Courses					
ST 2026	2581020	Energy Trading and Risk Management	2 SWS	Lecture / 🗣	Kraft, Fichtner, Beranek
Exams					
WT 25/26	7981020	Energy Trading and Risk Management			Fichtner
ST 2026	7981020	Energy Trade and Risk Management			Fichtner

Legend: 🖥 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Prerequisites
None

Recommendations
None

Workload
105 hours

Below you will find excerpts from courses related to this module component:

V Energy Trading and Risk Management

2581020, SS 2026, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

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

T 4.74 Module component: Ergodic Theory [T-MATH-113086]

Coordinators: PD Dr. Gabriele Link
Organisation: KIT Department of Mathematics
Part of: M-MATH-106473 - Ergodic Theory

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	8 CP	graded	Irregular	1 semesters	1

Assessment
Oral examination of ca. 20-30 minutes.

Prerequisites
none

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

Workload
240 hours

T 4.75 Module component: Evolution Equations [T-MATH-105844]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Courses					
WT 25/26	0105900	Evolution equations	4 SWS	Lecture	de Rijk
WT 25/26	0105910	Tutorial for 0105900 (Evolution Equations)	2 SWS	Practice	de Rijk
Exams					
WT 25/26	7700002	Evolution Equations			de Rijk

Below you will find excerpts from courses related to this module component:

V Evolution equations

0105900, WS 25/26, 4 SWS, Language: English, Open in study portal

Lecture (V)

Content
See ILIAS page

Literature
We will follow the lecture notes of Roland Schnaubelt (see ILIAS page)

* Engel, Nagel: One-Parameter Semigroups for Linear Evolution Equations
* Pazy: Semigroups of Linear Operators and Applications to Partial Differential Equations

* Arendt, Batty, Hieber, Neubrander: Vector-valued Laplace Transforms and Cauchy Problems
* Davies: One-Parameter Semigroups
* Engel, Nagel: A Short Course of Operator Semigroups
* Fattorini: The Cauchy Problem
* Goldstein: Semigroups of Linear Operators and Applications
* Hille, Phillips: Functional Analysis and Semi-groups
* Lunardi: Analytic Semigroups and Optimal Regularity in Parabolic Problems
* Tanabe: Equations of Evolution

T 4.76 Module component: Experimental Economics [T-WIWI-102614]

Coordinators: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102970 - Decision and Game Theory

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2540489	Experimental Economics	2 SWS	Lecture / 🗣	Knierim
WT 25/26	2540493	Übung zu Experimental Economics	1 SWS	Practice / 🗣	del Puppo
Exams					
WT 25/26	7900096	Experimental Economics			Weinhardt

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment consists of a written exam (60 min).

Prerequisites
None

Additional Information
The lecture will be taught in English.

Below you will find excerpts from courses related to this module component:

V Experimental Economics

2540489, WS 25/26, 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 4.77 Module component: Experimental Research in Economics and Information Systems [T-WIWI-115061]

Coordinators: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101505 - Experimental Economics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2540489	Experimental Economics	2 SWS	Lecture / 🗣	Knierim
WT 25/26	2540493	Übung zu Experimental Economics	1 SWS	Practice / 🗣	del Puppo

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written examination (60 min).

Prerequisites
None

Additional Information
The language of the course is English.

Below you will find excerpts from courses related to this module component:

V Experimental Economics

2540489, WS 25/26, 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 4.78 Module component: Exponential Integrators [T-MATH-107475]

Coordinators: Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke

Organisation: KIT Department of Mathematics

Part of: M-MATH-103700 - Exponential Integrators

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Prerequisites
none

T 4.79 Module component: Extremal Graph Theory [T-MATH-105931]

Coordinators: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-102957 - Extremal Graph Theory

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Irregular	2

Prerequisites
none

T 4.80 Module component: Extreme Value Theory [T-MATH-105908]

Coordinators: Prof. Dr. Vicky Fasen-Hartmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-102939 - Extreme Value Theory

Type	Credits	Grading	Version
Oral examination	4 CP	graded	2

T 4.81 Module component: Facility Location and Strategic Supply Chain Management [T-WIWI-102704]

Coordinators: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101413 - Applications of Operations Research
M-WIWI-101414 - Methodical Foundations of OR

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	4

Exams			
WT 25/26	7900091	Facility Location and Strategic Supply Chain Management	Nickel

Assessment
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.

Recommendations
None

Additional Information
The lecture is held in every winter term. The planned lectures and courses for the next three years are announced online at https://dol.ior.kit.edu/Lehrveranstaltungen.php.

Workload
135 hours

T 4.82 Module component: Financial Analysis [T-WIWI-102900]

Coordinators: Dr. Torsten Luedecke
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	2

Courses					
ST 2026	2530205	Financial Analysis	2 SWS	Lecture / 🗣	Luedecke
ST 2026	2530206	Übungen zu Financial Analysis	2 SWS	Practice / 🗣	Luedecke
Exams					
WT 25/26	7900059	Financial Analysis			Ruckes, Luedecke
ST 2026	7900075	Financial Analysis			Luedecke

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
See German version.

Prerequisites
None

Recommendations
Basic knowledge in corporate finance, accounting, and valuation is required.

Below you will find excerpts from courses related to this module component:

V Financial Analysis

2530205, SS 2026, 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 4.83 Module component: Financial Econometrics [T-WIWI-103064]

Coordinators: Prof. Dr. Melanie Schienle
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	2

Courses					
WT 25/26	2520022	Financial Econometrics I	2 SWS	Lecture / 🗣	Schienle
WT 25/26	2520023	Übungen zu Financial Econometrics I	2 SWS	Practice / 🗣	Buse
Exams					
WT 25/26	7900126	Financial Econometrics			Schienle
ST 2026	7900223	Financial Econometrics			Schienle

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
It is recommended that students have substantive knowledge of the course “Economics III: Introduction to Econometrics”.

Additional Information
The course will be held in English.

Below you will find excerpts from courses related to this module component:

V Financial Econometrics I

2520022, WS 25/26, 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 4.84 Module component: Financial Econometrics II [T-WIWI-110939]

Coordinators: Prof. Dr. Melanie Schienle
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	3

Courses					
ST 2026	2521302	Financial Econometrics II	2 SWS	Lecture / 🗣	Schienle, Buse
ST 2026	2521303	Übung zu Financial Econometrics II	2 SWS	Practice / 🗣	Buse, Schienle
Exams					
ST 2026	7900081	Financial Econometrics II			Schienle

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written examination (90 minutes). If the number of participants is low, an oral examination will be held instead.

Prerequisites
None

Recommendations
It is recommended that students have substantive knowledge of the course **"Financial Econometrics."**

Additional Information
The course will be held in English.

Workload
135 hours

T 4.85 Module component: Financial Intermediation [T-WIWI-102623]

Coordinators: Prof. Dr. Martin Ruckes
Organisation: KIT Department of Business and Economics
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	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2530232	Financial Intermediation	2 SWS	Lecture / 🗣	Ruckes
WT 25/26	2530233	Übung zu Finanzintermediation	1 SWS	Practice	Ruckes, Benz
Exams					
WT 25/26	7900063	Financial Intermediation			Ruckes
ST 2026	7900078	Financial Intermediation			Ruckes

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
None

Below you will find excerpts from courses related to this module component:

V Financial Intermediation

2530232, WS 25/26, 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 4.86 Module component: Finite Element Methods [T-MATH-105857]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Courses					
WT 25/26	0110300	Finite Element Methods	4 SWS	Lecture / 🗣	Hochbruck, Dörich
WT 25/26	0110310	Tutorial for 0110300 (Finite Element Methods)	2 SWS	Practice	Hochbruck, Dörich
Exams					
WT 25/26	7700046	Finite Element Methods			Hochbruck, Dörich
WT 25/26	7700047	Finite Element Methods			Hochbruck, Dörich

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
none

Below you will find excerpts from courses related to this module component:

V Finite Element Methods

0110300, WS 25/26, 4 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

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.

Literature
Complete lecture notes will be provided

T 4.87 Module component: Forecasting: Theory and Practice [T-MATH-105928]

Coordinators: Prof. Dr. Tilmann Gneiting
Organisation: KIT Department of Mathematics
Part of: M-MATH-102956 - Forecasting: Theory and Practice

Type	Credits	Grading	Version
Oral examination	8 CP	graded	2

Exams			
WT 25/26	7700110	Forecasting: Theory and Practice	Gneiting

Prerequisites
None.

T 4.88 Module component: Foundations of Continuum Mechanics [T-MATH-107044]

Coordinators: Prof. Dr. Christian Wieners
Organisation: KIT Department of Mathematics
Part of: M-MATH-103527 - Foundations of Continuum Mechanics

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Once	2

Assessment
Oral exam of approx. 20 minutes.

Prerequisites
none

T 4.89 Module component: Fractal Geometry [T-MATH-111296]

Coordinators: PD Dr. Steffen Winter
Organisation: KIT Department of Mathematics
Part of: M-MATH-105649 - Fractal Geometry

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Prerequisites
none

T 4.90 Module component: Functional Analysis [T-MATH-102255]

Coordinators: 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	Term offered	Version
Written examination	8 CP	graded	Each winter term	3

Courses					
WT 25/26	0104800	Functional Analysis	4 SWS	Lecture / 🗣	Hundertmark
WT 25/26	0104810	Tutorial for 0104800 (Functional Analysis)	2 SWS	Practice / 🗣	Hundertmark
Exams					
WT 25/26	0100047	Functional Analysis			Lamm, Hundertmark, Kunstmann, Schnaubelt, Frey, Reichel, Tolksdorf

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written examination of 120 minutes.

Prerequisites
none

Workload
240 hours

Below you will find excerpts from courses related to this module component:

V Functional Analysis

0104800, WS 25/26, 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 4.91 Module component: Functional Data Analysis [T-MATH-113102]

Coordinators: 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	Term offered	Version
Oral examination	4 CP	graded	Irregular	1

Exams			
WT 25/26	7700112	Functional Data Analysis	Ebner

Assessment
Oral examination of ca. 25 minutes.

Prerequisites
none

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

Workload
120 hours

T 4.92 Module component: Functions of Matrices [T-MATH-105906]

Coordinators: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: M-MATH-102937 - Functions of Matrices

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Prerequisites
none

T 4.93 Module component: Functions of Operators [T-MATH-105905]

Organisation: KIT Department of Mathematics
Part of: M-MATH-102936 - Functions of Operators

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

T 4.94 Module component: Fundamentals for Financial -Quant and -Machine Learning Research [T-WIWI-111846]

Coordinators: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-105894 - Foundations for Advanced Financial -Quant and -Machine Learning Research

Type	Credits	Grading	Term offered	Version
Examination of another type	9 CP	graded	Irregular	1

Assessment
The 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.

Recommendations

- 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.

Additional Information
Teaching and learning format: Lecture and exercise.

Workload
270 hours

T 4.95 Module component: Galerkin Methods for Time-dependent PDEs [T-MATH-114992]

Coordinators: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: M-MATH-107647 - Galerkin Methods for Time-dependent PDEs

Type	Credits	Grading	Version
Oral examination	5 CP	graded	1

Assessment
Success is assessed in form of an oral examination.

Prerequisites
None.

Workload
150 hours

T 4.96 Module component: Generalized Regression Models [T-MATH-105870]

Coordinators: 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	Version
Oral examination	4 CP	graded	3

Courses					
ST 2026	0161400	Generalisierte Regressionsmodelle	2 SWS	Lecture	Klar
ST 2026	0161410	Übungen zu 0161400 (generalisierte Regressionsmodelle)	1 SWS	Practice	Klar

Workload
120 hours

T 4.97 Module component: Geometric Group Theory [T-MATH-105842]

Coordinators: Prof. Dr. Frank Herrlich
PD 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	Version
Written examination	8 CP	graded	1

Exams			
WT 25/26	7700079	Geometric Group Theory	Link

Prerequisites
None.

Workload
240 hours

T 4.98 Module component: Geometric Numerical Integration [T-MATH-105919]

Coordinators: Prof. Dr. Marlis Hochbruck
Prof. Dr. Tobias Jahnke

Organisation: KIT Department of Mathematics

Part of: M-MATH-102921 - Geometric Numerical Integration

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

Courses					
ST 2026	0154100	Geometric Numerical Integration	3 SWS	Lecture	Jahnke
ST 2026	0154200	Tutorial for 0154100 (Geometric Numerical Integration)	1 SWS	Practice	Jahnke

Prerequisites
none

Workload
180 hours

Below you will find excerpts from courses related to this module component:

V Geometric Numerical Integration

0154100, SS 2026, 3 SWS, Language: English, Open in study portal

Lecture (V)

Content
Simulating time-dependent processes in science and technology often requires to solve a system of ordinary differential equations with a suitable numerical method. In many applications it can be shown that the exact flow of the differential equation exhibits certain qualitative or “geometric” properties. For example, it is well-known that the flow of a Hamiltonian system is symplectic, and that the energy remains constant along the solution although the solution itself changes as time evolves.

When the solution or the flow is approximated by a numerical integrator, it is desirable or even crucial to preserve these geometric properties. It turns out, however, that only selected methods respect the geometric properties of the dynamics. These methods are called geometric numerical integrators. In this lecture we will investigate

- why certain methods are (or are not) geometric numerical integrators,
- how to construct geometric numerical integrators, and
- which properties are conserved, and in which sense.

The lecture will be suited for Master students in mathematics, physics and other sciences with a basic knowledge in ordinary differential equations and Runge-Kutta methods. In particular, students should be familiar with concepts such as, e.g., order, consistency, convergence, A-stability, and so on. The course “Numerische Methoden für Differentialgleichungen” provides a good basis. Moreover, participants are expected to be familiar with Matlab or Python. In some of the exercises discussed in the tutorial, students will be asked to write short programs in order to test the behaviour of numerical methods.

Both the lecture and the exercise classes will be given in English.

T 4.99 Module component: Geometric Variational Problems [T-MATH-113418]

Coordinators: Prof. Dr. Tobias Lamm
Organisation: KIT Department of Mathematics
Part of: M-MATH-106667 - Geometric Variational Problems

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Assessment
oral exam of ca. 30 min

Prerequisites
none

Workload
240 hours

T 4.100 Module component: Geometry of Schemes [T-MATH-105841]

Coordinators: Prof. Dr. Frank Herrlich
PD Dr. Stefan Kühnlein

Organisation: KIT Department of Mathematics

Part of: M-MATH-102866 - Geometry of Schemes

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

T 4.101 Module component: Global Differential Geometry [T-MATH-105885]

Coordinators: Prof. Dr. Wilderich Tuschmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-102912 - Global Differential Geometry

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Prerequisites
none

Workload
240 hours

T 4.102 Module component: Global Optimization I [T-WIWI-102726]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101413 - Applications of Operations Research
M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2550134	Global Optimization I	2 SWS	Lecture / 🗣	Stein
Exams					
WT 25/26	7900004_WS2526_NK	Global Optimization I			Stein
ST 2026	7900205_SS2026_HK	Global Optimization I			Stein

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is in the form of a written examination in English (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

Recommendations
None

Additional Information
Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from courses related to this module component:

V **Global Optimization I** — **Lecture (V)** **On-Site**
2550134, SS 2026, 2 SWS, Language: English, 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 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, Basic Concepts of Global Optimization, Springer, 2024

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 4.103 Module component: Global Optimization I and II [T-WIWI-103638]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading	Term offered	Version
Written examination	9 CP	graded	Each summer term	1

Courses					
ST 2026	2550134	Global Optimization I	2 SWS	Lecture / 🗣	Stein
ST 2026	2550135	Exercise to Global Optimization I	1 SWS	Practice / 🗣	Stein, Beck
ST 2026	2550136	Global Optimization II	2 SWS	Lecture / 🗣	Stein
Exams					
WT 25/26	7900006_WS2526_NK	Global Optimization I and II			Stein
ST 2026	7900207_SS2026_HK	Global Optimization I and II			Stein

Legend: 🖥 Online, 🖥🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of the lecture is a written examination in English (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

Recommendations
None

Additional Information
Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from courses related to this module component:

V Global Optimization I

2550134, SS 2026, 2 SWS, Language: English, 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, Basic Concepts of Global Optimization, Springer, 2024

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 2026, 2 SWS, Language: English, 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, Basic Concepts of Global Optimization, Springer, 2024

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 4.104 Module component: Global Optimization II [T-WIWI-102727]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	2

Courses					
ST 2026	2550136	Global Optimization II	2 SWS	Lecture / 🗣	Stein
ST 2026	2550137	Exercise to Global Optimization II	1 SWS	Practice / 🗣	Stein, Beck
Exams					
WT 25/26	7900005_WS2526_NK	Global Optimization II			Stein
ST 2026	7900206_SS2026_HK	Global Optimization II			Stein

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of the lecture is a written examination in English (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

Additional Information
Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from courses related to this module component:

V **Global Optimization II** — **Lecture (V) On-Site**
2550136, SS 2026, 2 SWS, Language: English, 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, Basic Concepts of Global Optimization, Springer, 2024

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 4.105 Module component: Graph Theory [T-MATH-102273]

Coordinators: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-101336 - Graph Theory

Type	Credits	Grading	Version
Written examination	8 CP	graded	3

Courses					
WT 25/26	0104500	Graph Theory	4 SWS	Lecture	Aksenovich, Liu
WT 25/26	0104510	Tutorial for 0104500 (Graph Theory)	2 SWS	Practice	Aksenovich, Liu
Exams					
WT 25/26	7700050	Graph Theory			Aksenovich

Prerequisites
None

Below you will find excerpts from courses related to this module component:

V Graph Theory

0104500, WS 25/26, 4 SWS, Language: English, Open in study portal

Lecture (V)

Content
Graphs are structures in discrete mathematics that in particular model various networks. The course starts with basic concepts in graph theory such as trees, cycles, matchings, factors, connectivity, and their interconnections. Further topics include properties of graphs with forbidden subgraphs, planar graphs, graph colorings, random graphs, Ramsey theory, and graph minors. Not only classical, but very recent results in the field will be discussed. The class is oriented towards problem solving. Particular attention to proof writing techniques will be paid in the problem class. The final grade will be based on the written exam. Bonus points will be given for weekly or biweekly homework assignments.

T 4.106 Module component: Graph Theory and Advanced Location Models [T-WIWI-102723]

Coordinators: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	2

Courses					
ST 2026	2500033	Exercises for Graph Theory and Advanced Location Models	1.5 SWS	Practice / 🔀	Hoffmann
ST 2026	2500050	Graph Theory and Advanced Location Models	3 SWS	Lecture / 🗣	Nickel
Exams					
ST 2026	7900209	Graph Theory and Advanced Location Models			Nickel

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of the course (lecture and exercise) is a 60-minute 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

Recommendations
It is recommended that students have knowledge of Operations Research, such as that taught in the course "Introduction to Operations Research".

Additional Information
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 4.107 Module component: Harmonic Analysis [T-MATH-111289]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Exams			
ST 2026	7700081	Harmonic Analysis	Frey, Tolksdorf, Kunstmann

Prerequisites
None.

Workload
240 hours

T 4.108 Module component: Harmonic Analysis 2 [T-MATH-113103]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Exams			
WT 25/26	7700144	Harmonic Analysis 2	Frey

Assessment
oral examination of ca. 30 minutes.

Prerequisites
none

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

Workload
240 hours

T 4.109 Module component: Heat Economy [T-WIWI-102695]

Coordinators: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading	Term offered	Version
Written examination	3,5 CP	graded	Each summer term	2

Courses					
ST 2026	2581001	Heat Economy	2 SWS	Lecture / 🗣	Fichtner
Exams					
WT 25/26	7981001	Heat Economy			Fichtner
ST 2026	7981001	Heat Economy			Fichtner

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
None

Additional Information
See German version.

Below you will find excerpts from courses related to this module component:

V **Heat Economy** — **Lecture (V) On-Site**
2581001, SS 2026, 2 SWS, Language: German, Open in study portal

Organizational issues
Block, Seminarraum Standort West - siehe Institutsaushang

T 4.110 Module component: Human Factors in Autonomous Driving [T-WIWI-113059]

Coordinators: Prof. Dr. Alexey Vinel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2511452	Human Factors in Autonomous Driving	2 SWS	Lecture /	Vinel, Bied, Schrapel
WT 25/26	2511453	Exercises Human Factors in Autonomous Driving	1 SWS	Practice /	Vinel, Bied, Schrapel
Exams					
WT 25/26	79AIFB_HFAD_C6	Human Factors in Autonomous Driving (Registration extended until 16.02.2026)			Vinel
ST 2026	791-AIFB-HFAD-NK	Human Factors in Autonomous Driving (registration until 20.07.2026)			Vinel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The assessment of this course is a written examination (60 min) or an oral exam (approx. 20 min).

The exam takes place every semester and can be repeated at every regular examination date.

Workload
135 hours

T 4.111 Module component: Human Factors in Security and Privacy [T-WIWI-109270]

Coordinators: Prof. Dr. Melanie Volkamer
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	3

Assessment
The assessment of this course (lecture and exercise) 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

Recommendations
The prior attendance of the lecture "Information Security" is strongly recommended.

Additional Information
Please note: This course is only offered irregularly.

The lecture units are held partly in German and partly in English.

Workload
135 hours

T 4.112 Module component: Incentives in Organizations [T-WIWI-105781]

Coordinators: Prof. Dr. Petra Nieken
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101500 - Microeconomic Theory
M-WIWI-101505 - Experimental Economics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2573003	Incentives in Organizations	2 SWS	Lecture / 🗣	Nieken
ST 2026	2573004	Übung zu Incentives in Organizations	2 SWS	Practice / 🗣	Nieken, Mitarbeiter, Gorny
Exams					
WT 25/26	7900201	Incentives in Organizations			Nieken
ST 2026	7900132	Incentives in Organizations			Nieken

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
It is recommended that students have knowledge in microeconomics, game theory, and statistics.

Below you will find excerpts from courses related to this module component:

V **Incentives in Organizations** — Lecture (V) On-Site
2573003, SS 2026, 2 SWS, Language: English, Open in study portal

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 4.113 Module component: Integral Equations [T-MATH-105834]

Coordinators: 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	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Courses					
ST 2026	0160510	Übungen zu 0160500 (Integralgleichungen)	2 SWS	Practice	Arens

T 4.114 Module component: International Entrepreneurship and Brand Development [T-WIWI-114893]

Coordinators: Prof. Dr. Ann-Kristin Kupfer
Prof. Dr. Orestis Terzidis

Organisation: KIT Department of Business and Economics

Part of: M-WIWI-105312 - Marketing and Sales Management
M-WIWI-106258 - Digital Marketing

Type	Credits	Grading	Term offered	Version
Examination of another type	6 CP	graded	see Annotations	1

Courses					
WT 25/26	2572189	International Entrepreneurship and Brand Development	4 SWS	Block / 🗣	Terzidis, Kupfer
Exams					
WT 25/26	7900156	International Entrepreneurship and Brand Development			Kupfer, Terzidis

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Non exam assessment. The grade is based on the presentation, the subsequent discussion and the written elaboration.

Additional Information
Please contact the Marketing and Sales Research Group for further information.

Workload
180 hours

Below you will find excerpts from courses related to this module component:

V International Entrepreneurship and Brand Development

2572189, WS 25/26, 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 Institute for Entrepreneurship and Technology and the Institute for Customer Insights (CIN) shortly before the start of the lecture period.

Total workload for 6 ECTS: about 180 hours.

T 4.115 Module component: International Finance [T-WIWI-102646]

Coordinators: Prof. Dr. Marliese Uhrig-Homburg
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101483 - Finance 2

Type	Credits	Grading	Term offered	Version
Written examination	3 CP	graded	see Annotations	1

Courses					
ST 2026	2530570	International Finance	2 SWS	Lecture / 🗣	Walter, Uhrig-Homburg
Exams					
WT 25/26	7900052	International Finance			Uhrig-Homburg
ST 2026	7900097	International Finance			Uhrig-Homburg

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
None

Additional Information
The course is offered as a 14-day or block course.

Below you will find excerpts from courses related to this module component:

V International Finance

2530570, SS 2026, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Organizational issues
Kickoff am Mittwoch, 29.04.26, 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.

T 4.116 Module component: Interpolation Spaces [T-MATH-114639]

Coordinators: apl. Prof. Dr. Peer Kunstmann
Prof. Dr. Tobias Lamm

Organisation: KIT Department of Mathematics

Part of: M-MATH-107456 - Interpolation Spaces

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Assessment
Oral examination lasting approx. 30 minutes.

Prerequisites
none

Workload
180 hours

T 4.117 Module component: Introduction into Particulate Flows [T-MATH-105911]

Coordinators: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: M-MATH-102943 - Introduction into Particulate Flows

Type	Credits	Grading	Version
Oral examination	3 CP	graded	1

Prerequisites
none

T 4.118 Module component: Introduction to Convex Integration [T-MATH-112119]

Coordinators: Dr. Christian Zillinger
Organisation: KIT Department of Mathematics
Part of: M-MATH-105964 - Introduction to Convex Integration

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	3 CP	graded	Irregular	1 semesters	1

Assessment
oral examination of approx. 30 minutes

Prerequisites
none

Recommendations
The courses "Classical Methods for Partial Differential Equations" and "Functional Analysis" are recommended.

Workload
90 hours

T 4.119 Module component: Introduction to Dynamical Systems [T-MATH-113263]

Coordinators: 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	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Assessment
oral exam of ca. 30 min

Prerequisites
none

Workload
180 hours

T 4.120 Module component: Introduction to Fluid Dynamics [T-MATH-111297]

Coordinators: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-105650 - Introduction to Fluid Dynamics

Type	Credits	Grading	Term offered	Version
Oral examination	3 CP	graded	Irregular	1

Prerequisites
none

T 4.121 Module component: Introduction to Fluid Mechanics [T-MATH-112927]

Coordinators: TT-Prof. Dr. Xian Liao
Organisation: KIT Department of Mathematics
Part of: M-MATH-106401 - Introduction to Fluid Mechanics

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	6 CP	graded	Irregular	1 semesters	1

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

Prerequisites
none

Recommendations
The module *Functional Analysis* is strongly recommended.

Workload
180 hours

T 4.122 Module component: Introduction to Geometric Measure Theory [T-MATH-105918]

Coordinators: PD Dr. Steffen Winter
Organisation: KIT Department of Mathematics
Part of: M-MATH-102949 - Introduction to Geometric Measure Theory

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

Prerequisites
none

T 4.123 Module component: Introduction to Homogeneous Dynamics [T-MATH-110323]

Coordinators: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: M-MATH-105101 - Introduction to Homogeneous Dynamics

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Prerequisites
none

T 4.124 Module component: Introduction to Kinetic Equations [T-MATH-111721]

Coordinators: Dr. Christian Zillinger
Organisation: KIT Department of Mathematics
Part of: M-MATH-105837 - Introduction to Kinetic Equations

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	3 CP	graded	Irregular	1 semesters	1

Assessment
oral examination of circa 30 minutes

Prerequisites
none

Recommendations
The course "Classical Methods for Partial Differential Equations" should be studied beforehand.

T 4.125 Module component: Introduction to Kinetic Theory [T-MATH-108013]

Coordinators: Prof. Dr. Martin Frank
Organisation: KIT Department of Mathematics
Part of: M-MATH-103919 - Introduction to Kinetic Theory

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	0155450	Introduction to Kinetic Theory	2 SWS	Lecture	Loevbak
WT 25/26	0155460	Tutorial for 0155450 (Introduction to Kinetic Theory)	1 SWS	Practice	Loevbak
Exams					
WT 25/26	7700078	Introduction to Kinetic Theory			Frank, Loevbak

Prerequisites
none

Below you will find excerpts from courses related to this module component:

V Introduction to Kinetic Theory

0155450, WS 25/26, 2 SWS, Language: English, Open in study portal

Lecture (V)

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.

T 4.126 Module component: Introduction to Microlocal Analysis [T-MATH-111722]

Coordinators: TT-Prof. Dr. Xian Liao
Organisation: KIT Department of Mathematics
Part of: M-MATH-105838 - Introduction to Microlocal Analysis

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	3 CP	graded	Irregular	1 semesters	1

Assessment
oral examination of circa 30 minutes

Prerequisites
none

Recommendations
The courses "Classical Methods for Partial Differential Equations" and "Functional Analysis" should be studied beforehand.

T 4.127 Module component: Introduction to Scientific Computing [T-MATH-105837]

Coordinators: 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	Version
Oral examination	8 CP	graded	3

Courses					
ST 2026	0165000	Einführung in das Wissenschaftliche Rechnen	3 SWS	Lecture	Jahnke
ST 2026	0165010	Praktikum zu Einführung in das Wissenschaftliche Rechnen (0165000)	3 SWS	Practical course	Jahnke

T 4.128 Module component: Introduction to Stochastic Differential Equations [T-MATH-112234]

Coordinators: Josef Janák
Prof. Dr. Mathias Trabs

Organisation: KIT Department of Mathematics

Part of: M-MATH-106045 - Introduction to Stochastic Differential Equations

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Irregular	1

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

Prerequisites
none

Recommendations
The contents of the module "Probability Theory" are strongly recommended. The module "Continuous Time Finance" is recommended.

Workload
120 hours

T 4.129 Module component: Introduction to Stochastic Optimization [T-WIWI-106546]

Coordinators: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Business and Economics
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	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	3

Courses					
ST 2026	2550470	Introduction to Stochastic Optimization	2 SWS	Lecture /	Rebennack
ST 2026	2550471	Übung zur Einführung in die Stochastische Optimierung	1 SWS	Practice /	Rebennack, Kandora
ST 2026	2550474	Rechnerübung zur Einführung in die Stochastische Optimierung	2 SWS	Others	Rebennack, Kandora
Exams					
WT 25/26	7900242	Introduction to Stochastic Optimization			Rebennack
ST 2026	7900311	Introduction to Stochastic Optimization			Rebennack

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
The assessment consists of a written exam (60 minutes). The exam takes place in every semester.

Prerequisites
None.

Workload
135 hours

T 4.130 Module component: Inverse Problems [T-MATH-105835]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Courses					
WT 25/26	0105100	Inverse Problems	4 SWS	Lecture / 🗣	Griesmaier
WT 25/26	0105110	Tutorial for 0105100 (Inverse Problems)	2 SWS	Practice / 🗣	Griesmaier
Exams					
WT 25/26	7700143	Inverse Problems			Griesmaier

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Below you will find excerpts from courses related to this module component:

V Inverse Problems

0105100, WS 25/26, 4 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content

Following Hadamard, a problem whose solution does not depend continuously on the given data is called ill-posed. Prominent examples are the mathematical problems behind tomographic methods like X-ray tomography, ultrasound tomography or electrical impedance tomography as well as seismic imaging, radar imaging, or inverse scattering. The mathematical models used in this context are typically formulated in terms of integral transforms or differential equations. However the aim is not to evaluate the transform or to solve the differential equation but to invert the transform or to reconstruct parameters of this equation given (part of) its solution, respectively. Therefore these problems are called inverse problems.

Standard methods from numerical mathematics typically fail when they are directly applied to ill-posed problems -- the problem has to be regularized. The course gives an introduction to the functional analytic background of regularization methods for linear ill-posed problems. Results from functional analysis that are required in this context will be provided in the course of the lecture.

T 4.131 Module component: Knowledge Discovery [T-WIWI-102666]

Coordinators: Dr.-Ing. Tobias Käfer
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	4

Courses					
WT 25/26	2511303	Knowledge Discovery, Graph Neural Networks, and Language Models	3 SWS	Lecture / Practice / 🏵	Käfer, Shao, Noullet, Kubelka
Exams					
WT 25/26	79AIFB_KD_D1	Knowledge Discovery (Registration extended until 16.02.2026)			Käfer
ST 2026	791-AIFB-KD-NK	Knowledge Discovery (Registration until 20.07.2026)			Käfer

Legend: 🖥 Online, 🏵 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The Knowledge Discovery course is assessed through a written examination with a duration of 60 minutes. Depending on the number of participants, the examiner may replace the written exam with an oral examination lasting approximately 30 minutes

Prerequisites
None

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Knowledge Discovery, Graph Neural Networks, and Language Models

2511303, WS 25/26, 3 SWS, Language: English, Open in study portal

Lecture / Practice (VÜ)
Blended (On-Site/Online)

Content
This course represents an advanced, methodologically oriented course in the field of Artificial Intelligence. The course offers an in-depth examination of modern methods for knowledge extraction and processing at the interface of graph-based machine learning and natural language processing.

In the area of text-based methods, the lecture focuses on large language models (LLMs) such as ChatGPT, LLAMA, and DeepSeek, examining their underlying principles, training methods, and applications. Additional language processing techniques from text mining are also covered extensively.

In the area of graph-based methods, the lecture is dedicated to graph representation learning, which focuses on forming useful representations of graph data. The mathematical foundations of graph and geometric deep learning are covered, and applications in areas such as explainable artificial intelligence are highlighted.

Learning obectives:

Students

- Explain the core concepts of text mining, large language models (LLMs), and graph neural networks (GNNs).
- Compare and select different neural architectures and graph models in terms of structure, performance, and interpretability.
- Implement corresponding systems in practice, including data preprocessing, model selection, and evaluation.

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 4.132 Module component: Knowledge-Driven Artificial Intelligence [T-WIWI-114863]

Coordinators: Prof. Dr. Harald Sack
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2511606	Knowledge-driven Artificial Intelligence	2 SWS	Lecture / 🗣	Sack, Malakzadeh Mahani, Patronilo, Nahani, Yargan, Gader
ST 2026	2511607	Exercises to Knowledge-driven Artificial Intelligence	1 SWS	Practice / 🗣	Sack, Tietz, Malekzadeh Mahani, Ondraszek
Exams					
ST 2026	791-AIFB-KDAI-HK	Knowledge-Driven Artificial Intelligence (Registration until 20.07.2026)			Sack

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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 courses related to this module component:

V Knowledge-driven Artificial Intelligence

2511606, SS 2026, 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 and Successful Communication
- The Art of Understanding
- The Principles of Learning

- Basic Machine Learning

- Machine Learning Fundamentals
- How to evaluate a Machine Learning Experiment?
- Evaluation and Generalisation Problems
- Supervised and Unsupervised ML
- Basic ML Algorithms
- Linear Regression
- Decision Trees
- k-means Clustering
- Neural Networks and Deep Learning

- Natural Language Processing

- NLP and Basic Linguistic Knowledge
- NLP Applications, Techniques and Challenges
- Regular Expressions, Tokenisation and Word Normalisation
- Statistical Language Models (N-Gram Model)
- Naive Bayes Text Classification
- Distributional Semantics and Neural Language Models
- Word Embeddings

- 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
- The Graph in Knowledge Graphs

- Neurosymbolic AI

- Symbolic and Subsymbolic AI
- Knowledge Graph Embeddings and KG Completion
- The Limits of AI
- KDAI Master Thesis Topics

Learning objectives:

- The students know the fundamentals and measures of information theory and are able to apply those in the context of Knowledge-driven AI.
- 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 know the fundamentals of basic machine learning technologies. The students are able to apply these skills for simple prediction and classification tasks.
- The students know the basic principles of neurosymbolic AI.

Literature

- Machine Learning:
  G. Rebala, A. Ravi, S. Churiwala, An Introduction to Machine Learning, Springer, 2019. (available via KIT network)
- Natural Language Processing:
  D. Jurafsky, J.H. Martin, Speech and Language Processing, 3rd ed. Draft, 2023.
- Knowledge Graphs:
  A. Hogan, The Web of Data, Springer, 2020. (available via KIT network)

T 4.133 Module component: Large-scale Optimization [T-WIWI-106549]

Coordinators: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	3

Exams			
WT 25/26	7900244	Large-scale Optimization	Rebennack

Assessment
The assessment consists of a written exam (60 minutes). The exam takes place in every semester.

Prerequisites
None.

Workload
135 hours

T 4.134 Module component: Liberalised Power Markets [T-WIWI-107043]

Coordinators: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading	Term offered	Version
Written examination	5,5 CP	graded	Each winter term	3

Courses					
WT 25/26	2581998	Liberalised Power Markets	2 SWS	Lecture / 🗣	Fichtner
WT 25/26	2581999	Übungen zu Liberalised Power Markets	2 SWS	Practice / 🗣	Signer, Fichtner, Beranek
Exams					
WT 25/26	7900160	Liberalised Power Markets NEW			Fichtner
ST 2026	7900205	Liberalised Power Markets NEW			Fichtner

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
None

Workload
165 hours

Below you will find excerpts from courses related to this module component:

V Liberalised Power Markets

2581998, WS 25/26, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

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 4.135 Module component: Lie Groups and Lie Algebras [T-MATH-108799]

Coordinators: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: M-MATH-104261 - Lie Groups and Lie Algebras

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Prerequisites
none

T 4.136 Module component: Lie-Algebras [T-MATH-113907]

Coordinators: Prof. Dr. Tobias Hartnick
Organisation: KIT Department of Mathematics
Part of: M-MATH-106950 - Lie-Algebras

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	8 CP	graded	Irregular	1 semesters	1

Prerequisites
none

T 4.137 Module component: Machine Learning 1 - Basic Methods [T-WIWI-106340]

Coordinators: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	4

Courses					
WT 25/26	2511500	Machine Learning 1 - Fundamental Methods	2 SWS	Lecture / 🗣	Zöllner
WT 25/26	2511501	Exercises to Machine Learning 1 - Fundamental Methods	1 SWS	Practice / 🗣	Zöllner, Polley, Fechner
Exams					
WT 25/26	79AIFB_ML1_Deutsch	Machine Learning 1 - Basic Methods (Registration extended until Feb 16 – Late registration: Waitlist only, seat not guaranteed)			Zöllner
WT 25/26	79AIFB_ML1_English	Machine Learning 1 - Basic Methods (written exam in English, Registration extended until 16.02.2026)			Zöllner
ST 2026	791-AIFB-ML1-dt-NK	Machine Learning 1 - Basic Methods (Registration until 20.07.2026)			Zöllner
ST 2026	791-AIFB-ML1-en-NK	Machine Learning 1 - Basic Methods (written exam in English, registration until 20.07.2026)			Zöllner

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written examination (60 minutes). The examination is offered every semester and can be repeated at any regular examination date.

A grade bonus can be earned by successfully completing 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.

Workload
150 hours

Below you will find excerpts from courses related to this module component:

V Machine Learning 1 - Fundamental Methods

2511500, WS 25/26, 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 4.138 Module component: Machine Learning 2 - Advanced Methods [T-WIWI-106341]

Coordinators: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics
M-WIWI-101637 - Analytics and Statistics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	5

Courses					
ST 2026	2511502	Machine Learning 2 - Advanced Methods	2 SWS	Lecture / 🗣	Zöllner, Fechner, Polley, Stegmaier
ST 2026	2511503	Exercises for Machine Learning 2 - Advanced Methods	1 SWS	Practice / 🗣	Zöllner, Fechner, Polley, Stegmaier
Exams					
WT 25/26	79AIFB_ML2_Deutsch	Machine Learning 2 – Advanced Methods (exam in German, Registration extended until 16.02.2026)			Zöllner
WT 25/26	79AIFB_ML2E_B1	Machine Learning 2 – Advanced Methods (exam in English, Registration extended until 16.02.2026)			Zöllner
ST 2026	791-AIFB-ML2-dt-HK	Machine Learning 2 – Advanced Methods (written exam in German, registration until 20.07.2026)			Zöllner
ST 2026	791-AIFB-ML2-en_HK	Machine Learning 2 – Advanced Methods (written exam in English, registration until 20.07.2026)			Zöllner

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written examination (70 minutes). The examination is offered every semester and can be repeated at any regular examination date.

Prerequisites
None.

Workload
150 hours

Below you will find excerpts from courses related to this module component:

V Machine Learning 2 - Advanced Methods

2511502, SS 2026, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
Machine learning has become a central driver of innovation in science, engineering, and industry. Recent advances in learning algorithms and model architectures have enabled capabilities that were previously out of reach, such as high-quality image, video, and text generation, robust perception in complex environments, and intelligent decision-making under uncertainty. These developments are transforming how intelligent systems interact with the world and are increasingly deployed in large-scale, safety-critical, and autonomous applications.

This lecture provides an in-depth overview of the methods that enable these capabilities. It covers state-of-the-art network architectures, including transformers and graph neural networks, as well as modern generative models such as GANs and diffusion models. In addition, the lecture introduces model-free and model-based reinforcement learning for sequential decision-making and addresses practical aspects such as large-scale training, uncertainty-aware learning, active learning, and advanced computer vision. Through this integrated perspective, students gain a solid understanding of the principles, strengths, and limitations of modern machine learning methods and learn how to apply them in complex real-world systems.

Learning objectives:

- **Students have advanced knowledge of state-of-the-art machine learning methods and architectures**, including modern deep learning models, generative approaches, and reinforcement learning, as well as their theoretical foundations, assumptions, and application domains.
- **Students are able to formally describe, classify, and analyze advanced machine learning methods and architectures**, and to apply these methods within complex inference and decision-making systems while accounting for practical constraints such as data availability, scalability, robustness, and uncertainty.
- **Students are capable of critically evaluating advanced machine learning methods and architectures** and of selecting and justifying appropriate models and learning strategies for given problems in machine learning, based on problem characteristics, methodological trade-offs, and application requirements.

Recommendations: Attending the lecture Machine Learning 1 or a comparable lecture is very helpful in understanding this lecture.

Notes:

- The lecture will be taught in German with English slides. The exam can be taken in either German or English.
- The time of the exam is 70 minutes.

Literature
Weiterführende Literatur

- Probabilistic Machine Learning: An Introduction - Kevin P. Murphy
- Probabilistic Machine Learning: Advanced Topics - Kevin P. Murphy
- Deep Learning - Ian Goodfellow, Yoshua Bengio, Aaron Courville
- Reinforcement Learning: An Introduction - Richard S. Sutton and Andrew G. Barto

Weitere (spezifische) Literatur zu einzelnen Themen wird in der Vorlesung angegeben.

T 4.139 Module component: Machine Learning and Optimization in Energy Systems [T-WIWI-113073]

Coordinators: Prof. Dr. Wolf Fichtner
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading	Term offered	Version
Written examination	3,5 CP	graded	Each winter term	4

Courses					
WT 25/26	2581050	Machine Learning and Optimization in Energy Systems	3 SWS	Lecture / Practice / 🗣	Dengiz, Yilmaz, Kleinebrahm
Exams					
WT 25/26	7900179	Machine Learning and Optimization in Energy Systems			Fichtner
ST 2026	7900207	Machine Learning and Optimization in Energy Systems			Fichtner

Legend: 🖥 Online, 🖥🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of this course is a written examination (60 min) or an oral exam (30 min) depending on the number of participants.

Workload
105 hours

Below you will find excerpts from courses related to this module component:

V Machine Learning and Optimization in Energy Systems

2581050, WS 25/26, 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 4.140 Module component: Management of IT-Projects [T-WIWI-113968]

Coordinators: Prof. Dr.-Ing. Sascha Alpers
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2511214	IT Project Management	2 SWS	Lecture / 🗣	Alpers
ST 2026	2511215	Exercise IT Project Management	1 SWS	Practice / 🗣	Rybinski
Exams					
WT 25/26	79AIFB_ITP_C3	IT Project Management (Registration extended until 16.02.2026)			Oberweis
ST 2026	791-AIFB-ITPM-HK	IT Project Management (Registration until 20.07.2026)			Oberweis

Legend: 📱 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written examination (written exam) lasting 60 minutes.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V IT Project Management

2511214, SS 2026, 2 SWS, Language: German, Open in study portal

Lecture (V)
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 2026, 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 4.141 Module component: Market Research [T-WIWI-107720]

Coordinators: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Business and Economics
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	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	3

Courses					
ST 2026	2571150	Market Research	2 SWS	Lecture / 🗣	Klarmann
ST 2026	2571151	Market Research Tutorial	1 SWS	Practice / 🗣	Klarmann
Exams					
WT 25/26	7900053	Market Research			Klarmann
ST 2026	7900015	Market Research			Klarmann

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
None

Additional Information
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 courses related to this module component:

V **Market Research** — **Lecture (V) On-Site**
2571150, SS 2026, 2 SWS, Language: English, Open in study portal

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 4.142 Module component: Marketing Analytics [T-WIWI-103139]

Coordinators: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101647 - Data Science: Evidence-based Marketing

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each winter term	6

Courses					
WT 25/26	2572170	Marketing Analytics	2 SWS	Lecture / 🗣	Klarmann
WT 25/26	2572171		1 SWS	Practice / 🗣	Jacob
Exams					
WT 25/26	7900082	Marketing Analytics			Klarmann

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Alternative (according to §4(2), 3 of the examination regulation) exam assessment (working on tasks in groups during the lecture).

Prerequisites
None

Recommendations
It is strongly recommended to complete the course "Market Research" prior to taking the "Marketing Analytics" course.

Additional Information
"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 courses related to this module component:

V Marketing Analytics

2572170, WS 25/26, 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 25/26, 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 4.143 Module component: Markov Decision Processes [T-MATH-105921]

Coordinators: Prof. Dr. Nicole Bäuerle
Organisation: KIT Department of Mathematics
Part of: M-MATH-102907 - Markov Decision Processes

Type	Credits	Grading	Version
Oral examination	5 CP	graded	1

Exams			
WT 25/26	7700068	Markov Decision Processes	Bäuerle

Prerequisites
none

Workload
150 hours

T 4.144 Module component: Master's Thesis [T-MATH-105878]

Coordinators: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: M-MATH-102917 - Master's Thesis

Type	Credits	Grading	Version
Final Thesis	30 CP	graded	2

Final Thesis
This module component represents a final thesis. The following periods have been supplied:

Submission deadline	6 months
Maximum extension period	3 months
Correction period	8 weeks

T 4.145 Module component: Matching Theory [T-WIWI-113264]

Coordinators: Prof. Dr. Clemens Puppe
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101500 - Microeconomic Theory

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	see Annotations	1

Courses					
WT 25/26	2500042	Matching Theory	3 SWS	Lecture / Practice / 🗣	Okulicz
Exams					
WT 25/26	7900347	Matching Theory			Puppe

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination will be offered for the last time in the summer semester 2026. Success is assessed in the form of a written examination lasting 90 minutes.

Additional Information
The course is no longer offered.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Matching Theory

2500042, WS 25/26, 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

Workload:

- Attendance time – Lecture (2 SWS × 15 weeks): 30 h
- Attendance time – Tutorial (1 SWS × 15 weeks): 15 h
- Self-study – Lecture: 45 h
- Self-study – Tutorial: 25 h
- Exam preparation: 20 h
- **Total workload: 135 h**

T 4.146 Module component: Mathematical Methods in Signal and Image Processing [T-MATH-105862]

Coordinators: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-102897 - Mathematical Methods in Signal and Image Processing

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Prerequisites
none

Workload
240 hours

T 4.147 Module component: Mathematical Methods of Imaging [T-MATH-106488]

Coordinators: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-103260 - Mathematical Methods of Imaging

Type	Credits	Grading	Term offered	Version
Oral examination	5 CP	graded	Irregular	1

Courses					
WT 25/26	0100052	Mathematische Methoden der Bildgebung	2 SWS	Lecture	Rieder
WT 25/26	0100061	Übungen zu 0102900 (mathematische Methoden der Bildgebung)	2 SWS	Practice	Rieder
ST 2026	0102900	Mathematische Methoden der Bildgebung	4 SWS	Lecture	Rieder
ST 2026	0102910	Übungen zu 0102900 (mathematische Methoden der Bildgebung)	2 SWS	Practice	Rieder
Exams					
WT 25/26	7700138	Mathematical Methods of Imaging			Rieder

Prerequisites
None

T 4.148 Module component: Mathematical Modelling and Simulation in Practise [T-MATH-105889]

Coordinators: PD Dr. Gudrun Thäter
Organisation: KIT Department of Mathematics
Part of: M-MATH-102929 - Mathematical Modelling and Simulation in Practise

Type	Credits	Grading	Version
Oral examination	4 CP	graded	2

Courses					
WT 25/26	0109400	Mathematical Modelling and Simulation	2 SWS	Lecture / 🗣	Thäter
WT 25/26	0109410	Tutorial for 0109400 (Mathematical modelling and simulation)	1 SWS	Practice	Thäter
Exams					
WT 25/26	7500115	Mathematical Modelling and Simulation in Practise			Thäter

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Below you will find excerpts from courses related to this module component:

V Mathematical Modelling and Simulation

0109400, WS 25/26, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Content
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

We deal with topics such as

- Game theory
- Oscillation
- Population Models
- Simulation of traffic
- Chaotic behavior
- Heat conduction
- Fluids and Flow

There are no special prerequisites.

During the lecture course there will be one lecture of a person from industry (around the Christmas break) and one excursion (at the end of the lecture course).

To earn the credits you have to attend the lecture and finish the work on one project during the term in a group of 2-3 persons. The topic of the project is up to the choice of each group.

The exam is an oral exam.

Literature:
Hans-Joachim Bungartz e.a.: Modeling and Simulation: An Application-Oriented Introduction,
Springer, 2013 (English)

T 4.149 Module component: Mathematical Statistics [T-MATH-105872]

Coordinators: 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	Version
Oral examination	8 CP	graded	2

Exams			
WT 25/26	7700086	Mathematical Statistics	Fasen-Hartmann
WT 25/26	7700094	Mathematical Statistics	Fasen-Hartmann

Prerequisites
none

Workload
240 hours

T 4.150 Module component: Mathematical Topics in Kinetic Theory [T-MATH-108403]

Coordinators: Prof. Dr. Dirk Hundertmark
Organisation: KIT Department of Mathematics
Part of: M-MATH-104059 - Mathematical Topics in Kinetic Theory

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Irregular	1

Prerequisites
none

T 4.151 Module component: Mathematics for High Dimensional Statistics [T-WIWI-111247]

Coordinators: Prof. Dr. Oliver Grothe
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-101637 - Analytics and Statistics
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading	Term offered	Version
Oral examination	4,5 CP	graded	Irregular	1

Assessment
The assessment of the course (lecture and exercise) consists of an oral exam (approx. 30 min.) taking place in the recess period.

Prerequisites
None

Recommendations
Basic knowledge of mathematics and statistics is assumed.
Knowledge in multivariate statistics is an advantage, but not necessary for the course.

T 4.152 Module component: MathSEE Modeling Week [T-MATH-113711]

Coordinators: Prof. Dr. Sebastian Krumscheid
PD Dr. Stefan Kühnlein

Organisation: KIT Department of Mathematics

Part of: M-MATH-106836 - MathSEE Modeling Week

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each winter term	1

Assessment
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 4.153 Module component: Maxwell's Equations [T-MATH-105856]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Exams			
WT 25/26	7700139	Maxwell's Equations	Hettlich

T 4.154 Module component: Media Management [T-WIWI-112711]

Coordinators: Prof. Dr. Ann-Kristin Kupfer
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-106258 - Digital Marketing

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2572192	Media Management	2 SWS	Lecture / 🗣	Kupfer
WT 25/26	2572193	Media Management Exercise	1 SWS	Practice / 🗣	Kupfer, Mitarbeiter, Schmitt
Exams					
WT 25/26	7900135	Media Management			Kupfer
ST 2026	7900004	Media Management			Kupfer

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
Students are highly encouraged to actively participate in class.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Media Management

2572192, WS 25/26, 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 4.155 Module component: Metric Geometry [T-MATH-111933]

Coordinators: Prof. Dr. Alexander Lytchak
Dr. Artem Nepechiy
Organisation: KIT Department of Mathematics
Part of: M-MATH-105931 - Metric Geometry

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Exams			
WT 25/26	7700131	Metric Geometry	Lytchak

Assessment
Oral examination of circa 20 minutes.

Prerequisites
None.

Recommendations
Basic knowledge of set-theoretical topology, elementary geometry and fundamental groups, as taught in the module "M-MATH-103152 - Elementary Geometry", is recommended.

Workload
240 hours

T 4.156 Module component: Minimal Surfaces [T-MATH-113417]

Coordinators: Dr. Peter Lewintan
Organisation: KIT Department of Mathematics
Part of: M-MATH-106666 - Minimal Surfaces

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	3 CP	graded	Irregular	1 semesters	1

Prerequisites
None

Workload
90 hours

T 4.157 Module component: Mixed Integer Programming I [T-WIWI-102719]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	1

Courses					
WT 25/26	2550138	Mixed-integer Programming I	2 SWS	Lecture / 🗣	Stein
WT 25/26	2550139	Exercises Mixed Integer Programming I	2 SWS	Practice / 🗣	Stein, Beck, Neussel
ST 2026	2550140	Mixed-integer Programming II	2 SWS	Lecture / 🗣	Stein
Exams					
WT 25/26	7900180_WS2526_HK	Mixed Integer Programming I			Stein
ST 2026	7900014_SS2026_NK	Mixed Integer Programming I			Stein

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Additional Information
The lecture is offered irregularly. The curriculum of the next three years is available online (kop.ior.kit.edu).

Below you will find excerpts from courses related to this module component:

V Mixed-integer Programming I

2550138, WS 25/26, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
Many optimization problems from economics, engineering and natural sciences are modeled with continuous as well as with discrete variables. Examples are the energy minimal design of a chemical process in which several reactors may be switched on or off, and portfolio optimization with limitations on the number of securities. For the algorithmic identification of optimal points of such problems an interaction of ideas from discrete as well as continuous optimization is necessary.

The lecture focusses on mixed-integer *linear* optimization problems and is structured as follows:

- Introduction, solvability, and basic concepts
- LP relaxation and error bounds for roundings
- Branch-and-bound method
- Gomory's cutting plane method
- Benders decomposition

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 mixed-integer *nonlinear* optimization problems forms the contents of the lecture "Mixed-integer Programming II".

Learning objectives:

The student

- knows and understands the fundamentals of linear mixed integer programming,
- is able to choose, design and apply modern techniques of linear mixed integer programming in practice.

Literature

- C.A. Floudas, Nonlinear and Mixed-Integer Optimization: Fundamentals and Applications, Oxford University Press, 1995
- J. Kallrath: Gemischt-ganzzahlige Optimierung, Vieweg, 2002
- D. Li, X. Sun: Nonlinear Integer Programming, Springer, 2006
- G.L. Nemhauser, L.A. Wolsey, Integer and Combinatorial Optimization, Wiley, 1988
- M. Tawarmalani, N.V. Sahinidis, Convexification and Global Optimization in Continuous and Mixed-Integer Nonlinear Programming, Kluwer, 2002.

V

Mixed-integer Programming II

2550140, SS 2026, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content
Many optimization problems from economics, engineering and natural sciences are modeled with continuous as well as with discrete variables. Examples are the energy minimal design of a chemical process in which several reactors may be switched on or off, portfolio optimization with limitations on the number of securities, the choice of locations to serve customers at minimum cost, and the optimal design of vote allocations in election procedures. For the algorithmic identification of optimal points of such problems an interaction of ideas from discrete as well as continuous optimization is necessary.

The lecture focusses on mixed-integer *nonlinear* optimization problems and is structured as follows:

- Continuous relaxation and error bounds for roundings
- Branch-and-Bound for convex and nonconvex problems
- Generalized Benders decomposition
- Outer approximation methods
- Lagrange relaxation
- Dantzig-Wolfe decomposition
- Heuristics

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 mixed-integer *linear* optimization problems forms the contents of the lecture "Mixed-integer Programming I".

Learning objectives:

The student

- knows and understands the fundamentals of nonlinear mixed integer programming,
- is able to choose, design and apply modern techniques of nonlinear mixed integer programming in practice.

Literature

- C.A. Floudas, Nonlinear and Mixed-Integer Optimization: Fundamentals and Applications, Oxford University Press, 1995
- J. Kallrath: Gemischt-ganzzahlige Optimierung, Vieweg, 2002
- D. Li, X. Sun: Nonlinear Integer Programming, Springer, 2006
- G.L. Nemhauser, L.A. Wolsey, Integer and Combinatorial Optimization, Wiley, 1988
- M. Tawarmalani, N.V. Sahinidis, Convexification and Global Optimization in Continuous and Mixed-Integer Nonlinear Programming, Kluwer, 2002.

T 4.158 Module component: Mixed Integer Programming II [T-WIWI-102720]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	1

Courses					
ST 2026	2550140	Mixed-integer Programming II	2 SWS	Lecture / 🗣	Stein
ST 2026	2550141	Exercise to Mixed-integer Programming II	1 SWS	Practice / 🗣	Stein, Schwarze
Exams					
ST 2026	7900009_SS2026_HK	Mixed Integer Programming II			Stein

Legend: 💻 Online, 🎭 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Additional Information
The lecture is offered irregularly. The curriculum of the next three years is available online (kop.ior.kit.edu).

Below you will find excerpts from courses related to this module component:

V Mixed-integer Programming II

2550140, SS 2026, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Content

Many optimization problems from economics, engineering and natural sciences are modeled with continuous as well as with discrete variables. Examples are the energy minimal design of a chemical process in which several reactors may be switched on or off, portfolio optimization with limitations on the number of securities, the choice of locations to serve customers at minimum cost, and the optimal design of vote allocations in election procedures. For the algorithmic identification of optimal points of such problems an interaction of ideas from discrete as well as continuous optimization is necessary.

The lecture focusses on mixed-integer *nonlinear* optimization problems and is structured as follows:

- Continuous relaxation and error bounds for roundings
- Branch-and-Bound for convex and nonconvex problems
- Generalized Benders decomposition
- Outer approximation methods
- Lagrange relaxation
- Dantzig-Wolfe decomposition
- Heuristics

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 mixed-integer *linear* optimization problems forms the contents of the lecture "Mixed-integer Programming I".

Learning objectives:

The student

- knows and understands the fundamentals of nonlinear mixed integer programming,
- is able to choose, design and apply modern techniques of nonlinear mixed integer programming in practice.

Literature

- C.A. Floudas, Nonlinear and Mixed-Integer Optimization: Fundamentals and Applications, Oxford University Press, 1995
- J. Kallrath: Gemischt-ganzzahlige Optimierung, Vieweg, 2002
- D. Li, X. Sun: Nonlinear Integer Programming, Springer, 2006
- G.L. Nemhauser, L.A. Wolsey, Integer and Combinatorial Optimization, Wiley, 1988
- M. Tawarmalani, N.V. Sahinidis, Convexification and Global Optimization in Continuous and Mixed-Integer Nonlinear Programming, Kluwer, 2002.

T 4.159 Module component: Modeling and OR-Software: Advanced Topics [T-WIWI-106200]

Coordinators: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102832 - Operations Research in Supply Chain Management

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	4

Courses					
WT 25/26	2550490	Modellieren und OR-Software: Fortgeschrittene Themen	3 SWS	Practical course / 🔀	Pomes, Linner, Nickel
Exams					
WT 25/26	7900071	Modeling and OR-Software: Advanced Topics			Nickel
ST 2026	7900188	Modeling and OR-Software: Advanced Topics			Nickel

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
Basic knowledge as conveyed in the module *Introduction to Operations Research* is assumed.

Successful completion of the course *Modeling and OR-Software: Introduction*.

Additional Information
Due to the limited number of participants, please register in advance. Further information can be found on the website of the course. Registration takes place via the Wiwi-Portal.The course is offered every winter semester. The planned lectures and courses for the next three years are announced online at https://dol.ior.kit.edu/Lehrveranstaltungen.php.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Modellieren und OR-Software: Fortgeschrittene Themen

2550490, WS 25/26, 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 programming language is Python.

Please note that the second exam in the summer semester 26 will only be offered to students in their second try.

T 4.160 Module component: Modeling and OR-Software: Introduction [T-WIWI-106199]

Coordinators: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101413 - Applications of Operations Research

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	4

Courses					
ST 2026	2550490	Modellieren und OR-Software: Einführung	3 SWS	Practical course / 🧩	Nickel, Linner, Pomes
Exams					
WT 25/26	7900081	Modeling and OR-Software: Introduction			Nickel
ST 2026	7900153	Modeling and OR-Software: Introduction			Nickel

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is a written examination (60 min.). The successful completion of the exercises is required for admission to the written exam.
The examination is held in every semester

Recommendations
Firm knowledge of the contents from the lecture *Introduction to Operations Research I* [2550040] of the module *Operations Research*.

Additional Information
Due to capacity restrictions, registration before course start is required. For further information, see the webpage of the course. Registration is possible in the Wiwi portal. The lecture is offered in every term. The planned lectures and courses for the next three years are announced online at https://dol.ior.kit.edu/Lehrveranstaltungen.php.
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Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Modellieren und OR-Software: Einführung

2550490, SS 2026, 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, ...) CPLEX in combination with Python 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.

Die Nachklausur zu dieser Veranstaltung wird nur für Nachschreibende angeboten.

T 4.161 Module component: Modeling and Simulation [T-WIWI-112685]

Coordinators: Prof. Dr.-Ing. Sanja Lazarova-Molnar
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2511100	Modeling and Simulation	2 SWS	Lecture	Lazarova-Molnar
ST 2026	2511101	Exercises Modeling and Simulation	1 SWS	Practice	Lazarova-Molnar, Mostafa
Exams					
WT 25/26	79AIFB_MaS_A6	Modeling and Simulation (Registration extended until 16.02.2026)			Lazarova-Molnar
ST 2026	791-AIFB-MaS-HK	Modeling and Simulation (Registration until 20.07.2026)			Lazarova-Molnar

Assessment
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

Recommendations
Some experience in programming and knowledge of basic mathematics and statistics.

Additional Information
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 courses related to this module component:

V **Modeling and Simulation** **Lecture (V)**
2511100, SS 2026, 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

T 4.162 Module component: Modeling the Dynamics of Financial Markets [T-WIWI-113414]

Coordinators: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-106660 - Modeling the Dynamics of Financial Markets

Type	Credits	Grading	Term offered	Version
Written examination	9 CP	graded	Each summer term	1

Assessment
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".

Recommendations
Recommendation: Knowledge in the fields of Advanced Statistics, Deep Learning, Financial Economics, Differential Equations, Optimization.

Workload
270 hours

T 4.163 Module component: Modelling and Simulation of Lithium-Ion Batteries [T-MATH-113382]

Coordinators: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: M-MATH-106640 - Modelling and Simulation of Lithium-Ion Batteries

Type	Credits	Grading	Version
Oral examination	4 CP	graded	1

Assessment
oral exam (ca. 20 min)

Prerequisites
None

Workload
120 hours

T 4.164 Module component: Modern Methods in Combinatorics [T-MATH-113911]

Coordinators: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-106957 - Modern Methods in Combinatorics

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Assessment
Oral examination (approx. 30 min)

Prerequisites
None

Workload
180 hours

T 4.165 Module component: Monotonicity Methods in Analysis [T-MATH-105877]

Coordinators: PD Dr. Gerd Herzog
Organisation: KIT Department of Mathematics
Part of: M-MATH-102887 - Monotonicity Methods in Analysis

Type	Credits	Grading	Version
Oral examination	3 CP	graded	1

T 4.166 Module component: Multicriteria Optimization [T-WIWI-111587]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101473 - Mathematical Programming
M-WIWI-102832 - Operations Research in Supply Chain Management
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	see Annotations	1

Assessment
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

Recommendations
It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Additional Information
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

T 4.167 Module component: Multivariate Statistical Methods [T-WIWI-103124]

Coordinators: Prof. Dr. Oliver Grothe
Organisation: KIT Department of Business and Economics
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	Term offered	Version
Written examination	4,5 CP	graded	Irregular	1

Courses					
ST 2026	2550554	Analysis of Multivariate Data	2 SWS	Lecture / 🗣	Grothe
ST 2026	2550555	Übung zu Multivariate Verfahren	2 SWS	Practice / 🗣	Vetter
Exams					
ST 2026	7900351	Multivariate Statistical Methods			Grothe

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
Due to the strong quantitative focus and the treatment of advanced statistical methods, in-depth prior knowledge of statistics (comparable to the content of the 'Advanced Statistics' course) is very advantageous for successful completion of the course. Students without such prior knowledge are advised to prepare intensively before the start of the course, as a significantly higher level of familiarization is to be expected.

In addition, prior attendance of the Bachelor course 'Analysis of multivariate data' is recommended. Alternatively, the lecture notes for this course can be made available to students to help them prepare independently.

Additional Information
The course (lecture and exercise) is offered irregularly. Detailed information can be found on the chair's website.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Analysis of Multivariate Data

2550554, SS 2026, 2 SWS, Language: German, Open in study portal

Lecture (V)
On-Site

Literature
Skript zur Vorlesung

T 4.168 Module component: Nature-Inspired Optimization Methods [T-WIWI-102679]

Coordinators: Prof. Dr. Pradyumn Kumar Shukla
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	2

Courses					
ST 2026	2511106	Nature-Inspired Optimization Methods	2 SWS	Lecture /	Shukla
ST 2026	2511107	Übungen zu Nature-Inspired Optimization Methods	1 SWS	Practice /	Shukla
Exams					
WT 25/26	79AIFB_NOM_B5	Nature-Inspired Optimisation Methods (Registration extended until 16.02.2026)			Shukla
ST 2026	791-AIFB-NOM-HK	Nature-Inspired Optimization Methods (Registration until 20.07.2026)			Shukla

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Success is assessed in the form of a written (60 min) or oral examination.

The examination for this course is offered both in the semester in which the course takes place and in the following semester. In the following semester (winter term), participation in the exam is **exclusively reserved for students who did not pass the first attempt.** This regulation applies from summer semester 2025.

Prerequisites
None

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Nature-Inspired Optimization Methods

2511106, SS 2026, 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 4.169 Module component: Non- and Semiparametrics [T-WIWI-103126]

Coordinators: Prof. Dr. Melanie Schienle
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	1

Courses					
WT 25/26	2521300	Non- and Semiparametrics	2 SWS	Lecture	Schienle
WT 25/26	2521301		2 SWS	Practice	Rüter
Exams					
WT 25/26	7900009	Non- and Semiparametrics			Schienle

Assessment
The assessment consists of a written exam (90 minutes) (following §4(2), 1 of the examination regulation).

Prerequisites
None

Recommendations
Knowledge of the contents covered by the course *"Applied Econometrics"* [2520020]

Additional Information
The course takes place every second winter semester: 2018/19 then 2020/21

Below you will find excerpts from courses related to this module component:

V Non- and Semiparametrics

2521300, WS 25/26, 2 SWS, Language: German, Open in study portal

Lecture (V)

Content
Learning objectives:

The student

- has profound knowledge of non- and semiparametric estimation methods
- is capable of implementing these methods using statistical software and using them to assess empirical problems

Content:

Kernel density estimation, local constant and local linear regression, bandwidth choice, series and sieve estimators, additive models, semiparametric models

Requirements:

It is recommended to attend the course *Applied Econometrics* 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
Li, Racine: Nonparametric Econometrics: Theory and Practice. Princeton University Press, 2007.

T 4.170 Module component: Nonlinear Analysis [T-MATH-107065]

Coordinators: Prof. Dr. Tobias Lamm
Organisation: KIT Department of Mathematics
Part of: M-MATH-103539 - Nonlinear Analysis

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Prerequisites
none

T 4.171 Module component: Nonlinear Maxwell Equations [T-MATH-110283]

Coordinators: Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: M-MATH-105066 - Nonlinear Maxwell Equations

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Prerequisites
none

T 4.172 Module component: Nonlinear Optimization I [T-WIWI-102724]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	4

Courses					
WT 25/26	2550111	Nonlinear Optimization I	2 SWS	Lecture / 🗣	Stein
WT 25/26	2550112	Exercises Nonlinear Optimization I	1 SWS	Practice / 🗣	Stein, Schwarze, Neussel
Exams					
WT 25/26	7900001_WS2526_HK	Nonlinear Optimization I			Stein
ST 2026	7900202_SS2026_NK	Nonlinear Optimization I			Stein

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Additional Information
Part I and II of the lecture are held consecutively in the *same* semester.

Below you will find excerpts from courses related to this module component:

V Nonlinear Optimization I

2550111, WS 25/26, 2 SWS, Language: English, 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, Basic Concepts of Nonlinear Optimization, Springer, Berlin, 2024

Additional Literature:

- 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 4.173 Module component: Nonlinear Optimization I and II [T-WIWI-103637]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading	Term offered	Version
Written examination	9 CP	graded	Each winter term	6

Courses					
WT 25/26	2550111	Nonlinear Optimization I	2 SWS	Lecture / 🗣	Stein
WT 25/26	2550112	Exercises Nonlinear Optimization I	1 SWS	Practice / 🗣	Stein, Schwarze, Neussel
WT 25/26	2550113	Nonlinear Optimization II	2 SWS	Lecture / 🗣	Stein
Exams					
WT 25/26	7900003_WS2526_HK	Nonlinear Optimization I and II			Stein
ST 2026	7900204_SS2026_NK	Nonlinear Optimization I and II			Stein

Legend: 🖥 Online, 🖥🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment consits of a written exam in English (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.

Additional Information
Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from courses related to this module component:

V Nonlinear Optimization I

2550111, WS 25/26, 2 SWS, Language: English, 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, Basic Concepts of Nonlinear Optimization, Springer, Berlin, 2024

Additional Literature:

- 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 25/26, 2 SWS, Language: English, 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, Basic Concepts of Nonlinear Optimization, Springer, Berlin, 2024

Additional Literature:

- 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 4.174 Module component: Nonlinear Optimization II [T-WIWI-102725]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101414 - Methodical Foundations of OR
M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	3

Courses					
WT 25/26	2550112	Exercises Nonlinear Optimization I	1 SWS	Practice / 🗣	Stein, Schwarze, Neussel
WT 25/26	2550113	Nonlinear Optimization II	2 SWS	Lecture / 🗣	Stein
WT 25/26	2550114	Exercise to Nonlinear Optimization II	1 SWS	Practice / 🗣	Stein, Schwarze, Neussel
Exams					
WT 25/26	7900002_WS2526_HK	Nonlinear Optimization II			Stein
ST 2026	7900203_SS2026_NK	Nonlinear Optimization II			Stein

Legend: 🖥 Online, ⚙ Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment consits of a written exam (60 minutes) in English 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.

Additional Information
Part I and II of the lecture are held consecutively in the same semester.

Below you will find excerpts from courses related to this module component:

V Nonlinear Optimization II
2550113, WS 25/26, 2 SWS, Language: English, 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, Basic Concepts of Nonlinear Optimization, Springer, Berlin, 2024

Additional Literature:

- 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 4.175 Module component: Nonlinear Wave Equations [T-MATH-110806]

Coordinators: Prof. Dr. Wolfgang Reichel
Prof. Dr. Roland Schnaubelt

Organisation: KIT Department of Mathematics

Part of: M-MATH-105326 - Nonlinear Wave Equations

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Irregular	1

Prerequisites
none

T 4.176 Module component: Nonparametric Statistics [T-MATH-105873]

Coordinators: 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	Version
Oral examination	4 CP	graded	2

Assessment
oral exam of ca. 20 minutes

Workload
120 hours

T 4.177 Module component: Numerical Analysis of Neural Networks [T-MATH-113470]

Coordinators: TT-Prof. Dr. Roland Maier
Organisation: KIT Department of Mathematics
Part of: M-MATH-106695 - Numerical Analysis of Neural Networks

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

Exams			
WT 25/26	7700148	Numerical Analysis of Neural Networks (examination on February 19 and 20)	Maier
WT 25/26	7700152	Numerical Analysis of Neural Networks (examination on March 30 and 31)	Maier

Assessment
oral exam of ca. 30 minutes

Prerequisites
none

Workload
180 hours

T 4.178 Module component: Numerical Analysis on Quantum Computers [T-MATH-114990]

Coordinators: TT-Prof. Dr. Roland Maier
Organisation: KIT Department of Mathematics
Part of: M-MATH-107646 - Numerical Analysis on Quantum Computers

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Assessment
Oral examination lasting approx. 30 minutes.

Prerequisites
None.

Workload
180 hours

T 4.179 Module component: Numerical Complex Analysis [T-MATH-112280]

Coordinators: Prof. Dr. Marlis Hochbruck
Organisation: KIT Department of Mathematics
Part of: M-MATH-106063 - Numerical Complex Analysis

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	6 CP	graded	Irregular	1 semesters	1

Assessment
oral exam of ca. 20 minutes

Prerequisites
none

Recommendations
Some basic knowledge of Complex Analysis is strongly recommended.

Workload
180 hours

T 4.180 Module component: Numerical Linear Algebra in Image Processing [T-MATH-108402]

Coordinators: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: M-MATH-104058 - Numerical Linear Algebra in Image Processing

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Exams			
WT 25/26	7700127	Numerical Linear Algebra in Image Processing	Grimm

Prerequisites
none

T 4.181 Module component: Numerical Methods for Differential Equations [T-MATH-105836]

Coordinators: 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	Term offered	Version
Oral examination	8 CP	graded	Each winter term	4

Courses					
WT 25/26	0110700	Numerische Methoden für Differentialgleichungen	4 SWS	Lecture / 🗣	Jahnke
WT 25/26	0110800	Übungen zu 0110700 (numerische Methoden für Differentialgleichungen)	2 SWS	Practice / 🗣	Jahnke
Exams					
WT 25/26	7700142	Numerical Methods for Differential Equations			Jahnke
ST 2026	7700092	Numerical Methods for Differential Equations			Jahnke

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The module will be completed by an oral examination with a duration of approximately 30 minutes. If this would require an unreasonable amount of time, the oral examination may be replaced by a written exam with a duration of approximately 120 minutes. The decision will be announced at least six weeks before the examination.

Prerequisites
None.

Workload
240 hours

T 4.182 Module component: Numerical Methods for Hyperbolic Equations [T-MATH-105900]

Coordinators: Prof. Dr. Willy Dörfler
Organisation: KIT Department of Mathematics
Part of: M-MATH-102915 - Numerical Methods for Hyperbolic Equations

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

Prerequisites
none

Workload
180 hours

T 4.183 Module component: Numerical Methods for Integral Equations [T-MATH-105901]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Courses					
ST 2026	0160500	Integralgleichungen	4 SWS	Lecture	Arens

T 4.184 Module component: Numerical Methods for Maxwell's Equations [T-MATH-105920]

Coordinators: 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	Version
Oral examination	6 CP	graded	1

T 4.185 Module component: Numerical Methods for Oscillatory Differential Equations [T-MATH-113437]

Coordinators: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: M-MATH-106682 - Numerical Methods for Oscillatory Differential Equations

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Assessment
oral exam of ca. 30 minutes

Prerequisites
none

Workload
240 hours

T 4.186 Module component: Numerical Methods for Time-Dependent Partial Differential Equations [T-MATH-105899]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Assessment
Success is assessed in form of an oral examination lasting approx. 25 minutes.

Prerequisites
None.

Workload
240 hours

T 4.187 Module component: Numerical Methods in Computational Electrodynamics [T-MATH-105860]

Coordinators: 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	Version
Oral examination	6 CP	graded	1

Prerequisites
none

Workload
180 hours

T 4.188 Module component: Numerical Methods in Fluid Mechanics [T-MATH-105902]

Coordinators: 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	Version
Oral examination	4 CP	graded	1

Courses					
ST 2026	0164200	Numerische Methoden in der Strömungsmechanik	2 SWS	Lecture	Thäter
ST 2026	0164210	Übungen zu Numerische Methoden in der Strömungsmechanik (0164200)	1 SWS	Practice	Thäter

T 4.189 Module component: Numerical Methods in Mathematical Finance [T-MATH-105865]

Coordinators: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: M-MATH-102901 - Numerical Methods in Mathematical Finance

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Assessment
oral exam of ca. 30 minutes

Prerequisites
none

Workload
240 hours

T 4.190 Module component: Numerical Optimisation Methods [T-MATH-105858]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Courses					
WT 25/26	0124000	Numerische Optimierungsmethoden	4 SWS	Lecture	Wieners
WT 25/26	0124010	Übungen zu 0124000 (numerische Optimierungsmethoden)	2 SWS	Practice	Wieners, Schneiderhan
Exams					
WT 25/26	7700133	Numerical Optimisation Methods			Wieners

Prerequisites
none

T 4.191 Module component: Numerical Simulation in Molecular Dynamics [T-MATH-110807]

Coordinators: PD Dr. Volker Grimm
Organisation: KIT Department of Mathematics
Part of: M-MATH-105327 - Numerical Simulation in Molecular Dynamics

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Prerequisites
none

T 4.192 Module component: Online Concepts for Karlsruhe City Retailers [T-WIWI-111848]

Coordinators: Prof. Dr. Ann-Kristin Kupfer
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-105312 - Marketing and Sales Management
M-WIWI-106258 - Digital Marketing

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each summer term	2

Courses					
ST 2026	2571184	Online concepts for Karlsruhe city retailers	2 SWS	Others / 🗣	Kupfer
Exams					
ST 2026	7900221	Online Concepts for Karlsruhe City Retailers			Kupfer

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Additional Information
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 courses related to this module component:

V **Online concepts for Karlsruhe city retailers** — **Others (sonst.) On-Site**
2571184, SS 2026, 2 SWS, Language: German, Open in study portal

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

Organizational issues
Kick off Montag 11.5.26 Gebäude 01.87 Seminarraum 025

T 4.193 Module component: Operations Research in Health Care Management [T-WIWI-102884]

Coordinators: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102805 - Service Operations

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each term	4

Courses					
WT 25/26	2550495	Operations Research in Health Care Management	2 SWS	Lecture / 🗣	Graß
WT 25/26	2550496	Übungen zu OR im Health Care Management	1 SWS	Practice	Graß
ST 2026	2550495	Operations Research in Health Care Management	2 SWS	Lecture / 🗣	Graß
ST 2026	2550496	Übungen zu OR im Health Care Management	1 SWS	Practice / 💻	Graß
Exams					
WT 25/26	7900010	Operations Research in Health Care Management			Graß
ST 2026	7900229	Operations Research in Health Care Management			Graß

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
Basic knowledge as co nveyed in the module "Introduction to Operations Research" is assumed.

Additional Information
Lectures and examinations are held in English.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Operations Research in Health Care Management

2550495, WS 25/26, 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 2026, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

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 4.194 Module component: Operations Research in Supply Chain Management [T-WIWI-102715]

Coordinators: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Business and Economics
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	Term offered	Version
Written examination	4,5 CP	graded	Irregular	2

Exams			
WT 25/26	7900028	Operations Research in Supply Chain Management	Nickel

Assessment
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

Recommendations
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.

Additional Information
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 4.195 Module component: 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	Version
Oral examination	4 CP	graded	1

Prerequisites
none

Workload
120 hours

T 4.196 Module component: Optimization in Banach Spaces [T-MATH-105893]

Coordinators: 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	Version
Oral examination	5 CP	graded	2

Assessment
oral examination of approximately 30 minutes

Prerequisites
none

Recommendations
Some basic knowledge of finite dimensional optimization theory and functional analysis is desirable.

Workload
150 hours

T 4.197 Module component: Optimization under Uncertainty [T-WIWI-106545]

Coordinators: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101413 - Applications of Operations Research
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	3

Courses					
WT 25/26	2550464	Optimization Under Uncertainty	2 SWS	Lecture /	Rebennack, Kandora
WT 25/26	2550465	Übungen zu Optimierungsansätze unter Unsicherheit	1 SWS	Practice /	Rebennack
WT 25/26	2550466		2 SWS	Others	Rebennack
Exams					
WT 25/26	7900240	Optimization under Uncertainty			Rebennack
ST 2026	7900309	Optimization under Uncertainty			Rebennack

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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 4.198 Module component: Panel Data [T-WIWI-103127]

Coordinators: apl. Prof. Dr. Wolf-Dieter Heller
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each summer term	2

Courses					
ST 2026	2520320	Panel Data	2 SWS	Lecture	Heller
ST 2026	2520321	Übungen zu Paneldaten	2 SWS	Practice	Heller
Exams					
ST 2026	7900115	Panel Data			Heller

Assessment
The assessment is carried out as an examination of another type in the form of a one-hour exam that includes both a written and an oral part. The exam may be taken as an individual exam or in pairs. The individual components are integrated into a single overall grade that reflects the overall impression of the combined performance

Prerequisites
None

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Panel Data

2520320, SS 2026, 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 4.199 Module component: Parallel Computing [T-MATH-102271]

Coordinators: PD Dr. Mathias Krause
Prof. Dr. Christian Wieners

Organisation: KIT Department of Mathematics

Part of: M-MATH-101338 - Parallel Computing

Type	Credits	Grading	Version
Oral examination	5 CP	graded	1

Prerequisites
none

Workload
150 hours

T 4.200 Module component: Parametric Optimization [T-WIWI-102855]

Coordinators: Prof. Dr. Oliver Stein
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101473 - Mathematical Programming

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	1

Assessment
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

Recommendations
It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

Additional Information
The lecture is offered irregularly. The curriculum of the next three years is available online (www.ior.kit.edu).

T 4.201 Module component: Percolation [T-MATH-105869]

Coordinators: Prof. Dr. Daniel Hug
PD Dr. Steffen Winter
Organisation: KIT Department of Mathematics
Part of: M-MATH-102905 - Percolation

Type	Credits	Grading	Version
Oral examination	5 CP	graded	2

Exams			
WT 25/26	770117000	Percolation	Last

Prerequisites
none

Workload
150 hours

T 4.202 Module component: Poisson Processes [T-MATH-105922]

Coordinators: Prof. Dr. Vicky Fasen-Hartmann
Prof. Dr. Daniel Hug
Dr. Franz Nestmann
PD Dr. Steffen Winter

Organisation: KIT Department of Mathematics

Part of: M-MATH-102922 - Poisson Processes

Type	Credits	Grading	Version
Oral examination	5 CP	graded	1

Prerequisites
none

Workload
150 hours

T 4.203 Module component: Portfolio and Asset Liability Management [T-WIWI-103128]

Coordinators: Dr. Mher Safarian
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2520357	Portfolio and Asset Liability Management	2 SWS	Lecture	Safarian
ST 2026	2520358	Übungen zu Portfolio and Asset Liability Management	2 SWS	Practice	Safarian
Exams					
ST 2026	7900366	Portfolio and Asset Liability Management			Safarian

Assessment
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 courses related to this module component:

V Portfolio and Asset Liability Management

2520357, SS 2026, 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 4.204 Module component: Potential Theory [T-MATH-105850]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

T 4.205 Module component: Practical Seminar: Health Care Management (with Case Studies) [T-WIWI-102716]

Coordinators: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102805 - Service Operations

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each term	3

Courses					
WT 25/26	2500008	Practical seminar: Health Care Management	3 SWS	Others / 🗣	Nickel, Mitarbeiter
Exams					
WT 25/26	7900105	Practical Seminar: Health Care Management (with Case Studies)			Nickel

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment of this module is an examination of another type and consists of the following components:

- a case study to be worked on,
- a seminar paper and
- a final oral examination.

The overall grade results from the weighted evaluation of the case study, the seminar paper and the presentation. The exact weighting of these individual components for the grade will be announced at the beginning of the course.

Prerequisites
None.

Recommendations
Basic knowledge as conveyed in the module *Introduction toOperations Research* is assumed.

Additional Information
The lecture is offered every term.

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

Workload
135 hours

T 4.206 Module component: Practical Seminar: Human-Centered Systems [T-WIWI-113459]

Coordinators: Prof. Dr. Alexander Mädche
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-104068 - Information Systems in Organizations

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each term	1

Courses					
WT 25/26	2540554	Practical Seminar: Human-Centered Systems	3 SWS	Lecture /	Mädche
ST 2026	2500073	Practical Seminar: AI-based Mental Healthcare	3 SWS	Lecture /	Kuhlmeier, Mädche
ST 2026	2540554	Practical Seminar: Human-Centered Systems	3 SWS	Lecture /	Mädche
Exams					
WT 25/26	7900341	Practical Seminar: Human-Centered Systems			Mädche
ST 2026	7900262	Practical Seminar: Human-Centered Systems			Mädche

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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 courses related to this module component:

V **Practical Seminar: Human-Centered Systems** — **Lecture (V)** **Blended (On-Site/Online)**
2540554, WS 25/26, 3 SWS, Language: English, Open in study portal

V **Practical Seminar: AI-based Mental Healthcare** — **Lecture (V)** **Blended (On-Site/Online)**
2500073, SS 2026, 3 SWS, Language: English, Open in study portal

Content
Mental health disorders affect a significant share of the global population. Meeting the resulting demand for care is a challenge on two fronts: patients face long waiting times and limited access to support, while mental health practitioners work under significant time pressure with processes that are often still manual and fragmented. Two developments in AI offer complementary responses: AI-based process digitalization can make clinical and therapeutic workflows more efficient for practitioners, while conversational AI agents can extend therapeutic support directly to those who need it. This seminar engages students with both developments: working on real, ongoing projects at the h-lab and its clinical partners, students design, build, and evaluate prototypes of AI-based applications for mental health and acquire the domain knowledge needed to do so responsibly.

Three project briefs are available, each rooted in an active h-lab research project. Students may also propose their own project in the mental health and AI space.

1. **AI-assisted ADHD assessment system** in collaboration with LWL-Klinikum Marsberg, centered on the analysis of primary school reports as a source of retrospective diagnostic evidence. Example tasks include building an OCR and LLM pipeline for extracting and analyzing free-text reports, or evaluating the diagnostic utility of LLM-generated assessments against clinician judgments.
2. **AI-enhanced CBT group therapy platform** in collaboration with Rethink Wellbeing. Example tasks include building a faciliator feedback system that monitors group dynamics and recommends facilitator actions, automating participant or facilitator selection workflows, or evaluating the accuracy and clinical acceptability of AI-generated recommendations.
3. **AI-based Conversational Mental Health Agents**, in collaboration with the Chair of Clinical Psychology and Psychotherapy at the University of Greifswald. The h-lab and its partners developed an LLM-based chatbot that delivers a single-session behavioral activation session for young people with depressive symptoms. Example tasks include improving the behavioral activation module, implementing additional therapeutic modules (cognitive restructuring, sleep hygiene, emotion regulation, social skills) as LLM-based multi-agent systems, or evaluating agent outputs for therapeutic fidelity and safety.

The seminar is structured around **three phases**:

1. I**ntroductory session:** Introduction to designing and evaluating AI-based mental health and the project briefs.
2. **Working phase:** Students design, develop, and evaluate their prototypes (individually or in groups), with ad hoc support from h-lab assistants.
3. **Final presentation**: Groups present their projects, including a demonstration of their working prototype and a discussion of their evaluation approach and preliminary findings. Participants provide feedback to each other's projects. Technical documentation and a brief evaluation report are due at the end of the semester.

Learning Objectives: Upon completion, students will be able to:

- Understand the mental health domain sufficiently to make informed design decisions
- Build functional AI-based application prototypes addressing a concrete need in an active mental health research or practice context
- Design and apply appropriate evaluation strategies for AI-based mental health applications, assessing feasibility, effectiveness, and safety of their prototypes

V

Practical Seminar: Human-Centered Systems

2540554, SS 2026, 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 4.207 Module component: Predictive Mechanism and Market Design [T-WIWI-102862]

Coordinators: Prof. Dr. Johannes Philipp Reiß
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101505 - Experimental Economics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	1

Courses					
ST 2026	2500014	Predictive Mechanism and Market Design	2 SWS	Lecture / 🗣	Reiß
ST 2026	2500037	Übung zu Predictive Mechanism and Market Design	1 SWS	Practice / 🖥	Reiß, Peters

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment consists of a written exam (60 minutes) (following §4(2), 1 of the examination regulation).

Prerequisites
None

Additional Information
The retake exam is given in the summer term subsequent to the fall term where the course (lecture and final exam) is given.

T 4.208 Module component: Predictive Modeling [T-WIWI-110868]

Coordinators: Prof. Dr. Fabian Krüger
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	2

Courses					
ST 2026	2521311	Predictive Modeling	2 SWS	Lecture / 🗣	Krüger, Siefert
ST 2026	2521312	Predictive Modeling (Tutorial)	2 SWS	Practice / 🗣	Siefert, Krüger

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Below you will find excerpts from courses related to this module component:

V Predictive Modeling
2521311, SS 2026, 2 SWS, Language: English, Open in study portal
Lecture (V)
On-Site

Content
Contents

This course presents methods for making and evaluating statistical predictions based on data. We consider various types of predictions (mean, probability, quantile, and full distribution), all of which are practically relevant. In each case, we discuss selected modeling approaches and their implementation using R software. We consider various economic case studies. Furthermore, we present methods for absolute evaluation (assessing whether a given model is compatible with the data) and relative evaluation (comparing the predictive performance of alternative models).

Learning objectives
Students have a good conceptual understanding of statistical prediction methods. They are able to implement these methods using statistical software, and can assess which method is suitable in a given situation.

Prerequisites

Students should know econometrics on the level of the course `Applied Econometrics' [2520020]

Literature

- Elliott, G., und A. Timmermann (Hrsg.): "Handbook of Economic Forecasting", vol. 2A und 2B, 2013.
- Gneiting, T., und M. Katzfuss: "Probabilistic Forecasting", Annual Review of Statistics and Its Application 1, 125-151, 2014.
- Hastie, T., Tibshirani, R., and J. Friedman: "The Elements of Statistical Learning", 2. Ausgabe, Springer, 2009.
- Weitere Literatur wird in der Vorlesung bekanntgegeben.

V Predictive Modeling (Tutorial)
2521312, SS 2026, 2 SWS, Language: English, Open in study portal
Practice (Ü)
On-Site

T 4.209 Module component: Pricing [T-WIWI-102883]

Coordinators: Prof. Dr. Martin Klarmann
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-105312 - Marketing and Sales Management

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each winter term	3

Courses					
WT 25/26	2572199	Pricing	3 SWS	Block / 🗣	Klarmann, Bill, Schröder
Exams					
WT 25/26	7900343	Pricing			Klarmann

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
Students are highly encouraged to actively participate in class.

Additional Information
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 courses related to this module component:

V **Pricing** **Block (B) On-Site**
2572199, WS 25/26, 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 4.210 Module component: Probabilistic Time Series Forecasting Challenge [T-WIWI-111387]

Coordinators: Prof. Dr. Fabian Krüger
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Irregular	2

Assessment
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.

Additional Information
The course is limited in participation. Participants will be selected via the WIWI portal.

Workload
135 hours

T 4.211 Module component: Probability Theory and Combinatorial Optimization [T-MATH-105923]

Coordinators: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: M-MATH-102947 - Probability Theory and Combinatorial Optimization

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Prerequisites
none

T 4.212 Module component: Process Mining [T-WIWI-109799]

Coordinators: Dr.-Ing. Clemens Schreiber
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	2

Courses					
ST 2026	2511204	Process Mining	2 SWS	Lecture / 🗣	Schreiber
ST 2026	2511205	Exercise Process Mining	1 SWS	Practice / 🗣	Rybinski
Exams					
WT 25/26	79AIFB_PM_A5	Process Mining (Registration extended until 16.02.2026)			Oberweis
ST 2026	791-AIFB-PM-HK	Process Mining (Registration until 20.07.2026)			Schreiber

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Additional Information
Former name (up to winter semester 2018/1019) "Workflow Management".

Below you will find excerpts from courses related to this module component:

V **Process Mining** — Lecture (V) On-Site
2511204, SS 2026, 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.

T 4.213 Module component: Project Lab Cognitive Automobiles and Robots [T-WIWI-109985]

Coordinators: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Examination of another type	5 CP	graded	Each winter term	3

Courses					
WT 25/26	2512501	Practical Course Cognitive automobiles and robots (Master)	3 SWS	Practical course /	Zöllner, Schneider
Exams					
WT 25/26	7900107	Advanced Lab Cognitive Automobile and Robots (Master)			Zöllner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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 courses related to this module component:

V **Practical Course Cognitive automobiles and robots (Master)**
2512501, WS 25/26, 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 4.214 Module component: Project Lab Machine Learning [T-WIWI-109983]

Coordinators: Prof. Dr.-Ing. Johann Marius Zöllner
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Examination of another type	5 CP	graded	Each summer term	3

Courses					
ST 2026	2512500	Project Lab Machine Learning	3 SWS	Practical course /	Zöllner, Schneider
Exams					
ST 2026	7900086	Project Lab Machine Learning			Zöllner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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 courses related to this module component:

V Project Lab Machine Learning

2512500, SS 2026, 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 4.215 Module component: Project Lab Scientific Computing [T-MATH-114059]

Coordinators: 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	Version
Coursework	0 CP	pass/fail	1

T 4.216 Module component: Public Management [T-WIWI-102740]

Coordinators: Prof. Dr. Berthold Wigger
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101504 - Collective Decision Making

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2561127	Public Management	3 SWS	Lecture / Practice /	Wigger
Exams					
WT 25/26	790puma	Public Management			Wigger
ST 2026	790puma	Public Management			Wigger

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Success is assessed in the form of a written examination (90 minutes). The examination is offered every semester and can be repeated at any regular examination date.

Prerequisites
None

Recommendations
Basic knowledge of Public Finance is required.

Below you will find excerpts from courses related to this module component:

V Public Management

2561127, WS 25/26, 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 4.217 Module component: Python for Computational Risk and Asset Management [T-WIWI-110213]

Coordinators: Prof. Dr. Maxim Ulrich
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-105032 - Data Science for Finance

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each winter term	3

Assessment
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.

Recommendations
Good knowledge of statistics and basic programming skills

Workload
135 hours

T 4.218 Module component: Quantitative Methods in Energy Economics [T-WIWI-107446]

Coordinators: Patrick Plötz
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading	Term offered	Version
Oral examination	3,5 CP	graded	Each winter term	3

Courses					
WT 25/26	2581007	Quantitative Methods in Energy Economics	2 SWS	Lecture / 🗣	Plötz
WT 25/26	2581008	Übungen zu Quantitative Methods in Energy Economics	1 SWS	Practice / 🗣	Plötz, Britto
Exams					
WT 25/26	7981007	Quantitative Methods in Energy Economics			Fichtner
ST 2026	7981007	Quantitative Methods in Energy Economics			Fichtner

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
None

Below you will find excerpts from courses related to this module component:

V Quantitative Methods in Energy Economics

2581007, WS 25/26, 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 4.219 Module component: Random Graphs and Networks [T-MATH-112241]

Coordinators: Prof. Dr. Daniel Hug
Organisation: KIT Department of Mathematics
Part of: M-MATH-106052 - Random Graphs and Networks

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Assessment
oral exam of ca. 30 min

Prerequisites
none

Recommendations
The contents of the module 'Probability Theory' are strongly recommended.

Workload
240 hours

T 4.220 Module component: Regularity for Elliptic Operators [T-MATH-113472]

Coordinators: apl. Prof. Dr. Peer Kunstmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-106696 - Regularity for Elliptic Operators

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

Assessment
oral exam of ca. 30 minutes

Prerequisites
none

Workload
180 hours

T 4.221 Module component: Regulation Theory and Practice [T-WIWI-102712]

Coordinators: Prof. Dr. Kay Mitusch
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading	Term offered	Version
Oral examination	4,5 CP	graded	see Annotations	2

Assessment
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

Recommendations
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.

Additional Information
The lecture is not offered for an indefinite period of time.

T 4.222 Module component: Riemann Surfaces [T-MATH-113081]

Coordinators: Prof. Dr. Frank Herrlich
Organisation: KIT Department of Mathematics
Part of: M-MATH-106466 - Riemann Surfaces

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	8 CP	graded	Irregular	1 semesters	1

Assessment
Oral examination of ca. 30 minutes.

Prerequisites
none

Workload
240 hours

T 4.223 Module component: Ruin Theory [T-MATH-108400]

Coordinators: Prof. Dr. Vicky Fasen-Hartmann
Organisation: KIT Department of Mathematics
Part of: M-MATH-104055 - Ruin Theory

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Irregular	1

Prerequisites
none

T 4.224 Module component: Scattering Theory [T-MATH-105855]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

T 4.225 Module component: Scattering Theory for Time-dependent Waves [T-MATH-113416]

Coordinators: Prof. Dr. Roland Griesmaier
Organisation: KIT Department of Mathematics
Part of: M-MATH-106664 - Scattering Theory for Time-dependent Waves

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Assessment
oral exam of ca. 30 min

Prerequisites
none

Workload
180 hours

T 4.226 Module component: 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	Term offered	Expansion	Version
Oral examination	3 CP	graded	Irregular	1 semesters	1

Assessment
oral examination of approx. 30 minutes

Prerequisites
none

Recommendations
The courses "Classical Methods for Partial Differential Equations" and "Functional Analysis" are recommended.

Workload
90 hours

T 4.227 Module component: Selected Topics in Harmonic Analysis [T-MATH-109065]

Coordinators: Prof. Dr. Dirk Hundertmark
Organisation: KIT Department of Mathematics
Part of: M-MATH-104435 - Selected Topics in Harmonic Analysis

Type	Credits	Grading	Term offered	Version
Oral examination	3 CP	graded	Irregular	1

Prerequisites
none

T 4.228 Module component: Selected Topics in Statistics and Analytics: Seminal Papers in Theory and Methods [T-WIWI-114746]

Coordinators: Prof. Dr. Oliver Grothe
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101637 - Analytics and Statistics

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Irregular	1

Courses					
WT 25/26	2500005	Selected Topics in Statistics and Analytics: Seminal Papers in Theory and Methods	3 SWS	Lecture / Practice / 🗣	Grothe
Exams					
WT 25/26	7900044	Selected Topics in Statistics and Analytics: Seminal Papers in Theory and Methods			Grothe

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of an alternative exam assessment. The grade is composed of 30% active participation, 30% preparation of the sessions, and 40% written contributions during the semester (e.g. questions or reflections on the assigned papers).
Details on the structure of the performance assessment will be announced at the beginning of the course.

Prerequisites
None.

Recommendations
We recommend a sound statistical basis, such as that taught in the Advanced Statistics course.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Selected Topics in Statistics and Analytics: Seminal Papers in Theory and Methods

Lecture / Practice (VÜ)
On-Site

2500005, WS 25/26, 3 SWS, Language: German/English, Open in study portal

Content
In this course, 6–8 key scientific papers ("seminal works") from various areas of statistics and data analysis are read, analyzed, discussed, and optionally implemented. The goal is to develop and reflect on both core statistical concepts and scientific reading and writing skills.
The course is intended for advanced students with a solid background in statistics.

T 4.229 Module component: Semantic Web Technologies [T-WIWI-110848]

Coordinators: Dr.-Ing. Tobias Käfer
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2511310	Semantic Web Technologies	2 SWS	Lecture / 🗣	Käfer, Braun, Kubelka
ST 2026	2511311	Exercises to Semantic Web Technologies	1 SWS	Practice / 🗣	Käfer, Braun, Kubelka
Exams					
WT 25/26	79AIFB_SWebT_A2	Semantic Web Technologies (Registration extended until 16.02.2026)			Käfer
ST 2026	791-AIFB-SWebT-HK	Semantic Web Technologies (Registration until 20.07.2026)			Käfer

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
It is recommended that students have previously attended computer-science lectures from the Bachelor programmes Information Systems or Industrial Engineering and Management in semesters 1 – 4, or have taken equivalent courses.

Below you will find excerpts from courses related to this module component:

V Semantic Web Technologies

2511310, SS 2026, 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** **Practice (Ü) On-Site**
2511311, SS 2026, 1 SWS, Language: English, Open in study portal

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.

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 4.230 Module component: Semigroup Theory for the Navier-Stokes Equations [T-MATH-113415]

Coordinators: 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	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Assessment
oral exam of ca. 30 min

Prerequisites
none

Workload
180 hours

T 4.231 Module component: Seminar in Business Administration A (Master) [T-WIWI-103474]

Coordinators: Professorenschaft des Fachbereichs Betriebswirtschaftslehre
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102971 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	2500045	Digital Democracy - Challenges and Opportunities of the Digital Society	2 SWS	Seminar /	Fegert, Stein, Bezzaoui
WT 25/26	2500049	Seminar in Cognition and Consumer Behavior	2 SWS	Seminar /	Gradwohl
WT 25/26	2500055	Science communication in the innovation process	2 SWS	Seminar /	Schwind, Weissenberger-Eibl, Schwind
WT 25/26	2500125	Human-Centered Systems Seminar: Engineering	2 SWS	Seminar /	Mädche
WT 25/26	2530293		2 SWS	Seminar /	Ruckes, Luedecke, Kohl, Sarac, Fkyerat
WT 25/26	2530586		2 SWS	Seminar /	Uhrig-Homburg, Molnar
WT 25/26	2540472	Master Seminar (Information Systems III) – Future of Commerce / AI and Fairness	2 SWS	Seminar /	Bennardo, Gutschow, Heßler
WT 25/26	2540473	Business Data Analytics	2 SWS	Seminar /	Hariharan, Grote, Schulz, Motz
WT 25/26	2540475	Positive Information Systems	2 SWS	Seminar /	Knierim, del Puppo
WT 25/26	2540478	Smart Grids and Energy Markets	2 SWS	Seminar /	Weinhardt, Semmelmann, Miskiw, Speck
WT 25/26	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar /	Geyer-Schulz, Nazemi
WT 25/26	2540557	Human-Centered Systems Seminar: Research	2 SWS	Seminar /	Mädche
WT 25/26	2545105	Case studies seminar: Innovation management	2 SWS	Seminar /	Weissenberger-Eibl
WT 25/26	2571181	Seminar Digital Marketing (Master)	2 SWS	Seminar /	Kupfer, Schmitt, Cinar
WT 25/26	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter
WT 25/26	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter
WT 25/26	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar /	Wouters, Dickemann
WT 25/26	2581030	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Sloot
WT 25/26	2581032	Seminar Energy Economics VI	2 SWS	Seminar /	Fichtner, Slednev
WT 25/26	2581976	Seminar in Production and Operations Management I	2 SWS	Seminar /	Schultmann, Rudi
WT 25/26	2581977	Seminar in Production and Operations Management II	2 SWS	Seminar /	Schultmann, Steins
WT 25/26	2581978	Seminar in Production and Operations Management	2 SWS	Seminar /	Schultmann, Rosenberg
WT 25/26	2581979	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Kleinebrahm
WT 25/26	2581980	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Sandmeier

WT 25/26	2581981	Seminar in Energy Economics	2 SWS	Seminar / 🗣	Ardone, Fichtner
ST 2026	2500018	Successful transformation through innovation	2 SWS	Seminar / 🗣	Busch
ST 2026	2500020	Digital Democracy - Challenges and opportunities of the digital society	2 SWS	Seminar / 🧩	Fegert
ST 2026	2500125	Human-Centered Systems Seminar: Engineering	3 SWS	Seminar / 🧩	Mädche
ST 2026	2530580	Seminar in Finance (Master)	2 SWS	Seminar / 🗣	Uhrig-Homburg
ST 2026	2540469	Master Seminar: Intelligent & Responsible Information Systems	2 SWS	Seminar / 🗣	Bennardo, Gutschow, Heßler
ST 2026	2540473	Applied Responsible AI	2 SWS	Seminar	Schulz, Weinhardt
ST 2026	2540475	Positive Information Systems	2 SWS	Seminar	Knierim
ST 2026	2540478	Smart Grid Economics & Energy Markets	2 SWS	Seminar	Weinhardt
ST 2026	2540493	Data Science for Industrial Applications	2 SWS	Seminar / 🗣	Spitzer, Holstein, Hendriks
ST 2026	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar	Geyer-Schulz
ST 2026	2540553	Biosignal-Adaptive Systems Seminar	2 SWS	Seminar / 🧩	Mädche, Beigl
ST 2026	2540557	Human-Centered Systems Seminar: Research	3 SWS	Seminar / 🧩	Mädche
ST 2026	2545002	Entrepreneurship Research	2 SWS	Seminar / 🗣	Kuschel, Malik
ST 2026	2571180	Seminar in Marketing and Sales (Master)	2 SWS	Seminar / 🗣	Klarmann, Mitarbeiter
ST 2026	2571182	Seminar “The Future of Marketing” (Master)	2 SWS	Seminar / 🗣	Kupfer
ST 2026	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar / 🗣	Nieken, Mitarbeiter, Gorny
ST 2026	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar / 🗣	Nieken, Mitarbeiter
ST 2026	2581030	Seminar Energiewirtschaft IV	2 SWS	Seminar / 🗣	Fichtner, Sloot
ST 2026	2581031	Seminar Energiewirtschaft V	2 SWS	Seminar / 🗣	Plötz
ST 2026	2581032	Seminar Energiewirtschaft VI	2 SWS	Seminar / 🗣	Slednev, Fichtner
ST 2026	2581978	Seminar Produktionswirtschaft und Logistik III	2 SWS	Seminar / 🗣	Schultmann, Rosenberg
ST 2026	2581979	Seminar Energiewirtschaft I	2 SWS	Seminar / 🗣	Fichtner, Kleinebrahm
ST 2026	2581980	Seminar Energiewirtschaft II	2 SWS	Seminar / 🗣	Fichtner, Sandmeier
ST 2026	2581981	Seminar Energiewirtschaft III	2 SWS	Seminar / 🗣	Ardone, Fichtner
Exams					
WT 25/26	00072	Seminar Positive Information Systems			Weinhardt
WT 25/26	00074	Seminar Business Data Analytics			Weinhardt
WT 25/26	7900017	Seminar Smart Grid and Energy Markets			Weinhardt
WT 25/26	7900069	Human-Centered Systems Seminar: Engineering			Mädche
WT 25/26	7900106	Science Communication in the Innovation Process			Schwind
WT 25/26	7900151	Master Seminar in Data Science and Machine Learning			Geyer-Schulz
WT 25/26	7900163	Seminar Human Resource Management (Master)			Nieken
WT 25/26	7900164	Seminar Human Resources and Organizations (Master)			Nieken
WT 25/26	7900184	Seminar in Finance (Master)			Ruckes
WT 25/26	7900203	Seminar "Finance in a nutshell"			Uhrig-Homburg
WT 25/26	7900233	Human-Centered Systems Seminar: Research			Mädche
WT 25/26	7900237	Case Studies Seminar: Innovation Management			Weissenberger-Eibl
WT 25/26	7900318	Bond Markets - Models & Derivatives			Uhrig-Homburg
WT 25/26	7900322	Seminar in Cognition and Consumer Behavior (Master)			Scheibehenne

WT 25/26	7900328	Seminar in Energy Economics VI	Fichtner
WT 25/26	7900333	Seminar Digital Marketing (Master)	Kupfer
WT 25/26	7900335	Seminar Energy Economics IV	Fichtner
WT 25/26	79-2579919-M	Seminar Management Accounting - Sustainability Topics (Master)	Wouters
WT 25/26	7940469	Master Seminar: Information Systems III	Pfeiffer, Heßler
WT 25/26	7981976	Seminar in Production and Operations Management I	Schultmann
WT 25/26	7981977	Seminar in Production and Operations Management II	Schultmann
WT 25/26	7981978	Seminar in Production and Operations Management III	Schultmann
WT 25/26	7981979	Seminar Energy Economics I	Fichtner
WT 25/26	7981980	Seminar Energy Economics II	Fichtner
WT 25/26	7981981	Seminar Energy Economics III	Fichtner
ST 2026	7900052	Entrepreneurship Research	Terzidis
ST 2026	7900101	Seminar Human Resource Management (Master)	Nieken
ST 2026	7900127	Seminar in Finance: Structured Products –Pricing & Risk Management (Master)	Uhrig-Homburg
ST 2026	7900190	Human-Centered Systems Seminar: Engineering	Mädche
ST 2026	7900231	Seminar Human Resources and Organizations (Master)	Nieken
ST 2026	7900233	Seminar in Marketing and Sales (Master)	Klarmann
ST 2026	7900240	Seminar "The Future of Marketing" (Master)	Kupfer
ST 2026	7900261	Human-Centered Systems Seminar: Research	Mädche
ST 2026	7900265	Biosignal-Adaptive Systems Seminar	Mädche
ST 2026	7900326	Seminar Energy Economics VI	Fichtner
ST 2026	792581030	Seminar Energy Economics IV	Fichtner
ST 2026	792581031	Seminar Energy Economics V	Plötz
ST 2026	7940469	Master Seminar: Intelligent & Responsible Information Systems	Pfeiffer
ST 2026	7981978	Seminar in Production and Operations Management III	Schultmann
ST 2026	7981979	Seminar Energy Economics I: A Real-Time Day-Ahead Energy Time Series Forecasting Challenge	Fichtner
ST 2026	7981980	Seminar Energy Economics II: Sustainable Transformation of Energy Infrastructures	Fichtner
ST 2026	7981981	Seminar Energy Economics III	Fichtner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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.

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
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 courses related to this module component:

V **Science communication in the innovation process** **Seminar (S)**
2500055, WS 25/26, 2 SWS, Language: German, Open in study portal **On-Site**

Content
This seminar explores the role of science communication in the innovation process. Students will learn the basic definitions, concepts and models of science communication and critically examine them. They also explore the landscape of science communication actors, the distinction between communication for the common good and strategic communication, and the role of science communication in the acceptance of radical innovations. Through the critical analysis and reflection of science communication formats and their modes of action, students gain an understanding of proven and innovative communication strategies, learning how to adapt different formats to specific target groups and innovation phases.

As part of the seminar, students examine current, research-oriented issues independently and on the basis of scientific criteria. They research, analyze, abstract and reflect on relevant information. They draw their own conclusions using their interdisciplinary knowledge and develop current research results further in certain areas. They know how to validate the results obtained and present them logically and systematically in written and oral form, taking into account scientific methods (structuring, specialist terminology, citing sources). In doing so, they are able to argue professionally and defend the results in discussions with experts. In addition, students are familiar with the DFG Code of Conduct “Guidelines for Safeguarding Good Scientific Practice” and successfully apply these guidelines in the preparation of their scientific work.

V **Seminar (S)**
2530586, WS 25/26, 2 SWS, Language: German, Open in study portal **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 27.10.25 um 16 Uhr, Zwischenpräsentation am 09.12.25, 16 Uhr und Abschlusspräsentation am 27.01.26, 17:30 Uhr am Campus B (Geb. 09.21), Raum 209

V **Master Seminar (Information Systems III) – Future of Commerce / AI and Fairness** **Seminar (S)**
2540472, WS 25/26, 2 SWS, Language: English, Open in study portal **On-Site**

Content
This seminar is offered by the Information Systems III research group, which has been based at the Institute for Information Systems (WIN) since January 2025 and is led by Prof. Dr. Jella Pfeiffer. Further information about us can be found on our website (WIN - Information Systems III).

V **Business Data Analytics** **Seminar (S)**
2540473, WS 25/26, 2 SWS, Language: German/English, Open in study portal **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 25/26, 2 SWS, Language: German, Open in study portal

Seminar (S)
Blended (On-Site/Online)

V Case studies seminar: Innovation management

2545105, WS 25/26, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content

The objective of the seminar is to acquire selected concepts and methods of innovation management and to apply these in a practical way. The focus is on working on specific issues using a case study from business practice. Students work in groups and transfer the content taught, for example from the areas of scenario development, to entrepreneurial challenges in the context of fictitious case studies. The course follows a didactic interplay of theoretical input and direct application of what has been learned. At the end, the groups present their results in a plenary presentation, which is prepared by a short introduction to presentation techniques. The joint discussion promotes the transfer of knowledge to different contexts and strengthens the participants' ability to reflect.

As part of the seminar, students deal independently with current, research-oriented issues and systematically apply scientific criteria. They research relevant information, analyze, abstract and critically evaluate it. They draw conclusions independently from poorly structured data, incorporate interdisciplinary knowledge and contribute selectively to the further development of existing research perspectives. The results are validated and systematically prepared both orally and in writing using scientific standards - particularly with regard to structuring, terminology and correct citation of sources. In doing so, students argue in a technically sound manner and defend their findings in discourse with other participants and lecturers. They are also familiar with the DFG Code of Conduct “Guidelines for Safeguarding Good Scientific Practice” and apply these standards consistently in the preparation of their scientific work.

Literature

Werden in der ersten Veranstaltung bekannt gegeben.

V Seminar Human Resource Management (Master)

2573012, WS 25/26, 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 25/26, 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** **Seminar (S) On-Site**
2579919, WS 25/26, 2 SWS, Language: English, Open in study portal

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 2026, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content

This seminar uses strategic innovation management and concepts such as organizational ambidexterity, boundary spanning and stakeholder approaches to shed light on how companies can increase their innovative capacity through innovation. Students will use a core paper to understand the steps a company takes to become an innovative organization. The aim is to understand how medium-sized companies can develop into innovation-driven organizations in the context of organizational inertia and path dependency with the help of the aforementioned concepts. Part of the seminar will be to analyze the role of different stakeholders and how companies can become part of innovation ecosystems.

Based on the impulses and the core paper, students will apply the concepts they have learned to selected companies and present their results. These are also incorporated into academic seminar papers. As part of this work process, students deal independently with a current, research-oriented question and apply scientific criteria consistently. They research relevant information, analyze and abstract it critically and draw their own conclusions on this basis, reflecting their interdisciplinary knowledge and selectively developing current research findings.

The results obtained are systematically presented in written and oral form in compliance with academic standards - including structured presentation, correct specialist terminology and comprehensible references. In doing so, the students argue in a technically sound manner and are able to defend their positions in scientific discourse with experts. In addition, they are familiar with the DFG Code of Conduct “Guidelines for Safeguarding Good Scientific Practice” and successfully apply these guidelines in the preparation of their scientific work.

Organizational issues

Weblink: https://itm.entechnon.kit.edu/192_1281.phphttps://itm.entechnon.kit.edu/192_1673.php

V

Human-Centered Systems Seminar: Engineering

2500125, SS 2026, 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

Data Science for Industrial Applications

2540493, SS 2026, 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 2026, 2 SWS, Language: German/English, Open in study portal

V **Biosignal-Adaptive Systems Seminar** **Seminar (S)**
2540553, SS 2026, 2 SWS, Language: English, Open in study portal **Blended (On-Site/Online)**

Content
Biosignal-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 biosignal-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 biosignal-adaptive system is and how it can be conceptualized
- Suggest and evaluate different design solutions for addressing the identified problem
- Build a biosignal-adaptive system prototype using state-of-the-art hard- and software
- Perform a user-centric evaluation of the biosignal-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 2026, 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 2026, 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
Registration is via the Wiwi-Portal.

Seminar dates will probably be (as announced in Wiwi-Portal):

Wednesday, 29.04.2026, 10.00-16.00
Wednesday, 20.05.2026, 10.00-16.00
Wednesday, 24.06.2026, 09.00-12.00

Literature
Will be announced in the seminar.

V Seminar Human Resource Management (Master)
2573012, SS 2026, 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 2026, 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

T 4.232 Module component: Seminar in Business Administration B (Master) [T-WIWI-103476]

Coordinators: Professorenschaft des Fachbereichs Betriebswirtschaftslehre
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102972 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	2500045	Digital Democracy - Challenges and Opportunities of the Digital Society	2 SWS	Seminar /	Fegert, Stein, Bezzaoui
WT 25/26	2500055	Science communication in the innovation process	2 SWS	Seminar /	Schwind, Weissenberger-Eibl, Schwind
WT 25/26	2500125	Human-Centered Systems Seminar: Engineering	2 SWS	Seminar /	Mädche
WT 25/26	2530293		2 SWS	Seminar /	Ruckes, Luedecke, Kohl, Sarac, Fkyerat
WT 25/26	2530586		2 SWS	Seminar /	Uhrig-Homburg, Molnar
WT 25/26	2540472	Master Seminar (Information Systems III) – Future of Commerce / AI and Fairness	2 SWS	Seminar /	Bennardo, Gutschow, Heßler
WT 25/26	2540473	Business Data Analytics	2 SWS	Seminar /	Hariharan, Grote, Schulz, Motz
WT 25/26	2540475	Positive Information Systems	2 SWS	Seminar /	Knierim, del Puppo
WT 25/26	2540478	Smart Grids and Energy Markets	2 SWS	Seminar /	Weinhardt, Semmelmann, Miskiw, Speck
WT 25/26	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar /	Geyer-Schulz, Nazemi
WT 25/26	2540557	Human-Centered Systems Seminar: Research	2 SWS	Seminar /	Mädche
WT 25/26	2545105	Case studies seminar: Innovation management	2 SWS	Seminar /	Weissenberger-Eibl
WT 25/26	2571181	Seminar Digital Marketing (Master)	2 SWS	Seminar /	Kupfer, Schmitt, Cinar
WT 25/26	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter
WT 25/26	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar /	Nieken, Mitarbeiter
WT 25/26	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar /	Wouters, Dickemann
WT 25/26	2581030	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Sloot
WT 25/26	2581032	Seminar Energy Economics VI	2 SWS	Seminar /	Fichtner, Slednev
WT 25/26	2581976	Seminar in Production and Operations Management I	2 SWS	Seminar /	Schultmann, Rudi
WT 25/26	2581977	Seminar in Production and Operations Management II	2 SWS	Seminar /	Schultmann, Steins
WT 25/26	2581978	Seminar in Production and Operations Management	2 SWS	Seminar /	Schultmann, Rosenberg
WT 25/26	2581979	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Kleinebrahm
WT 25/26	2581980	Seminar in Energy Economics	2 SWS	Seminar /	Fichtner, Sandmeier
WT 25/26	2581981	Seminar in Energy Economics	2 SWS	Seminar /	Ardone, Fichtner

ST 2026	2500018	Successful transformation through innovation	2 SWS	Seminar / 🗣	Busch
ST 2026	2500020	Digital Democracy - Challenges and opportunities of the digital society	2 SWS	Seminar / 🧩	Fegert
ST 2026	2500125	Human-Centered Systems Seminar: Engineering	3 SWS	Seminar / 🧩	Mädche
ST 2026	2530580	Seminar in Finance (Master)	2 SWS	Seminar / 🗣	Uhrig-Homburg
ST 2026	2540469	Master Seminar: Intelligent & Responsible Information Systems	2 SWS	Seminar / 🗣	Bennardo, Gutschow, Heßler
ST 2026	2540473	Applied Responsible AI	2 SWS	Seminar	Schulz, Weinhardt
ST 2026	2540475	Positive Information Systems	2 SWS	Seminar	Knierim
ST 2026	2540478	Smart Grid Economics & Energy Markets	2 SWS	Seminar	Weinhardt
ST 2026	2540493	Data Science for Industrial Applications	2 SWS	Seminar / 🗣	Spitzer, Holstein, Hendriks
ST 2026	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar	Geyer-Schulz
ST 2026	2540553	Biosignal-Adaptive Systems Seminar	2 SWS	Seminar / 🧩	Mädche, Beigl
ST 2026	2540557	Human-Centered Systems Seminar: Research	3 SWS	Seminar / 🧩	Mädche
ST 2026	2545002	Entrepreneurship Research	2 SWS	Seminar / 🗣	Kuschel, Malik
ST 2026	2571180	Seminar in Marketing and Sales (Master)	2 SWS	Seminar / 🗣	Klarmann, Mitarbeiter
ST 2026	2571182	Seminar “The Future of Marketing” (Master)	2 SWS	Seminar / 🗣	Kupfer
ST 2026	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar / 🗣	Nieken, Mitarbeiter, Gorny
ST 2026	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar / 🗣	Nieken, Mitarbeiter
ST 2026	2581030	Seminar Energiewirtschaft IV	2 SWS	Seminar / 🗣	Fichtner, Sloot
ST 2026	2581031	Seminar Energiewirtschaft V	2 SWS	Seminar / 🗣	Plötz
ST 2026	2581032	Seminar Energiewirtschaft VI	2 SWS	Seminar / 🗣	Slednev, Fichtner
ST 2026	2581978	Seminar Produktionswirtschaft und Logistik III	2 SWS	Seminar / 🗣	Schultmann, Rosenberg
ST 2026	2581979	Seminar Energiewirtschaft I	2 SWS	Seminar / 🗣	Fichtner, Kleinebrahm
ST 2026	2581980	Seminar Energiewirtschaft II	2 SWS	Seminar / 🗣	Fichtner, Sandmeier
ST 2026	2581981	Seminar Energiewirtschaft III	2 SWS	Seminar / 🗣	Ardone, Fichtner
Exams					
WT 25/26	00072	Seminar Positive Information Systems			Weinhardt
WT 25/26	00074	Seminar Business Data Analytics			Weinhardt
WT 25/26	7900017	Seminar Smart Grid and Energy Markets			Weinhardt
WT 25/26	7900069	Human-Centered Systems Seminar: Engineering			Mädche
WT 25/26	7900106	Science Communication in the Innovation Process			Schwind
WT 25/26	7900151	Master Seminar in Data Science and Machine Learning			Geyer-Schulz
WT 25/26	7900163	Seminar Human Resource Management (Master)			Nieken
WT 25/26	7900164	Seminar Human Resources and Organizations (Master)			Nieken
WT 25/26	7900184	Seminar in Finance (Master)			Ruckes
WT 25/26	7900203	Seminar "Finance in a nutshell"			Uhrig-Homburg
WT 25/26	7900233	Human-Centered Systems Seminar: Research			Mädche
WT 25/26	7900237	Case Studies Seminar: Innovation Management			Weissenberger-Eibl
WT 25/26	7900318	Bond Markets - Models & Derivatives			Uhrig-Homburg
WT 25/26	7900322	Seminar in Cognition and Consumer Behavior (Master)			Scheibehenne
WT 25/26	7900328	Seminar in Energy Economics VI			Fichtner

WT 25/26	7900333	Seminar Digital Marketing (Master)	Kupfer
WT 25/26	7900335	Seminar Energy Economics IV	Fichtner
WT 25/26	79-2579919-M	Seminar Management Accounting - Sustainability Topics (Master)	Wouters
WT 25/26	7940469	Master Seminar: Information Systems III	Pfeiffer, Heßler
WT 25/26	7981976	Seminar in Production and Operations Management I	Schultmann
WT 25/26	7981977	Seminar in Production and Operations Management II	Schultmann
WT 25/26	7981978	Seminar in Production and Operations Management III	Schultmann
WT 25/26	7981979	Seminar Energy Economics I	Fichtner
WT 25/26	7981980	Seminar Energy Economics II	Fichtner
WT 25/26	7981981	Seminar Energy Economics III	Fichtner
ST 2026	7900052	Entrepreneurship Research	Terzidis
ST 2026	7900101	Seminar Human Resource Management (Master)	Nieken
ST 2026	7900127	Seminar in Finance: Structured Products –Pricing & Risk Management (Master)	Uhrig-Homburg
ST 2026	7900190	Human-Centered Systems Seminar: Engineering	Mädche
ST 2026	7900231	Seminar Human Resources and Organizations (Master)	Nieken
ST 2026	7900233	Seminar in Marketing and Sales (Master)	Klarmann
ST 2026	7900240	Seminar "The Future of Marketing" (Master)	Kupfer
ST 2026	7900261	Human-Centered Systems Seminar: Research	Mädche
ST 2026	7900265	Biosignal-Adaptive Systems Seminar	Mädche
ST 2026	7900326	Seminar Energy Economics VI	Fichtner
ST 2026	792581030	Seminar Energy Economics IV	Fichtner
ST 2026	792581031	Seminar Energy Economics V	Plötz
ST 2026	7940469	Master Seminar: Intelligent & Responsible Information Systems	Pfeiffer
ST 2026	7981978	Seminar in Production and Operations Management III	Schultmann
ST 2026	7981979	Seminar Energy Economics I: A Real-Time Day-Ahead Energy Time Series Forecasting Challenge	Fichtner
ST 2026	7981980	Seminar Energy Economics II: Sustainable Transformation of Energy Infrastructures	Fichtner
ST 2026	7981981	Seminar Energy Economics III	Fichtner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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.

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
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 courses related to this module component:

V

Science communication in the innovation process

2500055, WS 25/26, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content
This seminar explores the role of science communication in the innovation process. Students will learn the basic definitions, concepts and models of science communication and critically examine them. They also explore the landscape of science communication actors, the distinction between communication for the common good and strategic communication, and the role of science communication in the acceptance of radical innovations. Through the critical analysis and reflection of science communication formats and their modes of action, students gain an understanding of proven and innovative communication strategies, learning how to adapt different formats to specific target groups and innovation phases.

As part of the seminar, students examine current, research-oriented issues independently and on the basis of scientific criteria. They research, analyze, abstract and reflect on relevant information. They draw their own conclusions using their interdisciplinary knowledge and develop current research results further in certain areas. They know how to validate the results obtained and present them logically and systematically in written and oral form, taking into account scientific methods (structuring, specialist terminology, citing sources). In doing so, they are able to argue professionally and defend the results in discussions with experts. In addition, students are familiar with the DFG Code of Conduct “Guidelines for Safeguarding Good Scientific Practice” and successfully apply these guidelines in the preparation of their scientific work.

V

2530586, WS 25/26, 2 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 27.10.25 um 16 Uhr, Zwischenpräsentation am 09.12.25, 16 Uhr und Abschlusspräsentation am 27.01.26, 17:30 Uhr am Campus B (Geb. 09.21), Raum 209

V

Master Seminar (Information Systems III) – Future of Commerce / AI and Fairness

2540472, WS 25/26, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

Content
This seminar is offered by the Information Systems III research group, which has been based at the Institute for Information Systems (WIN) since January 2025 and is led by Prof. Dr. Jella Pfeiffer. Further information about us can be found on our website (WIN - Information Systems III).

V

Business Data Analytics

2540473, WS 25/26, 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 25/26, 2 SWS, Language: German, Open in study portal

Seminar (S)
Blended (On-Site/Online)

V

Case studies seminar: Innovation management

2545105, WS 25/26, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content

The objective of the seminar is to acquire selected concepts and methods of innovation management and to apply these in a practical way. The focus is on working on specific issues using a case study from business practice. Students work in groups and transfer the content taught, for example from the areas of scenario development, to entrepreneurial challenges in the context of fictitious case studies. The course follows a didactic interplay of theoretical input and direct application of what has been learned. At the end, the groups present their results in a plenary presentation, which is prepared by a short introduction to presentation techniques. The joint discussion promotes the transfer of knowledge to different contexts and strengthens the participants' ability to reflect.

As part of the seminar, students deal independently with current, research-oriented issues and systematically apply scientific criteria. They research relevant information, analyze, abstract and critically evaluate it. They draw conclusions independently from poorly structured data, incorporate interdisciplinary knowledge and contribute selectively to the further development of existing research perspectives. The results are validated and systematically prepared both orally and in writing using scientific standards - particularly with regard to structuring, terminology and correct citation of sources. In doing so, students argue in a technically sound manner and defend their findings in discourse with other participants and lecturers. They are also familiar with the DFG Code of Conduct “Guidelines for Safeguarding Good Scientific Practice” and apply these standards consistently in the preparation of their scientific work.

Literature

Werden in der ersten Veranstaltung bekannt gegeben.

V

Seminar Human Resource Management (Master)

2573012, WS 25/26, 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 25/26, 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** **Seminar (S) On-Site**
2579919, WS 25/26, 2 SWS, Language: English, Open in study portal

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 2026, 2 SWS, Language: German, Open in study portal

Seminar (S)
On-Site

Content
This seminar uses strategic innovation management and concepts such as organizational ambidexterity, boundary spanning and stakeholder approaches to shed light on how companies can increase their innovative capacity through innovation. Students will use a core paper to understand the steps a company takes to become an innovative organization. The aim is to understand how medium-sized companies can develop into innovation-driven organizations in the context of organizational inertia and path dependency with the help of the aforementioned concepts. Part of the seminar will be to analyze the role of different stakeholders and how companies can become part of innovation ecosystems.

Based on the impulses and the core paper, students will apply the concepts they have learned to selected companies and present their results. These are also incorporated into academic seminar papers. As part of this work process, students deal independently with a current, research-oriented question and apply scientific criteria consistently. They research relevant information, analyze and abstract it critically and draw their own conclusions on this basis, reflecting their interdisciplinary knowledge and selectively developing current research findings.

The results obtained are systematically presented in written and oral form in compliance with academic standards - including structured presentation, correct specialist terminology and comprehensible references. In doing so, the students argue in a technically sound manner and are able to defend their positions in scientific discourse with experts. In addition, they are familiar with the DFG Code of Conduct “Guidelines for Safeguarding Good Scientific Practice” and successfully apply these guidelines in the preparation of their scientific work.

Organizational issues
Weblink: https://itm.entechnon.kit.edu/192_1281.phphttps://itm.entechnon.kit.edu/192_1673.php

V

Human-Centered Systems Seminar: Engineering

2500125, SS 2026, 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

Data Science for Industrial Applications

2540493, SS 2026, 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 2026, 2 SWS, Language: German/English, Open in study portal

V **Biosignal-Adaptive Systems Seminar** **Seminar (S)**
2540553, SS 2026, 2 SWS, Language: English, Open in study portal **Blended (On-Site/Online)**

Content
Biosignal-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 biosignal-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 biosignal-adaptive system is and how it can be conceptualized
- Suggest and evaluate different design solutions for addressing the identified problem
- Build a biosignal-adaptive system prototype using state-of-the-art hard- and software
- Perform a user-centric evaluation of the biosignal-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** — **Seminar (S)**
2540557, SS 2026, 3 SWS, Language: English, Open in study portal — **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 2026, 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
Registration is via the Wiwi-Portal.

Seminar dates will probably be (as announced in Wiwi-Portal):

Wednesday, 29.04.2026, 10.00-16.00
Wednesday, 20.05.2026, 10.00-16.00
Wednesday, 24.06.2026, 09.00-12.00

Literature
Will be announced in the seminar.

V Seminar Human Resource Management (Master)
2573012, SS 2026, 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 2026, 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

T 4.233 Module component: Seminar in Economics A (Master) [T-WIWI-103478]

Coordinators: Professorenschaft des Fachbereichs Volkswirtschaftslehre
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102971 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	25000111	Statistics and Epidemics	2 SWS	Seminar / 🗣	Bracher, Nemcova
WT 25/26	2500024	Wirtschaftstheoretisches Seminar IV (Master)	2 SWS	Seminar / 🧩	Puppe, Kretz, Ammann, Okulicz
WT 25/26	2500052	Seminar on Topics in Digital Economics	2 SWS	Seminar / 🗣	Reiß, Hillenbrand, Potarca
WT 25/26	2500064	Economics of Crime	2 SWS	Seminar / 🗣	Mill
WT 25/26	2520500	Workshop on Economics, Finance and Statistics	2 SWS	Seminar	Puppe, Brumm, Nieken, Ott, Reiß, Ruckes, Schienle, Uhrig-Homburg, Wigger, Krüger
WT 25/26	2520563	Wirtschaftstheoretisches Seminar III (Master)	2 SWS	Seminar / 🗣	Ammann, Kretz
WT 25/26	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Bracher, Buse, Koster, Rüter, Leimenstoll, Renner, Pohle
WT 25/26	2560130	Seminar Public Finance	2 SWS	Seminar / 🧩	Wigger, Setio, Schmelzer
WT 25/26	2560142	Seminar in Digital Economics (Master)	2 SWS	Seminar / 🗣	Rosar
WT 25/26	2560143	Seminar Game Theory and Behavioral Economics (Master)	2 SWS	Seminar / 🗣	Rau
WT 25/26	2560282	Seminar in Economic Policy	2 SWS	Seminar / 🗣	Ott, Assistenten
WT 25/26	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🧩	Brumm, Pegorari, Kissling, Schang
WT 25/26	2561208	Selected aspects of European transport planning and -modelling	2 SWS	Seminar	Szimba, Sand
ST 2026	2500012	Making and Evaluating Predictions	2 SWS	Seminar	Schienle, Allen, Zhang
ST 2026	2500035	Efficiency analyses in network sectors	2 SWS	Seminar / 🗣	Mitusch, Latsch
ST 2026	2520536	Seminar in Economic Theory II	2 SWS	Seminar / 🗣	Ammann, Kretz, Okulicz
ST 2026	2520563	Seminar in Economic Theory III	2 SWS	Seminar / 🗣	Ammann, Kretz, Okulicz
ST 2026	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Bracher, Buse, Koster, Rüter, Leimenstoll, Renner
ST 2026	2560130	Seminar Public Finance	2 SWS	Block / 🧩	Wigger, Schmelzer
ST 2026	2560282	Seminar in economic policy	2 SWS	Seminar / 🗣	Ott, Assistenten
ST 2026	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🧩	Brumm, Frank
ST 2026	2560554	Seminar Lying and Cheating in Economic Decision Situations (Master)	2 SWS	Seminar / 🗣	Rau

Exams			
WT 25/26	7900015	Seminar Economics of Crime (Master)	Mill
WT 25/26	7900115	Seminar: How to Make Democracy Work? Voting Methods in Theory and Practice (Master)	Puppe
WT 25/26	7900117	Seminar in Economics A (Master)	Brumm
WT 25/26	7900139	Selected Aspects of European Transport Planning and Modelling	Mitusch
WT 25/26	7900140	Seminar in Digital Economics (Master)	Puppe
WT 25/26	7900212	Seminar in Economic Policy	Ott
WT 25/26	7900254	Topics in Econometrics	Schienle, Bracher
WT 25/26	7900296	Seminar Game Theory and Behavioral Economics (Master)	Mill
WT 25/26	7900361	Seminar on Topics in Digital Economics	Reiß, Hillenbrand
WT 25/26	79sefi2	Seminar Public Finance A (Master)	Wigger
ST 2026	7900051	Seminar in Economic Policy	Ott
ST 2026	7900131	Lying and Cheating in Economic Decision Situations (Master)	Rau
ST 2026	7900164	Seminar in Economics (Bachelor)	Mitusch

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
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

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
Note on Prof. Ingrid Ott's seminars: Due to a research semester, no seminars will be offered in the summer semester 2026.

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 courses related to this module component:

V **Statistics and Epidemics** **Seminar (S) On-Site**
25000111, WS 25/26, 2 SWS, Language: English, Open in study portal

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/8902

Application time frame: September 5th, 2025 to October, 31th, 2025.

V **Economics of Crime** — **Seminar (S) On-Site**

2500064, WS 25/26, 2 SWS, Open in study portal

Content

For Bachelor students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Economathematics.

Organizational issues

Application is possible via https://portal.wiwi.kit.edu/Seminare

Kick-off: 29.10.2025, 11.00 - 12.30 h 01.85, KD2 Lab (1. floor über Außentreppe), Team Room(Raum tbc)

Presentations: 17.01.2026 09.00 - 18.00 h, 01.85, KD2 Lab (1. floor über Außentreppe), Team Room

V **Topics in Econometrics** — **Seminar (S)**

2521310, WS 25/26, 2 SWS, Language: German, Open in study portal

Organizational issues

Wöchentliche Veranstaltung, Donnerstags 13:00-14:30 Uhr in B17 - R320

V **Seminar in Digital Economics (Master)** — **Seminar (S) On-Site**

2560142, WS 25/26, 2 SWS, Language: English, Open in study portal

Content

The seminar addresses issues in the digital economy from a game-theoretic perspective. All information about the seminar will be published on the Wiwi-Portal.

V Seminar Game Theory and Behavioral Economics (Master)

2560143, WS 25/26, 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.

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 https://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: 29.10.2025, 14.00 - 15.30 h, Geb. 01.85, KD2Lab Team room (über Außentreppe)

Presentations: 19.01.2026, 14.00 - 18.00 h, Geb. 01.85, KD2Lab Team room (über Außentreppe)

V Making and Evaluating Predictions

2500012, SS 2026, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Content
A key goal of statistics and data science is to make predictions. Good predictions are important for decision-making, allowing us to balance risks and mitigate the impacts of potentially damaging events. In this seminar, we will study theoretical questions regarding the evaluation of predictions, such as “What does it mean for a prediction to be good?”, before introducing statistical and machine learning methods to generate both point-valued and probabilistic predictions. We will discuss applications to economics, meteorology, and energy forecasting.

Format: The course will start with a short block course at the beginning of the lecture period. Evaluation will be based on a seminar thesis, which students are required to hand in at the end of the lecture period, and a short presentation. The presentations will also take place towards the end of the lecture period.

Organizational issues
Blockveranstaltung, Termine werden bekannt gegeben

V Advanced Topics in Econometrics

2521310, SS 2026, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Organizational issues
wöchentlich, Donnerstags 11:00-12:30, B17, R320

V Seminar Public Finance

2560130, SS 2026, 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 Lying and Cheating in Economic Decision Situations (Master)

2560554, SS 2026, 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

Seminar Kick-off: 28.04.2026, 14.00 - 14.45 h

Seminar Presentations: 30.06.2026 9.30 - 18.00 h

Hand-in Seminar Papers: 02.08.2026

T 4.234 Module component: Seminar in Economics B (Master) [T-WIWI-103477]

Coordinators: Professorenschaft des Fachbereichs Volkswirtschaftslehre
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102972 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	25000111	Statistics and Epidemics	2 SWS	Seminar / 🗣	Bracher, Nemcova
WT 25/26	2500024	Wirtschaftstheoretisches Seminar IV (Master)	2 SWS	Seminar / 🧩	Puppe, Kretz, Ammann, Okulicz
WT 25/26	2500052	Seminar on Topics in Digital Economics	2 SWS	Seminar / 🗣	Reiß, Hillenbrand, Potarca
WT 25/26	2500064	Economics of Crime	2 SWS	Seminar / 🗣	Mill
WT 25/26	2520500	Workshop on Economics, Finance and Statistics	2 SWS	Seminar	Puppe, Brumm, Nieken, Ott, Reiß, Ruckes, Schienle, Uhrig-Homburg, Wigger, Krüger
WT 25/26	2520563	Wirtschaftstheoretisches Seminar III (Master)	2 SWS	Seminar / 🗣	Ammann, Kretz
WT 25/26	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Bracher, Buse, Koster, Rüter, Leimenstoll, Renner, Pohle
WT 25/26	2560130	Seminar Public Finance	2 SWS	Seminar / 🧩	Wigger, Setio, Schmelzer
WT 25/26	2560142	Seminar in Digital Economics (Master)	2 SWS	Seminar / 🗣	Rosar
WT 25/26	2560143	Seminar Game Theory and Behavioral Economics (Master)	2 SWS	Seminar / 🗣	Rau
WT 25/26	2560282	Seminar in Economic Policy	2 SWS	Seminar / 🗣	Ott, Assistenten
WT 25/26	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🧩	Brumm, Pegorari, Kissling, Schang
WT 25/26	2561208	Selected aspects of European transport planning and -modelling	2 SWS	Seminar	Szimba, Sand
ST 2026	2500012	Making and Evaluating Predictions	2 SWS	Seminar	Schienle, Allen, Zhang
ST 2026	2500035	Efficiency analyses in network sectors	2 SWS	Seminar / 🗣	Mitusch, Latsch
ST 2026	2520536	Seminar in Economic Theory II	2 SWS	Seminar / 🗣	Ammann, Kretz, Okulicz
ST 2026	2520563	Seminar in Economic Theory III	2 SWS	Seminar / 🗣	Ammann, Kretz, Okulicz
ST 2026	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Bracher, Buse, Koster, Rüter, Leimenstoll, Renner
ST 2026	2560130	Seminar Public Finance	2 SWS	Block / 🧩	Wigger, Schmelzer
ST 2026	2560259	Organisation and Management of Development Projects	2 SWS	Seminar / 🧩	Sieber
ST 2026	2560282	Seminar in economic policy	2 SWS	Seminar / 🗣	Ott, Assistenten
ST 2026	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🧩	Brumm, Frank

ST 2026	2560554	Seminar Lying and Cheating in Economic Decision Situations (Master)	2 SWS	Seminar / 🗣	Rau
Exams					
WT 25/26	7900015	Seminar Economics of Crime (Master)			Mill
WT 25/26	7900115	Seminar: How to Make Democracy Work? Voting Methods in Theory and Practice (Master)			Puppe
WT 25/26	7900118	Seminar in Economics B (Master)			Brumm
WT 25/26	7900139	Selected Aspects of European Transport Planning and Modelling			Mitusch
WT 25/26	7900140	Seminar in Digital Economics (Master)			Puppe
WT 25/26	7900212	Seminar in Economic Policy			Ott
WT 25/26	7900254	Topics in Econometrics			Schienle, Bracher
WT 25/26	7900296	Seminar Game Theory and Behavioral Economics (Master)			Mill
WT 25/26	7900361	Seminar on Topics in Digital Economics			Reiß, Hillenbrand
WT 25/26	79sefi3	Seminar Public Finance B (Master)			Wigger
ST 2026	7900051	Seminar in Economic Policy			Ott
ST 2026	7900131	Lying and Cheating in Economic Decision Situations (Master)			Rau
ST 2026	7900164	Seminar in Economics (Bachelor)			Mitusch

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
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 courses related to this module component:

V **Statistics and Epidemics** — **Seminar (S) On-Site**
25000111, WS 25/26, 2 SWS, Language: English, Open in study portal

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/8902

Application time frame: September 5th, 2025 to October, 31th, 2025.

V **Economics of Crime** — **Seminar (S) On-Site**

2500064, WS 25/26, 2 SWS, Open in study portal

Content

For Bachelor students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Economathematics.

Organizational issues

Application is possible via https://portal.wiwi.kit.edu/Seminare

Kick-off: 29.10.2025, 11.00 - 12.30 h 01.85, KD2 Lab (1. floor über Außentreppe), Team Room(Raum tbc)

Presentations: 17.01.2026 09.00 - 18.00 h, 01.85, KD2 Lab (1. floor über Außentreppe), Team Room

V **Topics in Econometrics** — **Seminar (S)**

2521310, WS 25/26, 2 SWS, Language: German, Open in study portal

Organizational issues

Wöchentliche Veranstaltung, Donnerstags 13:00-14:30 Uhr in B17 - R320

V **Seminar in Digital Economics (Master)** — **Seminar (S) On-Site**

2560142, WS 25/26, 2 SWS, Language: English, Open in study portal

Content

The seminar addresses issues in the digital economy from a game-theoretic perspective. All information about the seminar will be published on the Wiwi-Portal.

V Seminar Game Theory and Behavioral Economics (Master)

2560143, WS 25/26, 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.

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 https://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: 29.10.2025, 14.00 - 15.30 h, Geb. 01.85, KD2Lab Team room (über Außentreppe)

Presentations: 19.01.2026, 14.00 - 18.00 h, Geb. 01.85, KD2Lab Team room (über Außentreppe)

V Making and Evaluating Predictions

2500012, SS 2026, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Content
A key goal of statistics and data science is to make predictions. Good predictions are important for decision-making, allowing us to balance risks and mitigate the impacts of potentially damaging events. In this seminar, we will study theoretical questions regarding the evaluation of predictions, such as “What does it mean for a prediction to be good?”, before introducing statistical and machine learning methods to generate both point-valued and probabilistic predictions. We will discuss applications to economics, meteorology, and energy forecasting.

Format: The course will start with a short block course at the beginning of the lecture period. Evaluation will be based on a seminar thesis, which students are required to hand in at the end of the lecture period, and a short presentation. The presentations will also take place towards the end of the lecture period.

Organizational issues
Blockveranstaltung, Termine werden bekannt gegeben

V Advanced Topics in Econometrics

2521310, SS 2026, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Organizational issues
wöchentlich, Donnerstags 11:00-12:30, B17, R320

V Seminar Public Finance

2560130, SS 2026, 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 Lying and Cheating in Economic Decision Situations (Master)

2560554, SS 2026, 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

Seminar Kick-off: 28.04.2026, 14.00 - 14.45 h

Seminar Presentations: 30.06.2026 9.30 - 18.00 h

Hand-in Seminar Papers: 02.08.2026

T 4.235 Module component: Seminar in Informatics A (Master) [T-WIWI-103479]

Coordinators: Professorenschaft des Instituts AIFB
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102973 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	2400125	Security and Privacy Awareness	2 SWS	Seminar /	Seidel-Saul, Volkamer, Boehm, Ballreich, Sikra, Veit
WT 25/26	2512101	Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Master)	2 SWS	Seminar /	Lazarova-Molnar, Khodadadi, Daniel
WT 25/26	2513103	Seminar: Applications of Digital Twins (Master)	2 SWS	Seminar /	Lazarova-Molnar, Lee, Mahmoud
WT 25/26	2513105	Seminar: New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)	2 SWS	Seminar /	Lazarova-Molnar, Demetgül
WT 25/26	2513107	Seminar: Data-Driven Reliability Modeling of Energy Systems (Master)	2 SWS	Seminar	Lazarova-Molnar, Mostafa
WT 25/26	2513313	Seminar Linked Data and the Semantic Web (Master)	3 SWS	Seminar /	Käfer, Braun, Li, Kubelka
WT 25/26	2513314	Seminar Real-World Challenges in Data Science and Analytics (Bachelor)	3 SWS	/	Hoellig, Käfer, Thoma
WT 25/26	2513315	Seminar Real-World Challenges in Data Science and Analytics (Master)	3 SWS	/	Hoellig, Käfer, Thoma
WT 25/26	2513451	Seminar Cooperative Autonomous Vehicles (Master)	2 SWS	Seminar /	Vinel
WT 25/26	2513458	Seminar Artificial Intelligence for Autonomous Driving (Master)	2 SWS	Seminar /	Zhao, Vinel
WT 25/26	2513460	Seminar Cooperative Robots (Master)	2 SWS	Seminar /	Vinel
WT 25/26	2513500	Seminar Cognitive Automobiles and Robots (Master)	2 SWS	Seminar /	Zöllner, Schneider
ST 2026	2512101	Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Seminar/ Master)	2 SWS	Seminar /	Lazarova-Molnar, Khodadadi, Lee, Daniel
ST 2026	2513103	Seminar: Applications of Digital Twins (Master)	2 SWS	Seminar /	Lazarova-Molnar, Lee, Mahmoud
ST 2026	2513108	Seminar: New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)	2 SWS	Seminar /	Demetgül, Lazarova-Molnar
ST 2026	2513109	Seminar: Data-driven Agent-based Modeling and Simulation (Master)	2 SWS	Seminar	Lazarova-Molnar, Lee
ST 2026	2513211	Seminar Business Information Systems (Master)	2 SWS	Seminar /	Oberweis, Forell, Fritsch, Rybinski, Schreiber, Ullrich, König

ST 2026	2513221	Seminar Intelligente Fahrzeugsysteme der nächsten Generation: Kognition, Personalisierung und adaptive Mobilität (Master)	2 SWS	Seminar	Ullrich, Schreiber
ST 2026	2513309	Seminar Knowledge Discovery and Data Mining (Master)	2 SWS	Seminar / 🗣	Käfer, Noullet, Kinder, Li
ST 2026	2513311	Seminar Data Science & Real-time Big Data Analytics (Master)	2 SWS	Seminar / 🗣	Käfer, Thoma, Slobodyanik
ST 2026	2513455	Seminar Machine Learning in Autonomous Driving (Master)	2 SWS	Seminar / 🧩	Zhao, Vinel
ST 2026	2513459	Seminar Vulnerable Road User Technologies (Master)	2 SWS	Seminar / 🧩	Schrapel, Vinel
ST 2026	2513500	Cognitive Automobiles and Robots	2 SWS	Seminar / 🗣	Zöllner, Schneider
ST 2026	2513607	Seminar Knowledge Graphs and Large Language Models (Master)	2 SWS	Seminar / 🧩	Sack, Gesese
Exams					
WT 25/26	7900025	Seminar "Applications of Digital Twins (Master)"			Lazarova-Molnar
WT 25/26	7900048	Seminar New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)			Lazarova-Molnar
WT 25/26	7900069	Human-Centered Systems Seminar: Engineering			Mädche
WT 25/26	7900102	Advanced Lab Knowledge-driven Artificial Intelligence (Master)			Sack
WT 25/26	7900119	Seminar Cognitive Automobiles and Robots			Zöllner
WT 25/26	7900121	Security and Privacy Awareness			Volkamer
WT 25/26	7900209	Seminar "From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Master)"			Lazarova-Molnar
WT 25/26	7900226	Seminar Modeling and Simulation for Energy Systems (Master)			Lazarova-Molnar
WT 25/26	7900233	Human-Centered Systems Seminar: Research			Mädche
WT 25/26	7900245	Seminar Cooperative Autonomous Vehicles (Master)			Vinel
WT 25/26	7900274	Seminar Real-World Challenges in Data Science and Analytics (Master)			Sure-Vetter, Färber
WT 25/26	7900279	Seminar Cooperative Robots (Master)			Vinel
WT 25/26	7900304	Seminar Linked Data and the Semantic Web (Master)			Färber
WT 25/26	7900356	Seminar Real-World Challenges in Data Science and Analytics (Master)			Sure-Vetter, Färber
WT 25/26	79AIFB_AIAD_C4	Seminar Artificial Intelligence for Autonomous Driving (Master)			Vinel
ST 2026	7900062	Seminar Data-driven Agent-based Modeling and Simulation (Master)			Lazarova-Molnar
ST 2026	7900088	Seminar Business Information Systems (Master)			Oberweis
ST 2026	7900147	Cognitive Automobiles and Robots			Zöllner
ST 2026	7900162	Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Master)			Lazarova-Molnar
ST 2026	7900190	Human-Centered Systems Seminar: Engineering			Mädche
ST 2026	7900191	Seminar Vulnerable Road User Technologies (Master)			Vinel
ST 2026	7900198	Seminar Data Science & Real-Time Big Data Analytics (Master)			Käfer
ST 2026	7900199	Seminar Large Language Model-Enhanced Representation Learning for Knowledge Graphs (Master)			Sack
ST 2026	7900202	Seminar Knowledge Discovery and Data Mining (Master)			Käfer
ST 2026	7900203	Seminar Machine Learning in Autonomous Driving (Master)			Vinel
ST 2026	7900206	Seminar New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)			Lazarova-Molnar
ST 2026	7900261	Human-Centered Systems Seminar: Research			Mädche
ST 2026	7900305	Seminar: Applications of Digital Twins (Master)			Lazarova-Molnar

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
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 courses related to this module component:

V **Security and Privacy Awareness** — **Seminar (S)** **Blended (On-Site/Online)**
2400125, WS 25/26, 2 SWS, Language: German/English, Open in study portal

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:

- The seminar language is English. This means that English is the standard for the presentation and the seminar paper, and German is only permitted for the paper after consultation with the supervisor, for example, if the topic of the thesis requires it.
- The seminar is only for MASTER students (or Mastervorzug)
- The link to enrol is for every student, regardless of the study background

Topics:

The advertised topics can be found in the wiwi portal.

V **Seminar: Applications of Digital Twins (Master)** — **Seminar (S)** **On-Site**
2513103, WS 25/26, 2 SWS, Language: English, Open in study portal

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

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· 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

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· 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**
2513105, WS 25/26, 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.

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)** **Seminar (S) On-Site**

2513313, WS 25/26, 3 SWS, Language: German/English, Open in study portal

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)** **On-Site**
2513314, WS 25/26, 3 SWS, Language: German/English, Open in study portal

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)** **On-Site**
2513315, WS 25/26, 3 SWS, Language: German/English, Open in study portal

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)** **Seminar (S)**
Blended (On-Site/Online)
2513500, WS 25/26, 2 SWS, Language: German/English, Open in study portal

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: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Seminar/Master)

Seminar (S)
On-Site

2512101, SS 2026, 2 SWS, Language: English, Open in study portal

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)

Seminar (S)
On-Site

2513103, SS 2026, 2 SWS, Language: English, Open in study portal

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

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· Zhang, Chenyuan, et al. "A reconfigurable modeling approach for digital twin-based manufacturing system." *Procedia Cirp* 83 (2019): 118-125. (96 citations)

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· Palensky, Peter, et al. "Digital twins and their use in future power systems." *Digital Twin* 1 (2022): 4. (37 citations)

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· 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)

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· Todorovski, Ljupčo, and Sašo Džeroski. "Integrating knowledge-driven and data-driven approaches to modeling." *ecological modelling* 194.1-3 (2006): 3-13. (80 citations)

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· 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)

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· Mostafa, Omar & Lazarova-Molnar, Sanja. (2024). Enhancing Reliability of Energy Systems with Digital Twins: Challenges and Opportunities. (0 citations – new articles)

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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 2026, 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 23, 2026**: 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 **28 May 2026**: Presentation of the current situation and information sharing.
- Final presentation on **July 9, 2026**: 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)

2513309, SS 2026, 2 SWS, Language: English, Open in study portal

Seminar (S)
On-Site

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)

Seminar (S)
On-Site

2513311, SS 2026, 2 SWS, Language: English, Open in study portal

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

Seminar (S)
On-Site

2513500, SS 2026, 2 SWS, Language: German/English, Open in study portal

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)

Seminar (S)
Blended (On-Site/Online)

2513607, SS 2026, 2 SWS, Language: English, Open in study portal

Content
Large language models (LLMs) such as GPT-4 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.

T 4.236 Module component: Seminar in Informatics B (Master) [T-WIWI-103480]

Coordinators: Professorenschaft des Instituts AIFB
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102974 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	2400125	Security and Privacy Awareness	2 SWS	Seminar /	Seidel-Saul, Volkamer, Boehm, Ballreich, Sikra, Veit
WT 25/26	2512101	Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Master)	2 SWS	Seminar /	Lazarova-Molnar, Khodadadi, Daniel
WT 25/26	2513103	Seminar: Applications of Digital Twins (Master)	2 SWS	Seminar /	Lazarova-Molnar, Lee, Mahmoud
WT 25/26	2513105	Seminar: New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)	2 SWS	Seminar /	Lazarova-Molnar, Demetgül
WT 25/26	2513107	Seminar: Data-Driven Reliability Modeling of Energy Systems (Master)	2 SWS	Seminar	Lazarova-Molnar, Mostafa
WT 25/26	2513313	Seminar Linked Data and the Semantic Web (Master)	3 SWS	Seminar /	Käfer, Braun, Li, Kubelka
WT 25/26	2513314	Seminar Real-World Challenges in Data Science and Analytics (Bachelor)	3 SWS	/	Hoellig, Käfer, Thoma
WT 25/26	2513315	Seminar Real-World Challenges in Data Science and Analytics (Master)	3 SWS	/	Hoellig, Käfer, Thoma
WT 25/26	2513451	Seminar Cooperative Autonomous Vehicles (Master)	2 SWS	Seminar /	Vinel
WT 25/26	2513458	Seminar Artificial Intelligence for Autonomous Driving (Master)	2 SWS	Seminar /	Zhao, Vinel
WT 25/26	2513460	Seminar Cooperative Robots (Master)	2 SWS	Seminar /	Vinel
WT 25/26	2513500	Seminar Cognitive Automobiles and Robots (Master)	2 SWS	Seminar /	Zöllner, Schneider
ST 2026	2512101	Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Seminar/ Master)	2 SWS	Seminar /	Lazarova-Molnar, Khodadadi, Lee, Daniel
ST 2026	2513103	Seminar: Applications of Digital Twins (Master)	2 SWS	Seminar /	Lazarova-Molnar, Lee, Mahmoud
ST 2026	2513108	Seminar: New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)	2 SWS	Seminar /	Demetgül, Lazarova-Molnar
ST 2026	2513109	Seminar: Data-driven Agent-based Modeling and Simulation (Master)	2 SWS	Seminar	Lazarova-Molnar, Lee
ST 2026	2513211	Seminar Business Information Systems (Master)	2 SWS	Seminar /	Oberweis, Forell, Fritsch, Rybinski, Schreiber, Ullrich, König

ST 2026	2513221	Seminar Intelligente Fahrzeugsysteme der nächsten Generation: Kognition, Personalisierung und adaptive Mobilität (Master)	2 SWS	Seminar	Ullrich, Schreiber
ST 2026	2513309	Seminar Knowledge Discovery and Data Mining (Master)	2 SWS	Seminar / 🗣	Käfer, Noullet, Kinder, Li
ST 2026	2513311	Seminar Data Science & Real-time Big Data Analytics (Master)	2 SWS	Seminar / 🗣	Käfer, Thoma, Slobodyanik
ST 2026	2513455	Seminar Machine Learning in Autonomous Driving (Master)	2 SWS	Seminar / 🧩	Zhao, Vinel
ST 2026	2513459	Seminar Vulnerable Road User Technologies (Master)	2 SWS	Seminar / 🧩	Schrapel, Vinel
ST 2026	2513500	Cognitive Automobiles and Robots	2 SWS	Seminar / 🗣	Zöllner, Schneider
ST 2026	2513607	Seminar Knowledge Graphs and Large Language Models (Master)	2 SWS	Seminar / 🧩	Sack, Gesese
Exams					
WT 25/26	7500175	Seminar: Energy Informatics			Hagenmeyer, Bläsius
WT 25/26	7900025	Seminar "Applications of Digital Twins (Master)"			Lazarova-Molnar
WT 25/26	7900048	Seminar New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)			Lazarova-Molnar
WT 25/26	7900102	Advanced Lab Knowledge-driven Artificial Intelligence (Master)			Sack
WT 25/26	7900119	Seminar Cognitive Automobiles and Robots			Zöllner
WT 25/26	7900121	Security and Privacy Awareness			Volkamer
WT 25/26	7900209	Seminar "From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Master)"			Lazarova-Molnar
WT 25/26	7900226	Seminar Modeling and Simulation for Energy Systems (Master)			Lazarova-Molnar
WT 25/26	7900245	Seminar Cooperative Autonomous Vehicles (Master)			Vinel
WT 25/26	7900274	Seminar Real-World Challenges in Data Science and Analytics (Master)			Sure-Vetter, Färber
WT 25/26	7900279	Seminar Cooperative Robots (Master)			Vinel
WT 25/26	7900304	Seminar Linked Data and the Semantic Web (Master)			Färber
WT 25/26	7900356	Seminar Real-World Challenges in Data Science and Analytics (Master)			Sure-Vetter, Färber
WT 25/26	79AIFB_AIAD_C4	Seminar Artificial Intelligence for Autonomous Driving (Master)			Vinel
ST 2026	7900062	Seminar Data-driven Agent-based Modeling and Simulation (Master)			Lazarova-Molnar
ST 2026	7900088	Seminar Business Information Systems (Master)			Oberweis
ST 2026	7900147	Cognitive Automobiles and Robots			Zöllner
ST 2026	7900162	Seminar: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Master)			Lazarova-Molnar
ST 2026	7900191	Seminar Vulnerable Road User Technologies (Master)			Vinel
ST 2026	7900198	Seminar Data Science & Real-Time Big Data Analytics (Master)			Käfer
ST 2026	7900199	Seminar Large Language Model-Enhanced Representation Learning for Knowledge Graphs (Master)			Sack
ST 2026	7900202	Seminar Knowledge Discovery and Data Mining (Master)			Käfer
ST 2026	7900203	Seminar Machine Learning in Autonomous Driving (Master)			Vinel
ST 2026	7900206	Seminar New Trends in Artificial Intelligence Techniques for Noise Prediction (Master)			Lazarova-Molnar
ST 2026	7900305	Seminar: Applications of Digital Twins (Master)			Lazarova-Molnar

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
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 courses related to this module component:

V **Security and Privacy Awareness** — **Seminar (S)** **Blended (On-Site/Online)**
2400125, WS 25/26, 2 SWS, Language: German/English, Open in study portal

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:

- The seminar language is English. This means that English is the standard for the presentation and the seminar paper, and German is only permitted for the paper after consultation with the supervisor, for example, if the topic of the thesis requires it.
- The seminar is only for MASTER students (or Mastervorzug)
- The link to enrol is for every student, regardless of the study background

Topics:

The advertised topics can be found in the wiwi portal.

V **Seminar: Applications of Digital Twins (Master)** — **Seminar (S)** **On-Site**
2513103, WS 25/26, 2 SWS, Language: English, Open in study portal

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**
2513105, WS 25/26, 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.

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)** **Seminar (S)**
2513313, WS 25/26, 3 SWS, Language: German/English, Open in study portal **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)** **On-Site**
2513314, WS 25/26, 3 SWS, Language: German/English, Open in study portal

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)** **On-Site**
2513315, WS 25/26, 3 SWS, Language: German/English, Open in study portal

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)** **Seminar (S)**
Blended (On-Site/Online)
2513500, WS 25/26, 2 SWS, Language: German/English, Open in study portal

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: From Physical Models to Digital Twins: A Data-Driven Simulation Workshop (Seminar/Master)

Seminar (S)
On-Site

2512101, SS 2026, 2 SWS, Language: English, Open in study portal

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)

Seminar (S)
On-Site

2513103, SS 2026, 2 SWS, Language: English, Open in study portal

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 2026, 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 23, 2026**: 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 **28 May 2026**: Presentation of the current situation and information sharing.
- Final presentation on **July 9, 2026**: 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 2026, 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)

Seminar (S)
On-Site

2513311, SS 2026, 2 SWS, Language: English, Open in study portal

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

Seminar (S)
On-Site

2513500, SS 2026, 2 SWS, Language: German/English, Open in study portal

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)

Seminar (S)
Blended (On-Site/Online)

2513607, SS 2026, 2 SWS, Language: English, Open in study portal

Content
Large language models (LLMs) such as GPT-4 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.

T 4.237 Module component: Seminar in Operations Research A (Master) [T-WIWI-103481]

Coordinators: Prof. Dr. Stefan Nickel
Prof. Dr. Steffen Rebennack
Prof. Dr. Oliver Stein

Organisation: KIT Department of Business and Economics

Part of: M-WIWI-102973 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	2500056	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / 🧩	Nickel, Mitarbeiter, Pomes, Hoffmann
WT 25/26	2550131	Seminar on Methodical Foundations of Operations Research (B)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
WT 25/26	2550132	Seminar zur Mathematischen Optimierung (MA)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
WT 25/26	2550462	Seminar on Trending Topics in Optimization and Machine Learning (Master)	2 SWS	Seminar / 🧩	Rebennack, Kandora
WT 25/26	2550473	Seminar on Energy and Power Systems Optimization (Master)	2 SWS	Seminar / 🧩	Rebennack, Kandora
ST 2026	2550131	Seminar on Methodical Foundations of Operations Research (BA)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
ST 2026	2550132	Seminar on Mathematical Optimization (MA)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
Exams					
WT 25/26	7900011_WS2425	Seminar in Operations Research B (Bachelor)			Stein
WT 25/26	7900012_WS2425	Seminar in Operations Research A (Master)			Stein
WT 25/26	7900040	Seminar: Modern OR and Innovative Logistics			Nickel
WT 25/26	7900169	Seminar Trending Topics in Optimization and Machine Learning (Master)			Rebennack
WT 25/26	7900194	Digitalization in the Steel Industry			Nickel
WT 25/26	7900314	Seminar on Power Systems Optimization (Master)			Rebennack
ST 2026	7900200_SS2025	Seminar in Operations Research A (Master)			Stein
ST 2026	7900201_SS2025	Seminar in Operations Research (Bachelor)			Stein

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
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 courses related to this module component:

V **Seminar: Modern OR and Innovative Logistics**
2500056, WS 25/26, 2 SWS, Language: German, Open in study portal
Seminar (S)
Blended (On-Site/Online)

Content
This seminar presents current issues in the field of Operations Research and Logistics, critically evaluates them, and discusses them using examples. The focus of the seminar lies on optimization models and algorithms, with particular attention to their practical applicability (especially in supply chain and health care management). All participants are required to write a seminar paper and give a presentation. Depending on the topic, an implementation of the models or heuristics using standard software (e.g., IBM CPLEX or Java) is expected. Further details can be found in the information sheet on Prof. Nickel's website. All topics have the potential to be developed into a thesis.

The seminar topics will be assigned during a preliminary meeting at the beginning of the semester. Attendance is mandatory for the preliminary meeting as well as for all seminar presentations.

In addition, students will receive an introduction to academic writing, literature research, and scientific presenting in three sessions.

Organizational issues
Die Anmeldung erfolgt über das Wiwi-Portal. Nähere Informationen erhalten Sie auf der Homepage dol.ior.kit.edu bzw. im WiWi-Portal sowie bei der Vorbesprechung.

Literature
Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

V **Seminar on Methodical Foundations of Operations Research (B)**
2550131, WS 25/26, 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 on Methodical Foundations of Operations Research (BA)

2550131, SS 2026, 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.

T 4.238 Module component: Seminar in Operations Research B (Master) [T-WIWI-103482]

Coordinators: Prof. Dr. Stefan Nickel
Prof. Dr. Steffen Rebennack
Prof. Dr. Oliver Stein

Organisation: KIT Department of Business and Economics

Part of: M-WIWI-102974 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	2500056	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / 🧩	Nickel, Mitarbeiter, Pomes, Hoffmann
WT 25/26	2550131	Seminar on Methodical Foundations of Operations Research (B)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
WT 25/26	2550132	Seminar zur Mathematischen Optimierung (MA)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
WT 25/26	2550462	Seminar on Trending Topics in Optimization and Machine Learning (Master)	2 SWS	Seminar / 🧩	Rebennack, Kandora
WT 25/26	2550473	Seminar on Energy and Power Systems Optimization (Master)	2 SWS	Seminar / 🧩	Rebennack, Kandora
ST 2026	2550131	Seminar on Methodical Foundations of Operations Research (BA)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
ST 2026	2550132	Seminar on Mathematical Optimization (MA)	2 SWS	Seminar / 🗣	Stein, Beck, Schwarze, Neussel
Exams					
WT 25/26	7900011_WS2425	Seminar in Operations Research B (Bachelor)			Stein
WT 25/26	7900012_WS2425	Seminar in Operations Research A (Master)			Stein
WT 25/26	7900040	Seminar: Modern OR and Innovative Logistics			Nickel
WT 25/26	7900194	Digitalization in the Steel Industry			Nickel
WT 25/26	7900314	Seminar on Power Systems Optimization (Master)			Rebennack
ST 2026	7900200_SS2025	Seminar in Operations Research A (Master)			Stein
ST 2026	7900201_SS2025	Seminar in Operations Research (Bachelor)			Stein

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
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 courses related to this module component:

V **Seminar: Modern OR and Innovative Logistics**
2500056, WS 25/26, 2 SWS, Language: German, Open in study portal
Seminar (S)
Blended (On-Site/Online)

Content
This seminar presents current issues in the field of Operations Research and Logistics, critically evaluates them, and discusses them using examples. The focus of the seminar lies on optimization models and algorithms, with particular attention to their practical applicability (especially in supply chain and health care management). All participants are required to write a seminar paper and give a presentation. Depending on the topic, an implementation of the models or heuristics using standard software (e.g., IBM CPLEX or Java) is expected. Further details can be found in the information sheet on Prof. Nickel's website. All topics have the potential to be developed into a thesis.

The seminar topics will be assigned during a preliminary meeting at the beginning of the semester. Attendance is mandatory for the preliminary meeting as well as for all seminar presentations.

In addition, students will receive an introduction to academic writing, literature research, and scientific presenting in three sessions.

Organizational issues
Die Anmeldung erfolgt über das Wiwi-Portal. Nähere Informationen erhalten Sie auf der Homepage dol.ior.kit.edu bzw. im WiWi-Portal sowie bei der Vorbesprechung.

Literature
Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

V **Seminar on Methodical Foundations of Operations Research (B)**
2550131, WS 25/26, 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 on Methodical Foundations of Operations Research (BA)

2550131, SS 2026, 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.

T 4.239 Module component: Seminar in Statistics A (Master) [T-WIWI-103483]

Coordinators: Prof. Dr. Oliver Grothe
Prof. Dr. Melanie Schienle

Organisation: KIT Department of Business and Economics

Part of: M-WIWI-102971 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	25000111	Statistics and Epidemics	2 SWS	Seminar / 🗣	Bracher, Nemcova
WT 25/26	2500012		2 SWS	Seminar / 🗣	Grothe, Liu
WT 25/26	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Bracher, Buse, Koster, Rüter, Leimenstoll, Renner, Pohle
ST 2026	2500012	Making and Evaluating Predictions	2 SWS	Seminar	Schienle, Allen, Zhang
ST 2026	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Bracher, Buse, Koster, Rüter, Leimenstoll, Renner
ST 2026	2550561	Fortgeschrittene Themen zu Statistik, Datenanalyse und maschinellem Lernen (Master)	2 SWS	Seminar / 🗣	Grothe, Liu
Exams					
WT 25/26	7900216	Seminar in Statistics A (Master)			Grothe
WT 25/26	7900254	Topics in Econometrics			Schienle, Bracher

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
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 courses related to this module component:

Statistics and Epidemics

25000111, WS 25/26, 2 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/8902

Application time frame: September 5th, 2025 to October, 31th, 2025.

Topics in Econometrics

2521310, WS 25/26, 2 SWS, Language: German, Open in study portal

Seminar (S)

Organizational issues

Wöchentliche Veranstaltung, Donnerstags 13:00-14:30 Uhr in B17 - R320

Making and Evaluating Predictions

2500012, SS 2026, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Content

A key goal of statistics and data science is to make predictions. Good predictions are important for decision-making, allowing us to balance risks and mitigate the impacts of potentially damaging events. In this seminar, we will study theoretical questions regarding the evaluation of predictions, such as “What does it mean for a prediction to be good?”, before introducing statistical and machine learning methods to generate both point-valued and probabilistic predictions. We will discuss applications to economics, meteorology, and energy forecasting.

Format: The course will start with a short block course at the beginning of the lecture period. Evaluation will be based on a seminar thesis, which students are required to hand in at the end of the lecture period, and a short presentation. The presentations will also take place towards the end of the lecture period.

Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben

V

Advanced Topics in Econometrics

2521310, SS 2026, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Organizational issues
wöchentlich, Donnerstags 11:00-12:30, B17, R320

T 4.240 Module component: Seminar in Statistics B (Master) [T-WIWI-103484]

Coordinators: Prof. Dr. Oliver Grothe
Prof. Dr. Melanie Schienle

Organisation: KIT Department of Business and Economics

Part of: M-WIWI-102972 - Seminar

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
WT 25/26	25000111	Statistics and Epidemics	2 SWS	Seminar / 🗣	Bracher, Nemcova
WT 25/26	2500012		2 SWS	Seminar / 🗣	Grothe, Liu
WT 25/26	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Bracher, Buse, Koster, Rüter, Leimenstoll, Renner, Pohle
ST 2026	2500012	Making and Evaluating Predictions	2 SWS	Seminar	Schienle, Allen, Zhang
ST 2026	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Bracher, Buse, Koster, Rüter, Leimenstoll, Renner
ST 2026	2550561	Fortgeschrittene Themen zu Statistik, Datenanalyse und maschinellem Lernen (Master)	2 SWS	Seminar / 🗣	Grothe, Liu
Exams					
WT 25/26	7900241	Seminar in Statistics B (Master)			Grothe
WT 25/26	7900254	Topics in Econometrics			Schienle, Bracher

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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.

Recommendations
See seminar description in the course catalogue of the KIT (https://campus.kit.edu/)

Additional Information
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 courses related to this module component:

V Statistics and Epidemics

25000111, WS 25/26, 2 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/8902

Application time frame: September 5th, 2025 to October, 31th, 2025.

V Topics in Econometrics

2521310, WS 25/26, 2 SWS, Language: German, Open in study portal

Seminar (S)

Organizational issues

Wöchentliche Veranstaltung, Donnerstags 13:00-14:30 Uhr in B17 - R320

V Making and Evaluating Predictions

2500012, SS 2026, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Content

A key goal of statistics and data science is to make predictions. Good predictions are important for decision-making, allowing us to balance risks and mitigate the impacts of potentially damaging events. In this seminar, we will study theoretical questions regarding the evaluation of predictions, such as “What does it mean for a prediction to be good?”, before introducing statistical and machine learning methods to generate both point-valued and probabilistic predictions. We will discuss applications to economics, meteorology, and energy forecasting.

Format: The course will start with a short block course at the beginning of the lecture period. Evaluation will be based on a seminar thesis, which students are required to hand in at the end of the lecture period, and a short presentation. The presentations will also take place towards the end of the lecture period.

Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben

V

Advanced Topics in Econometrics

2521310, SS 2026, 2 SWS, Language: German/English, Open in study portal

Seminar (S)

Organizational issues
wöchentlich, Donnerstags 11:00-12:30, B17, R320

T 4.241 Module component: Seminar Mathematics [T-MATH-105686]

Coordinators: PD Dr. Stefan Kühnlein
Organisation: KIT Department of Mathematics
Part of: M-MATH-102730 - Seminar

Type	Credits	Grading	Version
Coursework	3 CP	pass/fail	1

Exams			
WT 25/26	7700048	Seminar Mathematics	Kühnlein
ST 2026	7700025	Seminar Mathematics	Kühnlein

T 4.242 Module component: Service Operations and Cyber Security [T-WIWI-114109]

Coordinators: Esther Mohr
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-102805 - Service Operations

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each summer term	1

Exams			
ST 2026	00030	Service Operations and Cyber Security	Nickel

Assessment
The assessment is carried out as a single examination of another type that combines two mandatory components:

1. written dissertation
2. oral final exam (duration ≈ 30 – 40 minutes)

Both components are integrated into one overall assessment, which reflects the overall impression of the combined performance.

Further details on the concrete design (e.g., grading criteria) will be announced during the lecture.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-WIWI-102872 - Challenges in Supply Chain Management must not have been started.

Recommendations
Basic knowledge as conveyed in the module "Introduction to Operations Research" is assumed.

Additional Information
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 4.243 Module component: Simulation Game in Energy Economics [T-WIWI-108016]

Coordinators: Dr. Massimo Genoese
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101451 - Energy Economics and Energy Markets

Type	Credits	Grading	Term offered	Version
Examination of another type	3,5 CP	graded	Each summer term	2

Courses					
ST 2026	2581025	Simulation Game in Energy Economics	3 SWS	Lecture / Practice / 🗣	Genoese, Zimmermann
Exams					
ST 2026	7981025	Simulation Game in Energy Economics			Fichtner

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Examination as written assignment and oral presentation (§4 (2), 1 SPO).

Prerequisites
None

Recommendations
Visiting the course "Introduction to Energy Economics"

Additional Information
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 courses related to this module component:

V Simulation Game in Energy Economics

2581025, SS 2026, 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 4.244 Module component: Smart Energy Infrastructure [T-WIWI-107464]

Coordinators: Dr. Armin Ardone
Dr. Dr. Andrej Marko Pustisek
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101452 - Energy Economics and Technology

Type	Credits	Grading	Term offered	Version
Written examination	5,5 CP	graded	Each winter term	2

Courses					
WT 25/26	2581023	(Smart) Energy Infrastructure	4 SWS	Lecture / 🗣	Ardone, Pustisek, Schuler
Exams					
WT 25/26	7900178	Smart Energy Infrastructure NEW			Fichtner
ST 2026	7900228	Smart Energy Infrastructure NEW			Fichtner

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment consists of a written exam (90 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 courses related to this module component:

V (Smart) Energy Infrastructure

2581023, WS 25/26, 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.

T 4.245 Module component: Smart Grid Applications [T-WIWI-107504]

Coordinators: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-103720 - eEnergy: Markets, Services and Systems

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	see Annotations	2

Assessment
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

Recommendations
None

Additional Information
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 4.246 Module component: Sobolev Spaces [T-MATH-105896]

Coordinators: Prof. Dr. Dorothee Frey
Prof. Dr. Roland Schnaubelt
Organisation: KIT Department of Mathematics
Part of: M-MATH-102926 - Sobolev Spaces

Type	Credits	Grading	Version
Oral examination	8 CP	graded	2

Courses					
ST 2026	0161150	Sobolev Spaces	4 SWS	Lecture	Frey

Recommendations
Some basic knowledge of (elementary) linear functional analysis is strongly recommended.

Below you will find excerpts from courses related to this module component:

V Sobolev Spaces

0161150 , SS 2026, 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 4.247 Module component: Social Choice Theory [T-WIWI-102859]

Coordinators: Prof. Dr. Clemens Puppe
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101500 - Microeconomic Theory
M-WIWI-101504 - Collective Decision Making

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	3

Courses					
ST 2026	2520537	Social Choice Theory	2 SWS	Lecture / 🗣	Puppe, Kretz
ST 2026	2520539	Übung zu Social Choice Theory	1 SWS	Practice / 🗣	Puppe, Kretz

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment consists of a written exam (60 min.). The examination is offered every summer semester.

Prerequisites
None

Below you will find excerpts from courses related to this module component:

V Social Choice Theory

2520537, SS 2026, 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.

T 4.248 Module component: Software Quality Management [T-WIWI-102895]

Coordinators: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	3

Courses					
ST 2026	2511208	Software Quality Management	2 SWS	Lecture / 🗣	Oberweis
ST 2026	2511209	Übungen zu Software-Qualitätsmanagement	1 SWS	Practice / 🗣	Kruse
Exams					
WT 25/26	79AIFB_STQM_C1	Software Quality Management (Registration extended until 16.02.2026)			Oberweis
ST 2026	791-AIFB-STQM-HK	Software Quality Management (Registration until 20.07.2026)			Oberweis

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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 courses related to this module component:

V Software Quality Management

2511208, SS 2026, 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 4.249 Module component: Space and Time Discretization of Nonlinear Wave Equations [T-MATH-112120]

Coordinators: 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	Term offered	Expansion	Version
Oral examination	6 CP	graded	Irregular	1 semesters	1

Prerequisites
none

Workload
180 hours

T 4.250 Module component: Spatial Stochastics [T-MATH-105867]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Courses					
WT 25/26	0105600	Spatial Stochastics	4 SWS	Lecture	Last
WT 25/26	0105610	Tutorial for 0105600 (Spatial Stochastics)	2 SWS	Practice	Last
Exams					
WT 25/26	7700052	Spatial Stochastics			Last, Hug
ST 2026	7700090	Spatial Stochastics			Last

Prerequisites
none

Workload
240 hours

Below you will find excerpts from courses related to this module component:

V Spatial Stochastics

0105600, WS 25/26, 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 4.251 Module component: Special Topics in Information Systems [T-WIWI-113726]

Coordinators: Prof. Dr. Christof Weinhardt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-103720 - eEnergy: Markets, Services and Systems

Type	Credits	Grading	Term offered	Version
Examination of another type	4,5 CP	graded	Each term	1

Assessment
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

Recommendations
None

Additional Information
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 4.252 Module component: Special Topics of Numerical Linear Algebra [T-MATH-105891]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Exams			
WT 25/26	7700125	Special Topics of Numerical Linear Algebra January 28, 2026	Neher

Prerequisites
none

Workload
240 hours

T 4.253 Module component: Spectral Theory - Exam [T-MATH-103414]

Coordinators: 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	Version
Oral examination	8 CP	graded	1

Courses					
ST 2026	0163700	Spectral Theory	4 SWS	Lecture	Hundertmark
ST 2026	0163710	Tutorial for 0163700 (Spectral Theory)	2 SWS	Practice	Hundertmark
Exams					
WT 25/26	0100017	Spectral Theory - Exam			Schnaubelt
ST 2026	7700087	Spectral Theory - Exam			Hundertmark

Assessment
Oral examination of approx. 30 minutes.

Prerequisites
none

Workload
240 hours

Below you will find excerpts from courses related to this module component:

V Spectral Theory

0163700, SS 2026, 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 4.254 Module component: Splitting Methods for Evolution Equations [T-MATH-110805]

Coordinators: Prof. Dr. Tobias Jahnke
Organisation: KIT Department of Mathematics
Part of: M-MATH-105325 - Splitting Methods for Evolution Equations

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Prerequisites
none

Workload
180 hours

T 4.255 Module component: Statistical Learning [T-MATH-111726]

Coordinators: Prof. Dr. Mathias Trabs
Organisation: KIT Department of Mathematics
Part of: M-MATH-105840 - Statistical Learning

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Exams			
WT 25/26	7700151	Statistical Learning - Exam 3	Klar

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

Prerequisites
none

Recommendations
The module "Introduction to Stochastics" is recommended. The module "Probability theory" is preferable.

T 4.256 Module component: Statistical Modeling of Generalized Regression Models [T-WIWI-103065]

Coordinators: apl. Prof. Dr. Wolf-Dieter Heller
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101638 - Econometrics and Statistics I
M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2521350	Statistical Modeling of Generalized Regression Models	2 SWS	Lecture	Heller
Exams					
WT 25/26	7900011	Statistical Modeling of Generalized Regression Models			Heller
WT 25/26	7900146 (WS23/24)	Statistical Modeling of generalized regression models			Heller

Assessment
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.

Recommendations
Knowledge of the contents covered by the course "Economics III: Introduction in Econometrics" [2520016]

Below you will find excerpts from courses related to this module component:

V Statistical Modeling of Generalized Regression Models

2521350, WS 25/26, 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 4.257 Module component: Steins Method with Applications in Statistics [T-MATH-111187]

Coordinators: 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	Term offered	Version
Oral examination	4 CP	graded	Irregular	1

Prerequisites
none

T 4.258 Module component: Stochastic Calculus and Finance [T-WIWI-103129]

Coordinators: Dr. Mher Safarian
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101639 - Econometrics and Statistics II

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2521331	Stochastic Calculus and Finance	2 SWS	Lecture	Safarian
WT 25/26	2521332	Übungen zu Stochastic Calculus and Finance	2 SWS	Practice	Safarian
Exams					
WT 25/26	7900225	Stochastic Calculus and Finance			Safarian

Assessment
The assessment of this course consists of a written examination (§4(2), 1 SPOs, 180 min.).

Prerequisites
None

Additional Information
For more information see http://statistik.econ.kit.edu/

Below you will find excerpts from courses related to this module component:

V Stochastic Calculus and Finance

2521331, WS 25/26, 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 4.259 Module component: Stochastic Control [T-MATH-105871]

Coordinators: Prof. Dr. Nicole Bäuerle
Organisation: KIT Department of Mathematics
Part of: M-MATH-102908 - Stochastic Control

Type	Credits	Grading	Version
Oral examination	4 CP	graded	1

Prerequisites
none

Workload
120 hours

T 4.260 Module component: Stochastic Geometry [T-MATH-105840]

Coordinators: Prof. Dr. Daniel Hug
PD Dr. Steffen Winter

Organisation: KIT Department of Mathematics

Part of: M-MATH-102865 - Stochastic Geometry

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Courses					
ST 2026	0152600	Stochastic Geometry	4 SWS	Lecture	Winter
ST 2026	0152610	Tutorial for 0152600 (Stochastic Geometry)	2 SWS	Practice	Winter

Below you will find excerpts from courses related to this module component:

V Stochastic Geometry

0152600, SS 2026, 4 SWS, Open in study portal

Lecture (V)

Content

For some idea what this course is about see

https://stoch.math.kit.edu/94.php

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 4.261 Module component: Stochastic Simulation [T-MATH-112242]

Coordinators: Prof. Dr. Sebastian Krumscheid
Organisation: KIT Department of Mathematics
Part of: M-MATH-106053 - Stochastic Simulation

Type	Credits	Grading	Term offered	Version
Oral examination	5 CP	graded	Each winter term	1

Courses					
WT 25/26	0100027	Stochastic Simulation	2 SWS	Lecture	Krumscheid
Exams					
WT 25/26	7700109	Stochastic Simulation			Krumscheid

Assessment
oral exam of ca. 30 min

Prerequisites
none

Workload
150 hours

Below you will find excerpts from courses related to this module component:

V Stochastic Simulation

0100027, WS 25/26, 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 4.262 Module component: Strategy and Management Theory: Developments and “Classics” [T-WIWI-106190]

Coordinators: Prof. Dr. Hagen Lindstädt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-103119 - Advanced Topics in Strategy and Management

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Irregular	1

Courses					
WT 25/26	2577921	Strategy and Management Theory: Developments and "Classics" (Master)	2 SWS	Lecture / 🗣	Lindstädt
Exams					
WT 25/26	7900120	Strategy and Management Theory: Developments and “Classics”			Lindstädt

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
Basic knowledge as conveyed in the bachelor module „Strategy and Organization“ is recommended.

Additional Information
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 courses related to this module component:

V Strategy and Management Theory: Developments and "Classics" (Master)

2577921, WS 25/26, 2 SWS, Language: German, Open in study portal

Lecture (V)
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

Success Monitoring:

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.

T 4.263 Module component: Structural Graph Theory [T-MATH-111004]

Coordinators: Prof. Dr. Maria Aksenovich
Organisation: KIT Department of Mathematics
Part of: M-MATH-105463 - Structural Graph Theory

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Irregular	1

Prerequisites
none

T 4.264 Module component: Supplement Enterprise Information Systems [T-WIWI-110346]

Coordinators: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each term	1

Assessment
Success is assessed in the form of a written examination (60 minutes) or, if applicable, an oral examination (approx. 30 minutes).

Prerequisites
None

Additional Information
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 4.265 Module component: Supplement Software- and Systemsengineering [T-WIWI-110372]

Coordinators: Prof. Dr. Andreas Oberweis
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101472 - Informatics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each term	1

Assessment
The assessment of this course is a written or (if necessary) oral examination.

Prerequisites
None

Additional Information
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 4.266 Module component: Sustainable Information Systems [T-WIWI-114995]

Coordinators: TT-Prof. Dr. Philipp Staudt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-107649 - Sustainable Information Systems

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	1

Courses					
ST 2026	2500007	Methods in Sustainable Information Systems Research	3 SWS	Lecture	Staudt

Assessment
Written examination (60 minutes). The examination is offered every semester and can be repeated at any regular examination date.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Methods in Sustainable Information Systems Research

2500007, SS 2026, 3 SWS, Open in study portal **Lecture (V)**

Content
This lecture provides students with essential research methods for studying sustainability challenges in information systems. The course begins with an introduction to Green IS and sustainability fundamentals, establishing the theoretical foundation for understanding how information systems can contribute to environmental and social goals. Students will gain insight into current research topics and debates in the field of sustainable information systems. The core of the course focuses on key research methodologies used in MIS research, including qualitative approaches such as case study research, as well as quantitative methods including surveys, laboratory experiments, and field experiments. Each method is introduced through published research papers from the sustainability domain, allowing students to see how these approaches are applied in practice. By the end of the course, students will be equipped with the methodological toolkit needed to design and conduct rigorous research on sustainability questions in information systems contexts.

T 4.267 Module component: Tactical and Operational Supply Chain Management [T-WIWI-102714]

Coordinators: Prof. Dr. Stefan Nickel
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101413 - Applications of Operations Research

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each summer term	3

Courses					
ST 2026	2550486	Tactical and operational SCM	3 SWS	Lecture / 🗣	Nickel
ST 2026	2550487	Übungen zu Taktisches und operatives SCM	1.5 SWS	Practice / 🗣	Pomes, Hoffmann
Exams					
WT 25/26	7900094	Tactical and Operational Supply Chain Management			Nickel
ST 2026	7900239	Tactical and Operational Supply Chain Management			Nickel

Legend: 🖥 Online, 🖥🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success is assessed in the form of a written examination (60 minutes). The examination is offered every semester and can be repeated at any regular examination date.

Successful participation in the online exercises is a prerequisite for admission to the written exam.

Prerequisites
Prerequisite for admission to examination is the succesful completion of the online assessments.

Recommendations
None

Additional Information
The lecture is held in every summer term. The planned lectures and courses for the next three years are announced online at https://dol.ior.kit.edu/Lehrveranstaltungen.php.

Workload
135 hours

Below you will find excerpts from courses related to this module component:

V Tactical and operational SCM

2550486, SS 2026, 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 4.268 Module component: Time Series Analysis [T-MATH-105874]

Coordinators: 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	Version
Oral examination	4 CP	graded	4

Courses					
ST 2026	0161100	Time Series Analysis	2 SWS	Lecture	Gneiting
ST 2026	0161110	Tutorial for 0161100 (Time Series Analysis)	1 SWS	Practice	Gneiting

Workload
120 hours

Below you will find excerpts from courses related to this module component:

V Time Series Analysis

0161100, SS 2026, 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 4.269 Module component: Topics in Algebraic Topology [T-MATH-114063]

Coordinators: TT-Prof. Dr. Manuel Krannich
Organisation: KIT Department of Mathematics
Part of: M-MATH-107017 - Topics in Algebraic Topology

Type	Credits	Grading	Term offered	Expansion	Version
Written examination	6 CP	graded	Irregular	1 semesters	1

Exams			
WT 25/26	7700146	Topics in Algebraic Topology	Krannich

Assessment
written exam (120 min.)

Prerequisites
none

Workload
180 hours

T 4.270 Module component: Topics in Experimental Economics [T-WIWI-102863]

Coordinators: Prof. Dr. Johannes Philipp Reiß
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101505 - Experimental Economics

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Irregular	1

Assessment
The assessment consists of a written exam (following §4(2), 1 of the examination regulation).

Prerequisites
None

Recommendations
Basic knowledge of Experimental Economics is assumed. Therefore, it is strongly recommended to attend the course Experimental Economics beforehand.

Additional Information
The repeat examination can be taken at any later, regular examination date. The examination dates are only offered in the semester in which the course is offered and in the semester immediately following. The subject matter relates to the last course held.

Workload
135 hours

T 4.271 Module component: Topics in Homotopy Theory [T-MATH-114682]

Coordinators: TT-Prof. Dr. Manuel Krannich
Organisation: KIT Department of Mathematics
Part of: M-MATH-107484 - Topics in Homotopy Theory

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Exams			
WT 25/26	7700145	Topics in Homotopy Theory	Krannich

Prerequisites
none

Workload
180 hours

T 4.272 Module component: Topics in Stochastic Optimization [T-WIWI-112109]

Coordinators: Prof. Dr. Steffen Rebennack
Organisation: KIT Department of Business and Economics
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	Term offered	Version
Examination of another type	4,5 CP	graded	Each winter term	1

Assessment
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.

Recommendations
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.

Additional Information
Teaching and learning format: Lecture and exercise

Workload
135 hours

T 4.273 Module component: Topological Data Analysis [T-MATH-111031]

Coordinators: Prof. Dr. Tobias Hartnick
Prof. Dr. Roman Sauer

Organisation: KIT Department of Mathematics

Part of: M-MATH-105487 - Topological Data Analysis

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Irregular	1

Prerequisites
none

T 4.274 Module component: Translation Surfaces [T-MATH-112128]

Coordinators: Prof. Dr. Frank Herrlich
Organisation: KIT Department of Mathematics
Part of: M-MATH-105973 - Translation Surfaces

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Prerequisites
none

Workload
240 hours

T 4.275 Module component: Traveling Waves [T-MATH-105897]

Coordinators: Dr. Björn de Rijk
Prof. Dr. Wolfgang Reichel

Organisation: KIT Department of Mathematics

Part of: M-MATH-102927 - Traveling Waves

Type	Credits	Grading	Version
Oral examination	6 CP	graded	2

Assessment
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

Recommendations
The following background is strongly recommended: Analysis 1-4.

Workload
180 hours

T 4.276 Module component: Uncertainty Quantification [T-MATH-108399]

Coordinators: Prof. Dr. Martin Frank
Organisation: KIT Department of Mathematics
Part of: M-MATH-104054 - Uncertainty Quantification

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Irregular	1

Courses					
ST 2026	0164400	Uncertainty Quantification	2 SWS	Lecture	Frank
ST 2026	0164410	Tutorial for 0164400 (Uncertainty quantification)	1 SWS	Practice	Frank

Prerequisites
none

Below you will find excerpts from courses related to this module component:

V Uncertainty Quantification

0164400, SS 2026, 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 4.277 Module component: Valuation [T-WIWI-102621]

Coordinators: Prof. Dr. Martin Ruckes
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3
M-WIWI-101482 - Finance 1
M-WIWI-101483 - Finance 2

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Each winter term	1

Courses					
WT 25/26	2530212	Valuation	2 SWS	Lecture / 🗣	Ruckes
WT 25/26	2530213	Übungen zu Valuation	1 SWS	Practice / 🗣	Ruckes, Luedecke
Exams					
WT 25/26	7900057	Valuation			Ruckes
ST 2026	7900072	Valuation			Ruckes

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
See German version.

Prerequisites
None

Recommendations
None

Below you will find excerpts from courses related to this module component:

V Valuation

2530212, WS 25/26, 2 SWS, Language: English, Open in study portal

Lecture (V)
On-Site

Literature
Weiterführende Literatur

Titman/Martin (2013): *Valuation - The Art and Science of Corporate Investment Decisions*, 2nd. ed. Pearson International.

T 4.278 Module component: Variational Methods [T-MATH-110302]

Coordinators: Prof. Dr. Wolfgang Reichel
Organisation: KIT Department of Mathematics
Part of: M-MATH-105093 - Variational Methods

Type	Credits	Grading	Version
Oral examination	8 CP	graded	1

Exams			
WT 25/26	7700104	Variational Methods	Reichel, Lamm

T 4.279 Module component: Wavelets [T-MATH-105838]

Coordinators: Prof. Dr. Andreas Rieder
Organisation: KIT Department of Mathematics
Part of: M-MATH-102895 - Wavelets

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Irregular	1

Exams			
WT 25/26	7700137	Wavelets	Rieder

Assessment
Mündliche Prüfung im Umfang von ca. 30 Minuten.

Prerequisites
none

Workload
240 hours

T 4.280 Module component: Web App Programming for Finance [T-WIWI-110933]

Coordinators: Prof. Dr. Julian Thimme
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-101480 - Finance 3

Type	Credits	Grading	Term offered	Version
Written examination	4,5 CP	graded	Once	1

Assessment
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

Recommendations
The content of the bachelor course Investments is assumed to be known and necessary to follow the course.

Workload
135 hours

T 4.281 Module component: Workshop Business Wargaming – Analyzing Strategic Interactions [T-WIWI-106189]

Coordinators: Prof. Dr. Hagen Lindstädt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-103119 - Advanced Topics in Strategy and Management

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Irregular	1

Courses					
ST 2026	2577922	Workshop Business Wargaming - Analyse strategischer Interaktionen (Master)	2 SWS	Lecture / 🗣	Lindstädt
Exams					
ST 2026	7900071	Workshop Business Wargaming – Analyzing Strategic Interactions			Lindstädt

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
Basic knowledge as conveyed in the bachelor module „Strategy and Organization“ is recommended.

Additional Information
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 courses related to this module component:

V Workshop Business Wargaming - Analyse strategischer Interaktionen (Master)

2577922, SS 2026, 2 SWS, Language: English, Open in study portal

Lecture (V)
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

Competence Certificate:

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.

Note:

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 4.282 Module component: Workshop Current Topics in Strategy and Management [T-WIWI-106188]

Coordinators: Prof. Dr. Hagen Lindstädt
Organisation: KIT Department of Business and Economics
Part of: M-WIWI-103119 - Advanced Topics in Strategy and Management

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Irregular	1

Courses					
WT 25/26	2577923	Workshop aktuelle Themen Strategie und Management (Master)	2 SWS	Lecture / 🗣	Lindstädt
Exams					
WT 25/26	7900171	Workshop Current Topics in Strategy and Management			Lindstädt

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
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

Recommendations
Basic knowledge as conveyed in the bachelor module „Strategy and Organization“ is recommended.

Additional Information
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 courses related to this module component:

V **Workshop aktuelle Themen Strategie und Management (Master)** — **Lecture (V) On-Site**
2577923, WS 25/26, 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

Competence Certificate:

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.