

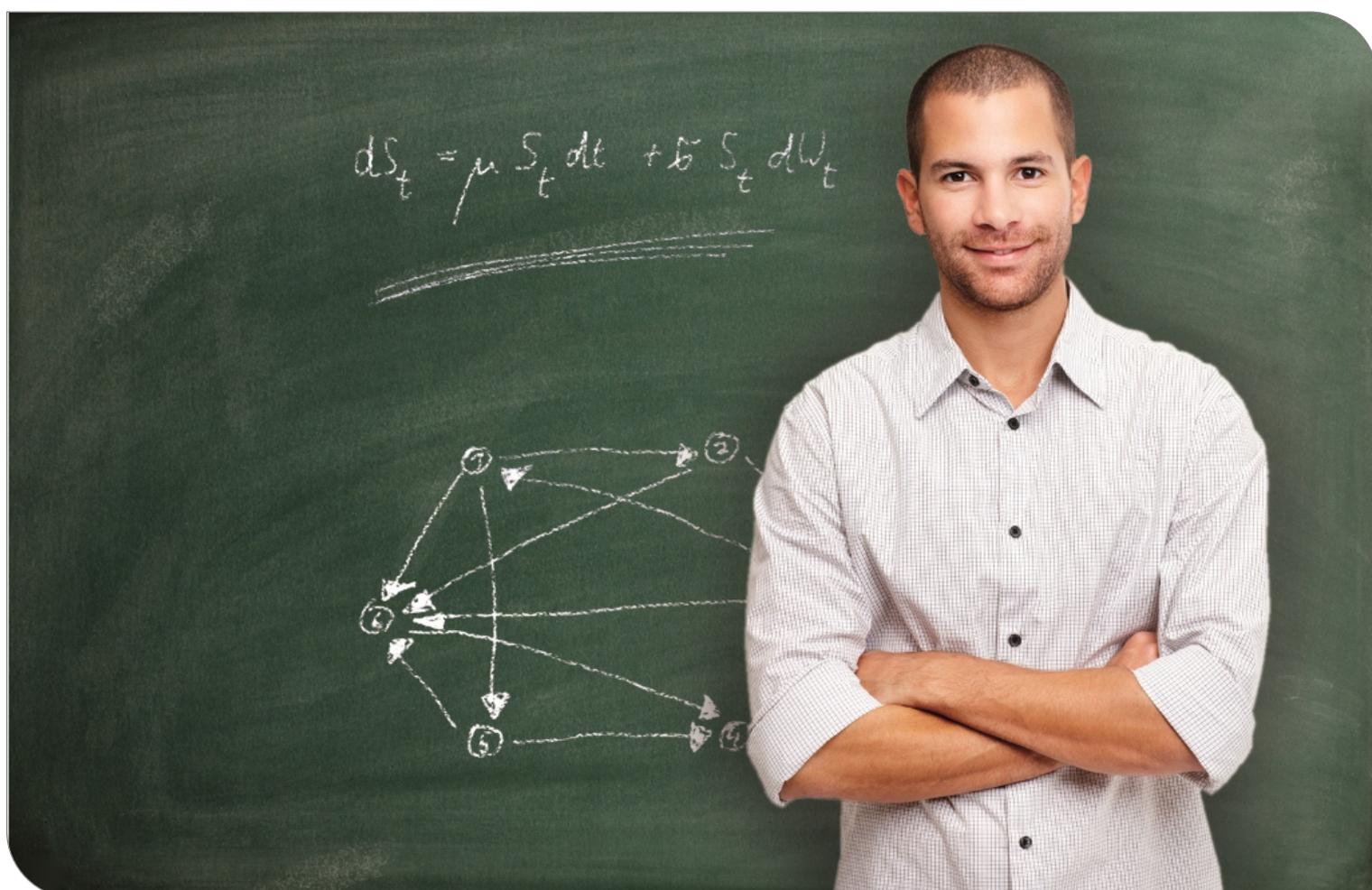
# Module Handbook Econometrics M.Sc.

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KIT DEPARTMENT OF ECONOMICS AND MANAGEMENT / KIT DEPARTMENT OF MATHEMATICS



## Table Of Contents

<b>1. General information</b> .....	<b>11</b>
1.1. Structural elements .....	11
1.2. Begin and completion of a module .....	11
1.3. Module versions .....	11
1.4. General and partial examinations .....	11
1.5. Types of examinations .....	12
1.6. Repeating examinations .....	12
1.7. Examiners .....	12
1.8. Additional accomplishments .....	12
1.9. Further information .....	12
1.10. Contact .....	12
<b>2. Field of study structure</b> .....	<b>13</b>
2.1. Master's Thesis .....	13
2.2. Mathematical Methods .....	14
2.3. Finance - Risk Management - Managerial Economics .....	18
2.4. Operations Management - Data Analysis - Informatics .....	19
2.5. Seminar in Economics and Management .....	19
2.6. Mathematical Seminar .....	19
2.7. Elective Field .....	20
<b>3. Modules</b> .....	<b>25</b>
3.1. Adaptive Finite Element Methods - M-MATH-102900 .....	25
3.2. Advanced Inverse Problems: Nonlinearity and Banach Spaces - M-MATH-102955 .....	26
3.3. Advanced Machine Learning and Data Science - M-WIWI-105659 .....	27
3.4. Advanced Methods in Nonlinear Partial Differential Equations - M-MATH-106822 .....	28
3.5. Advanced Topics in Strategy and Management - M-WIWI-103119 .....	29
3.6. Algebra - M-MATH-101315 .....	30
3.7. Algebraic Geometry - M-MATH-101724 .....	31
3.8. Algebraic Number Theory - M-MATH-101725 .....	32
3.9. Algebraic Topology - M-MATH-102948 .....	33
3.10. Algebraic Topology II - M-MATH-102953 .....	34
3.11. Analytical and Numerical Homogenization - M-MATH-105636 .....	35
3.12. Analytics and Statistics - M-WIWI-101637 .....	36
3.13. Applications of Operations Research - M-WIWI-101413 .....	37
3.14. Applications of Topological Data Analysis - M-MATH-105651 .....	39
3.15. Bayesian Inverse Problems with Connections to Machine Learning - M-MATH-106328 .....	40
3.16. Bifurcation Theory - M-MATH-103259 .....	41
3.17. Bott Periodicity - M-MATH-104349 .....	42
3.18. Boundary and Eigenvalue Problems - M-MATH-102871 .....	43
3.19. Boundary Element Methods - M-MATH-103540 .....	44
3.20. Brownian Motion - M-MATH-102904 .....	45
3.21. Classical Methods for Partial Differential Equations - M-MATH-102870 .....	46
3.22. Collective Decision Making - M-WIWI-101504 .....	47
3.23. Combinatorics - M-MATH-102950 .....	48
3.24. Comparison Geometry - M-MATH-102940 .....	49
3.25. Complex Analysis - M-MATH-102878 .....	50
3.26. Complex Geometry - M-MATH-106776 .....	52
3.27. Compressive Sensing - M-MATH-102935 .....	53
3.28. Computational Fluid Dynamics and Simulation Lab - M-MATH-106634 .....	54
3.29. Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems - M-MATH-102883 .....	55
3.30. Continuous Time Finance - M-MATH-102860 .....	56
3.31. Control Theory - M-MATH-102941 .....	58
3.32. Convex Geometry - M-MATH-102864 .....	59
3.33. Curves on Surfaces - M-MATH-106632 .....	61
3.34. Data Science for Finance - M-WIWI-105032 .....	62
3.35. Data Science: Evidence-based Marketing - M-WIWI-101647 .....	63
3.36. Decision and Game Theory - M-WIWI-102970 .....	64
3.37. Differential Geometry - M-MATH-101317 .....	65

3.38. Digital Marketing - M-WIWI-106258 .....	66
3.39. Discrete Dynamical Systems - M-MATH-105432 .....	67
3.40. Discrete Time Finance - M-MATH-102919 .....	68
3.41. Dispersive Equations - M-MATH-104425 .....	69
3.42. Dynamical Systems - M-MATH-103080 .....	70
3.43. Econometrics and Statistics I - M-WIWI-101638 .....	71
3.44. Econometrics and Statistics II - M-WIWI-101639 .....	72
3.45. Economic Theory and its Application in Finance - M-WIWI-101502 .....	73
3.46. eEnergy: Markets, Services and Systems - M-WIWI-103720 .....	74
3.47. Energy Economics and Energy Markets - M-WIWI-101451 .....	75
3.48. Energy Economics and Technology - M-WIWI-101452 .....	76
3.49. Ergodic Theory - M-MATH-106473 .....	77
3.50. Evolution Equations - M-MATH-102872 .....	78
3.51. Experimental Economics - M-WIWI-101505 .....	80
3.52. Exponential Integrators - M-MATH-103700 .....	81
3.53. Extremal Graph Theory - M-MATH-102957 .....	82
3.54. Extreme Value Theory - M-MATH-102939 .....	83
3.55. Finance 1 - M-WIWI-101482 .....	84
3.56. Finance 2 - M-WIWI-101483 .....	85
3.57. Finance 3 - M-WIWI-101480 .....	87
3.58. Finite Element Methods - M-MATH-102891 .....	88
3.59. Forecasting: Theory and Practice - M-MATH-102956 .....	89
3.60. Foundations for Advanced Financial -Quant and -Machine Learning Research - M-WIWI-105894 .....	90
3.61. Foundations of Continuum Mechanics - M-MATH-103527 .....	91
3.62. Fourier Analysis and its Applications to PDEs - M-MATH-104827 .....	92
3.63. Fractal Geometry - M-MATH-105649 .....	93
3.64. Functional Analysis - M-MATH-101320 .....	94
3.65. Functional Data Analysis - M-MATH-106485 .....	95
3.66. Functions of Matrices - M-MATH-102937 .....	96
3.67. Functions of Operators - M-MATH-102936 .....	97
3.68. Generalized Regression Models - M-MATH-102906 .....	98
3.69. Geometric Group Theory - M-MATH-102867 .....	99
3.70. Geometric Numerical Integration - M-MATH-102921 .....	100
3.71. Geometric Variational Problems - M-MATH-106667 .....	101
3.72. Geometry of Schemes - M-MATH-102866 .....	102
3.73. Global Differential Geometry - M-MATH-102912 .....	103
3.74. Graph Theory - M-MATH-101336 .....	104
3.75. Group Actions in Riemannian Geometry - M-MATH-102954 .....	105
3.76. Growth and Agglomeration - M-WIWI-101496 .....	106
3.77. Harmonic Analysis - M-MATH-105324 .....	107
3.78. Harmonic Analysis 2 - M-MATH-106486 .....	108
3.79. Homotopy Theory - M-MATH-102959 .....	109
3.80. Informatics - M-WIWI-101472 .....	110
3.81. Information Systems in Organizations - M-WIWI-104068 .....	112
3.82. Innovation and Growth - M-WIWI-101478 .....	113
3.83. Integral Equations - M-MATH-102874 .....	114
3.84. Introduction into Particulate Flows - M-MATH-102943 .....	115
3.85. Introduction to Aperiodic Order - M-MATH-105331 .....	116
3.86. Introduction to Convex Integration - M-MATH-105964 .....	117
3.87. Introduction to Dynamical Systems - M-MATH-106591 .....	118
3.88. Introduction to Fluid Dynamics - M-MATH-105650 .....	120
3.89. Introduction to Fluid Mechanics - M-MATH-106401 .....	121
3.90. Introduction to Geometric Measure Theory - M-MATH-102949 .....	122
3.91. Introduction to Homogeneous Dynamics - M-MATH-105101 .....	123
3.92. Introduction to Kinetic Equations - M-MATH-105837 .....	124
3.93. Introduction to Kinetic Theory - M-MATH-103919 .....	125
3.94. Introduction to Microlocal Analysis - M-MATH-105838 .....	126
3.95. Introduction to Scientific Computing - M-MATH-102889 .....	127
3.96. Introduction to Stochastic Differential Equations - M-MATH-106045 .....	128
3.97. Inverse Problems - M-MATH-102890 .....	129

3.98. Key Moments in Geometry - M-MATH-104057 .....	130
3.99. L2-Invariants - M-MATH-102952 .....	131
3.100. Lie Groups and Lie Algebras - M-MATH-104261 .....	132
3.101. Lie-Algebras (Linear Algebra 3) - M-MATH-105839 .....	133
3.102. Marketing and Sales Management - M-WIWI-105312 .....	134
3.103. Markov Decision Processes - M-MATH-102907 .....	135
3.104. Master's Thesis - M-MATH-102917 .....	136
3.105. Mathematical Methods in Signal and Image Processing - M-MATH-102897 .....	137
3.106. Mathematical Methods of Imaging - M-MATH-103260 .....	138
3.107. Mathematical Modelling and Simulation in Practise - M-MATH-102929 .....	139
3.108. Mathematical Programming - M-WIWI-101473 .....	141
3.109. Mathematical Statistics - M-MATH-102909 .....	143
3.110. Mathematical Topics in Kinetic Theory - M-MATH-104059 .....	145
3.111. Maxwell's Equations - M-MATH-102885 .....	146
3.112. Methodical Foundations of OR - M-WIWI-101414 .....	147
3.113. Metric Geometry - M-MATH-105931 .....	148
3.114. Microeconomic Theory - M-WIWI-101500 .....	149
3.115. Minimal Surfaces - M-MATH-106666 .....	150
3.116. Modeling the Dynamics of Financial Markets - M-WIWI-106660 .....	151
3.117. Modelling and Simulation of Lithium-Ion Batteries - M-MATH-106640 .....	154
3.118. Monotonicity Methods in Analysis - M-MATH-102887 .....	155
3.119. Nonlinear Analysis - M-MATH-103539 .....	156
3.120. Nonlinear Maxwell Equations - M-MATH-105066 .....	157
3.121. Nonlinear Wave Equations - M-MATH-105326 .....	158
3.122. Nonparametric Statistics - M-MATH-102910 .....	159
3.123. Numerical Analysis of Helmholtz Problems - M-MATH-105764 .....	160
3.124. Numerical Analysis of Neural Networks - M-MATH-106695 .....	161
3.125. Numerical Complex Analysis - M-MATH-106063 .....	162
3.126. Numerical Linear Algebra for Scientific High Performance Computing - M-MATH-103709 .....	163
3.127. Numerical Linear Algebra in Image Processing - M-MATH-104058 .....	164
3.128. Numerical Methods for Differential Equations - M-MATH-102888 .....	165
3.129. Numerical Methods for Hyperbolic Equations - M-MATH-102915 .....	166
3.130. Numerical Methods for Integral Equations - M-MATH-102930 .....	167
3.131. Numerical Methods for Maxwell's Equations - M-MATH-102931 .....	168
3.132. Numerical Methods for Oscillatory Differential Equations - M-MATH-106682 .....	169
3.133. Numerical Methods for Time-Dependent Partial Differential Equations - M-MATH-102928 .....	170
3.134. Numerical Methods in Computational Electrodynamics - M-MATH-102894 .....	171
3.135. Numerical Methods in Fluid Mechanics - M-MATH-102932 .....	172
3.136. Numerical Methods in Mathematical Finance - M-MATH-102901 .....	173
3.137. Numerical Optimisation Methods - M-MATH-102892 .....	175
3.138. Numerical Simulation in Molecular Dynamics - M-MATH-105327 .....	176
3.139. Operations Research in Supply Chain Management - M-WIWI-102832 .....	177
3.140. Optimisation and Optimal Control for Differential Equations - M-MATH-102899 .....	179
3.141. Optimization in Banach Spaces - M-MATH-102924 .....	180
3.142. Parallel Computing - M-MATH-101338 .....	181
3.143. Percolation - M-MATH-102905 .....	182
3.144. Poisson Processes - M-MATH-102922 .....	183
3.145. Potential Theory - M-MATH-102879 .....	184
3.146. Probability Theory and Combinatorial Optimization - M-MATH-102947 .....	185
3.147. Random Graphs and Networks - M-MATH-106052 .....	187
3.148. Regularity for Elliptic Operators - M-MATH-106696 .....	189
3.149. Riemann Surfaces - M-MATH-106466 .....	190
3.150. Ruin Theory - M-MATH-104055 .....	191
3.151. Scattering Theory - M-MATH-102884 .....	192
3.152. Scattering Theory for Time-dependent Waves - M-MATH-106664 .....	193
3.153. Selected Methods in Fluids and Kinetic Equations - M-MATH-105897 .....	194
3.154. Selected Topics in Harmonic Analysis - M-MATH-104435 .....	195
3.155. Semigroup Theory for the Navier-Stokes Equations - M-MATH-106663 .....	196
3.156. Seminar - M-WIWI-102971 .....	197
3.157. Seminar - M-MATH-102730 .....	198

3.158. Seminar - M-WIWI-102973 .....	199
3.159. Seminar - M-WIWI-102974 .....	200
3.160. Seminar - M-WIWI-102972 .....	201
3.161. Service Operations - M-WIWI-102805 .....	202
3.162. Sobolev Spaces - M-MATH-102926 .....	204
3.163. Space and Time Discretization of Nonlinear Wave Equations - M-MATH-105966 .....	205
3.164. Spatial Stochastics - M-MATH-102903 .....	206
3.165. Special Topics of Numerical Linear Algebra - M-MATH-102920 .....	207
3.166. Spectral Theory - M-MATH-101768 .....	208
3.167. Splitting Methods for Evolution Equations - M-MATH-105325 .....	209
3.168. Statistical Learning - M-MATH-105840 .....	210
3.169. Steins Method with Applications in Statistics - M-MATH-105579 .....	212
3.170. Stochastic Control - M-MATH-102908 .....	213
3.171. Stochastic Differential Equations - M-MATH-102881 .....	214
3.172. Stochastic Geometry - M-MATH-102865 .....	215
3.173. Stochastic Optimization - M-WIWI-103289 .....	216
3.174. Stochastic Simulation - M-MATH-106053 .....	218
3.175. Structural Graph Theory - M-MATH-105463 .....	219
3.176. Time Series Analysis - M-MATH-102911 .....	220
3.177. Topological Data Analysis - M-MATH-105487 .....	221
3.178. Topological Genomics - M-MATH-106064 .....	222
3.179. Translation Surfaces - M-MATH-105973 .....	223
3.180. Traveling Waves - M-MATH-102927 .....	224
3.181. Uncertainty Quantification - M-MATH-104054 .....	226
3.182. Variational Methods - M-MATH-105093 .....	227
3.183. Wavelets - M-MATH-102895 .....	228
<b>4. Courses.....</b>	<b>229</b>
4.1. Adaptive Finite Element Methods - T-MATH-105898 .....	229
4.2. Advanced Corporate Finance - T-WIWI-113469 .....	230
4.3. Advanced Empirical Asset Pricing - T-WIWI-110513 .....	231
4.4. Advanced Game Theory - T-WIWI-102861 .....	232
4.5. Advanced Inverse Problems: Nonlinearity and Banach Spaces - T-MATH-105927 .....	234
4.6. Advanced Lab Blockchain Hackathon (Master) - T-WIWI-111126 .....	235
4.7. Advanced Lab Informatics (Master) - T-WIWI-110548 .....	236
4.8. Advanced Lab Realization of Innovative Services (Master) - T-WIWI-112914 .....	243
4.9. Advanced Lab Security - T-WIWI-109786 .....	244
4.10. Advanced Lab Security, Usability and Society - T-WIWI-108439 .....	245
4.11. Advanced Lab Sociotechnical Information Systems Development (Master) - T-WIWI-111125 .....	252
4.12. Advanced Machine Learning and Data Science - T-WIWI-111305 .....	253
4.13. Advanced Methods in Nonlinear Partial Differential Equations - T-MATH-113691 .....	254
4.14. Advanced Statistics - T-WIWI-103123 .....	255
4.15. Advanced Stochastic Optimization - T-WIWI-106548 .....	256
4.16. Advanced Topics in Economic Theory - T-WIWI-102609 .....	257
4.17. Agent-Based Modelling and Simulation - T-WIWI-113629 .....	258
4.18. Algebra - T-MATH-102253 .....	261
4.19. Algebraic Geometry - T-MATH-103340 .....	262
4.20. Algebraic Number Theory - T-MATH-103346 .....	263
4.21. Algebraic Topology - T-MATH-105915 .....	264
4.22. Algebraic Topology II - T-MATH-105926 .....	265
4.23. Analytical and Numerical Homogenization - T-MATH-111272 .....	266
4.24. Applications of Topological Data Analysis - T-MATH-111290 .....	267
4.25. Applied Econometrics - T-WIWI-111388 .....	268
4.26. Applied Informatics – Principles of Internet Computing: Foundations for Emerging Technologies and Future Services - T-WIWI-110339 .....	269
4.27. Applied material flow simulation - T-MACH-112213 .....	271
4.28. Asset Pricing - T-WIWI-102647 .....	273
4.29. Auction Theory - T-WIWI-102613 .....	274
4.30. Bayesian Inverse Problems with Connections to Machine Learning - T-MATH-112842 .....	275
4.31. Bifurcation Theory - T-MATH-106487 .....	276
4.32. Bond Markets - T-WIWI-110995 .....	277

4.33. Bond Markets - Models & Derivatives - T-WIWI-110997 .....	278
4.34. Bond Markets - Tools & Applications - T-WIWI-110996 .....	279
4.35. Bott Periodicity - T-MATH-108905 .....	280
4.36. Boundary and Eigenvalue Problems - T-MATH-105833 .....	281
4.37. Boundary Element Methods - T-MATH-109851 .....	282
4.38. Brownian Motion - T-MATH-105868 .....	283
4.39. Business Intelligence Systems - T-WIWI-105777 .....	284
4.40. Business Process Modelling - T-WIWI-102697 .....	286
4.41. Challenges in Supply Chain Management - T-WIWI-102872 .....	288
4.42. Classical Methods for Partial Differential Equations - T-MATH-105832 .....	289
4.43. Collective Perception in Autonomous Driving - T-WIWI-113363 .....	290
4.44. Combinatorics - T-MATH-105916 .....	291
4.45. Comparison Geometry - T-MATH-105917 .....	292
4.46. Complex Analysis - T-MATH-105849 .....	293
4.47. Complex Geometry - T-MATH-113614 .....	294
4.48. Compressive Sensing - T-MATH-105894 .....	295
4.49. Computational Economics - T-WIWI-102680 .....	296
4.50. Computational Fluid Dynamics and Simulation Lab - T-MATH-113373 .....	298
4.51. Computational Risk and Asset Management - T-WIWI-102878 .....	299
4.52. Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems - T-MATH-105854 .....	300
4.53. Continuous Time Finance - T-MATH-105930 .....	301
4.54. Control Theory - T-MATH-105909 .....	302
4.55. Convex Analysis - T-WIWI-102856 .....	303
4.56. Convex Geometry - T-MATH-105831 .....	304
4.57. Cooperative Autonomous Vehicles - T-WIWI-112690 .....	305
4.58. Corporate Risk Management - T-WIWI-109050 .....	306
4.59. Critical Information Infrastructures - T-WIWI-109248 .....	307
4.60. Curves on Surfaces - T-MATH-113364 .....	308
4.61. Database Systems and XML - T-WIWI-102661 .....	309
4.62. Demand-Driven Supply Chain Planning - T-WIWI-110971 .....	311
4.63. Derivatives - T-WIWI-102643 .....	312
4.64. Designing Interactive Systems: Human-AI Interaction - T-WIWI-113465 .....	313
4.65. Differential Geometry - T-MATH-102275 .....	315
4.66. Digital Health - T-WIWI-109246 .....	316
4.67. Digital Marketing - T-WIWI-112693 .....	317
4.68. Digital Marketing and Sales in B2B - T-WIWI-106981 .....	318
4.69. Discrete Dynamical Systems - T-MATH-110952 .....	320
4.70. Discrete Time Finance - T-MATH-105839 .....	321
4.71. Discrete-Event Simulation in Production and Logistics - T-WIWI-102718 .....	322
4.72. Dispersive Equations - T-MATH-109001 .....	324
4.73. Dynamic Macroeconomics - T-WIWI-109194 .....	325
4.74. Dynamical Systems - T-MATH-106114 .....	326
4.75. Economics of Innovation - T-WIWI-112822 .....	327
4.76. Efficient Energy Systems and Electric Mobility - T-WIWI-102793 .....	329
4.77. eFinance: Information Systems for Securities Trading - T-WIWI-110797 .....	330
4.78. Emerging Trends in Digital Health - T-WIWI-110144 .....	331
4.79. Emerging Trends in Internet Technologies - T-WIWI-110143 .....	332
4.80. Energy and Environment - T-WIWI-102650 .....	333
4.81. Energy Market Engineering - T-WIWI-107501 .....	334
4.82. Energy Networks and Regulation - T-WIWI-107503 .....	336
4.83. Energy Trading and Risk Management - T-WIWI-112151 .....	337
4.84. Ergodic Theory - T-MATH-113086 .....	338
4.85. Evolution Equations - T-MATH-105844 .....	339
4.86. Experimental Economics - T-WIWI-102614 .....	340
4.87. Exponential Integrators - T-MATH-107475 .....	341
4.88. Extremal Graph Theory - T-MATH-105931 .....	342
4.89. Extreme Value Theory - T-MATH-105908 .....	343
4.90. Facility Location and Strategic Supply Chain Management - T-WIWI-102704 .....	344
4.91. Financial Analysis - T-WIWI-102900 .....	345
4.92. Financial Econometrics - T-WIWI-103064 .....	346

4.93. Financial Econometrics II - T-WIWI-110939 .....	348
4.94. Financial Intermediation - T-WIWI-102623 .....	349
4.95. Finite Element Methods - T-MATH-105857 .....	350
4.96. Forecasting: Theory and Practice - T-MATH-105928 .....	351
4.97. Foundations of Continuum Mechanics - T-MATH-107044 .....	352
4.98. Fourier Analysis and its Applications to PDEs - T-MATH-109850 .....	353
4.99. Fractal Geometry - T-MATH-111296 .....	354
4.100. Functional Analysis - T-MATH-102255 .....	355
4.101. Functional Data Analysis - T-MATH-113102 .....	357
4.102. Functions of Matrices - T-MATH-105906 .....	358
4.103. Functions of Operators - T-MATH-105905 .....	359
4.104. Fundamentals for Financial -Quant and -Machine Learning Research - T-WIWI-111846 .....	360
4.105. Generalized Regression Models - T-MATH-105870 .....	361
4.106. Geometric Group Theory - T-MATH-105842 .....	362
4.107. Geometric Numerical Integration - T-MATH-105919 .....	363
4.108. Geometric Variational Problems - T-MATH-113418 .....	364
4.109. Geometry of Schemes - T-MATH-105841 .....	365
4.110. Global Differential Geometry - T-MATH-105885 .....	366
4.111. Global Optimization I - T-WIWI-102726 .....	367
4.112. Global Optimization I and II - T-WIWI-103638 .....	369
4.113. Global Optimization II - T-WIWI-102727 .....	372
4.114. Graph Theory - T-MATH-102273 .....	374
4.115. Graph Theory and Advanced Location Models - T-WIWI-102723 .....	375
4.116. Group Actions in Riemannian Geometry - T-MATH-105925 .....	376
4.117. Growth and Development - T-WIWI-112816 .....	377
4.118. Harmonic Analysis - T-MATH-111289 .....	379
4.119. Harmonic Analysis 2 - T-MATH-113103 .....	380
4.120. Heat Economy - T-WIWI-102695 .....	381
4.121. Homotopy Theory - T-MATH-105933 .....	382
4.122. Human Factors in Autonomous Driving - T-WIWI-113059 .....	383
4.123. Human Factors in Security and Privacy - T-WIWI-109270 .....	384
4.124. Incentives in Organizations - T-WIWI-105781 .....	385
4.125. Information Service Engineering - T-WIWI-106423 .....	387
4.126. Integral Equations - T-MATH-105834 .....	389
4.127. International Business Development and Sales - T-WIWI-110985 .....	390
4.128. International Finance - T-WIWI-102646 .....	391
4.129. Introduction into Particulate Flows - T-MATH-105911 .....	392
4.130. Introduction to Aperiodic Order - T-MATH-110811 .....	393
4.131. Introduction to Convex Integration - T-MATH-112119 .....	394
4.132. Introduction to Dynamical Systems - T-MATH-113263 .....	395
4.133. Introduction to Fluid Dynamics - T-MATH-111297 .....	396
4.134. Introduction to Fluid Mechanics - T-MATH-112927 .....	397
4.135. Introduction to Geometric Measure Theory - T-MATH-105918 .....	398
4.136. Introduction to Homogeneous Dynamics - T-MATH-110323 .....	399
4.137. Introduction to Kinetic Equations - T-MATH-111721 .....	400
4.138. Introduction to Kinetic Theory - T-MATH-108013 .....	401
4.139. Introduction to Microlocal Analysis - T-MATH-111722 .....	402
4.140. Introduction to Scientific Computing - T-MATH-105837 .....	403
4.141. Introduction to Stochastic Differential Equations - T-MATH-112234 .....	404
4.142. Introduction to Stochastic Optimization - T-WIWI-106546 .....	405
4.143. Inverse Problems - T-MATH-105835 .....	406
4.144. Judgement and Decision Making - T-WIWI-111099 .....	407
4.145. Key Moments in Geometry - T-MATH-108401 .....	409
4.146. Knowledge Discovery - T-WIWI-102666 .....	410
4.147. L2-Invariants - T-MATH-105924 .....	412
4.148. Large-scale Optimization - T-WIWI-106549 .....	413
4.149. Liberalised Power Markets - T-WIWI-107043 .....	414
4.150. Lie Groups and Lie Algebras - T-MATH-108799 .....	417
4.151. Lie-Algebras (Linear Algebra 3) - T-MATH-111723 .....	418
4.152. Machine Learning 1 - Basic Methods - T-WIWI-106340 .....	419

4.153. Machine Learning 2 – Advanced Methods - T-WIWI-106341 .....	421
4.154. Machine Learning and Optimization in Energy Systems - T-WIWI-113073 .....	423
4.155. Market Research - T-WIWI-107720 .....	424
4.156. Marketing Analytics - T-WIWI-103139 .....	426
4.157. Markov Decision Processes - T-MATH-105921 .....	428
4.158. Master's Thesis - T-MATH-105878 .....	429
4.159. Matching Theory - T-WIWI-113264 .....	430
4.160. Mathematical Methods in Signal and Image Processing - T-MATH-105862 .....	431
4.161. Mathematical Methods of Imaging - T-MATH-106488 .....	432
4.162. Mathematical Modelling and Simulation in Practise - T-MATH-105889 .....	433
4.163. Mathematical Statistics - T-MATH-105872 .....	434
4.164. Mathematical Topics in Kinetic Theory - T-MATH-108403 .....	435
4.165. Mathematics for High Dimensional Statistics - T-WIWI-111247 .....	436
4.166. Maxwell's Equations - T-MATH-105856 .....	437
4.167. Media Management - T-WIWI-112711 .....	438
4.168. Metric Geometry - T-MATH-111933 .....	439
4.169. Minimal Surfaces - T-MATH-113417 .....	440
4.170. Mixed Integer Programming I - T-WIWI-102719 .....	441
4.171. Mixed Integer Programming II - T-WIWI-102720 .....	443
4.172. Modeling and OR-Software: Advanced Topics - T-WIWI-106200 .....	445
4.173. Modeling and OR-Software: Introduction - T-WIWI-106199 .....	446
4.174. Modeling and Simulation - T-WIWI-112685 .....	447
4.175. Modeling the Dynamics of Financial Markets - T-WIWI-113414 .....	449
4.176. Modelling and Simulation of Lithium-Ion Batteries - T-MATH-113382 .....	451
4.177. Monotonicity Methods in Analysis - T-MATH-105877 .....	452
4.178. Multicriteria Optimization - T-WIWI-111587 .....	453
4.179. Multivariate Statistical Methods - T-WIWI-103124 .....	455
4.180. Nature-Inspired Optimization Methods - T-WIWI-102679 .....	456
4.181. Non- and Semiparametrics - T-WIWI-103126 .....	457
4.182. Nonlinear Analysis - T-MATH-107065 .....	458
4.183. Nonlinear Maxwell Equations - T-MATH-110283 .....	459
4.184. Nonlinear Optimization I - T-WIWI-102724 .....	460
4.185. Nonlinear Optimization I and II - T-WIWI-103637 .....	462
4.186. Nonlinear Optimization II - T-WIWI-102725 .....	464
4.187. Nonlinear Wave Equations - T-MATH-110806 .....	466
4.188. Nonparametric Statistics - T-MATH-105873 .....	467
4.189. Numerical Analysis of Helmholtz Problems - T-MATH-111514 .....	468
4.190. Numerical Analysis of Neural Networks - T-MATH-113470 .....	469
4.191. Numerical Complex Analysis - T-MATH-112280 .....	470
4.192. Numerical Linear Algebra for Scientific High Performance Computing - T-MATH-107497 .....	471
4.193. Numerical Linear Algebra in Image Processing - T-MATH-108402 .....	472
4.194. Numerical Methods for Differential Equations - T-MATH-105836 .....	473
4.195. Numerical Methods for Hyperbolic Equations - T-MATH-105900 .....	474
4.196. Numerical Methods for Integral Equations - T-MATH-105901 .....	475
4.197. Numerical Methods for Maxwell's Equations - T-MATH-105920 .....	476
4.198. Numerical Methods for Oscillatory Differential Equations - T-MATH-113437 .....	477
4.199. Numerical Methods for Time-Dependent Partial Differential Equations - T-MATH-105899 .....	478
4.200. Numerical Methods in Computational Electrodynamics - T-MATH-105860 .....	479
4.201. Numerical Methods in Fluid Mechanics - T-MATH-105902 .....	480
4.202. Numerical Methods in Mathematical Finance - T-MATH-105865 .....	481
4.203. Numerical Optimisation Methods - T-MATH-105858 .....	482
4.204. Numerical Simulation in Molecular Dynamics - T-MATH-110807 .....	483
4.205. Online Concepts for Karlsruhe City Retailers - T-WIWI-111848 .....	484
4.206. Operations Research in Health Care Management - T-WIWI-102884 .....	485
4.207. Operations Research in Supply Chain Management - T-WIWI-102715 .....	486
4.208. Optimisation and Optimal Control for Differential Equations - T-MATH-105864 .....	487
4.209. Optimization in Banach Spaces - T-MATH-105893 .....	488
4.210. Optimization under Uncertainty - T-WIWI-106545 .....	489
4.211. Panel Data - T-WIWI-103127 .....	490
4.212. Parallel Computing - T-MATH-102271 .....	491



4.213. Parametric Optimization - T-WIWI-102855 .....	492
4.214. Percolation - T-MATH-105869 .....	493
4.215. Poisson Processes - T-MATH-105922 .....	494
4.216. Portfolio and Asset Liability Management - T-WIWI-103128 .....	495
4.217. Potential Theory - T-MATH-105850 .....	496
4.218. Practical Seminar: Health Care Management (with Case Studies) - T-WIWI-102716 .....	497
4.219. Practical Seminar: Human-Centered Systems - T-WIWI-113459 .....	498
4.220. Predictive Mechanism and Market Design - T-WIWI-102862 .....	499
4.221. Predictive Modeling - T-WIWI-110868 .....	500
4.222. Pricing - T-WIWI-102883 .....	501
4.223. Probabilistic Time Series Forecasting Challenge - T-WIWI-111387 .....	503
4.224. Probability Theory and Combinatorial Optimization - T-MATH-105923 .....	505
4.225. Process Mining - T-WIWI-109799 .....	506
4.226. Project Lab Cognitive Automobiles and Robots - T-WIWI-109985 .....	508
4.227. Project Lab Machine Learning - T-WIWI-109983 .....	510
4.228. Public Management - T-WIWI-102740 .....	511
4.229. Python for Computational Risk and Asset Management - T-WIWI-110213 .....	512
4.230. Quantitative Methods in Energy Economics - T-WIWI-107446 .....	513
4.231. Random Graphs and Networks - T-MATH-112241 .....	514
4.232. Regularity for Elliptic Operators - T-MATH-113472 .....	515
4.233. Regulation Theory and Practice - T-WIWI-102712 .....	516
4.234. Riemann Surfaces - T-MATH-113081 .....	517
4.235. Ruin Theory - T-MATH-108400 .....	518
4.236. Scattering Theory - T-MATH-105855 .....	519
4.237. Scattering Theory for Time-dependent Waves - T-MATH-113416 .....	520
4.238. Selected Methods in Fluids and Kinetic Equations - T-MATH-111853 .....	521
4.239. Selected Topics in Harmonic Analysis - T-MATH-109065 .....	522
4.240. Semantic Web Technologies - T-WIWI-110848 .....	523
4.241. Semigroup Theory for the Navier-Stokes Equations - T-MATH-113415 .....	526
4.242. Seminar in Business Administration A (Master) - T-WIWI-103474 .....	527
4.243. Seminar in Business Administration B (Master) - T-WIWI-103476 .....	538
4.244. Seminar in Economics A (Master) - T-WIWI-103478 .....	548
4.245. Seminar in Economics B (Master) - T-WIWI-103477 .....	553
4.246. Seminar in Informatics A (Master) - T-WIWI-103479 .....	557
4.247. Seminar in Informatics B (Master) - T-WIWI-103480 .....	568
4.248. Seminar in Operations Research A (Master) - T-WIWI-103481 .....	578
4.249. Seminar in Operations Research B (Master) - T-WIWI-103482 .....	581
4.250. Seminar in Statistics A (Master) - T-WIWI-103483 .....	584
4.251. Seminar in Statistics B (Master) - T-WIWI-103484 .....	587
4.252. Seminar Mathematics - T-MATH-105686 .....	590
4.253. Simulation Game in Energy Economics - T-WIWI-108016 .....	591
4.254. Smart Energy Infrastructure - T-WIWI-107464 .....	592
4.255. Smart Grid Applications - T-WIWI-107504 .....	593
4.256. Sobolev Spaces - T-MATH-105896 .....	594
4.257. Social Choice Theory - T-WIWI-102859 .....	595
4.258. Sociotechnical Information Systems Development - T-WIWI-109249 .....	596
4.259. Software Quality Management - T-WIWI-102895 .....	597
4.260. Space and Time Discretization of Nonlinear Wave Equations - T-MATH-112120 .....	599
4.261. Spatial Economics - T-WIWI-103107 .....	600
4.262. Spatial Stochastics - T-MATH-105867 .....	602
4.263. Special Topics in Information Systems - T-WIWI-113726 .....	603
4.264. Special Topics of Numerical Linear Algebra - T-MATH-105891 .....	604
4.265. Spectral Theory - Exam - T-MATH-103414 .....	605
4.266. Splitting Methods for Evolution Equations - T-MATH-110805 .....	606
4.267. Statistical Learning - T-MATH-111726 .....	607
4.268. Statistical Modeling of Generalized Regression Models - T-WIWI-103065 .....	608
4.269. Steins Method with Applications in Statistics - T-MATH-111187 .....	609
4.270. Stochastic Calculus and Finance - T-WIWI-103129 .....	610
4.271. Stochastic Control - T-MATH-105871 .....	612
4.272. Stochastic Differential Equations - T-MATH-105852 .....	613

4.273. Stochastic Geometry - T-MATH-105840 .....	614
4.274. Stochastic Simulation - T-MATH-112242 .....	615
4.275. Strategy and Management Theory: Developments and “Classics” - T-WIWI-106190 .....	616
4.276. Structural Graph Theory - T-MATH-111004 .....	619
4.277. Supplement Enterprise Information Systems - T-WIWI-110346 .....	620
4.278. Supplement Software- and Systemsengineering - T-WIWI-110372 .....	621
4.279. Tactical and Operational Supply Chain Management - T-WIWI-102714 .....	622
4.280. Time Series Analysis - T-MATH-105874 .....	624
4.281. Topics in Experimental Economics - T-WIWI-102863 .....	625
4.282. Topics in Stochastic Optimization - T-WIWI-112109 .....	626
4.283. Topological Data Analysis - T-MATH-111031 .....	627
4.284. Topological Genomics - T-MATH-112281 .....	628
4.285. Translation Surfaces - T-MATH-112128 .....	629
4.286. Traveling Waves - T-MATH-105897 .....	630
4.287. Trustworthy Emerging Technologies - T-WIWI-113026 .....	631
4.288. Uncertainty Quantification - T-MATH-108399 .....	632
4.289. Valuation - T-WIWI-102621 .....	634
4.290. Variational Methods - T-MATH-110302 .....	635
4.291. Wavelets - T-MATH-105838 .....	636
4.292. Web App Programming for Finance - T-WIWI-110933 .....	637
4.293. Workshop Business Wargaming – Analyzing Strategic Interactions - T-WIWI-106189 .....	638
4.294. Workshop Current Topics in Strategy and Management - T-WIWI-106188 .....	640

## 1 General information

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

### 1.1 Structural elements

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

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

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

### 1.2 Begin and completion of a module

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

### 1.3 Module versions

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

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

### 1.4 General and partial examinations

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

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

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

## 1.5 Types of examinations

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

## 1.6 Repeating examinations

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

## 1.7 Examiners

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

## 1.8 Additional accomplishments

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

## 1.9 Further information

For current information about studying at the KIT Department of Economics and Management, please visit our website [www.wiwi.kit.edu](http://www.wiwi.kit.edu) as well as [Instagram](#), [LinkedIn](#), and [YouTube](#). Please also see current notices and announcements for students at: <https://www.wiwi.kit.edu/studium.php>.

Information around the legal and official framework of the study program can be found in the respective study and examination regulations of your study program. These are available under the Official Announcements of KIT (<http://www.sle.kit.edu/amtlicheBekanntmachungen.php>).

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

## 1.10 Contact

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

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

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## 2 Field of study structure

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

### 2.1 Master's Thesis

**Credits**  
30

<b>Mandatory</b>	
M-MATH-102917	Master's Thesis 30 CR

## 2.2 Mathematical Methods

Credits  
36

<b>Stochastics (Election: at least 8 credits)</b>		
M-MATH-102860	Continuous Time Finance	8 CR
M-MATH-102865	Stochastic Geometry	8 CR
M-MATH-102903	Spatial Stochastics	8 CR
M-MATH-102904	Brownian Motion	4 CR
M-MATH-102905	Percolation	5 CR
M-MATH-102906	Generalized Regression Models	4 CR
M-MATH-102907	Markov Decision Processes	5 CR
M-MATH-102908	Stochastic Control	4 CR
M-MATH-102909	Mathematical Statistics	8 CR
M-MATH-102910	Nonparametric Statistics	4 CR
M-MATH-102911	Time Series Analysis	4 CR
M-MATH-102919	Discrete Time Finance	8 CR
M-MATH-102922	Poisson Processes	5 CR
M-MATH-102939	Extreme Value Theory	4 CR
M-MATH-102947	Probability Theory and Combinatorial Optimization	8 CR
M-MATH-102956	Forecasting: Theory and Practice	8 CR
M-MATH-104055	Ruin Theory	4 CR
M-MATH-105101	Introduction to Homogeneous Dynamics	6 CR
M-MATH-105487	Topological Data Analysis	6 CR
M-MATH-105579	Steins Method with Applications in Statistics	4 CR
M-MATH-105649	Fractal Geometry	6 CR
M-MATH-105651	Applications of Topological Data Analysis	4 CR
M-MATH-102864	Convex Geometry	8 CR
M-MATH-105840	Statistical Learning	8 CR
M-MATH-106045	Introduction to Stochastic Differential Equations	4 CR
M-MATH-106052	Random Graphs and Networks	8 CR
M-MATH-106064	Topological Genomics	3 CR
M-MATH-106485	Functional Data Analysis	4 CR
<b>Analysis or Applied and Numerical Mathematics, Optimization (Election: at least 8 credits)</b>		
M-MATH-101320	Functional Analysis	8 CR
M-MATH-101768	Spectral Theory	8 CR
M-MATH-102870	Classical Methods for Partial Differential Equations	8 CR
M-MATH-102871	Boundary and Eigenvalue Problems	8 CR
M-MATH-102872	Evolution Equations	8 CR
M-MATH-102874	Integral Equations	8 CR
M-MATH-102878	Complex Analysis	8 CR
M-MATH-102879	Potential Theory	8 CR
M-MATH-102881	Stochastic Differential Equations	8 CR
M-MATH-102883	Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems	8 CR
M-MATH-102885	Maxwell's Equations	8 CR
M-MATH-102890	Inverse Problems	8 CR
M-MATH-102924	Optimization in Banach Spaces	5 CR
M-MATH-102926	Sobolev Spaces	8 CR
M-MATH-102927	Traveling Waves	6 CR
M-MATH-102941	Control Theory	6 CR
M-MATH-102952	L2-Invariants	5 CR
M-MATH-103080	Dynamical Systems	8 CR
M-MATH-103259	Bifurcation Theory	5 CR
M-MATH-103539	Nonlinear Analysis	8 CR

M-MATH-102884	Scattering Theory	8 CR
M-MATH-104059	Mathematical Topics in Kinetic Theory	4 CR
M-MATH-104425	Dispersive Equations	6 CR
M-MATH-104435	Selected Topics in Harmonic Analysis	3 CR
M-MATH-101338	Parallel Computing	5 CR
M-MATH-102888	Numerical Methods for Differential Equations	8 CR
M-MATH-102889	Introduction to Scientific Computing	8 CR
M-MATH-102891	Finite Element Methods	8 CR
M-MATH-102892	Numerical Optimisation Methods	8 CR
M-MATH-102894	Numerical Methods in Computational Electrodynamics	6 CR
M-MATH-102895	Wavelets	8 CR
M-MATH-102897	Mathematical Methods in Signal and Image Processing	8 CR
M-MATH-102899	Optimisation and Optimal Control for Differential Equations	4 CR
M-MATH-102900	Adaptive Finite Element Methods	6 CR
M-MATH-102901	Numerical Methods in Mathematical Finance	8 CR
M-MATH-102915	Numerical Methods for Hyperbolic Equations	6 CR
M-MATH-102920	Special Topics of Numerical Linear Algebra	8 CR
M-MATH-102921	Geometric Numerical Integration	6 CR
M-MATH-102928	Numerical Methods for Time-Dependent Partial Differential Equations	8 CR
M-MATH-102929	Mathematical Modelling and Simulation in Practise	4 CR
M-MATH-102930	Numerical Methods for Integral Equations	8 CR
M-MATH-102931	Numerical Methods for Maxwell's Equations	6 CR
M-MATH-102932	Numerical Methods in Fluid Mechanics	4 CR
M-MATH-102935	Compressive Sensing	5 CR
M-MATH-102936	Functions of Operators	6 CR
M-MATH-102937	Functions of Matrices	8 CR
M-MATH-106634	Computational Fluid Dynamics and Simulation Lab	4 CR
M-MATH-102943	Introduction into Particulate Flows	3 CR
M-MATH-102955	Advanced Inverse Problems: Nonlinearity and Banach Spaces	5 CR
M-MATH-103260	Mathematical Methods of Imaging	5 CR
M-MATH-103527	Foundations of Continuum Mechanics	3 CR
M-MATH-103700	Exponential Integrators	6 CR
M-MATH-103709	Numerical Linear Algebra for Scientific High Performance Computing	5 CR
M-MATH-103919	Introduction to Kinetic Theory	4 CR
M-MATH-104054	Uncertainty Quantification	4 CR
M-MATH-104058	Numerical Linear Algebra in Image Processing	6 CR
M-MATH-104827	Fourier Analysis and its Applications to PDEs	6 CR
M-MATH-103540	Boundary Element Methods	8 CR
M-MATH-102887	Monotonicity Methods in Analysis	3 CR
M-MATH-105066	Nonlinear Maxwell Equations	8 CR
M-MATH-105101	Introduction to Homogeneous Dynamics	6 CR
M-MATH-105093	Variational Methods	8 CR
M-MATH-105324	Harmonic Analysis	8 CR
M-MATH-105325	Splitting Methods for Evolution Equations	6 CR
M-MATH-105326	Nonlinear Wave Equations	4 CR
M-MATH-105327	Numerical Simulation in Molecular Dynamics	8 CR
M-MATH-105432	Discrete Dynamical Systems	3 CR
M-MATH-105487	Topological Data Analysis	6 CR
M-MATH-105636	Analytical and Numerical Homogenization	6 CR
M-MATH-105650	Introduction to Fluid Dynamics	3 CR



M-MATH-105651	Applications of Topological Data Analysis	4 CR
M-MATH-105764	Numerical Analysis of Helmholtz Problems	3 CR
M-MATH-105837	Introduction to Kinetic Equations	3 CR
M-MATH-105838	Introduction to Microlocal Analysis	3 CR
M-MATH-105897	Selected Methods in Fluids and Kinetic Equations	3 CR
M-MATH-105964	Introduction to Convex Integration	3 CR
M-MATH-105966	Space and Time Discretization of Nonlinear Wave Equations	6 CR
M-MATH-106053	Stochastic Simulation	5 CR
M-MATH-106063	Numerical Complex Analysis	6 CR
M-MATH-106064	Topological Genomics	3 CR
M-MATH-106328	Bayesian Inverse Problems with Connections to Machine Learning	4 CR
M-MATH-106401	Introduction to Fluid Mechanics	6 CR
M-MATH-106486	Harmonic Analysis 2	8 CR
M-MATH-106591	Introduction to Dynamical Systems	6 CR
M-MATH-106640	Modelling and Simulation of Lithium-Ion Batteries	4 CR
M-MATH-106664	Scattering Theory for Time-dependent Waves	6 CR
M-MATH-106667	Geometric Variational Problems	8 CR
M-MATH-106666	Minimal Surfaces	3 CR
M-MATH-106663	Semigroup Theory for the Navier-Stokes Equations	6 CR
M-MATH-106696	Regularity for Elliptic Operators	6 CR
M-MATH-106695	Numerical Analysis of Neural Networks	6 CR
M-MATH-106682	Numerical Methods for Oscillatory Differential Equations	8 CR
M-MATH-106822	Advanced Methods in Nonlinear Partial Differential Equations <span style="color: red;">neu</span>	3 CR
<b>Algebra and Geometry (Election: at most 20 credits)</b>		
M-MATH-101315	Algebra	8 CR
M-MATH-101317	Differential Geometry	8 CR
M-MATH-101336	Graph Theory	8 CR
M-MATH-101724	Algebraic Geometry	8 CR
M-MATH-101725	Algebraic Number Theory	8 CR
M-MATH-102864	Convex Geometry	8 CR
M-MATH-102867	Geometric Group Theory	8 CR
M-MATH-102948	Algebraic Topology	8 CR
M-MATH-102949	Introduction to Geometric Measure Theory	6 CR
M-MATH-102950	Combinatorics	8 CR
M-MATH-102952	L2-Invariants	5 CR
M-MATH-102957	Extremal Graph Theory	4 CR
M-MATH-102959	Homotopy Theory	8 CR
M-MATH-102865	Stochastic Geometry	8 CR
M-MATH-102866	Geometry of Schemes	8 CR
M-MATH-102912	Global Differential Geometry	8 CR
M-MATH-102940	Comparison Geometry	5 CR
M-MATH-102953	Algebraic Topology II	8 CR
M-MATH-102954	Group Actions in Riemannian Geometry	5 CR
M-MATH-104057	Key Moments in Geometry	5 CR
M-MATH-104261	Lie Groups and Lie Algebras	8 CR
M-MATH-104349	Bott Periodicity	5 CR
M-MATH-105101	Introduction to Homogeneous Dynamics	6 CR
M-MATH-105331	Introduction to Aperiodic Order	3 CR
M-MATH-105463	Structural Graph Theory	4 CR
M-MATH-105487	Topological Data Analysis	6 CR

M-MATH-105649	Fractal Geometry	6 CR
M-MATH-105651	Applications of Topological Data Analysis	4 CR
M-MATH-105839	Lie-Algebras (Linear Algebra 3)	8 CR
M-MATH-105931	Metric Geometry	8 CR
M-MATH-105973	Translation Surfaces	8 CR
M-MATH-106064	Topological Genomics	3 CR
M-MATH-106466	Riemann Surfaces	8 CR
M-MATH-106473	Ergodic Theory	8 CR
M-MATH-106632	Curves on Surfaces	3 CR
M-MATH-106776	Complex Geometry	6 CR

### 2.3 Finance - Risk Management - Managerial Economics

Credits  
18

Finance - Risk Management - Managerial Economics (Election: at least 18 credits)		
M-WIWI-105659	Advanced Machine Learning and Data Science	9 CR
M-WIWI-101637	Analytics and Statistics	9 CR
M-WIWI-101504	Collective Decision Making	9 CR
M-WIWI-105032	Data Science for Finance	9 CR
M-WIWI-101647	Data Science: Evidence-based Marketing	9 CR
M-WIWI-106258	Digital Marketing	9 CR
M-WIWI-103720	eEnergy: Markets, Services and Systems	9 CR
M-WIWI-102970	Decision and Game Theory	9 CR
M-WIWI-101505	Experimental Economics	9 CR
M-WIWI-101482	Finance 1	9 CR
M-WIWI-101483	Finance 2	9 CR
M-WIWI-101480	Finance 3	9 CR
M-WIWI-105894	Foundations for Advanced Financial -Quant and -Machine Learning Research	9 CR
M-WIWI-104068	Information Systems in Organizations	9 CR
M-WIWI-101478	Innovation and Growth	9 CR
M-WIWI-101500	Microeconomic Theory	9 CR
M-WIWI-106660	Modeling the Dynamics of Financial Markets	9 CR
M-WIWI-101502	Economic Theory and its Application in Finance	9 CR
M-WIWI-101638	Econometrics and Statistics I	9 CR
M-WIWI-101639	Econometrics and Statistics II	9 CR
M-WIWI-103119	Advanced Topics in Strategy and Management	9 CR
M-WIWI-101496	Growth and Agglomeration	9 CR

**2.4 Operations Management - Data Analysis - Informatics****Credits**  
18

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

**2.5 Seminar in Economics and Management****Credits**  
3

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

**2.6 Mathematical Seminar****Credits**  
3

<b>Mandatory</b>		
M-MATH-102730	Seminar	3 CR

**2.7 Elective Field**

**Credits**  
12

Elective Field (Election: at least 12 credits)		
M-MATH-102864	Convex Geometry	8 CR
M-MATH-102866	Geometry of Schemes	8 CR
M-MATH-102872	Evolution Equations	8 CR
M-MATH-102879	Potential Theory	8 CR
M-MATH-102883	Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems	8 CR
M-MATH-102888	Numerical Methods for Differential Equations	8 CR
M-MATH-102890	Inverse Problems	8 CR
M-MATH-102891	Finite Element Methods	8 CR
M-MATH-102894	Numerical Methods in Computational Electrodynamics	6 CR
M-MATH-102904	Brownian Motion	4 CR
M-MATH-102906	Generalized Regression Models	4 CR
M-MATH-102909	Mathematical Statistics	8 CR
M-MATH-102910	Nonparametric Statistics	4 CR
M-MATH-102924	Optimization in Banach Spaces	5 CR
M-MATH-102927	Traveling Waves	6 CR
M-MATH-102931	Numerical Methods for Maxwell's Equations	6 CR
M-MATH-102936	Functions of Operators	6 CR
M-MATH-101315	Algebra	8 CR
M-MATH-101724	Algebraic Geometry	8 CR
M-MATH-101725	Algebraic Number Theory	8 CR
M-MATH-101768	Spectral Theory	8 CR
M-MATH-102867	Geometric Group Theory	8 CR
M-MATH-102874	Integral Equations	8 CR
M-MATH-102899	Optimisation and Optimal Control for Differential Equations	4 CR
M-MATH-102905	Percolation	5 CR
M-MATH-102915	Numerical Methods for Hyperbolic Equations	6 CR
M-MATH-102947	Probability Theory and Combinatorial Optimization	8 CR
M-MATH-102956	Forecasting: Theory and Practice	8 CR
M-MATH-101317	Differential Geometry	8 CR
M-MATH-101320	Functional Analysis	8 CR
M-MATH-101336	Graph Theory	8 CR
M-MATH-101338	Parallel Computing	5 CR
M-MATH-102860	Continuous Time Finance	8 CR
M-MATH-102878	Complex Analysis	8 CR
M-MATH-102885	Maxwell's Equations	8 CR
M-MATH-102889	Introduction to Scientific Computing	8 CR
M-MATH-102892	Numerical Optimisation Methods	8 CR
M-MATH-102930	Numerical Methods for Integral Equations	8 CR
M-MATH-102940	Comparison Geometry	5 CR
M-MATH-102941	Control Theory	6 CR
M-MATH-102952	L2-Invariants	5 CR
M-MATH-102895	Wavelets	8 CR
M-MATH-102897	Mathematical Methods in Signal and Image Processing	8 CR
M-MATH-102901	Numerical Methods in Mathematical Finance	8 CR
M-MATH-102907	Markov Decision Processes	5 CR
M-MATH-102908	Stochastic Control	4 CR
M-MATH-102911	Time Series Analysis	4 CR
M-MATH-102912	Global Differential Geometry	8 CR
M-MATH-102919	Discrete Time Finance	8 CR

M-MATH-102920	Special Topics of Numerical Linear Algebra	8 CR
M-MATH-102922	Poisson Processes	5 CR
M-MATH-102926	Sobolev Spaces	8 CR
M-MATH-102928	Numerical Methods for Time-Dependent Partial Differential Equations	8 CR
M-MATH-102929	Mathematical Modelling and Simulation in Practise	4 CR
M-MATH-102932	Numerical Methods in Fluid Mechanics	4 CR
M-MATH-102935	Compressive Sensing	5 CR
M-MATH-102937	Functions of Matrices	8 CR
M-MATH-102939	Extreme Value Theory	4 CR
M-MATH-102943	Introduction into Particulate Flows	3 CR
M-MATH-102948	Algebraic Topology	8 CR
M-MATH-102949	Introduction to Geometric Measure Theory	6 CR
M-MATH-102954	Group Actions in Riemannian Geometry	5 CR
M-MATH-102959	Homotopy Theory	8 CR
M-MATH-102865	Stochastic Geometry	8 CR
M-MATH-102870	Classical Methods for Partial Differential Equations	8 CR
M-MATH-102871	Boundary and Eigenvalue Problems	8 CR
M-MATH-102881	Stochastic Differential Equations	8 CR
M-MATH-102900	Adaptive Finite Element Methods	6 CR
M-MATH-102903	Spatial Stochastics	8 CR
M-MATH-102921	Geometric Numerical Integration	6 CR
M-MATH-106634	Computational Fluid Dynamics and Simulation Lab	4 CR
M-MATH-102950	Combinatorics	8 CR
M-MATH-102953	Algebraic Topology II	8 CR
M-MATH-102955	Advanced Inverse Problems: Nonlinearity and Banach Spaces	5 CR
M-MATH-102957	Extremal Graph Theory	4 CR
M-WIWI-101413	Applications of Operations Research	9 CR
M-WIWI-101414	Methodical Foundations of OR	9 CR
M-WIWI-101452	Energy Economics and Technology	9 CR
M-WIWI-101472	Informatics	9 CR
M-WIWI-101473	Mathematical Programming	9 CR
M-WIWI-101478	Innovation and Growth	9 CR
M-WIWI-101480	Finance 3	9 CR
M-WIWI-101482	Finance 1	9 CR
M-WIWI-101483	Finance 2	9 CR
M-WIWI-101496	Growth and Agglomeration	9 CR
M-WIWI-101500	Microeconomic Theory	9 CR
M-WIWI-101502	Economic Theory and its Application in Finance	9 CR
M-WIWI-101504	Collective Decision Making	9 CR
M-WIWI-101505	Experimental Economics	9 CR
M-WIWI-101637	Analytics and Statistics	9 CR
M-WIWI-101638	Econometrics and Statistics I	9 CR
M-WIWI-101639	Econometrics and Statistics II	9 CR
M-WIWI-102832	Operations Research in Supply Chain Management	9 CR
M-WIWI-102970	Decision and Game Theory	9 CR
M-WIWI-102971	Seminar	3 CR
M-WIWI-102972	Seminar	3 CR
M-WIWI-102973	Seminar	3 CR
M-WIWI-102974	Seminar	3 CR
M-MATH-103080	Dynamical Systems	8 CR

M-MATH-103259	Bifurcation Theory	5 CR
M-MATH-103260	Mathematical Methods of Imaging	5 CR
M-WIWI-103289	Stochastic Optimization	9 CR
M-WIWI-103119	Advanced Topics in Strategy and Management	9 CR
M-WIWI-103720	eEnergy: Markets, Services and Systems	9 CR
M-MATH-103527	Foundations of Continuum Mechanics	3 CR
M-MATH-103539	Nonlinear Analysis	8 CR
M-MATH-103700	Exponential Integrators	6 CR
M-MATH-103709	Numerical Linear Algebra for Scientific High Performance Computing	5 CR
M-MATH-103919	Introduction to Kinetic Theory	4 CR
M-WIWI-104068	Information Systems in Organizations	9 CR
M-MATH-104054	Uncertainty Quantification	4 CR
M-MATH-104055	Ruin Theory	4 CR
M-MATH-104057	Key Moments in Geometry	5 CR
M-MATH-104058	Numerical Linear Algebra in Image Processing	6 CR
M-MATH-104059	Mathematical Topics in Kinetic Theory	4 CR
M-MATH-102884	Scattering Theory	8 CR
M-MATH-104261	Lie Groups and Lie Algebras	8 CR
M-MATH-104349	Bott Periodicity	5 CR
M-MATH-104425	Dispersive Equations	6 CR
M-MATH-104435	Selected Topics in Harmonic Analysis	3 CR
M-MATH-104827	Fourier Analysis and its Applications to PDEs	6 CR
M-MATH-103540	Boundary Element Methods	8 CR
M-MATH-102887	Monotonicity Methods in Analysis	3 CR
M-MATH-105066	Nonlinear Maxwell Equations	8 CR
M-MATH-105101	Introduction to Homogeneous Dynamics	6 CR
M-MATH-105093	Variational Methods	8 CR
M-WIWI-105312	Marketing and Sales Management	9 CR
M-MATH-105324	Harmonic Analysis	8 CR
M-MATH-105325	Splitting Methods for Evolution Equations	6 CR
M-MATH-105326	Nonlinear Wave Equations	4 CR
M-MATH-105327	Numerical Simulation in Molecular Dynamics	8 CR
M-MATH-105331	Introduction to Aperiodic Order	3 CR
M-MATH-105432	Discrete Dynamical Systems	3 CR
M-MATH-105463	Structural Graph Theory	4 CR
M-MATH-105487	Topological Data Analysis	6 CR
M-MATH-105579	Steins Method with Applications in Statistics	4 CR
M-MATH-105636	Analytical and Numerical Homogenization	6 CR
M-MATH-105649	Fractal Geometry	6 CR
M-MATH-105650	Introduction to Fluid Dynamics	3 CR
M-MATH-105651	Applications of Topological Data Analysis	4 CR
M-MATH-105764	Numerical Analysis of Helmholtz Problems	3 CR
M-MATH-105837	Introduction to Kinetic Equations	3 CR
M-MATH-105838	Introduction to Microlocal Analysis	3 CR
M-MATH-105839	Lie-Algebras (Linear Algebra 3)	8 CR
M-MATH-105840	Statistical Learning	8 CR
M-MATH-105897	Selected Methods in Fluids and Kinetic Equations	3 CR
M-MATH-105931	Metric Geometry	8 CR
M-MATH-105964	Introduction to Convex Integration	3 CR
M-MATH-105966	Space and Time Discretization of Nonlinear Wave Equations	6 CR

M-MATH-105973	Translation Surfaces	8 CR
M-MATH-106045	Introduction to Stochastic Differential Equations	4 CR
M-MATH-106052	Random Graphs and Networks	8 CR
M-MATH-106053	Stochastic Simulation	5 CR
M-MATH-106063	Numerical Complex Analysis	6 CR
M-MATH-106064	Topological Genomics	3 CR
M-MATH-106328	Bayesian Inverse Problems with Connections to Machine Learning	4 CR
M-MATH-106401	Introduction to Fluid Mechanics	6 CR
M-MATH-106466	Riemann Surfaces	8 CR
M-MATH-106473	Ergodic Theory	8 CR
M-MATH-106485	Functional Data Analysis	4 CR
M-MATH-106486	Harmonic Analysis 2	8 CR
M-MATH-106591	Introduction to Dynamical Systems	6 CR
M-MATH-106632	Curves on Surfaces	3 CR
M-MATH-106640	Modelling and Simulation of Lithium-Ion Batteries	4 CR
M-MATH-106664	Scattering Theory for Time-dependent Waves	6 CR
M-MATH-106667	Geometric Variational Problems	8 CR
M-MATH-106666	Minimal Surfaces	3 CR
M-MATH-106663	Semigroup Theory for the Navier-Stokes Equations	6 CR
M-MATH-106696	Regularity for Elliptic Operators	6 CR
M-MATH-106695	Numerical Analysis of Neural Networks	6 CR
M-MATH-106682	Numerical Methods for Oscillatory Differential Equations	8 CR
M-MATH-106776	Complex Geometry	6 CR
M-MATH-106822	Advanced Methods in Nonlinear Partial Differential Equations <sup>neu</sup>	3 CR
M-WIWI-101647	Data Science: Evidence-based Marketing <sup>neu</sup>	9 CR



## 3 Modules

M

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

**Responsible:** Prof. Dr. Willy Dörfler

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-105898	<a href="#">Adaptive Finite Element Methods</a>	6 CR	Dörfler

#### Competence Certificate

oral exam of ca. 25 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 boundary value problems numerically

#### Content

- Necessity of adaptive methods
- Residual error estimator
- Aspects of implementations
- Optimality of adaptive methods
- Functional error estimator
- hp-Finite Elements

#### Module grade calculation

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

#### Workload

Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

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

#### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Andreas Rieder

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-105927	<a href="#">Advanced Inverse Problems: Nonlinearity and Banach Spaces</a>	5 CR	Rieder

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

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

### Content

Inexact Newton methods in Hilbert spaces,

Approximate Inverse in Banach spaces

Tikhonov regularization with convex penalty

Kaczmarz-Newton methods in Banach spaces

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

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

### Recommendation

Inverse problems, Functional analysis

## M

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

**Responsible:** Prof. Dr. Maxim Ulrich  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)

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

Mandatory			
T-WIWI-111305	<a href="#">Advanced Machine Learning and Data Science</a>	9 CR	Ulrich

**Competence Certificate**

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

**Prerequisites**

The module M-WIWI-106660 "Modeling the Dynamics of Financial Markets" must be passed.

**Competence Goal**

After a successful project, the students can:

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

**Content**

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

**Workload**

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

**Recommendation**

None

## M

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

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-113691	<a href="#">Advanced Methods in Nonlinear Partial Differential Equations</a>	3 CR	de Rijk, Reichel

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

After successful completion of this module students

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

### Content

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

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

### Module grade calculation

The module grade is the grade of the oral examination.

### Workload

Total workload: 90 hours

Attendance: 30 hours

- lectures and examination

Self-studies: 60 hours

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

### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Hagen Lindstädt  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

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

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

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

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

**Content**

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

**Annotation**

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

**Workload**

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

## M

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

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

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each winter term

**Duration**  
1 term

**Level**  
4

**Version**  
2

Mandatory			
T-MATH-102253	<a href="#">Algebra</a>	8 CR	Kühnlein, Sauer

**Competence Certificate**

Oral examination of ca. 30 minutes.

**Prerequisites**

None

**Competence Goal**

Students are able to

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

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

**Content**

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

**Module grade calculation**

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

**Workload**

Total workload : 240 hours.

Attendance: 90 h

- lectures and tutorials including the examination

Self studies: 150 h

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

**Recommendation**

Basic knowledge on groups and rings is beneficial.

## M

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

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

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

Mandatory			
T-MATH-103340	<a href="#">Algebraic Geometry</a>	8 CR	Herrlich, Kühnlein

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

Participants are able to

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

**Content**

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

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total work load:

Attendance: 90 minutes

- lectures, problem classes an examination

Self studies: 150 hours

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

**Recommendation**

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

## M

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

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

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

Mandatory			
T-MATH-103346	<a href="#">Algebraic Number Theory</a>	8 CR	Herrlich, Kühnlein

**Competence Certificate**

oral examination of ca. 30 minutes

**Prerequisites**

none

**Competence Goal**

Students are able to

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

**Content**

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

**Module grade calculation**

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

**Workload**

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

**Recommendation**

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



## M

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

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

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

Mandatory			
T-MATH-105915	<a href="#">Algebraic Topology</a>	8 CR	Krannich, Sauer

**Prerequisites**  
 none

## M

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

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

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

Mandatory			
T-MATH-105926	<a href="#">Algebraic Topology II</a>	8 CR	Sauer

**Prerequisites**  
 none

## M

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

**Responsible:** TT-Prof. Dr. Roland Maier

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-111272	<a href="#">Analytical and Numerical Homogenization</a>	6 CR	Hochbruck, Maier

#### Competence Certificate

Oral examination of approximately 30 minutes.

#### Prerequisites

None.

#### Competence Goal

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

#### Content

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

#### Module grade calculation

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

#### Annotation

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

#### Workload

Total workload: 180 h

Attendance: 60 h

- Course including module examination during study.

Self-studies: 120 h

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

#### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Oliver Grothe  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

Compulsory Elective Courses (Election: )			
T-WIWI-106341	<a href="#">Machine Learning 2 - Advanced Methods</a>	4,5 CR	Zöllner
T-WIWI-111247	<a href="#">Mathematics for High Dimensional Statistics</a>	4,5 CR	Grothe
T-WIWI-103124	<a href="#">Multivariate Statistical Methods</a>	4,5 CR	Grothe
T-WIWI-103123	<a href="#">Advanced Statistics</a>	4,5 CR	Grothe
T-WIWI-112109	<a href="#">Topics in Stochastic Optimization</a>	4,5 CR	Rebennack

**Competence Certificate**

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

**Competence Goal**

A Student

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

**Content**

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

**Annotation**

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

**Workload**

The total workload for this module is approximately 270 hours.

## M

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

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Operations Management - Data Analysis - Informatics](#)  
 Elective Field

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

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

### Competence Certificate

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

The assessment procedures are described for each course of the module 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 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 Supply Chain Management, including methods of scheduling as well as different approaches in procurement and distribution logistics. Finally, issues of warehousing and inventory management will be discussed.

### Annotation

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

**Workload**

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

**Recommendation**

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

## M

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

**Responsible:** Dr. Andreas Ott

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Stochastics\)](#)  
[Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Mathematical Methods \(Algebra and Geometry\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-111290	<a href="#">Applications of Topological Data Analysis</a>	4 CR	Ott

**Prerequisites**

None

## M

**3.15 Module: Bayesian Inverse Problems with Connections to Machine Learning [M-MATH-106328]****Responsible:** TT-Prof. Dr. Sebastian Krumscheid**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-112842	<a href="#">Bayesian Inverse Problems with Connections to Machine Learning</a>	4 CR	Krumscheid

**Competence Certificate**

oral exam of ca. 30 min

**Prerequisites**

None

**Competence Goal**

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

**Content**

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

Topics covered include:

- Bayesian Inverse Problems and Well-Posedness
- The Linear-Gaussian Setting
- Optimization Perspective on Bayesian Inverse Problems
- Gaussian Approximation
- Markov Chain Monte Carlo
- Blending Inverse Problems and Machine-Learning
- Bayesian Inversion in Banach spaces

**Module grade calculation**

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

**Workload**

total workload: 120 hours

**Recommendation**

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



## M

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

**Responsible:** Dr. Rainer Mandel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
5

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-106487	<a href="#">Bifurcation Theory</a>	5 CR	Mandel

**Prerequisites**

None

**Annotation**

Course is held in English

M

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

**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Algebra and Geometry\)](#)  
Elective Field

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

Mandatory			
T-MATH-108905	<a href="#">Bott Periodicity</a>	5 CR	Tuschmann

**Prerequisites**

None

## M

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

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each summer term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105833	<a href="#">Boundary and Eigenvalue Problems</a>	8 CR	Frey, Hundertmark, Lamm, Plum, Reichel, Schnaubelt

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

Graduates will be able to

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

## M

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

**Responsible:** PD Dr. Tilo Arens

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-109851	<a href="#">Boundary Element Methods</a>	8 CR	Arens

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

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

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral examination.

### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

### Recommendation

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

## M

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

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

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

Mandatory			
T-MATH-105868	<a href="#">Brownian Motion</a>	4 CR	Bäuerle, Fassen-Hartmann, Last

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

At the end of the course, students

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

**Content**

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

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: zz hours

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

**Recommendation**

The course 'Probability Theory' is strongly recommended.

## M

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

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each winter term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105832	<a href="#">Classical Methods for Partial Differential Equations</a>	8 CR	Frey, Hundertmark, Lamm, Plum, Reichel, Schnaubelt

## M

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

**Responsible:** Prof. Dr. Clemens Puppe  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

Compulsory Elective Courses (Election: )			
T-WIWI-102740	<a href="#">Public Management</a>	4,5 CR	Wigger
T-WIWI-102859	<a href="#">Social Choice Theory</a>	4,5 CR	Puppe

**Competence Certificate**

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

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

## 3.23 Module: Combinatorics [M-MATH-102950]

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

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

Mandatory			
T-MATH-105916	<a href="#">Combinatorics</a>	8 CR	Aksenovich

**Competence Certificate**

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

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

**Prerequisites**

none

**Competence Goal**

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

**Content**

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

**Module grade calculation**

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

**Annotation**

- Regular cycle: every 2nd year, summer semester
- Course is held in English

**Workload**

Total workload: 240 hours

Attendance time: 90 hours

- Course including module examination during the course of study

Self-study: 150 hours

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

**Recommendation**

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



## M

## 3.24 Module: Comparison Geometry [M-MATH-102940]

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

**Credits**  
5

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
5

**Version**  
1

Mandatory			
T-MATH-105917	<a href="#">Comparison Geometry</a>	5 CR	Tuschmann

**Prerequisites**  
none

## M

## 3.25 Module: Complex Analysis [M-MATH-102878]

**Responsible:** PD Dr. Gerd Herzog

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105849	<a href="#">Complex Analysis</a>	8 CR	Herzog, Plum, Reichel, Schnaubelt, Tolksdorf

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

At the end of the course, students can

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

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

## M

## 3.26 Module: Complex Geometry [M-MATH-106776]

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

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

Mandatory			
T-MATH-113614	<a href="#">Complex Geometry</a>	6 CR	Llosa Isenrich

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

Graduates

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

**Content**

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

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 180 hours

Attendance: 60 hours

- lectures and examination

Self-studies: 120 hours

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

**Recommendation**

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

## M

## 3.27 Module: Compressive Sensing [M-MATH-102935]

**Responsible:** Prof. Dr. Andreas Rieder

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
5

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105894	<a href="#">Compressive Sensing</a>	5 CR	Rieder

### Competence Certificate

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

### Competence Goal

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

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

### Recommendation

The course "Introduction to stochastics" is recommended.

## M

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

**Responsible:** PD Dr. Gudrun Thäter

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-113373	<a href="#">Computational Fluid Dynamics and Simulation Lab</a>	4 CR	Krause, Thäter

#### Competence Certificate

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

#### Prerequisites

none

#### Competence Goal

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

#### Content

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

**Own group work:** Working on 1-2 projects in which modelling, discretization, simulation and evaluation (e.g. visualization) are carried out for specific topics from the catalog. The catalog includes e.g: Diffusion processes, turbulent flows, multiphase flows, reactive flows, particle dynamics, optimal control and optimization under constraints, stabilization methods for advection-dominated transport problems.

#### Module grade calculation

The module grade is the grade of the final project.

#### Workload

Total workload: 120 hours

Attendance: 60 hours

- lectures and examination

Self-studies: 60 hours

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

#### Recommendation

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

## M

**3.29 Module: Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems [M-MATH-102883]****Responsible:** Prof. Dr. Michael Plum**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field**Credits**  
8**Grading scale**  
Grade to a tenth**Recurrence**  
Irregular**Duration**  
1 term**Level**  
4**Version**  
1

Mandatory			
T-MATH-105854	<a href="#">Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems</a>	8 CR	Plum

## M

## 3.30 Module: Continuous Time Finance [M-MATH-102860]

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

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

Mandatory			
T-MATH-105930	<a href="#">Continuous Time Finance</a>	8 CR	Bäuerle, Fassen-Hartmann, Trabs

**Competence Certificate**

oral examination of ca. 30 min.

**Prerequisites**

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

**Competence Goal**

Students are able to

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

**Content**

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

**Module grade calculation**

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

**Workload**

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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



**Recommendation**

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

## M

## 3.31 Module: Control Theory [M-MATH-102941]

**Responsible:** Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105909	<a href="#">Control Theory</a>	6 CR	Schnaubelt

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

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

### Content

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

### Module grade calculation

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

### Workload

Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

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

### Recommendation

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

### Literature

J. Zabczyk, Mathematical Control Theory. An Introduction.

## M

## 3.32 Module: Convex Geometry [M-MATH-102864]

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

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105831	<a href="#">Convex Geometry</a>	8 CR	Hug

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

The students

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

**Content**

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

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Literature**

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

## M

## 3.33 Module: Curves on Surfaces [M-MATH-106632]

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

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

Mandatory			
T-MATH-113364	<a href="#">Curves on Surfaces</a>	3 CR	Fioravanti

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

At the end of the course, students

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

**Content**

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

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 90 hours

Attendance: 30 hours

- lectures and examination

Self-studies: 60 hours

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

**Recommendation**

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

## M

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

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

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

Mandatory			
T-WIWI-102878	<a href="#">Computational Risk and Asset Management</a>	4,5 CR	Ulrich
T-WIWI-110213	<a href="#">Python for Computational Risk and Asset Management</a>	4,5 CR	Ulrich

### Competence Certificate

The module examination takes the form of an alternative exam assessment.

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

### Competence Goal

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

### Content

The course covers several topics, among them:

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

### Workload

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

### Recommendation

Basic knowledge of capital market theory.

## M

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

**Responsible:** Prof. Dr. Martin Klarmann  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

Compulsory Elective Courses (Election: 9 credits)			
T-WIWI-103139	<a href="#">Marketing Analytics</a>	4,5 CR	Klarmann
T-WIWI-107720	<a href="#">Market Research</a>	4,5 CR	Klarmann

**Competence Certificate**

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

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

**Prerequisites**

Keine.

**Competence Goal**

Students

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

**Content**

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

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

**Workload**

The total workload for this module is approximately 270 hours.

**Recommendation**

None

## M

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

**Responsible:** Prof. Dr. Clemens Puppe  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

Wahlpflichtangebot (Election: 9 credits)			
T-WIWI-102613	<a href="#">Auction Theory</a>	4,5 CR	Ehrhart
T-WIWI-102614	<a href="#">Experimental Economics</a>	4,5 CR	Weinhardt
T-WIWI-102861	<a href="#">Advanced Game Theory</a>	4,5 CR	Ehrhart, Puppe, Reiß

**Competence Certificate**

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

## 3.37 Module: Differential Geometry [M-MATH-101317]

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

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each summer term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-102275	<a href="#">Differential Geometry</a>	8 CR	Tuschmann

**Prerequisites**  
None

## M

## 3.38 Module: Digital Marketing [M-WIWI-106258]

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

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

Mandatory			
T-WIWI-112693	Digital Marketing	4,5 CR	Kupfer
Supplementary Courses (Election: 4,5 credits)			
T-WIWI-106981	Digital Marketing and Sales in B2B	1,5 CR	Klarmann, Konhäuser
T-WIWI-111099	Judgement and Decision Making	4,5 CR	Scheibehenne
T-WIWI-107720	Market Research	4,5 CR	Klarmann
T-WIWI-112711	Media Management	4,5 CR	Kupfer
T-WIWI-111848	Online Concepts for Karlsruhe City Retailers	3 CR	Klarmann

**Competence Certificate**

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

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

**Prerequisites**

None

**Competence Goal**

Students

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

**Content**

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

**Workload**

Total effort for 9 credit points: approx. 270 hours.

The exact distribution is done according to the credit points of the courses of the module.

## M

## 3.39 Module: Discrete Dynamical Systems [M-MATH-105432]

**Responsible:** PD Dr. Gerd Herzog

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-110952	<a href="#">Discrete Dynamical Systems</a>	3 CR	Herzog

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

At the end of the course, students can

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 90 hours

Attendance: 30 hours

- lectures, problem classes, and examination

Self-studies: 60 hours

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

### Recommendation

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

## M

## 3.40 Module: Discrete Time Finance [M-MATH-102919]

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

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each winter term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105839	<a href="#">Discrete Time Finance</a>	8 CR	Bäuerle, Fassen-Hartmann, Trabs

**Competence Certificate**

Written exam of 2h.

**Prerequisites**

none

**Competence Goal**

Students are able to

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

**Content**

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

**Module grade calculation**

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

**Workload**

Total workload: 240 hours

Attendance: 90 h

- lectures and examination

Self studies: 150 h

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

**Recommendation**

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

## M

## 3.41 Module: Dispersive Equations [M-MATH-104425]

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
6

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-109001	<a href="#">Dispersive Equations</a>	6 CR	Reichel

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

Graduates will be able to

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

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

### Recommendation

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

## M

## 3.42 Module: Dynamical Systems [M-MATH-103080]

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-106114	<a href="#">Dynamical Systems</a>	8 CR	Reichel

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

Graduates will be able to

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

### Recommendation

The module 'Functional Analysis' is recommended.

## M

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

**Responsible:** Prof. Dr. Melanie Schienle  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

<b>Credits</b> 9	<b>Grading scale</b> Grade to a tenth	<b>Recurrence</b> Each term	<b>Duration</b> 1 term	<b>Language</b> German/English	<b>Level</b> 4	<b>Version</b> 5
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Mandatory			
T-WIWI-111388	<a href="#">Applied Econometrics</a>	4,5 CR	Schienle
Supplementary Courses (Election: between 4,5 and 5 credits)			
T-WIWI-103064	<a href="#">Financial Econometrics</a>	4,5 CR	Schienle
T-WIWI-103126	<a href="#">Non- and Semiparametrics</a>	4,5 CR	Schienle
T-WIWI-103127	<a href="#">Panel Data</a>	4,5 CR	Heller
T-WIWI-110868	<a href="#">Predictive Modeling</a>	4,5 CR	Krüger
T-WIWI-111387	<a href="#">Probabilistic Time Series Forecasting Challenge</a>	4,5 CR	Krüger
T-WIWI-103065	<a href="#">Statistical Modeling of Generalized Regression Models</a>	4,5 CR	Heller
T-WIWI-110939	<a href="#">Financial Econometrics II</a>	4,5 CR	Schienle

**Competence Certificate**

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

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

**Prerequisites**

The course "Applied Econometrics" [2520020] is compulsory and must be examined.

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

**Responsible:** Prof. Dr. Melanie Schienle  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

<b>Credits</b> 9	<b>Grading scale</b> Grade to a tenth	<b>Recurrence</b> Each term	<b>Duration</b> 1 term	<b>Language</b> German	<b>Level</b> 4	<b>Version</b> 5
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**Election notes**

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

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

**Competence Certificate**

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

**Prerequisites**

This module can only be passed if the module "Econometrics and Statistics I" has been finished successfully before.  
 At least one course must be chosen from the compulsory elective programme.

**Competence Goal**

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

**Content**

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

**Workload**

The total workload for this module is approximately 270 hours.



## M

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

**Responsible:** Prof. Dr. Kay Mitusch  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

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

**Competence Certificate**

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

**Prerequisites**

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

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

**Responsible:** Prof. Dr. Christof Weinhardt  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

<b>Credits</b> 9	<b>Grading scale</b> Grade to a tenth	<b>Recurrence</b> Each term	<b>Duration</b> 1 term	<b>Language</b> German	<b>Level</b> 4	<b>Version</b> 3
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Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-107501	<a href="#">Energy Market Engineering</a>	4,5 CR	Weinhardt
T-WIWI-107503	<a href="#">Energy Networks and Regulation</a>	4,5 CR	Weinhardt
T-WIWI-107504	<a href="#">Smart Grid Applications</a>	4,5 CR	Weinhardt
T-WIWI-113726	<a href="#">Special Topics in Information Systems</a>	4,5 CR	Weinhardt

**Competence Certificate**

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

**Prerequisites**

None.

**Competence Goal**

The student

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

**Content**

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

**Annotation**

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

**Workload**

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

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

## M

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

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

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

Mandatory			
T-WIWI-107043	<a href="#">Liberalised Power Markets</a>	5,5 CR	Fichtner
Supplementary Courses (Election: )			
T-WIWI-107501	<a href="#">Energy Market Engineering</a>	4,5 CR	Weinhardt
T-WIWI-112151	<a href="#">Energy Trading and Risk Management</a>	3,5 CR	N.N.
T-WIWI-108016	<a href="#">Simulation Game in Energy Economics</a>	3,5 CR	Genoese
T-WIWI-107446	<a href="#">Quantitative Methods in Energy Economics</a>	3,5 CR	Plötz
T-WIWI-102712	<a href="#">Regulation Theory and Practice</a>	4,5 CR	Mitsch

### Competence Certificate

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

### Competence Goal

The student

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

### Content

**Liberalised Power Markets:** The European liberalisation process, energy markets, pricing, market failure, investment incentives, market power

**Energy Trade and Risk Management:** trade centres, trade products, market mechanisms, position and risk management

**Simulation Game in Energy Economics:** Simulation of the German electricity system

### Workload

The total workload for this module is approx. 270 hours (9 credits). The allocation is based on the credit points of the courses in the module. The workload for courses with 3.5 credits is approx. 105 hours, for courses with 5.5 credits approx. 165 hours.

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

### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Wolf Fichtner  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Operations Management - Data Analysis - Informatics](#)  
 Elective Field

<b>Credits</b> 9	<b>Grading scale</b> Grade to a tenth	<b>Recurrence</b> Each term	<b>Duration</b> 1 term	<b>Language</b> German/English	<b>Level</b> 4	<b>Version</b> 5
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Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-102793	<a href="#">Efficient Energy Systems and Electric Mobility</a>	3,5 CR	Jochem
T-WIWI-102650	<a href="#">Energy and Environment</a>	3,5 CR	Karl
T-WIWI-113073	<a href="#">Machine Learning and Optimization in Energy Systems</a>	3,5 CR	Fichtner
T-WIWI-107464	<a href="#">Smart Energy Infrastructure</a>	5,5 CR	Ardone, Pustisek
T-WIWI-102695	<a href="#">Heat Economy</a>	3,5 CR	Fichtner

### Competence Certificate

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

To integrate the module "Energy Economics and Technology" in the degree programme "Wirtschaftsmathematik" it is compulsory to choose the course „Energy Systems Analysis“.

### Competence Goal

The student

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

### Content

*Heat Economy:* district heating, heating technologies, reduction of heat demand, statutory provisions

*Energy Systems Analysis:* Interdependencies in energy economics, energy systems modelling approaches in energy economics

*Energy and Environment:* emission factors, emission reduction measures, environmental impact

*Efficient Energy Systems and Electric Mobility:* concepts and current trends in energy efficiency, Overview of and economical, ecological and social impacts through electric mobility

### Workload

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

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

## M

## 3.49 Module: Ergodic Theory [M-MATH-106473]

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

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

Mandatory			
T-MATH-113086	<a href="#">Ergodic Theory</a>	8 CR	Link

**Competence Certificate**

Oral examination of ca. 20-30 minutes.

**Prerequisites**

None

**Competence Goal**

Students

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

**Content**

- Elementary examples of dynamical systems such as Bernoulli systems and billiards
- Poincare recurrence 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  $SL(2, \mathbb{R})$ )

**Module grade calculation**

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

**Workload**

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

**Recommendation**

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

## M

## 3.50 Module: Evolution Equations [M-MATH-102872]

**Responsible:** Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
see Annotations

**Duration**  
1 term

**Language**  
German/English

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105844	<a href="#">Evolution Equations</a>	8 CR	Frey, Kunstmann, Schnaubelt

### Competence Certificate

Oral examination of ca. 30 minutes.

### Prerequisites

none

### Competence Goal

The students

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

### Content

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

### Module grade calculation

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

### Annotation

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

**Workload**

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

**Recommendation**

The module "Functional Analysis" is strongly recommended.

**Literature**

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

## M

**3.51 Module: Experimental Economics [M-WIWI-101505]**

**Responsible:** Prof. Dr. Johannes Philipp Reiß  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

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

**Competence Certificate**

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

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

**Prerequisites**

None.

**Competence Goal**

Students

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

**Content**

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

**Annotation**

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

**Workload**

Total workload for 9 credit points: approx. 270 hours

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

**Recommendation**

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



## M

## 3.52 Module: Exponential Integrators [M-MATH-103700]

**Responsible:** Prof. Dr. Marlis Hochbruck

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
6

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-107475	<a href="#">Exponential Integrators</a>	6 CR	Hochbruck, Jahnke

#### Competence Certificate

Oral exam of approximately 20 minutes.

#### Prerequisites

None.

#### Competence Goal

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

#### Content

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

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

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

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

#### Module grade calculation

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

#### Workload

Total workload: 180 h

Attendance: 60 h

- Course including module examination during study.

Self-studies: 120 h

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

#### Recommendation

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

## M

## 3.53 Module: Extremal Graph Theory [M-MATH-102957]

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

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

Mandatory			
T-MATH-105931	<a href="#">Extremal Graph Theory</a>	4 CR	Aksenovich

**Competence Certificate**

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

**Competence Goal**

The students understand, describe, and use fundamental notions and techniques in extremal graph theory. They can analyze, structure, and formally describe typical combinatorial questions. The students understand and use Szemerédi's regularity lemma and Szemerédi'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, Erdős-Stone theorem, Szemerédi's lemma, graph colorings and probabilistic techniques.

**Annotation**

Course is held in English

**Recommendation**

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

## M

## 3.54 Module: Extreme Value Theory [M-MATH-102939]

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

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

Mandatory			
T-MATH-105908	<a href="#">Extreme Value Theory</a>	4 CR	Fasen-Hartmann

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

Students are able to

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

**Content**

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

**Module grade calculation**

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

**Workload**

Total workload: 120 hours

Attendance: 45 hours

- lectures and problem classes including the examination.

Self studies: 75 hours

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

**Recommendation**

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

## M

**3.55 Module: Finance 1 [M-WIWI-101482]**

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

**Organisation:** KIT Department of Economics and Management

**Part of:** [Finance - Risk Management - Managerial Economics](#)  
[Elective Field](#)

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

Compulsory Elective Courses (Election: 9 credits)			
T-WIWI-102643	<a href="#">Derivatives</a>	4,5 CR	Uhrig-Homburg
T-WIWI-102621	<a href="#">Valuation</a>	4,5 CR	Ruckes
T-WIWI-102647	<a href="#">Asset Pricing</a>	4,5 CR	Ruckes, Uhrig-Homburg

**Competence Certificate**

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

## 3.56 Module: Finance 2 [M-WIWI-101483]

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

**Organisation:** KIT Department of Economics and Management

**Part of:** [Finance - Risk Management - Managerial Economics](#)  
Elective Field

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

**Election notes**

+++++

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

+++++

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

**Competence Certificate**

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

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

**Competence Goal**

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

**Content**

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

**Annotation**

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

**Workload**

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

## M

## 3.57 Module: Finance 3 [M-WIWI-101480]

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

**Organisation:** KIT Department of Economics and Management

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

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

**Election notes**

+++++

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

+++++

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

**Competence Certificate**

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

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

**Competence Goal**

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

**Content**

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

**Workload**

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

## M

## 3.58 Module: Finite Element Methods [M-MATH-102891]

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

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each winter term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105857	<a href="#">Finite Element Methods</a>	8 CR	Dörfler, Hochbruck, Jahnke, Maier, Rieder, Wieners



## M

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

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

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

Mandatory			
T-MATH-105928	<a href="#">Forecasting: Theory and Practice</a>	8 CR	Gneiting

**Prerequisites**

None

**Annotation**

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

## M

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

**Responsible:** Prof. Dr. Maxim Ulrich

**Organisation:** KIT Department of Economics and Management

**Part of:** Finance - Risk Management - Managerial Economics

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

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

### Competence Certificate

Due to the professor's research sabbatical, the BSc module "Financial Data Science" and MSc module "Foundations for Advanced Financial -Quant and -Machine Learning Research" and the MSc module "Advanced Machine Learning and Data Science" along with the respective examinations will not be offered in SS2023. Bachelor and Master thesis projects are not affected and will be supervised.

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

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

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

### Competence Goal

This MSc module teaches students fundamental stats and analytics concepts, as well necessary financial economic intuition, necessary to identify, design and execute interesting research questions in quant finance and financial machine learning.

Topics include: Maximum Likelihood learning of arma-garch models, expectation maximization learning applied to stochastic volatility and valuation models, Kalman filter techniques to learn latent states, estimation of affine jump diffusion models with options and higher-order moments, stochastic calculus, dynamic modeling of asset markets (bond, equity, options), equilibrium determination of risk premiums, risk premiums for higher moment risk, risk decomposition (fundamental vs idiosyncratic), option-implied return distributions, mixture-density-networks and neural nets.

### Content

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

### Annotation

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

### Workload

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

## M

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

**Responsible:** Prof. Dr. Christian Wieners

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
3

**Grading scale**  
Grade to a tenth

**Recurrence**  
Once

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-107044	<a href="#">Foundations of Continuum Mechanics</a>	3 CR	Wieners

**Prerequisites**

none

**M****3.62 Module: Fourier Analysis and its Applications to PDEs [M-MATH-104827]****Responsible:** TT-Prof. Dr. Xian Liao**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field**Credits**  
6**Grading scale**  
Grade to a tenth**Recurrence**  
Irregular**Duration**  
1 term**Level**  
4**Version**  
3

Mandatory			
T-MATH-109850	<a href="#">Fourier Analysis and its Applications to PDEs</a>	6 CR	Liao

**Prerequisites**

None

## M

## 3.63 Module: Fractal Geometry [M-MATH-105649]

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

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

Mandatory			
T-MATH-111296	<a href="#">Fractal Geometry</a>	6 CR	Winter

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

Students

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

**Content**

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

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

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

**Recommendation**

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

## M

## 3.64 Module: Functional Analysis [M-MATH-101320]

**Responsible:** Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each winter term

**Duration**  
1 term

**Level**  
4

**Version**  
2

Mandatory			
T-MATH-102255	<a href="#">Functional Analysis</a>	8 CR	Frey, Herzog, Hundertmark, Lamm, Liao, Reichel, Schnaubelt, Tolksdorf

### Competence Certificate

Written examination of 120 minutes.

### Prerequisites

None

### Competence Goal

The students can

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

### Content

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

### Module grade calculation

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

### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

## M

## 3.65 Module: Functional Data Analysis [M-MATH-106485]

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

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

Mandatory			
T-MATH-113102	<a href="#">Functional Data Analysis</a>	4 CR	Ebner, Klar, Trabs

**Competence Certificate**

Oral examination of ca. 25 minutes.

**Prerequisites**

None

**Competence Goal**

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

After successful participation students can

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

**Content**

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

**Module grade calculation**

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

**Workload**

Total workload: 120 hours

Attendance: 45 h

- lectures and examination

Self studies: 75 h

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

**Recommendation**

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

## M

## 3.66 Module: Functions of Matrices [M-MATH-102937]

**Responsible:** PD Dr. Volker Grimm

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105906	<a href="#">Functions of Matrices</a>	8 CR	Grimm

#### Competence Certificate

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

#### Prerequisites

none

#### Competence Goal

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

#### Content

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

#### Module grade calculation

The module grade is the grade of the oral exam.

#### Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

#### Recommendation

The courses Numerical Analysis 1 and 2 are strongly recommended.



## M

## 3.67 Module: Functions of Operators [M-MATH-102936]

**Responsible:** PD Dr. Volker Grimm

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105905	<a href="#">Functions of Operators</a>	6 CR	

#### Competence Certificate

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

#### Prerequisites

None

#### Competence Goal

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

#### Content

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

#### Module grade calculation

The module grade is the grade of the oral exam.

#### Workload

Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

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

#### Recommendation

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

## M

## 3.68 Module: Generalized Regression Models [M-MATH-102906]

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

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

Mandatory			
T-MATH-105870	<a href="#">Generalized Regression Models</a>	4 CR	Ebner, Fasen-Hartmann, Klar, Trabs

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

At the end of the course, students will

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

**Content**

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

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

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: 75 hours

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

**Recommendation**

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

## M

## 3.69 Module: Geometric Group Theory [M-MATH-102867]

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

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

Mandatory			
T-MATH-105842	<a href="#">Geometric Group Theory</a>	8 CR	Herrlich, Link, Llosa Isenrich, Sauer, Tuschmann

## M

## 3.70 Module: Geometric Numerical Integration [M-MATH-102921]

**Responsible:** Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105919	<a href="#">Geometric Numerical Integration</a>	6 CR	Hochbruck, Jahnke

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral exam.

### Annotation

The module is offered about every two years

### Workload

Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

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

### Recommendation

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

## M

## 3.71 Module: Geometric Variational Problems [M-MATH-106667]

**Responsible:** Prof. Dr. Tobias Lamm

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-113418	<a href="#">Geometric Variational Problems</a>	8 CR	Lamm

### Competence Certificate

oral exam of ca. 30 min

### Prerequisites

none

### Competence Goal

The students

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral examination.

### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

### Recommendation

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

## M

## 3.72 Module: Geometry of Schemes [M-MATH-102866]

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

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

Mandatory			
T-MATH-105841	<a href="#">Geometry of Schemes</a>	8 CR	Herrlich, Kühnlein

**Competence Certificate**

The module 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 quasicohherent sheaves
- cohomology of sheaves

**Module grade calculation**

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

**Workload**

Total work load. 240 hours

Attendance: 90 hours

- lectures, problem classes and examination

Self studies: 150 hours

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

**Recommendation**

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

**M****3.73 Module: Global Differential Geometry [M-MATH-102912]**

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

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

Mandatory			
T-MATH-105885	<a href="#">Global Differential Geometry</a>	8 CR	Tuschmann

**Prerequisites**  
 none

## M

## 3.74 Module: Graph Theory [M-MATH-101336]

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

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

Mandatory			
T-MATH-102273	<a href="#">Graph Theory</a>	8 CR	Aksenovich

**Competence Certificate**

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

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

**Prerequisites**

None

**Competence Goal**

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

**Content**

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

**Annotation**

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



**M****3.75 Module: Group Actions in Riemannian Geometry [M-MATH-102954]**

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

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

Mandatory			
T-MATH-105925	<a href="#">Group Actions in Riemannian Geometry</a>	5 CR	Tuschmann

**Prerequisites**  
 none

## M

## 3.76 Module: Growth and Agglomeration [M-WIWI-101496]

**Responsible:** Prof. Dr. Ingrid Ott  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

Compulsory Elective Courses (Election: 9 credits)			
T-WIWI-109194	<a href="#">Dynamic Macroeconomics</a>	4,5 CR	Brumm
T-WIWI-112816	<a href="#">Growth and Development</a>	4,5 CR	Ott
T-WIWI-103107	<a href="#">Spatial Economics</a>	4,5 CR	Ott

**Competence Certificate**

The assessment is carried out as partial written exams (see the lectures descriptions).

The overall grade for the module is the average of the grades for each course weighted by the credits.

**Prerequisites**

None

**Competence Goal**

The student

- gains deepened knowledge of micro-based general equilibrium models
- understands how based on individual optimizing decisions aggregate phenomena like economic growth or agglomeration (cities / metropolises) result
- is able to understand and evaluate the contribution of these phenomena to the development of economic trends
- can derive policy recommendations based on theory

**Content**

The module includes the contents of the lectures *Endogenous Growth Theory*, *Spatial Economics* and *Dynamic Macroeconomics*. While the first lecture focuses on dynamic programming in modern macroeconomics, the other two lectures are more formal and analytical.

The common underlying principle of all three lectures in this module is that, based on different theoretical models, economic policy recommendations are derived.

**Workload**

Total workload for 9 credit points: approx. 270 hours

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

**Recommendation**

Attendance of the course *Introduction Economic Policy* [2560280] is recommended.

Successful completion of the courses *Economics I: Microeconomics* and *Economics II: Macroeconomics* is required.

## M

## 3.77 Module: Harmonic Analysis [M-MATH-105324]

**Responsible:** Prof. Dr. Dorothee Frey

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
2

Mandatory			
T-MATH-111289	<a href="#">Harmonic Analysis</a>	8 CR	Frey, Kunstmann, Schnaubelt, Tolksdorf

### 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 in  $\mathbb{R}^n$
- the Hilbert transform
- the interpolation theorem of Marcinkiewicz
- Singular integral operators
- the Fourier multiplier theorem of Mihlin

## M

## 3.78 Module: Harmonic Analysis 2 [M-MATH-106486]

**Responsible:** Prof. Dr. Dorothee Frey

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-113103	<a href="#">Harmonic Analysis 2</a>	8 CR	Frey, Kunstmann, Tolksdorf

#### Competence Certificate

Oral examination of ca. 30 minutes.

#### Prerequisites

None

#### Module grade calculation

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

#### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

#### Recommendation

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

**M****3.79 Module: Homotopy Theory [M-MATH-102959]**

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

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

Mandatory			
T-MATH-105933	<a href="#">Homotopy Theory</a>	8 CR	Sauer

## M

## 3.80 Module: Informatics [M-WIWI-101472]

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

**Organisation:** KIT Department of Economics and Management

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

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	19

Compulsory Elective Area (Election: )			
T-WIWI-113629	Agent-Based Modelling and Simulation	4,5 CR	Lazarova-Molnar
T-WIWI-110339	Applied Informatics – Principles of Internet Computing: Foundations for Emerging Technologies and Future Services	4,5 CR	Sunyaev
T-WIWI-102680	Computational Economics	4,5 CR	Shukla
T-WIWI-112690	Cooperative Autonomous Vehicles	4,5 CR	Vinel
T-WIWI-113363	Collective Perception in Autonomous Driving	4,5 CR	Vinel
T-WIWI-109248	Critical Information Infrastructures	4,5 CR	Sunyaev
T-WIWI-109246	Digital Health	4,5 CR	Sunyaev
T-WIWI-113059	Human Factors in Autonomous Driving	4,5 CR	Vinel
T-WIWI-109270	Human Factors in Security and Privacy	4,5 CR	Volkamer
T-WIWI-102661	Database Systems and XML	4,5 CR	Oberweis
T-WIWI-110346	Supplement Enterprise Information Systems	4,5 CR	Oberweis
T-WIWI-110372	Supplement Software- and Systemsengineering	4,5 CR	Oberweis
T-WIWI-106423	Information Service Engineering	4,5 CR	Sack
T-WIWI-102666	Knowledge Discovery	4,5 CR	Käfer
T-WIWI-106340	Machine Learning 1 - Basic Methods	4,5 CR	Zöllner
T-WIWI-106341	Machine Learning 2 – Advanced Methods	4,5 CR	Zöllner
T-WIWI-112685	Modeling and Simulation	4,5 CR	Lazarova-Molnar
T-WIWI-102697	Business Process Modelling	4,5 CR	Oberweis
T-WIWI-102679	Nature-Inspired Optimization Methods	4,5 CR	Shukla
T-WIWI-109799	Process Mining	4,5 CR	Oberweis
T-WIWI-110848	Semantic Web Technologies	4,5 CR	Käfer
T-WIWI-102895	Software Quality Management	4,5 CR	Oberweis
Seminars and Advanced Labs (Election: between 0 and 1 items)			
T-WIWI-110144	Emerging Trends in Digital Health	4,5 CR	Sunyaev
T-WIWI-110143	Emerging Trends in Internet Technologies	4,5 CR	Sunyaev
T-WIWI-109249	Sociotechnical Information Systems Development	4,5 CR	Sunyaev
T-WIWI-111126	Advanced Lab Blockchain Hackathon (Master)	4,5 CR	Sunyaev
T-WIWI-111125	Advanced Lab Sociotechnical Information Systems Development (Master)	4,5 CR	Sunyaev
T-WIWI-110548	Advanced Lab Informatics (Master)	4,5 CR	Professorenschaft des Instituts AIFB
T-WIWI-112914	Advanced Lab Realization of Innovative Services (Master)	4,5 CR	Oberweis
T-WIWI-108439	Advanced Lab Security, Usability and Society	4,5 CR	Volkamer

T-WIWI-109786	<a href="#">Advanced Lab Security</a>	4,5 CR	Volkamer
T-WIWI-109985	<a href="#">Project Lab Cognitive Automobiles and Robots</a>	5 CR	Zöllner
T-WIWI-109983	<a href="#">Project Lab Machine Learning</a>	5 CR	Zöllner
T-WIWI-113026	<a href="#">Trustworthy Emerging Technologies</a>	4,5 CR	Sunyaev

### Competence Certificate

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

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

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

### Prerequisites

It is only allowed to choose one lab.

### Competence Goal

The student

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

### Content

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

### Workload

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

## M

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

**Responsible:** Prof. Dr. Alexander Mädche  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-105777	<a href="#">Business Intelligence Systems</a>	4,5 CR	Mädche
T-WIWI-113465	<a href="#">Designing Interactive Systems: Human-AI Interaction</a>	4,5 CR	Mädche
T-WIWI-113459	<a href="#">Practical Seminar: Human-Centered Systems</a>	4,5 CR	Mädche

**Competence Certificate**

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

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

**Prerequisites**

None

**Competence Goal**

The student

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

**Content**

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

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

**Annotation**

New module starting summer term 2018.

**Workload**

The total workload for this module is approximately 270 hours.



## M

## 3.82 Module: Innovation and Growth [M-WIWI-101478]

**Responsible:** Prof. Dr. Ingrid Ott  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Finance - Risk Management - Managerial Economics](#)  
 Elective Field

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

Compulsory Elective Courses (Election: between 9 and 10 credits)			
T-WIWI-109194	<a href="#">Dynamic Macroeconomics</a>	4,5 CR	Brumm
T-WIWI-112822	<a href="#">Economics of Innovation</a>	4,5 CR	Ott
T-WIWI-112816	<a href="#">Growth and Development</a>	4,5 CR	Ott

**Competence Certificate**

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

None

**Competence Goal**

Students shall be given the ability to

- know the basic techniques for analyzing static and dynamic optimization models that are applied in the context of micro- and macroeconomic theories
- understand the important role of innovation to the overall economic growth and welfare
- identify the importance of alternative incentive mechanisms for the emergence and dissemination of innovations
- explain, in which situations market interventions by the state, for example taxes and subsidies, can be legitimized, and evaluate them in the light of economic welfare

**Content**

The module includes courses that deal with issues of innovation and growth in the context of micro- and macroeconomic theories. The dynamic analysis makes it possible to analyze the consequences of individual decisions over time, and sheds light on the tension between static and dynamic efficiency in particular. In this context is also analyzed, which policy is appropriate to carry out corrective interventions in the market and thus increase welfare in the presence of market failure.

**Workload**

Total expenditure of time for 9 credits: 270 hours

Attendance time per lecture: 3x14h

Preparation and wrap-up time per lecture: 3x14h

Rest: Exam Preparation

The exact distribution is subject to the credits of the courses of the module.

**Recommendation**

Basic knowledge of micro- and macroeconomics is assumed, as taught in the courses Economics I [2600012], and Economics II [2600014]. In addition, an interest in quantitative-mathematical modeling is required.

## M

## 3.83 Module: Integral Equations [M-MATH-102874]

**Responsible:** PD Dr. Frank Hettlich

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105834	<a href="#">Integral Equations</a>	8 CR	Arens, Griesmaier, Hettlich

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

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

### Content

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

### Module grade calculation

The module grade is the the grade of the oral exam

### Workload

Total workload: 240h

Attendance: 90h

- Lecture, problem class, examination

Self studies: 150h

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

**M****3.84 Module: Introduction into Particulate Flows [M-MATH-102943]****Responsible:** Prof. Dr. Willy Dörfler**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field**Credits**  
3**Grading scale**  
Grade to a tenth**Recurrence**  
Once**Duration**  
1 term**Level**  
4**Version**  
1

Mandatory			
T-MATH-105911	<a href="#">Introduction into Particulate Flows</a>	3 CR	Dörfler

**Prerequisites**

none

## M

## 3.85 Module: Introduction to Aperiodic Order [M-MATH-105331]

**Responsible:** Prof. Dr. Tobias Hartnick  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Algebra and Geometry\)](#)  
 Elective Field

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

Mandatory			
T-MATH-110811	<a href="#">Introduction to Aperiodic Order</a>	3 CR	Hartnick

**Prerequisites**  
None

## M

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

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-112119	<a href="#">Introduction to Convex Integration</a>	3 CR	Zillinger

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

The main aim of this lecture is to introduce students to convex integration as a tool to construct solutions to partial differential equations.

In particular, they will be able to

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

### Content

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

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

### Module grade calculation

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

### Workload

Total workload: 90 hours

Attendance: 30 h

- lectures and examination

Self studies: 60 h

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

### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-113263	<a href="#">Introduction to Dynamical Systems</a>	6 CR	de Rijk, Reichel

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

After successful completion of this module students

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral exam.

**Workload**

Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

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

**Recommendation**

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

## M

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

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
3

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
2

Mandatory			
T-MATH-111297	<a href="#">Introduction to Fluid Dynamics</a>	3 CR	Reichel

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

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

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

### Content

Mathematical description and analysis of fluid dynamics:

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

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 90 hours

Attendance: 30 hours

- lectures, problem classes, and examination

Self-studies: 60 hours

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

### Recommendation

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



## M

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

**Responsible:** TT-Prof. Dr. Xian Liao

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-112927	<a href="#">Introduction to Fluid Mechanics</a>	6 CR	Liao

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

Graduates can

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

### Content

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

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

total work load: 180 hours

### Recommendation

The module *Functional Analysis* is strongly recommended.

## M

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

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

**Credits**  
6

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105918	<a href="#">Introduction to Geometric Measure Theory</a>	6 CR	Winter

**Prerequisites**  
none

## M

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

**Responsible:** Prof. Dr. Tobias Hartnick

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Stochastics\)](#)  
[Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Mathematical Methods \(Algebra and Geometry\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-110323	<a href="#">Introduction to Homogeneous Dynamics</a>	6 CR	Hartnick

**Prerequisites**

None

## M

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

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-111721	<a href="#">Introduction to Kinetic Equations</a>	3 CR	Zillinger

### Competence Certificate

oral examination of approx. 30 minutes

### Prerequisites

none

### Competence Goal

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

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

### Content

Mathematical description and analysis of kinetic transport equations:

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

### Module grade calculation

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

### Workload

Total workload: 90 h

Attendance: 30 h

- lectures and examination

Self studies: 60 h

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

### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Martin Frank

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-108013	<a href="#">Introduction to Kinetic Theory</a>	4 CR	Frank

#### Prerequisites

None

#### Competence Goal

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

#### Content

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

#### Recommendation

Partial Differential Equations, Functional Analysis

## M

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

**Responsible:** TT-Prof. Dr. Xian Liao

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-111722	<a href="#">Introduction to Microlocal Analysis</a>	3 CR	Liao

### Competence Certificate

oral examination of circa 30 minutes

### Prerequisites

none

### Competence Goal

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

### Content

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

### Module grade calculation

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

### Workload

Total workload: 90 h

Attendance: 30 h

- lectures and examination

Self studies: 60 h

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

### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Willy Dörfler  
Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each summer term

**Duration**  
1 term

**Level**  
4

**Version**  
2

Mandatory			
T-MATH-105837	<a href="#">Introduction to Scientific Computing</a>	8 CR	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

At the end of the course, students

- are able to develop the interlinking of all aspects of scientific computing using simple examples: from modeling and algorithmic implementation to stability and error analysis.
- can explain concepts of modeling with differential equations
- are able to implement simple application examples algorithmically, evaluate the code and present and discuss the results.

**Content**

- Numerical methods for initial value problems, boundary value problems, and initial boundary value problems
- Modelling with differential equations
- Algorithmic realization of applications
- Presentation of results of scientific computations

**Module grade calculation**

The module grade is the grade of the oral exam.

**Annotation**

3 SWS lecture plus 3 SWS hands-on training

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

It is strongly recommended that participants have completed the modules "Numerische Mathematik 1 und 2" as well as "Programmieren: Einstieg in die Informatik und algorithmische Mathematik".

## M

## 3.96 Module: Introduction to Stochastic Differential Equations [M-MATH-106045]

**Responsible:** Prof. Dr. Mathias Trabs  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Stochastics\)](#)  
 Elective Field

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

Mandatory			
T-MATH-112234	<a href="#">Introduction to Stochastic Differential Equations</a>	4 CR	Janák, Trabs

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

The students will

- know fundamental examples for linear and non-linear stochastic differential equations,
- be able to apply basic solution concepts for stochastic differential equations,
- know fundamental theorems of stochastic calculus and will be able to apply these to stochastic differential equations.

**Content**

1. Introduction and recapitulation of stochastic integration, Itô's formula, Lévy Theorem
2. Burkholder-Davis-Gundy inequality
3. Existence and uniqueness of solutions of stochastic differential equations
4. Explicit solutions of linear stochastic differential equations
5. Change of the time scale of Brownian motion
6. Representation of continuous time martingales
7. Brownian martingales
8. Local and global solutions of stochastic differential equations
9. Girsanov Theorem

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: 75 hours

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

**Recommendation**

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



## M

## 3.97 Module: Inverse Problems [M-MATH-102890]

**Responsible:** Prof. Dr. Roland Griesmaier

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each winter term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105835	<a href="#">Inverse Problems</a>	8 CR	Arens, Griesmaier, Hettlich, Rieder

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

At the end of the course, students are able to distinguish well-posed from ill-posed problems. They acquire a systematic knowledge of the theory of linear inverse problems and their regularization in Hilbert spaces and can provide proof ideas. They are able to analyze regularization methods such as, e.g., Tikhonov regularization and assess their convergence properties.

### Content

- Compact operator equations
- Ill-posed problems
- Regularization
- Tikhonov regularization
- Iterative regularization
- Examples for ill-posed problems

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

### Recommendation

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

**M****3.98 Module: Key Moments in Geometry [M-MATH-104057]**

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

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

Mandatory			
T-MATH-108401	<a href="#">Key Moments in Geometry</a>	5 CR	Tuschmann

**Prerequisites**  
 None

## M

## 3.99 Module: L2-Invariants [M-MATH-102952]

**Responsible:** Dr. Holger Kammeyer

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Mathematical Methods \(Algebra and Geometry\)](#)  
 Elective Field

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

Mandatory			
T-MATH-105924	<a href="#">L2-Invariants</a>	5 CR	Kammeyer, Sauer

**Prerequisites**

none

## M

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

**Responsible:** Prof. Dr. Tobias Hartnick  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Algebra and Geometry\)](#)  
 Elective Field

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

Mandatory			
T-MATH-108799	<a href="#">Lie Groups and Lie Algebras</a>	8 CR	Hartnick

## M

## 3.101 Module: Lie-Algebras (Linear Algebra 3) [M-MATH-105839]

**Responsible:** Prof. Dr. Tobias Hartnick  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Algebra and Geometry\)](#)  
 Elective Field

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

Mandatory			
T-MATH-111723	<a href="#">Lie-Algebras (Linear Algebra 3)</a>	8 CR	

## M

## 3.102 Module: Marketing and Sales Management [M-WIWI-105312]

**Responsible:** Prof. Dr. Martin Klarmann  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Operations Management - Data Analysis - Informatics](#)  
 Elective Field

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

Compulsory Elective Courses (Election:)			
T-WIWI-112693	<a href="#">Digital Marketing</a>	4,5 CR	Kupfer
T-WIWI-106981	<a href="#">Digital Marketing and Sales in B2B</a>	1,5 CR	Klarmann, Konhäuser
T-WIWI-110985	<a href="#">International Business Development and Sales</a>	6 CR	Casenave , Klarmann, Terzidis
T-WIWI-111099	<a href="#">Judgement and Decision Making</a>	4,5 CR	Scheibehenne
T-WIWI-107720	<a href="#">Market Research</a>	4,5 CR	Klarmann
T-WIWI-111848	<a href="#">Online Concepts for Karlsruhe City Retailers</a>	3 CR	Klarmann
T-WIWI-102883	<a href="#">Pricing</a>	4,5 CR	Klarmann

**Competence Certificate**

The assessment is carried out as partial exams (according to Section 4(2) of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. For passing the module exam in every singled partial exam the respective minimum requirements has to be achieved.

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

**Prerequisites**

The course "Market Research" is obligatory.

**Competence Goal**

Students

- have an advanced knowledge about central marketing contents
- have a fundamental understanding of the marketing instruments
- know and understand several strategic concepts and how to implement them
- are able to implement their extensive marketing knowledge in a practical context
- know several qualitative and quantitative approaches to prepare decisions in Marketing
- have the theoretical knowledge to write a master thesis in Marketing
- have the theoretical knowledge to work in/together with the Marketing department

**Content**

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

**Workload**

The total workload for this module is approximately 270 hours.

## M

## 3.103 Module: Markov Decision Processes [M-MATH-102907]

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

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

Mandatory			
T-MATH-105921	<a href="#">Markov Decision Processes</a>	5 CR	Bäuerle

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

At the end of the course, students

- can name the mathematical foundations of Markov Decision Processes and apply solution algorithm,
- can formulate stochastic, dynamic optimization problems as Markov Decision Processes,
- are able to work in a self-organized and reflective manner.

**Content**

- MDPs with finite time horizon
  - Bellman equation
  - Problems with structure
  - Applications
- MDPs with infinite time horizon
  - contracting MDPs
  - positive MDPs
  - Howards policy improvement
  - Solution by linear programs
- Stopping problems
  - finite and infinite time horizon
  - One-step-look-ahead rule

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

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

**Recommendation**

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

## M

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

**Responsible:** PD Dr. Stefan Kühnlein  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Master's Thesis](#)

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

Mandatory			
T-MATH-105878	<a href="#">Master's Thesis</a>	30 CR	Kühnlein

**Competence Certificate**

The Master's Thesis is graded according to the regulations from §14 (7) of Studien- und Prüfungsordnung. The handling time is six months. On submission of the Master's Thesis, according to §14 (5) the students have to confirm, that the thesis has been written independently without using undisclosed sources and tools, that passages which have been copied literally or in content have clearly been marked as such, and that the by-laws to implement scientific integrity at KIT in the recent version have been taken into account. If this confirmation is not contained, the thesis gets rejected. In case of a wrong confirmation, the thesis is graded with "not sufficient" (5.0). The thesis may be written in English.

If the thesis is planned to be written outside the KIT-departments of Mathematics or Economics and Management, the approval by the examination board is required.

Further details are regulated by §14 of Studien- und Prüfungsordnung.

**Prerequisites**

For admission to the module Master's Thesis it is required that the student has successfully accomplished module examinations of at least 70 credit points.

**Competence Goal**

The students are able to work on a given topic independently and in a limited time, using scientific methods from the state of the art. They master the necessary scientific methods and techniques, modify them if necessary and develop them further if required. Alternative approaches are compared critically. In their thesis, the students write up their results clearly structured and in a way adequate to academic standards.

**Content**

Following §14 SPO the thesis should demonstrate that the students are able to work on a given topic from their course of studies independently and in a bounded time, using scientific methods from the state of the art. The students should have the opportunity to make suggestions for their topic. If the student petitions, in exceptional cases the head of the examination board takes care that the student receives a topic for a master thesis within four weeks. In that case, the topic is given by the head of the examination board. Further details are regulated by §14 of Studien- und Prüfungsordnung.

**Workload**

Total work load: 900 hours

Attendance: 0 hours

Self studies: 900 hours



## M

**3.105 Module: Mathematical Methods in Signal and Image Processing [M-MATH-102897]****Responsible:** Prof. Dr. Andreas Rieder**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-105862	<a href="#">Mathematical Methods in Signal and Image Processing</a>	8 CR	Rieder

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

Graduates know the essential mathematical tools of signal and image processing and their properties. They are able to apply these tools appropriately and to scrutinize and evaluate the results obtained.

**Content**

- Digital and analog systems
- Integral Fourier transform
- Sampling and resolution
- Discrete and fast Fourier transform
- Non-uniform sampling
- Anisotropic diffusion filters
- Variational methods

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

The course "Functional analysis" is recommended.

## M

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

**Responsible:** Prof. Dr. Andreas Rieder

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-106488	<a href="#">Mathematical Methods of Imaging</a>	5 CR	Rieder

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

Graduates become familiar with some imaging methods and are able to discuss and analyze the underlying mathematical aspects. In particular, they will be able to explain the functional-analytical properties of the imaging operators. They can implement the corresponding reconstruction algorithms and they can explain and evaluate the artifacts that appear. They are able to apply the techniques they have learned to related problems.

### Content

- Variants of tomography (X-ray, impedance, seismic, etc.)
- Properties of (generalized) Radon transforms
- Microlocal analysis/Pseudodifferential operators
- Ill-Posedness and regularization
- Reconstruction algorithms

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total work load: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

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

### Recommendation

The course „Functional Analysis“ is recommended.

## M

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

**Responsible:** PD Dr. Gudrun Thäter

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
4

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Language**  
English

**Level**  
4

**Version**  
2

Mandatory			
T-MATH-105889	<a href="#">Mathematical Modelling and Simulation in Practise</a>	4 CR	Thäter

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

The general aim of this lecture course is threefold:

- 1) to interconnect different mathematical fields,
- 2) to connect mathematics and real life problems,
- 3) to learn to be critical and to ask relevant questions.

At the end of the course, students can

- work Project-orientated,
- link knowledge from different fields,
- develop typical modelling approaches on their own.

### Content

Mathematical thinking (as modelling) and mathematical techniques (as tools) meet application problems such as:

- Differential equations
- Population models
- Traffic flow
- Game theory
- Chaos
- Mechanics and fluids

### Module grade calculation

The module grade is the grade of the oral exam.

### Annotation

The lecture is always in English.

To earn the credits you have to attend the lecture, finish the work on one project during the term in a group of 2-3 persons and pass the exam. The topic of the project is up to the choice of each group.

**Workload**

Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination
- Project presentations

Self-studies: 75 hours

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

**Recommendation**

Some basic knowledge of numerical mathematics is recommended.

**Literature**

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

## M

## 3.108 Module: Mathematical Programming [M-WIWI-101473]

**Responsible:** Prof. Dr. Oliver Stein  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Operations Management - Data Analysis - Informatics](#)  
 Elective Field

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

Compulsory Elective Courses (Election: at most 2 items)			
T-WIWI-102719	<a href="#">Mixed Integer Programming I</a>	4,5 CR	Stein
T-WIWI-102726	<a href="#">Global Optimization I</a>	4,5 CR	Stein
T-WIWI-103638	<a href="#">Global Optimization I and II</a>	9 CR	Stein
T-WIWI-102856	<a href="#">Convex Analysis</a>	4,5 CR	Stein
T-WIWI-111587	<a href="#">Multicriteria Optimization</a>	4,5 CR	Stein
T-WIWI-102724	<a href="#">Nonlinear Optimization I</a>	4,5 CR	Stein
T-WIWI-103637	<a href="#">Nonlinear Optimization I and II</a>	9 CR	Stein
T-WIWI-102855	<a href="#">Parametric Optimization</a>	4,5 CR	Stein
Supplementary Courses (Election: at most 2 items)			
T-WIWI-106548	<a href="#">Advanced Stochastic Optimization</a>	4,5 CR	Rebennack
T-WIWI-102720	<a href="#">Mixed Integer Programming II</a>	4,5 CR	Stein
T-WIWI-102727	<a href="#">Global Optimization II</a>	4,5 CR	Stein
T-WIWI-102723	<a href="#">Graph Theory and Advanced Location Models</a>	4,5 CR	Nickel
T-WIWI-106549	<a href="#">Large-scale Optimization</a>	4,5 CR	Rebennack
T-WIWI-111247	<a href="#">Mathematics for High Dimensional Statistics</a>	4,5 CR	Grothe
T-WIWI-103124	<a href="#">Multivariate Statistical Methods</a>	4,5 CR	Grothe
T-WIWI-102725	<a href="#">Nonlinear Optimization II</a>	4,5 CR	Stein
T-WIWI-102715	<a href="#">Operations Research in Supply Chain Management</a>	4,5 CR	Nickel
T-WIWI-112109	<a href="#">Topics in Stochastic Optimization</a>	4,5 CR	Rebennack

**Competence Certificate**

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

**Content**

The modul focuses on theoretical foundations as well as solution algorithms for optimization problems with continuous and mixed integer decision variables.

**Annotation**

The lectures are partly offered irregularly. The curriculum of the next three years is available online ([www.ior.kit.edu](http://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

## 3.109 Module: Mathematical Statistics [M-MATH-102909]

**Responsible:** PD Dr. Bernhard Klar  
Prof. Dr. Mathias Trabs

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Stochastics\)](#)  
[Elective Field](#)

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each winter term

**Duration**  
1 term

**Level**  
4

**Version**  
2

Mandatory			
T-MATH-105872	<a href="#">Mathematical Statistics</a>	8 CR	Ebner, Fasen-Hartmann, Klar, Trabs

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

By the end of the course, students will

- know the basic concepts of mathematical statistics,
- be able to apply them independently to simple problems and examples,
- know specific probabilistic techniques and be able to use them for the mathematical analysis of estimation and test procedures,
- know the asymptotic behavior of maximum likelihood estimators and the generalized likelihood ratio for parametric test problems.

**Content**

The course covers basic concepts of mathematical statistics, in particular the finite optimality theory of estimators and tests, and the asymptotic behavior of estimators and test statistics. Topics are:

- Optimal and best linear unbiased estimators,
- Cramér-Rao bound in exponential families,
- sufficiency, completeness and the Lehmann-Scheffé theorem,
- the multivariate normal distribution,
- convergence in distribution and multivariate central limit theorem,
- Glivenko-Cantelli theorem,
- limit theorems for U-statistics,
- asymptotic estimation theory (maximum likelihood estimator),
- asymptotic relative efficiency of estimators,
- Neyman-Pearson tests and optimal unbiased tests,
- asymptotic tests in parametric models (likelihood ratio tests).

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

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



## M

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

**Responsible:** Prof. Dr. Dirk Hundertmark

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
4

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-108403	<a href="#">Mathematical Topics in Kinetic Theory</a>	4 CR	Hundertmark

#### Prerequisites

None

#### Competence Goal

The students are familiar with the basic questions in kinetic theory and methodical approaches to their solutions. With the acquired knowledge they are able to understand the required analytical methods and are able to apply them to the basic equations in kinetic theory.

#### Content

- Boltzmann equation: Cauchy problem and properties of solutions
- entropy and H theorem
- equilibrium and convergence to equilibrium
- other models of kinetic theory

## M

## 3.111 Module: Maxwell's Equations [M-MATH-102885]

**Responsible:** PD Dr. Frank Hettlich

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105856	<a href="#">Maxwell's Equations</a>	8 CR	Arens, Griesmaier, Hettlich

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

The students can explain mathematical questions from the theory of Maxwell's equations. They can formulate and prove the main theorems on properties and existence of solutions, can apply these to specific cases, and can compare results with simpler differential equations (like the Helmholtz equation).

### Content

Specific examples of solutions to Maxwell's equations, properties of solutions (e.g. representation theorems), specific cases like E-mode and H-mode, corresponding boundary value problems.

### Module grade calculation

The module grade is the grade of the oral exam

### Workload

Total workload: 240h

Attendace: 90h

- lecture, problem class, examination

Self-studies: 150h

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

### Recommendation

Desirable is basic knowledge from functional analysis

## M

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

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

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

Compulsory Elective Courses (Election: at least 1 item as well as between 4,5 and 9 credits)			
T-WIWI-102726	Global Optimization I	4,5 CR	Stein
T-WIWI-103638	Global Optimization I and II	9 CR	Stein
T-WIWI-102724	Nonlinear Optimization I	4,5 CR	Stein
T-WIWI-103637	Nonlinear Optimization I and II	9 CR	Stein
Supplementary Courses (Election: )			
T-WIWI-106546	Introduction to Stochastic Optimization	4,5 CR	Rebennack
T-WIWI-102727	Global Optimization II	4,5 CR	Stein
T-WIWI-102725	Nonlinear Optimization II	4,5 CR	Stein
T-WIWI-102704	Facility Location and Strategic Supply Chain Management	4,5 CR	Nickel

### Competence Certificate

The assessment is carried out as partial written exams (according to Section 4(2), 1 of the examination regulation) of the single courses of this module, whose sum of credits must meet the minimum requirement of credits of this module. The assessment procedures are described for each course of the module 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 courses *Nonlinear Optimization I* and *Global Optimization I* has to be examined.

### Competence Goal

The student

- names and describes basic notions for optimization methods, in particular from nonlinear and from global optimization,
- knows the indispensable methods and models for quantitative analysis,
- models and classifies optimization problems and chooses the appropriate solution methods to solve also challenging optimization problems independently and, if necessary, with the aid of a computer,
- validates, illustrates and interprets the obtained solutions.

### Content

The modul focuses on theoretical foundations as well as solution algorithms for optimization problems with continuous decision variables. The lectures on nonlinear programming deal with local solution concepts, whereas the lectures on global optimization treat approaches for global solutions.

### Annotation

The planned lectures and courses for the next three years are announced online (<http://www.ior.kit.edu>).

### Workload

The total workload for this module is approx. 270 hours (9 credits). The allocation is based on the credit points of the courses in the module.

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

### Recommendation

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

## M

## 3.113 Module: Metric Geometry [M-MATH-105931]

**Responsible:** Prof. Dr. Alexander Lytchak  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Algebra and Geometry\)](#)  
 Elective Field

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

Mandatory			
T-MATH-111933	<a href="#">Metric Geometry</a>	8 CR	Lytchak, Nepechiy

**Competence Certificate**

oral examination of circa 20 minutes

**Prerequisites**

None

**Module grade calculation**

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

## M

## 3.114 Module: Microeconomic Theory [M-WIWI-101500]

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

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

Compulsory Elective Courses (Election: at least 9 credits)			
T-WIWI-102609	<a href="#">Advanced Topics in Economic Theory</a>	4,5 CR	Mitusch
T-WIWI-102861	<a href="#">Advanced Game Theory</a>	4,5 CR	Ehrhart, Puppe, Reiß
T-WIWI-102613	<a href="#">Auction Theory</a>	4,5 CR	Ehrhart
T-WIWI-105781	<a href="#">Incentives in Organizations</a>	4,5 CR	Nieken
T-WIWI-113264	<a href="#">Matching Theory</a>	4,5 CR	Puppe
T-WIWI-102859	<a href="#">Social Choice Theory</a>	4,5 CR	Puppe

**Competence Certificate**

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

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 microeconomic problems mathematically and to analyze them with respect to positive and normative questions,
- understand individual incentives and social outcomes of different institutional designs.

Here is an example of a positive question: what firm decisions does a specific regulatory policy result in under imperfect competition? An example of a normative question would be: which voting rule has appealing properties?

**Content**

The module teaches advanced concepts and content in microeconomic theory. Thematically, it offers a formally rigorous treatment of game theory and exemplary applications, such as strategic interaction on markets and non-/cooperative bargaining ("Advanced Game Theory"), as well as specialized courses dedicated to auctions ("Auktionstheorie") and incentive systems in organizations ("Incentives in Organizations"). Moreover, it offers the opportunity to delve deeper into the mathematical theory of voting and collective decision making, i.e. the systematic aggregation of preferences and judgments ("Social Choice Theory").

**Workload**

Total workload for 9 credit points: approx. 270 hours

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

## M

## 3.115 Module: Minimal Surfaces [M-MATH-106666]

**Responsible:** Dr. Peter Lewintan

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-113417	<a href="#">Minimal Surfaces</a>	3 CR	Lewintan

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

Graduates

- are able to mathematically understand and solve a practical problem;
- can explain important results of the theory of minimal surfaces and apply them to examples;
- are prepared to write a thesis in the field of the theory of minimal surfaces or the calculus of variations.

### Content

Minimal surfaces are critical points of the area functional and locally minimize its area. They can also be described by having zero mean curvature. In this course we consider two dimensional minimal surfaces in  $\mathbb{R}^3$  and discuss their properties. We will use arguments from differential geometry, the calculus of variations, the theory of partial differential equations and functions of a complex variable. Our goal is to prove the classical Plateau's problem.

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 90 hours

Attendance: 30 hours

- lectures, problem classes, and examination

Self-studies: 60 hours

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

### Recommendation

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

## M

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

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

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

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

**Competence Certificate**

The module examination takes the form of a one-hour written comprehensive examination on the courses "Dynamic Capital Market Theory", "Essentials for Dynamic Financial Machine Learning" and "Exercises, Python, Research Frontier in Dynamic Capital Markets".

**Competence Goal****Dynamic Capital Market Theory:**

Professional competence:

- Understanding of the principles of Dynamic Asset Pricing Theory
- Mastery of concepts such as stochastic calculus and dynamic modeling in discrete and continuous time
- Application of dynamic programming theory to portfolio and investment decisions
- Knowledge of pricing bonds, stocks, futures and options markets.

Interdisciplinary skills:

- Develop analytical skills for working on and solving complex problems in finance
- Ability to apply theoretical models to real financial market scenarios.

**Essentials for Dynamic Financial Machine Learning:**

Professional Competence:

- Competencies in Multivariate Time Series Modeling and Dynamic Volatility Modeling.
- Skills in dealing with big financial data.
- Knowledge in the estimation of risk premia and the application of Kalman Filtering.

Interdisciplinary skills:

- Analytical skills in applying machine learning algorithms to dynamic financial market data.
- Development of problem-solving skills through the practical application of Python in financial data analysis.

## Content

### Dynamic Capital Market Theory:

The course "Dynamic Capital Market Theory" offers an introduction to the modeling of dynamic capital markets. Portfolio holdings and asset prices move dynamically across time and states. This course teaches basic financial economic thinking to help understand why this is the case and how to optimally act in such environments.

Next to the asset pricing focus, the second focus of the course is on optimal portfolio choice (robo advisory). For that, this course develops the theory of dynamic programming in discrete and continuous time and applies it to solve portfolio choice and corporate investment decisions. These concepts are key for financial engineering and the machine learning branch of Reinforcement Learning.

Students obtain proficiency in the following topics:

- Dynamic Valuation and Optimal Dynamic Asset Allocation
- Dynamic modeling in discrete time and continuous time
- Stochastic Calculus
- Markov Decision Processes and Dynamic Programming in discrete time and continuous time
- Pricing of bonds, equity, futures and options

Lectures (2 SWS) develop all concepts on the whiteboard.

### Essentials for Dynamic Financial Machine Learning:

The course "Essentials for Dynamic Financial Machine Learning" teaches students to work with financial data, algorithms and statistical concepts.

Students are exposed to algorithms to learn key quantities of dynamic capital markets, such as time-varying risk premia, time-varying volatility and unobserved realizations of random states. The course covers the following concepts:

- Multivariate time series modeling
- Dynamic volatility modeling
- Handling big financial data
- Estimating risk premia
- Kalman Filtering

Weekly lectures (2 SWS) develop all algorithmic material on the whiteboard.

### Exercises, Python, Research Frontier in Dynamic Capital Markets:

This course provides hands-on experience in implementing concepts from dynamic capital market theory and financial machine learning using Python. Students will develop practical skills in coding and data analysis that complement the theoretical knowledge gained in the companion courses. The course covers:

- Introduction to Python for financial applications Data manipulation and visualization with pandas and matplotlib.
- Implementing dynamic portfolio optimization algorithms.
- Coding stochastic processes and simulations.
- Building and testing time series models.
- Applying machine learning techniques to financial data.
- Developing Reinforcement Learning algorithms for trading strategies.
- Implementing and backtesting option pricing models.
- Creating interactive financial dashboards

Weekly computer lab sessions (2 SWS) will guide students through coding exercises and problem sets that directly relate to topics covered in "Dynamic Capital Market Theory" and "Essentials for Dynamic Financial Machine Learning". Students will work on individual and group projects, applying their programming skills to real-world financial problems and current research questions in dynamic capital markets.

This course forms an integral part of the module, complementing the theoretical components with practical implementation skills essential for modern quantitative finance.

## Workload

Total workload for 9 credit points: approx. 270 hours. The exact distribution is based on the credit points of the courses in the module:

- Dynamic Capital Market Theory: 3 CP
- Essentials for Dynamic Financial Machine Learning: 3 CP
- Exercises, Python, Research Frontier in Dynamic Capital Markets: 3 CP

The total number of hours per course is determined by the amount of time spent attending the lectures and tutorials, as well as the exam times and the time required to achieve the module's learning objectives for an average student for an average performance.



**Recommendation**

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

**Learning type**

The module consists of two weekly lectures and respective tutorials:

1. **Dynamic Capital Market Theory and**
2. **Essentials for Dynamic Financial Machine Learning.**
3. **Exercises, Python, Research Frontier in Dynamic Capital Markets**

## M

## 3.117 Module: Modelling and Simulation of Lithium-Ion Batteries [M-MATH-106640]

**Responsible:** Prof. Dr. Willy Dörfler

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-113382	<a href="#">Modelling and Simulation of Lithium-Ion Batteries</a>	4 CR	Dörfler

#### Competence Certificate

oral exam of ca. 20 minutes

#### Prerequisites

None

#### Competence Goal

Participants know about the modelling and physical basics that lead to the model equations. They can explain (at least for simplified problems) their well-posedness. They are able to analyze stability and convergence of the presented methods.

#### Content

- Derivation of the model equations,
- Existence for simplified model problems,
- Discretization of the initial boundary value problems with finite elements,
- Nonlinear diffusion equations, Cahn-Hilliard equation, linear elasticity and contact problems,
- Stability and convergence of the discrete models,
- Applications

#### Module grade calculation

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

#### Workload

Total workload: 120 hours

Attendance: 45 h

- lectures, problem classes and examination

Self studies: 75 h

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

#### Recommendation

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

## M

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

**Responsible:** PD Dr. Gerd Herzog

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
3

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105877	<a href="#">Monotonicity Methods in Analysis</a>	3 CR	Herzog

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

At the end of the course, students can

- name, discuss and apply basic techniques of the order-theoretical methods of analysis,
- apply specific order theory techniques to fixed point problems and differential equations.

### Content

- Fixed point theorems in ordered sets and ordered metric spaces.
- Ordered Banach spaces.
- Quasimonotone increasing functions.
- Differential equations and differential inequalities in ordered Banach spaces.

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 90 hours

Attendance: 30 hours

- lectures, problem classes, and examination

Self-studies: 60 hours

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

### Recommendation

The course "Functional Analysis" is recommended.

**M****3.119 Module: Nonlinear Analysis [M-MATH-103539]****Responsible:** Prof. Dr. Tobias Lamm**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field**Credits**  
8**Grading scale**  
Grade to a tenth**Recurrence**  
Irregular**Duration**  
1 term**Level**  
4**Version**  
1**Mandatory**

T-MATH-107065	<a href="#">Nonlinear Analysis</a>	8 CR	Lamm
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**Prerequisites**

None

## M

## 3.120 Module: Nonlinear Maxwell Equations [M-MATH-105066]

**Responsible:** Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-110283	<a href="#">Nonlinear Maxwell Equations</a>	8 CR	Schnaubelt

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

Students can explain some basic types of nonlinear Maxwell equations and the physical significance of the variables that occur. They are able to prove and discuss local wellposedness theorems in the whole space using energy methods. They can derive Strichartz inequalities for linear Maxwell equations. With their help, they can show improved wellposedness results.

### Content

- Maxwell equations with nonlinear material laws
- local wellposedness theory in the whole space using linearisation, apriori estimates and regularisation
- Strichartz inequalities and improved wellposedness theory

### Module grade calculation

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

### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

### Recommendation

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

## M

## 3.121 Module: Nonlinear Wave Equations [M-MATH-105326]

**Responsible:** Prof. Dr. Wolfgang Reichel  
Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-110806	<a href="#">Nonlinear Wave Equations</a>	4 CR	Reichel, Schnaubelt

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

Graduates will be able to

- name important properties of nonlinear wave equations,
- describe essential difficulties in the analysis of the initial value problem,
- analyze the short- and long-term behavior of solutions of semilinear wave equations using modern techniques.

**Content**

The aim of the course is an introduction to methods for analyzing nonlinear wave equations. The aim is to get to know the basics of various important techniques and to apply them to simple models. The following topics will be covered:

- Symmetries and conservation laws
- Fourier transformation, Sobolev spaces
- Energy estimates
- Strichartz estimates
- Local and global well-posedness results
- Vector field methods
- Longtime behavior

**Module grade calculation**

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

**Workload**

Total workload: 120 hours

Attendance: 45 h

- lectures, problem classes and examination

Self studies: 75 h

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

**Recommendation**

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

## M

## 3.122 Module: Nonparametric Statistics [M-MATH-102910]

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

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

Mandatory			
T-MATH-105873	<a href="#">Nonparametric Statistics</a>	4 CR	Ebner, Fasen-Hartmann, Klar, Trabs

**Competence Certificate**

The module will be completed with an oral exam (ca. 20 min).

**Prerequisites**

None

**Competence Goal**

By the end of the course, students will be able to

- explain nonparametric statistical tests based on location problems and distinguish them from parametric methods,
- name and explain nonparametric estimation methods for nonparametric regression and density estimation,
- know and apply optimality criteria for the statistical methods covered.

**Content**

- Introduction to nonparametric models
- Nonparametric tests, especially rank statistics
- Nonparametric density and regression estimation
- Dependence measures or optimal convergence rates

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 120 hours

Attendance: 45 h

- lectures, problem classes and examination

Self studies: 75 h

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

**Recommendation**

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

## M

## 3.123 Module: Numerical Analysis of Helmholtz Problems [M-MATH-105764]

**Responsible:** TT-Prof. Dr. Barbara Verfürth  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
 Elective Field

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

Mandatory			
T-MATH-111514	<a href="#">Numerical Analysis of Helmholtz Problems</a>	3 CR	Verfürth

**Competence Certificate**

oral examination of circa 30 minutes

**Prerequisites**

none

**Module grade calculation**

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



## M

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

**Responsible:** TT-Prof. Dr. Roland Maier

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-113470	<a href="#">Numerical Analysis of Neural Networks</a>	6 CR	Maier

### Competence Certificate

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

### Prerequisites

None.

### Competence Goal

The goal of the lecture is to provide a mathematical foundation of neural networks from the perspective of numerical analysis. Students know basic definitions and terminology as well as classical approximation results for neural networks. They are familiar with numerical methods for the efficient training of neural networks and can analyze them. Moreover, students can apply the concepts to popular applications (such as physics-informed neural networks, Deep Ritz method, etc.).

### Content

- Neural networks
- Approximation results
- Connections to finite element methods
- Numerical methods for the efficient learning
- Datasets

### Module grade calculation

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

### Annotation

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

### Workload

Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

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

### Recommendation

Basic knowledge of ordinary and/or partial differential equations as well as the contents of the module "Numerical Methods for Differential Equations" are recommended. Basic knowledge of functional analysis and finite element methods is helpful, but not required.

## M

## 3.125 Module: Numerical Complex Analysis [M-MATH-106063]

**Responsible:** Prof. Dr. Marlis Hochbruck

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-112280	<a href="#">Numerical Complex Analysis</a>	6 CR	Hochbruck

### Competence Certificate

Oral exam of approximately 20 minutes.

### Prerequisites

None.

### Competence Goal

Graduates

- can apply techniques and concepts from complex analysis in numerical analysis,
- are prepared to write a thesis in numerical analysis.

### Content

In this lecture we consider numerical methods for problems in complex analysis and complex analysis techniques to analyze numerical methods. It provides the chance to rediscover theorems known from the complex analysis lecture in applications.

The following topics are planned

- Calculations with power series: formal Newton's method and FFT,
- control systems and convolution quadrature (Cauchy integral formula, Laplace transform, argument principle),
- rational approximation to the exponential: order stars (maximum principle, argument principle),
- convergence of iterative methods for linear systems of equations an approximation of the matrix exponential operator (conformal mappings, Cauchy integral formula),
- numerical conformal mapping.

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 180 h

Attendance: 60 h

- lectures, problem classes, and examination

Self-studies: 120 h

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

### Recommendation

Basic knowledge of complex analysis is highly recommended.

### Literature

Lecture notes with references.

**M****3.126 Module: Numerical Linear Algebra for Scientific High Performance Computing [M-MATH-103709]****Responsible:** Prof. Dr. Hartwig Anzt**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-107497	<a href="#">Numerical Linear Algebra for Scientific High Performance Computing</a>	5 CR	Anzt

**Prerequisites**

None

## M

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

**Responsible:** PD Dr. Volker Grimm

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
6

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-108402	<a href="#">Numerical Linear Algebra in Image Processing</a>	6 CR	Grimm

#### Competence Certificate

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

#### Prerequisites

None

#### Competence Goal

Graduates can name essential concepts of image processing using numerical linear algebra methods and implement them efficiently.

#### Content

- Linear models of optical devices
- Point spread function and discrete convolution
- Structured matrices and fast transformations
- Large, ill-conditioned linear systems of equations
- Krylov subspace methods, preconditioning
- Several applications

#### Module grade calculation

The module grade is the grade of the oral exam.

#### Workload

Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

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

## M

## 3.128 Module: Numerical Methods for Differential Equations [M-MATH-102888]

**Responsible:** Prof. Dr. Willy Dörfler  
Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each winter term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105836	<a href="#">Numerical Methods for Differential Equations</a>	8 CR	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

### Competence Certificate

The module will be completed by a written exam (120 min).

### 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 written exam.

### Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

### Recommendation

It is highly recommended that participants have completed the modules "Numerische Mathematik 1 und 2" as well as "Programmieren: Einstieg in die Informatik und algorithmische Mathematik".

**M****3.129 Module: Numerical Methods for Hyperbolic Equations [M-MATH-102915]****Responsible:** Prof. Dr. Willy Dörfler**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field**Credits**  
6**Grading scale**  
Grade to a tenth**Recurrence**  
Irregular**Duration**  
1 term**Level**  
4**Version**  
1

Mandatory			
T-MATH-105900	<a href="#">Numerical Methods for Hyperbolic Equations</a>	6 CR	Dörfler

**Prerequisites**

none

**Competence Goal**

.

## M

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

**Responsible:** PD Dr. Tilo Arens

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
5

**Version**  
1

Mandatory			
T-MATH-105901	<a href="#">Numerical Methods for Integral Equations</a>	8 CR	Arens, Hettlich

### Competence Certificate

The module examination is carried out by one oral examination (approx. 30 minutes).

By successfully participating in the problem classes by correctly completing 60% of the programming exercise assignments, students will obtain a bonus to the grade of the oral examination. This bonus amounts to an improvement of the grade to the next marking step (a decrease by 0.3 or 0.4, respectively), if the original grade is between 4.0 and 1.3.

### Prerequisites

None

### Competence Goal

Students are able to name and describe basic methods for numerically solving linear integral equations of the second kind, such as the Nyström method, collocation method and Galerkin method, as well as their underlying principles such as interpolation and numerical integration. They are able to apply these methods for numerically solving integral equations and to implement concrete examples on a computer. Students are able to state convergence results concerning these methods and have mastered the application of methods of proof for such results. They can independently derive corresponding results for simple variations of these methods and perform the analysis of the convergence behavior for specific applications.

### Content

- Boundary integral operators
- Interpolation and quadrature formulae
- Nyström methods
- Projection methods and boundary element methods

### Module grade calculation

The grade of the module is the grade of the oral examination, modified by the bonus from the problem class assignments.

### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

### Recommendation

Numerical Analysis I

Integral Equations

## M

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

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

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

Mandatory			
T-MATH-105920	<a href="#">Numerical Methods for Maxwell's Equations</a>	6 CR	Hochbruck, Jahnke

**Competence Certificate**

Oral examination of approximately 20 minutes.

**Prerequisites**

None.

**Competence Goal**

The students can interpret the terms arising in the time-dependent Maxwell equations physically and prove the existence and uniqueness of the solution under appropriate assumptions. They know numerical methods and techniques to approximate these solutions and they are able to perform an error analysis. From the practical point of view they are able to evaluate advantages and disadvantages of different methods.

**Content**

Maxwell equations are a set of vector valued partial differential equations that are fundamental for the propagation of electromagnetic waves in media. In this lecture we start to derive Maxwell equations in integral- and differential form, discuss examples of material laws, boundary conditions, and study the well-posedness in suitable function spaces. For the numerical solution of Maxwell equations, we employ finite element methods for the spatial discretization. Our emphasis is on discontinuous Galerkin methods. Favorable methods for time discretization are splitting methods, (locally) implicit schemes, and exponential integrators. We construct and analyse these methods and discuss their efficient implementation.

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 180 h

Attendance: 60 h

- lectures, problem classes, and examination

Self-studies: 120 h

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

**Recommendation**

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

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

**Learning type**

Lecture and tutorial with the active contribution of the students; problem sheets every 2 weeks.

**Literature**

Lecture notes with many references will be provided.



## M

## 3.132 Module: Numerical Methods for Oscillatory Differential Equations [M-MATH-106682]

**Responsible:** Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-113437	<a href="#">Numerical Methods for Oscillatory Differential Equations</a>	8 CR	Jahnke

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

The central topic of the lecture are numerical time-integrators for highly oscillatory ordinary and partial differential equations.

After participation, students

- know selected classes of ordinary and partial differential equations with oscillatory solutions and can explain the reason for the oscillations.
- can explain why time-integration of such problems with traditional methods is usually inefficient.
- know different techniques which can be used to construct more efficient methods for selected problems.
- can explain error bounds for such integrators and know the ideas, techniques and assumptions used in the error analysis.

### Content

- Oscillatory ordinary and partial differential equations: examples and applications
- Construction of time integrators
- Oscillations and resonances
- Error analysis
- Space discretization by Fourier collocation methods

### Module grade calculation

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

### Annotation

The module will be offered about every second summer semester.

### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

### Recommendation

Participants are expected to be familiar with numerical methods for ordinary differential equations (e.g. Runge-Kutta methods) and with concepts required for their analysis (stability, order, local and global error, etc.).

## M

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

**Responsible:** Prof. Dr. Marlis Hochbruck

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-105899	<a href="#">Numerical Methods for Time-Dependent Partial Differential Equations</a>	8 CR	Hochbruck, Jahnke

### Competence Certificate

Oral exam of approximately 25 minutes.

### Prerequisites

None.

### Competence Goal

Students can analyze numerical methods for abstract evolution equations. They can understand current research results and master various techniques for proving stability and error estimates of time integration methods. They can independently solve exercises, and present and discuss solutions.

### Content

- Time integration methods for linear, semilinear, and quasilinear evolution equations and their semi-discretization in place, in particular, implicit Runge-Kutta and multistep methods,
- rigorous error estimates and stability proofs.

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 240 h

Attendance: 90 h

- lectures, problem classes, and examination

Self-studies: 150 h

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

### Recommendation

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

**M****3.134 Module: Numerical Methods in Computational Electrodynamics [M-MATH-102894]****Responsible:** Prof. Dr. Willy Dörfler**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)**Credits**  
6**Grading scale**  
Grade to a tenth**Recurrence**  
Irregular**Duration**  
1 term**Level**  
4**Version**  
1

Mandatory			
T-MATH-105860	<a href="#">Numerical Methods in Computational Electrodynamics</a>	6 CR	Dörfler, Hochbruck, Jahnke, Rieder, Wiens

**Prerequisites**

none

## M

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

**Responsible:** Prof. Dr. Willy Dörfler  
PD Dr. Gudrun Thäter

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105902	<a href="#">Numerical Methods in Fluid Mechanics</a>	4 CR	Dörfler, Thäter

### Competence Certificate

Oral exam of about 20 minutes.

### Prerequisites

None

### Competence Goal

Participants know about the modelling and physical basics that lead to the model equations. They know how to discretize fluidmechanical problems with the finite element method and know especially how to treat the incompressibility condition. They are able to analyze stability and convergence of the presented methods.

### Content

- Modelling and derivation of the Navier-Stokes equations
- Mathematical and physical representation of energy and stress
- Lax-Milgram theorem, Céa lemma and saddle point theory
- Analytical and numerical treatment of the potential and Stokes flow
- Stability and convergence of the discrete models
- Numerical treatment of the stationary nonlinear equation
- Numerical treatment of the instationary problems
- Applications

### Module grade calculation

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

### Workload

Total workload: 120 hours

Attendance: 45 h

- lectures, problem classes and examination.

Self studies: 75 h

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

### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105865	<a href="#">Numerical Methods in Mathematical Finance</a>	8 CR	Jahnke

### Competence Certificate

oral exam of ca. 30 minutes

### Prerequisites

none

### Competence Goal

The lecture concentrates on option pricing with numerical methods.

After participation, students

- know how to model the price dynamics of different types of options by stochastic or partial differential equations, and to evaluate the differences between these models.
- know, in particular, the assumptions on which these models are based, which enables them to discuss and question the meaningfulness and reliability of the models.
- know different methods for solving stochastic and partial differential equations numerically, and for solving high-dimensional integration problems.
- are able to implement and apply these methods to different types of options, and to analyze their stability and convergence.

### Content

- Options, arbitrage and other basic concepts,
- Black-Scholes equation und Black-Scholes formulas,
- Numerical methods for stochastic differential equations,
- (Multilevel) Monte Carlo methods,
- (Quasi-)Monte Carlo integration,
- Numerical methods for Black-Scholes equations,
- Numerical methods for American options

### Module grade calculation

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

### Annotation

The module is offered every second winter term.

### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

**Recommendation**

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

**M****3.137 Module: Numerical Optimisation Methods [M-MATH-102892]****Responsible:** Prof. Dr. Christian Wieners**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field**Credits**  
8**Grading scale**  
Grade to a tenth**Recurrence**  
Irregular**Duration**  
1 term**Level**  
4**Version**  
1

Mandatory			
T-MATH-105858	<a href="#">Numerical Optimisation Methods</a>	8 CR	Dörfler, Hochbruck, Jahnke, Rieder, Wieners

## M

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

**Responsible:** PD Dr. Volker Grimm

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-110807	<a href="#">Numerical Simulation in Molecular Dynamics</a>	8 CR	Grimm

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

Graduates know the basic concepts for implementing numerical simulations in molecular dynamics on serial and parallel computer architectures. They can name the numerical results and procedures required for simulation in molecular dynamics, apply them to specific problems and implement them.

### Content

- Linked-cell method for short-range potentials
- Parallel programming with MPI
- Various potentials and molecules
- Time integration methods
- Aspects of numerical geometric integration
- Methods for the simulation of long-range potentials

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-study: 150 hours

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

### Recommendation

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



## M

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

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Operations Management - Data Analysis - Informatics](#)  
 Elective Field

<b>Credits</b> 9	<b>Grading scale</b> Grade to a tenth	<b>Recurrence</b> Each term	<b>Duration</b> 2 terms	<b>Language</b> German/English	<b>Level</b> 4	<b>Version</b> 9
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**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.

<b>Compulsory Elective Courses (Election: between 1 and 2 items)</b>			
T-WIWI-102723	<a href="#">Graph Theory and Advanced Location Models</a>	4,5 CR	Nickel
T-WIWI-106200	<a href="#">Modeling and OR-Software: Advanced Topics</a>	4,5 CR	Nickel
T-WIWI-102715	<a href="#">Operations Research in Supply Chain Management</a>	4,5 CR	Nickel
<b>Supplementary Courses (Election: at most 1 item)</b>			
T-MACH-112213	<a href="#">Applied material flow simulation</a>	4,5 CR	Baumann
T-WIWI-106546	<a href="#">Introduction to Stochastic Optimization</a>	4,5 CR	Rebennack
T-WIWI-102718	<a href="#">Discrete-Event Simulation in Production and Logistics</a>	4,5 CR	Spieckermann
T-WIWI-102719	<a href="#">Mixed Integer Programming I</a>	4,5 CR	Stein
T-WIWI-102720	<a href="#">Mixed Integer Programming II</a>	4,5 CR	Stein
T-WIWI-106549	<a href="#">Large-scale Optimization</a>	4,5 CR	Rebennack
T-WIWI-111587	<a href="#">Multicriteria Optimization</a>	4,5 CR	Stein
T-WIWI-112109	<a href="#">Topics in Stochastic Optimization</a>	4,5 CR	Rebennack

**Competence Certificate**

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

The assessment procedures are described for each course of the module 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 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 Supply Chain Management, including methods of scheduling as well as different approaches in procurement and distribution logistics. Finally, issues of warehousing and inventory management will be discussed.

**Annotation**

Some lectures and courses are offered irregularly.

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

**Workload**

Total effort for 9 credits: ca. 270 hours

- Presence time: 84 hours
- Preparation/Wrap-up: 112 hours
- Examination and examination preparation: 74 hours

**Recommendation**

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

M

**3.140 Module: Optimisation and Optimal Control for Differential Equations [M-MATH-102899]****Responsible:** Prof. Dr. Christian Wieners**Organisation:** KIT Department of Mathematics**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105864	<a href="#">Optimisation and Optimal Control for Differential Equations</a>	4 CR	

**Prerequisites**

none

## M

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

**Responsible:** Prof. Dr. Roland Griesmaier

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105893	<a href="#">Optimization in Banach Spaces</a>	5 CR	Griesmaier, Hettlich

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

The students can transfer properties from finite dimensional optimization problems to infinite dimensional cases. Furthermore, they can apply these results to problems from approximation theory, calculus of variation and optimal control. The students know about the main theorems and their proofs and can explain conclusions with the help of examples.

### Content

Basics from Functional Analysis (in particular separation theorems, properties of convex functions and generalized derivatives), duality theory of convex problems, differentiable optimization problems (Lagrange multiplier), sufficient optimality conditions, existence results, applications in approximation theory, calculus of variation, and optimal control theory.

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 150 hours

Attendance: 60 hours

- lecture including course related examinations

Self-studies: 90 hours

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

### Recommendation

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

## M

## 3.142 Module: Parallel Computing [M-MATH-101338]

**Responsible:** PD Dr. Mathias Krause  
Prof. Dr. Christian Wieners

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-102271	<a href="#">Parallel Computing</a>	5 CR	Krause, Wieners

**Prerequisites**

None

## M

## 3.143 Module: Percolation [M-MATH-102905]

**Responsible:** Prof. Dr. Günter Last  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Stochastics\)](#)  
 Elective Field

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

Mandatory			
T-MATH-105869	<a href="#">Percolation</a>	5 CR	Hug, Last, Winter

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

The students

- are acquainted with basic models of discrete and continuum percolation,
- acquire the skills needed to use specific probabilistic and graph-theoretical methods for the analysis of these models,
- know how to work self-organised and self-reflexive.

**Content**

- Bond and site percolation on graphs
- Infinite clusters and critical probabilities
- Asymptotics of cluster sizes
- Uniqueness of the infinite cluster
- Continuous percolation

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

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

**Recommendation**

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

## M

## 3.144 Module: Poisson Processes [M-MATH-102922]

**Responsible:** Prof. Dr. Günter Last  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Stochastics\)](#)  
 Elective Field

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

Mandatory			
T-MATH-105922	<a href="#">Poisson Processes</a>	5 CR	Fasen-Hartmann, Hug, Last, Nestmann, Winter

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

The students know about important properties of the Poisson process. The focus is on probabilistic methods and results which are independent of the specific phase space. The students understand the central role of the Poisson process as a specific point process and as a random measure.

**Content**

- The Poisson process as particular point process
- Multivariate Mecke equation
- Superpositions, markings and thinnings
- Characterizations of the Poisson process
- Stationary Poisson and point processes
- Balanced allocations and the Gale-Shapley algorithm
- Compound Poisson processes
- Wiener-Ito integrals
- Fock space representation

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 150 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 90 hours

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

**Recommendation**

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

## M

## 3.145 Module: Potential Theory [M-MATH-102879]

**Responsible:** Prof. Dr. Roland Griesmaier

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105850	<a href="#">Potential Theory</a>	8 CR	Arens, Griesmaier, Hettlich, Reichel

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

Students can explain basic properties of harmonic functions and prove existence and uniqueness of solutions to boundary value problems for the Laplace equation in interior and exterior domains using integral equation techniques. They master representation theorems and are able to apply single- and double layer potentials to solve 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

## 3.146 Module: Probability Theory and Combinatorial Optimization [M-MATH-102947]

**Responsible:** Prof. Dr. Daniel Hug  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Stochastics\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-105923	<a href="#">Probability Theory and Combinatorial Optimization</a>	8 CR	Hug, Last

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

The students

- know basic problems of combinatorial optimization as discussed in the lectures and are able to explain them,
- know typical methods for the probabilistic analysis of algorithms and combinatorial optimization problems and are able to use them for the solution of specific optimization problems,
- are familiar with the essential techniques of proof and are able to explain them,
- know how to work in a self-organized and self-reflexive manner.

### Content

This course is devoted to the analysis of algorithms and combinatorial optimization problems in a probabilistic framework. A natural setting for the investigation of such problems is often provided by a (geometric) graph. For a given system (graph), the average or most likely behavior of an objective function of the system will be studied. In addition to asymptotic results, which describe a system as its size increases, quantitative laws for systems of fixed size will be described. Among the specific problems to be explored are

- the long-common-subsequence problem,
- packing problems,
- the Euclidean traveling salesperson problem,
- minimal Euclidean matching,
- minimal Euclidean spanning tree.

For the analysis of problems of this type, several techniques and concepts have been developed and will be introduced and applied in this course. Some of these are

- concentration inequalities and concentration of measure,
- subadditivity and superadditivity,
- martingale methods,
- isoperimetry,
- entropy.

### Module grade calculation

The modul grade is the grade of the oral exam.

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

It is recommended to have taken the module 'Probability Theory' from the Bachelor program beforehand.

## M

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

**Responsible:** Prof. Dr. Daniel Hug  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Stochastics\)](#)  
 Elective Field

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

Mandatory			
T-MATH-112241	<a href="#">Random Graphs and Networks</a>	8 CR	Hug

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

Students

- know the basic models of random graphs and their properties,
- are familiar with probabilistic techniques for the investigation of random graphs,
- are able to work in a self-organized and reflexive manner.

**Content**

In the course, models of random graphs and networks are presented and methods will be developed which allow to state and prove results about the structure of such models.

In particular, the following models are treated:

- Erdős--Renyi graphs
- Configuration models
- Preferential-Attachment graphs
- Generalized inhomogeneous random graphs
- Geometric random graphs

and the following methods are addressed:

- Branching processes
- Coupling arguments
- Probabilistic bounds
- Martingales
- Local convergence of random graphs

**Module grade calculation**

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

**Annotation**

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

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

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

## M

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

**Responsible:** apl. Prof. Dr. Peer Kunstmann  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
 Elective Field

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

Mandatory			
T-MATH-113472	<a href="#">Regularity for Elliptic Operators</a>	6 CR	Kunstmann

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

The students

- can explain methods for definition of elliptic operators,
- can name results on spectral properties in  $L^q$  and relate them,
- can explain the relevance of heat kernel estimates and sketch corresponding methods of proof,
- can sketch the construction of the  $H^\infty$  calculus and name classes of elliptic operators for which it is bounded,
- can explain the concept of  $L^p$  maximal regularity and its relation to other parts of the theory and can name examples,
- have mastered the important techniques of proofs for regularity properties of elliptic operators,
- are able to start a master thesis in the field.

**Content**

- elliptic operators in divergence and non-divergence form
- elliptic operators on domains with boundary conditions
- heat kernel estimates for elliptic operators
- spectrum of elliptic operators in Lebesgue spaces  $L^q$
- maximal  $L^p$  regularity for the parabolic problem
- $H^\infty$  functional calculus for elliptic operators
- $L^q$  theory for parabolic boundary value problems

**Module grade calculation**

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

**Workload**

Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

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

**Recommendation**

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

## M

## 3.149 Module: Riemann Surfaces [M-MATH-106466]

**Responsible:** Prof. Dr. Frank Herrlich  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Algebra and Geometry\)](#)  
 Elective Field

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

Mandatory			
T-MATH-113081	<a href="#">Riemann Surfaces</a>	8 CR	Herrlich

**Competence Certificate**

Oral examination of ca. 30 minutes.

**Prerequisites**

None

**Competence Goal**

Students know

- essential structural properties of Riemann surfaces,
- topological, analytic and algebraic methods for the investigation of Riemann surfaces, and are able to apply them.

**Content**

- Definition of Riemann surfaces
- holomorphic and meromorphic functions on Riemann surfaces
- Compact Riemann surfaces
- The Riemann-Roch theorem
- Uniformization, Fuchsian groups and hyperbolic metric
- Classification of compact Riemann surfaces

**Module grade calculation**

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

**Workload**

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

**Recommendation**

Some knowledge of complex analysis (e.g. "Analysis 4") is strongly recommended as well as the modules "Elementary Geometry" and "Introduction to Algebra and Number Theory".

## M

## 3.150 Module: Ruin Theory [M-MATH-104055]

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

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

Mandatory			
T-MATH-108400	<a href="#">Ruin Theory</a>	4 CR	Fasen-Hartmann

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

Students are able to

- name and discuss key concepts and results of ruin theory with applications in actuarial mathematics and can apply them to examples,
- apply specific probabilistic methods to analyse risk processes,
- master proof techniques,
- work in a self-orientated and reflective manner.

**Content**

- renewal theory
- classical risk process of Cramér and Lundberg
- asymptotic behaviour of the probability of ruin probability if the Lundberg constant exists (losses with light tailed distributions)
- subexponential distributions
- asymptotic behaviour of the probability of ruin if the losses are subexponentially distributed (losses with heavy tailed distributions)
- approximation of the ruin probability
- integrated risk processes
- portfolio of risk processes

**Module grade calculation**

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

**Workload**

Total workload: 120 hours

Attendance: 45 hours

- lectures and problem classes including the examination

Self studies: 75 hours

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

**Recommendation**

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

## M

## 3.151 Module: Scattering Theory [M-MATH-102884]

**Responsible:** PD Dr. Frank Hettlich

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105855	<a href="#">Scattering Theory</a>	8 CR	Arens, Griesmaier, Hettlich

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

The students can prove and apply basic properties of solutions of the Helmholtz equation in the interior and in the exterior of a domain. They know about the representation theorems for such solutions. Students can explain the existence theory of corresponding boundary value problems by integral equations and/or variational formulations including appropriate proofs. Furthermore, the students can show and apply the dependence of a scattered field on the scattering object and the wave number as well as the relationship with its far field pattern.

### Content

- Helmholtz equation and elementary solutions
- Greens representation theorems
- Existence and uniqueness of scattering problems
- Radiation condition and far field pattern

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 240h

Attendance: 90h

- lecture, problem class, examination

Self-studies: 150h

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

### Recommendation

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



## M

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

**Responsible:** Prof. Dr. Roland Griesmaier

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-113416	<a href="#">Scattering Theory for Time-dependent Waves</a>	6 CR	Griesmaier

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

The students can prove and apply basic properties of solutions of the wave equation in interior or exterior domains. They know about representation theorems for such solutions and can apply the Fourier-Laplace-transform to analyze causal solutions. Students master the existence and uniqueness theory of associated boundary value problems using integral equations and retarded single and double layer potentials including proofs. Furthermore, the students can apply these results to scattering problems and explain the dependence of scattered waves on the scattering object as well as the relationship with its far field pattern.

### Content

- Wave equations and elementary solutions
- Representation theorems
- Fourier-Laplace-transform
- Boundary element formulations of boundary value problems for the wave equation
- Existence and uniqueness of solutions to interior and exterior boundary value problems
- Scattering problems and far field patterns

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 180 hours

Attendance: 60 h

Self studies: 120 h

### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-111853	<a href="#">Selected Methods in Fluids and Kinetic Equations</a>	3 CR	

#### Competence Certificate

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

#### Prerequisites

none

#### Competence Goal

The main aim of this lecture is to introduce students to tools and techniques developed in recent years to analyze the evolution of fluids and kinetic equations.

The students will learn how to use these techniques and how to apply them to families of equations.

#### Content

In this lecture we discuss selected techniques and tools that have lead to significant progress in the analysis of fluids and kinetic equations.

These, for instance, include:

- energy methods and local well-posedness results (e.g. fixed point results, Osgood lemma)
- Newton iteration
- Cauchy-Kowalewskaya and ghost energy approaches

No prior knowledge of fluids or kinetic equations is required.

#### Module grade calculation

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

#### Workload

Total workload: 90 hours

Attendance: 30 h

- lectures and examination

Self studies: 60 h

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

#### Recommendation

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

## M

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

**Responsible:** Prof. Dr. Dirk Hundertmark

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
3

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-109065	<a href="#">Selected Topics in Harmonic Analysis</a>	3 CR	Hundertmark

#### Prerequisites

None

#### Competence Goal

The students are familiar with the concepts of singular integral operators and weighted estimates in Harmonic Analysis. They know the relations between the BMO space and the Muckenhoupt weights and also how to use dyadic analysis operators to obtain estimates for Calderon-Zygmund operators.

#### Content

- Calderon-Zygmund and Singular Integral operators
- BMO space and Muckenhoupt weights
- Reverse Holder Inequality and Factorisation of  $A_p$  weights
- Extrapolation Theory and weighted norm inequalities for singular integral operators

## M

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

**Responsible:** Dr. rer. nat. Patrick Tolksdorf

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-113415	<a href="#">Semigroup Theory for the Navier-Stokes Equations</a>	6 CR	Tolksdorf

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

After a successful participation of the course, students are familiar with essential concepts of semigroup theory, such as analytic semigroups and fractional powers of sectorial operators. They are able to apply these concepts to the Stokes operator and derive basic regularity properties of solutions to the Stokes equations. Furthermore, they can use these concepts to construct solutions to the Navier-Stokes equations in critical spaces through an iteration scheme.

### Content

Content from abstract semigroup theory:

- Sectorial operators
- Analytic semigroups
- Fractional powers

Content from fluid mechanics:

- Helmholtz decomposition
- Bogovskii operator
- Stokes operator
- Mapping properties of the Stokes semigroup
- Solvability of the Navier-Stokes equations in critical spaces

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 180 hours

Attendance: 60 h

- lectures, problem classes and examination

Self studies: 120 h

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

### Recommendation

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

## M

## 3.156 Module: Seminar [M-WIWI-102971]

**Responsible:** Prof. Dr. Hagen Lindstädt  
Prof. Dr. Oliver Stein

**Organisation:** KIT Department of Economics and Management

**Part of:** [Seminar in Economics and Management](#)  
[Elective Field](#)

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

Wahlpflichtangebot (Election: 3 credits)			
T-WIWI-103474	<a href="#">Seminar in Business Administration A (Master)</a>	3 CR	Professorenschaft des Fachbereichs Betriebswirtschaftslehre
T-WIWI-103478	<a href="#">Seminar in Economics A (Master)</a>	3 CR	Professorenschaft des Fachbereichs Volkswirtschaftslehre
T-WIWI-103483	<a href="#">Seminar in Statistics A (Master)</a>	3 CR	Grothe, Schienle

**Competence Certificate**

The modul examination consists of one seminar (according to §4 (3), 3 of the examintaion regulation). A detailed description of the assessment is given in the specific course characerization.

The final mark for the module is the mark of the seminar.

**Prerequisites**

None.

**Competence Goal**

The students are in a position to independently handle current, research-based tasks according to scientific criteria.

- They are able to research, analyze, abstract and critically review the information.
- They can draw own conclusions using their interdisciplinary knowledge from the less structured information and selectively develop current research results.
- They can logically and systematically present the obtained results both orally and in written form in accordance with scientific guidelines (structuring, technical terminology, referencing). They can argue and defend the results professionally in the discussion.

**Content**

Competences which are gained in the seminar module especially prepare the student for composing the final thesis. Within the term paper and the presentation the student exercises himself in scientific working techniques supported by the supervisor.

Beside advancing skills in techniques of scientific working there are gained integrative key qualifications as well. A detailed description o these qualifications is given in the section "Key Qualifications" of the module handbook.

Furthermore, the module also includes additional key qualifications provided by the KQ-courses.

**Annotation**

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required. The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

**Recommendation**

None.

## M

## 3.157 Module: Seminar [M-MATH-102730]

**Responsible:** PD Dr. Stefan Kühnlein  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Seminar](#)

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

Elective Seminar (Election: 1 item)			
T-MATH-105686	<a href="#">Seminar Mathematics</a>	3 CR	Kühnlein

**Competence Certificate**

The control of success (pass/fail) is based on a seminar talk lasting at least 45 minutes.

**Prerequisites**

None

**Competence Goal**

At the end of the module, participants should

- have analyzed a specific problem in a mathematical area
- be able to discuss subject-specific problems in the given context and present as well as defend them, using suitable media
- have summarized the most relevant results of their topic
- have communicative, organizational and didactic skills in complex problem analyses at their disposal. They can use techniques of scientific work.

**Content**

The specific content is based on the seminar topics being offered.

**Module grade calculation**

Omitted, as ungraded (pass/fail)

**Workload**

Total work load: 90 hours

Attendance: 30 hours

Self studies: 60 hours

- Preparation of the scientific content of the talk
- Preparation of a didactical concept for the talk
- Preparation of the presentation (blackboard, beamer, etc.)
- getting practice for the talk, creating a hand-out

## M

## 3.158 Module: Seminar [M-WIWI-102973]

**Responsible:** Prof. Dr. Hagen Lindstädt  
Prof. Dr. Oliver Stein

**Organisation:** KIT Department of Economics and Management

**Part of:** [Seminar in Economics and Management](#)  
Elective Field

<b>Credits</b> 3	<b>Grading scale</b> Grade to a tenth	<b>Recurrence</b> Each term	<b>Duration</b> 1 term	<b>Language</b> German	<b>Level</b> 4	<b>Version</b> 1
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Wahlpflichtangebot (Election: 3 credits)			
T-WIWI-103479	<a href="#">Seminar in Informatics A (Master)</a>	3 CR	Professorenschaft des Instituts AIFB
T-WIWI-103481	<a href="#">Seminar in Operations Research A (Master)</a>	3 CR	Nickel, Rebennack, Stein

**Competence Certificate**

The modul examination consists of one seminar (according to §4 (3), 3 of the examintaion regulation). A detailed description of the assessment is given in the specific course characerization.

The final mark for the module is the mark of the seminar.

**Prerequisites**

None.

**Competence Goal**

The students are in a position to independently handle current, research-based tasks according to scientific criteria.

- They are able to research, analyze, abstract and critically review the information.
- They can draw own conclusions using their interdisciplinary knowledge from the less structured information and selectively develop current research results.
- They can logically and systematically present the obtained results both orally and in written form in accordance with scientific guidelines (structuring, technical terminology, referencing). They can argue and defend the results professionally in the discussion.

**Content**

Competences which are gained in the seminar module especially prepare the student for composing the final thesis. Within the term paper and the presentation the student exercises himself in scientific working techniques supported by the supervisor.

Beside advancing skills in techniques of scientific working there are gained integrative key qualifications as well. A detailed description o these qualifications is given in the section "Key Qualifications" of the module handbook.

Furthermore, the module also includes additional key qualifications provided by the KQ-courses.

**Annotation**

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required. The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

**Recommendation**

None.

## M

## 3.159 Module: Seminar [M-WIWI-102974]

**Responsible:** Prof. Dr. Hagen Lindstädt  
Prof. Dr. Oliver Stein

**Organisation:** KIT Department of Economics and Management

**Part of:** [Elective Field](#)

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

Wahlpflichtangebot (Election: 1 item)			
T-WIWI-103480	<a href="#">Seminar in Informatics B (Master)</a>	3 CR	Professorenschaft des Instituts AIFB
T-WIWI-103482	<a href="#">Seminar in Operations Research B (Master)</a>	3 CR	Nickel, Rebennack, Stein

**Competence Certificate**

The modul examination consists of one seminar (according to §4 (3), 3 of the examintaion regulation). A detailed description of the assessment is given in the specific course characerization.

The final mark for the module is the mark of the seminar

**Prerequisites**

None.

**Competence Goal**

- The students are in a position to independently handle current, research-based tasks according to scientific criteria.
- They are able to research, analyze, abstract and critically review the information.
- They can draw own conclusions using their interdisciplinary knowledge from the less structured information and selectively develop current research results.
- They can logically and systematically present the obtained results both orally and in written form in accordance with scientific guidelines (structuring, technical terminology, referencing). They can argue and defend the results professionally in the discussion.

**Content**

Competences which are gained in the seminar module especially prepare the student for composing the final thesis. Within the term paper and the presentation the student exercises himself in scientific working techniques supported by the supervisor.

Beside advancing skills in techniques of scientific working there are gained integrative key qualifications as well.

**Annotation**

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

**Workload**

he total workload for this module is approximately 90 hours.



## M

## 3.160 Module: Seminar [M-WIWI-102972]

**Responsible:** Prof. Dr. Hagen Lindstädt  
Prof. Dr. Oliver Stein

**Organisation:** KIT Department of Economics and Management

**Part of:** [Elective Field](#)

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

Wahlpflichtangebot (Election: 1 item)			
T-WIWI-103476	<a href="#">Seminar in Business Administration B (Master)</a>	3 CR	Professorenschaft des Fachbereichs Betriebswirtschaftslehre
T-WIWI-103477	<a href="#">Seminar in Economics B (Master)</a>	3 CR	Professorenschaft des Fachbereichs Volkswirtschaftslehre
T-WIWI-103484	<a href="#">Seminar in Statistics B (Master)</a>	3 CR	Grothe, Schienle

**Competence Certificate**

The modul examination consists of one seminar (according to §4 (3), 3 of the examintaion regulation). A detailed description of the assessment is given in the specific course characerization.

The final mark for the module is the mark of the seminar

**Prerequisites**

None.

**Competence Goal**

- The students are in a position to independently handle current, research-based tasks according to scientific criteria.
- They are able to research, analyze, abstract and critically review the information.
- They can draw own conclusions using their interdisciplinary knowledge from the less structured information and selectively develop current research results.
- They can logically and systematically present the obtained results both orally and in written form in accordance with scientific guidelines (structuring, technical terminology, referencing). They can argue and defend the results professionally in the discussion.

**Content**

Competences which are gained in the seminar module especially prepare the student for composing the final thesis. Within the term paper and the presentation the student exercises himself in scientific working techniques supported by the supervisor.

Beside advancing skills in techniques of scientific working there are gained integrative key qualifications as well.

**Annotation**

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

**Workload**

he total workload for this module is approximately 90 hours.

## M

## 3.161 Module: Service Operations [M-WIWI-102805]

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Operations Management - Data Analysis - Informatics](#)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	7

**Election notes**

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.

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	<a href="#">Discrete-Event Simulation in Production and Logistics</a>	4,5 CR	Spieckermann
T-WIWI-102884	<a href="#">Operations Research in Health Care Management</a>	4,5 CR	Nickel
T-WIWI-102715	<a href="#">Operations Research in Supply Chain Management</a>	4,5 CR	Nickel
T-WIWI-102716	<a href="#">Practical Seminar: Health Care Management (with Case Studies)</a>	4,5 CR	Nickel
Supplementary Courses (Election: at most 1 item)			
T-MACH-112213	<a href="#">Applied material flow simulation</a>	4,5 CR	Baumann
T-WIWI-102872	<a href="#">Challenges in Supply Chain Management</a>	4,5 CR	Mohr
T-WIWI-110971	<a href="#">Demand-Driven Supply Chain Planning</a>	4,5 CR	Heckmann

**Competence Certificate**

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

**Prerequisites**

At least one of the four courses "Operations Research in Supply Chain Management", "Operations Research in Health Care Management", "Practical seminar: Health Care Management" or "Discrete-Event Simulation in Production and Logistics" has to be assigned.

If the module is taken as an elective, no compulsory courses need to be taken. If you take the module in the compulsory elective area and only want to complete courses from the supplementary offer, please contact the examination office of the KIT Department of Economics and Management.

**Competence Goal**

Students

- knows the theoretical bases and the key components of Business Intelligence systems,
- acquires the basic skills to make use of business intelligence and analytics software in the service context
- are introduced into various application scenarios of analytics in the service context
- are able to distinguish different analytics methods and apply them in context
- learn how to apply analytics software in the service context
- are trained for the structured compilation and solution of practice relevant problems with the help of commercial business intelligence software packages as well as analytics methods and tools

**Content**

The importance of services in modern economies is most evident – nearly 70% of gross value added are achieved in the tertiary sector and a growing number of industrial enterprises add customer specific services to their material goods or transform their business models fundamentally. The growing availability of data “Big Data” and their intelligent processing by applying analytic methods and business intelligence systems plays a key role.

It is the goal of the module to give students a comprehensive overview on the subject Business Intelligence & Analytics focusing on service issues. Various scenarios illustrate how the methods and systems introduced help to improve existing services or create innovative data-based services.

**Annotation**

This module is part of the KSRI teaching profile “Digital Service Systems”. Further information on a service-specific profiling is available under [www.ksri.kit.edu/teaching](http://www.ksri.kit.edu/teaching).

**Workload**

Total workload for 9 credit points: approx. 270 hours. The allocation is based on the credit points of the courses in the module.

**Recommendation**

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

## M

## 3.162 Module: Sobolev Spaces [M-MATH-102926]

**Responsible:** Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105896	<a href="#">Sobolev Spaces</a>	8 CR	Schnaubelt

#### Competence Certificate

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

#### Prerequisites

None

#### Competence Goal

Students can explain the significance of Sobolev spaces in the theory of partial differential equations. They are able to reproduce and prove the most important properties.

#### Content

Definition of Sobolev spaces for functions on Lipschitz domains, density, continuation and trace theorems, compact embeddings, Helmholtz decomposition, simple applications to partial differential equations.

#### Module grade calculation

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

#### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

#### Recommendation

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

## M

**3.163 Module: Space and Time Discretization of Nonlinear Wave Equations [M-MATH-105966]**

**Responsible:** Dr. rer. nat. Benjamin Dörich  
Prof. Dr. Marlis Hochbruck

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-112120	<a href="#">Space and Time Discretization of Nonlinear Wave Equations</a>	6 CR	Hochbruck

**Competence Certificate**

Oral exam of approximately 20 minutes.

**Prerequisites**

None.

**Competence Goal**

Graduates

- can name and discuss essential concepts of error analysis of space and time discretizations for nonlinear wave equations,
- are prepared to write a thesis in the field of numerics of partial differential equations.

**Content**

The topic of the lecture is a unified error analysis of the space and time discretization of nonlinear wave-like equations. For this purpose, evolution equations with monotone operators on Hilbert spaces and different types of space discretization are considered, e.g. finite elements, discontinuous Galerkin methods or spectral methods, and, in particular, non-conformal discretizations.

After the analysis of the space discretization errors, this is combined with time integration methods such as the Crank-Nicolson and an implicit-explicit method.

The abstract analysis is illustrated with concrete examples.

**Module grade calculation**

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

**Workload**

Total workload: 180 h

Attendance: 60 h

- lectures, problem classes, and examination

Self-studies: 120 h

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

**Recommendation**

Basic knowledge of partial differential equations and the contents of the modules [M-MATH-102888 - Numerische Methoden für Differentialgleichungen](#) and [M-MATH-102891 - Finite Elemente Methoden](#) are strongly recommended. Knowledge of functional analysis is also recommended.

## M

## 3.164 Module: Spatial Stochastics [M-MATH-102903]

**Responsible:** Prof. Dr. Günter Last  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Stochastics\)](#)  
 Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each winter term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105867	<a href="#">Spatial Stochastics</a>	8 CR	Hug, Last, Winter

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

The students are familiar with some basic spatial stochastic processes. They do not only understand how to deal with general properties of distributions, but also know how to describe and apply specific models (Poisson process, Gaussian random fields). They know how to work self-organised and self-reflexive.

**Content**

- Random sets
- Point processes
- Random measures
- Palm distributions
- Random fields
- Gaussian fields
- Spectral theory of random fields
- Spatial ergodic theorem

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

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

## M

## 3.165 Module: Special Topics of Numerical Linear Algebra [M-MATH-102920]

**Responsible:** Prof. Dr. Marlis Hochbruck

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-105891	<a href="#">Special Topics of Numerical Linear Algebra</a>	8 CR	Grimm, Hochbruck, Neher

#### Competence Certificate

Oral exam of approximately 30 minutes.

#### Prerequisites

None.

#### Competence Goal

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

#### Content

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

#### Module grade calculation

The module grade is the grade of the oral exam.

#### Annotation

Bi-yearly course.

#### Workload

Total workload: 240 h

Attendance: 90 h

- lectures, problem classes, and examination

Self-studies: 150 h

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

#### Recommendation

Numerical analysis 1 and 2.

## M

## 3.166 Module: Spectral Theory [M-MATH-101768]

**Responsible:** Prof. Dr. Dorothee Frey

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each summer term	1 term	German	5	1

Mandatory			
T-MATH-103414	<a href="#">Spectral Theory - Exam</a>	8 CR	Frey, Herzog, Kunstmann, Schnaubelt, Tolksdorf

### Competence Certificate

Oral examination of approx. 30 minutes.

### Prerequisites

none

### Competence Goal

After participation, students

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

### Content

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

### Module grade calculation

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

### Workload

Total workload: 240 hours

Attendance: 90 h

- lectures, problem classes and examination

Self studies: 150 h

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

### Recommendation

The module „Functional Analysis“ is strongly recommended.



## M

## 3.167 Module: Splitting Methods for Evolution Equations [M-MATH-105325]

**Responsible:** Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
6

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-110805	<a href="#">Splitting Methods for Evolution Equations</a>	6 CR	Jahnke

### Competence Certificate

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

### Prerequisites

None

### Competence Goal

After attending the course, students can explain the concept and the advantages of splitting methods. They know important examples of such methods and typical problem classes to which these methods can be applied. They can explain the relation between classical order and accuracy, and they know the (classical) order conditions of such methods. Students can reproduce and explain error estimates for splitting methods for linear and nonlinear evolution equations, and to explain the essential steps of the proof as well as the relevance of the made assumptions.

### Content

- Concept and advantages of splitting methods
- Splitting methods for ordinary differential equations
- Baker-Campbell-Hausdorff formula and order conditions
- Tools from operator theory
- Splitting methods for linear evolution equations (Schrödinger equation, parabolic problems)
- Splitting methods for nonlinear evolution equations (nonlinear Schrödinger equation, Gross-Pitaevskii equation, Korteweg-de Vries equation)

### Module grade calculation

The module grade is the grade of the oral exam.

### Annotation

The module will be offered about every second summer semester.

### Workload

Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

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

### Recommendation

Familiarity with ordinary differential equations, Runge-Kutta methods (construction, order, stability) and Sobolev spaces (definition, basic properties, Sobolev embeddings) is strongly recommended.

## M

## 3.168 Module: Statistical Learning [M-MATH-105840]

**Responsible:** Prof. Dr. Mathias Trabs  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Stochastics\)](#)  
 Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each summer term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-111726	<a href="#">Statistical Learning</a>	8 CR	Trabs

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

At the end of the course, students

- know the fundamental principles and problems of machine learning and can relate learning methods to these,
- are able to explain how selected machine learning methods work and can apply these,
- are able to derive and to discuss a statistical analysis of selected learning methods,
- are able to independently develop and apply new learning methods.

**Content**

The course aims for a rigorous and mathematical analysis of some popular machine learning methods with a focus is on statistical aspects. Topics are:

- Regression
  - Empirical risk minimization
  - Lasso
  - Regression trees and Random forests
- Classification
  - Bayes classifier
  - model based classifiers (e.g. logistic regression, discriminant analysis)
  - model-free classifiers (e.g. k nearest neighbors, support vector machines)
- Neural networks
  - training
  - approximation properties
  - statistical analysis
- Unsupervised learning
  - principle component analysis
  - clustering
  - generative models

**Module grade calculation**

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

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

The modules "Probability Theory" and "Statistics" (M-MATH-103220) are recommended.

## M

## 3.169 Module: Steins Method with Applications in Statistics [M-MATH-105579]

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

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

Mandatory			
T-MATH-111187	<a href="#">Steins Method with Applications in Statistics</a>	4 CR	Ebner, Hug

**Prerequisites**  
None

## M

## 3.170 Module: Stochastic Control [M-MATH-102908]

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

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

Mandatory			
T-MATH-105871	<a href="#">Stochastic Control</a>	4 CR	Bäuerle

**Competence Certificate**

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

**Prerequisites**

none

**Competence Goal**

At the end of the course, students

- can name the mathematical foundations of stochastic control and are able to apply solution techniques,
- can formulate continuous-time dynamic stochastic optimization problems as stochastic control problems,
- are able to work in a self-organized and reflective manner,

**Content**

- Verification techniques, Hamilton-Jacobi-Bellman equation
- Viscosity solution
- Singular control
- Feynman-Kac representations
- Applications from finance and insurance

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: 75 hours

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

**Recommendation**

The course 'Probably Theory' is strongly recommended. The courses 'Brownian motion' and 'Continuous time finance' are recommended.

## M

## 3.171 Module: Stochastic Differential Equations [M-MATH-102881]

**Responsible:** Prof. Dr. Dorothee Frey

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
5

**Version**  
1

Mandatory			
T-MATH-105852	<a href="#">Stochastic Differential Equations</a>	8 CR	Frey, Schnaubelt

### Content

- Brownian motion
- Martingales and Martingal inequalities
- Stochastic integrals and Ito's formula
- Existence and uniqueness of solutions for systems of stochastic differential equations
- Perturbation and stability results
- Application to equations in financial mathematics, physics and engineering
- Connection with diffusion equations and potential theory

## M

## 3.172 Module: Stochastic Geometry [M-MATH-102865]

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

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each summer term

**Duration**  
1 term

**Level**  
5

**Version**  
1

Mandatory			
T-MATH-105840	<a href="#">Stochastic Geometry</a>	8 CR	Hug, Last, Winter

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

The students

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

**Content**

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

**Module grade calculation**

The modul grade is the grade of the oral exam.

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

It is recommended to have taken the module 'Spatial Stochastics' beforehand.

## M

## 3.173 Module: Stochastic Optimization [M-WIWI-103289]

**Responsible:** Prof. Dr. Steffen Rebennack  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [Operations Management - Data Analysis - Informatics Elective Field](#)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
9	Grade to a tenth	Each term	1 term	German/English	4	11

Compulsory Elective Courses (Election: between 1 and 2 items)			
T-WIWI-106546	<a href="#">Introduction to Stochastic Optimization</a>	4,5 CR	Rebennack
T-WIWI-106548	<a href="#">Advanced Stochastic Optimization</a>	4,5 CR	Rebennack
T-WIWI-106549	<a href="#">Large-scale Optimization</a>	4,5 CR	Rebennack
Supplementary Courses (Election: at most 1 item)			
T-WIWI-102723	<a href="#">Graph Theory and Advanced Location Models</a>	4,5 CR	Nickel
T-WIWI-102719	<a href="#">Mixed Integer Programming I</a>	4,5 CR	Stein
T-WIWI-102720	<a href="#">Mixed Integer Programming II</a>	4,5 CR	Stein
T-WIWI-111247	<a href="#">Mathematics for High Dimensional Statistics</a>	4,5 CR	Grothe
T-WIWI-111587	<a href="#">Multicriteria Optimization</a>	4,5 CR	Stein
T-WIWI-103124	<a href="#">Multivariate Statistical Methods</a>	4,5 CR	Grothe
T-WIWI-102715	<a href="#">Operations Research in Supply Chain Management</a>	4,5 CR	Nickel
T-WIWI-106545	<a href="#">Optimization under Uncertainty</a>	4,5 CR	Rebennack
T-WIWI-112109	<a href="#">Topics in Stochastic Optimization</a>	4,5 CR	Rebennack

**Competence Certificate**

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

The assessment procedures are described for each course of the module 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 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 make suggestions to adapt them to practical problems.

**Content**

The module focuses on the modeling as well as the imparting of theoretical principles and solution methods for optimization problems with special structure, which occur for example in the stochastic optimization.



**Annotation**

The courses are sometimes offered irregularly. The curriculum, planned for three years in advance, can be found on the Internet at <http://sop.ior.kit.edu/28.php>.

**Workload**

The total workload for this module is approximately 270 hours (9 credits). The allocation is made according to the credit points of the courses of the module. The total number of hours per course is determined by the amount of time spent attending the lectures and exercises, as well as the exam times and the time required to achieve the module's learning objectives for an average student for an average performance.

**Recommendation**

It is recommended to listen to the lecture "Introduction to Stochastic Optimization" before the lecture "Advanced Stochastic Optimization" is visited.

## M

## 3.174 Module: Stochastic Simulation [M-MATH-106053]

**Responsible:** TT-Prof. Dr. Sebastian Krumscheid

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

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

Mandatory			
T-MATH-112242	<a href="#">Stochastic Simulation</a>	5 CR	Krumscheid

### Competence Certificate

oral exam of ca. 30 min

### Prerequisites

None

### Competence Goal

After successfully taking part in the module's classes and the exam, students will be acquainted with sampling-based computational tools used to analyze systems with uncertainty arising in engineering, physics, chemistry, and economics. Specifically, by the end of this course, students will be able to analyze the convergence of sampling algorithms and implement the discussed sampling methods for different stochastic processes as computer codes. Understanding the advantages and disadvantages of different sampling-based methods, the students can, in particular, choose appropriate stochastic simulation techniques and propose efficient sampling methods for a specific stochastic problem. In particular, they can name and discuss essential theoretical concepts, and understand the structure of the sampling-based computational methods. Finally, the course prepares students to write a thesis in the field of Uncertainty Quantification.

### Content

The course covers mathematical concepts and computational tools used to analyze systems with uncertainty arising across various application domains. First, we will address stochastic modelling strategies to represent uncertainty in such systems. Then we will discuss sampling-based methods to assess uncertain system outputs via stochastic simulation techniques. The focus of this course will be on the theoretical foundations of the discussed techniques, as well as their methodological realization as efficient computational tools. Topics covered include:

- Random variable generation
- Simulation of random processes
- Simulation of Gaussian random fields
- Monte Carlo method; output analysis
- Variance reduction techniques
- Rare event simulations
- Quasi Monte Carlo methods
- Markov Chain Monte Carlo methods (Metropolis-Hasting, Gibbs sampler)

### Module grade calculation

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

### Workload

total workload: 150 hours

### Recommendation

The contents of the modules 'M-MATH-101321 - Introduction to Stochastics' and 'M-MATH-103214 - Numerical Mathematics 1+2' are recommended.

## M

## 3.175 Module: Structural Graph Theory [M-MATH-105463]

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

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

Mandatory			
T-MATH-111004	<a href="#">Structural Graph Theory</a>	4 CR	Aksenovich

**Prerequisites**

None

**Competence Goal**

After successful completion of the course, the participants should be able to present and analyse main results in Structural Graph Theory. They should be able to establish connections between graph minors and other graph parameters, give examples, and apply fundamental results to related problems.

**Content**

The purpose of this course is to provide an introduction to some of the central results and methods of structural graph theory. Our main point of emphasis will be on graph minor theory and the concepts devised in Robertson and Seymour's intricate proof of the Graph Minor Theorem: in every infinite set of graphs there are two graphs such that one is a minor of the other.

Our second point of emphasis (time permitting) will be on Hadwiger's conjecture: that every graph with chromatic number at least  $r$  has a  $K_r$  minor. We shall survey what is known about this conjecture, including some very recent progress.

**Recommendation**

A solid background in the fundamentals of graph theory.

## M

## 3.176 Module: Time Series Analysis [M-MATH-102911]

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

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

Mandatory			
T-MATH-105874	<a href="#">Time Series Analysis</a>	4 CR	Ebner, Fasen-Hartmann, Gneiting, Klar, Trabs

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

At the end of the course, students will

- know and understand the standard models of time series analysis,
- know exemplary statistical methods for model selection and model validation,
- independently apply models and methods from the lecture to real and simulated data,
- know specific mathematical techniques and be able to use them to analyze time series models.

**Content**

The lecture covers the basic concepts of classical time series analysis:

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

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 120 hours

Attendance: 45 hours

- lectures, problem classes, and examination

Self-studies: 75 hours

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

**Recommendation**

The contents of the course "Probability Theory" are strongly recommended. The contents of the course "Statistics" are recommended.

## M

## 3.177 Module: Topological Data Analysis [M-MATH-105487]

**Responsible:** Prof. Dr. Tobias Hartnick  
Prof. Dr. Roman Sauer

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Stochastics\)](#)  
[Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Mathematical Methods \(Algebra and Geometry\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-111031	<a href="#">Topological Data Analysis</a>	6 CR	Hartnick, Sauer

## M

## 3.178 Module: Topological Genomics [M-MATH-106064]

**Responsible:** Dr. Andreas Ott

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Stochastics\)](#)  
[Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
[Mathematical Methods \(Algebra and Geometry\)](#)  
[Elective Field](#)

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

Mandatory			
T-MATH-112281	<a href="#">Topological Genomics</a>	3 CR	Ott

#### Competence Certificate

oral exam of ca. 20 min

#### Prerequisites

None

#### Module grade calculation

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

#### Workload

total workload: 90 hours

## M

## 3.179 Module: Translation Surfaces [M-MATH-105973]

**Responsible:** Prof. Dr. Frank Herrlich  
**Organisation:** KIT Department of Mathematics  
**Part of:** [Mathematical Methods \(Algebra and Geometry\)](#)  
 Elective Field

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

Mandatory			
T-MATH-112128	<a href="#">Translation Surfaces</a>	8 CR	Herrlich

**Competence Certificate**

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

**Prerequisites**

None

**Competence Goal**

At the end of the module, participants are able to

- name and discuss basic concepts to study translation surfaces,
- describe and use in examples essential methods for the classification of translation surfaces,
- read recent research papers on translation surfaces and write a thesis in this field.

**Content**

- Characterization of finite translation surfaces
- Riemann surfaces and algebraic curves
- Moduli space of Riemann surfaces
- Classification of translation surfaces
- Strata and the action of  $SL(2, \mathbb{R})$
- Period coordinates

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

Basic knowledge in surface topology and complex analysis is strongly recommended. The module "Algebraic Geometry" is also recommended.

## M

## 3.180 Module: Traveling Waves [M-MATH-102927]

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

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

Mandatory			
T-MATH-105897	<a href="#">Traveling Waves</a>	6 CR	de Rijk, Reichel

**Competence Certificate**

The module examination takes place in form of an oral exam of about 30 minutes. Please see under "Modulnote" for more information about the bonus regulation.

**Prerequisites**

none

**Competence Goal**

After successful completion of this module students:

- can explain the significance of traveling waves and their dynamic stability;
- know basic methods to study the existence of traveling waves;
- outline the main steps in a stability analysis and address potential complications;
- have acquired several mathematical tools to compute or approximate the spectrum;
- master several techniques to derive (in)stability of the wave from spectral information;
- understand how spectrum and stability might depend on the class of perturbations.

**Content**

Traveling waves are solutions to nonlinear partial differential equations (PDEs) that propagate over time with a fixed speed without changing their profiles. These special solutions arise in many applied problems where they model, for instance, water waves, nerve impulses in axons or light in optical fibers. Therefore, their existence and the naturally associated question of their dynamic stability is of interest, because only those waves which are stable can be observed in practice.

The first step in the stability analysis is to linearize the underlying PDE about the wave and compute the associated spectrum, which is in general a nontrivial task. To approximate spectra associated with various waves, such as fronts, pulses and periodic wave trains, we introduce the following tools:

- Sturm-Liouville theory
- exponential dichotomies
- Fredholm theory
- the Evans function
- parity arguments
- essential spectrum, point spectrum and absolute spectrum
- exponential weights

The next step is to derive useful bounds on the linear solution operator, or semigroup, based on the spectral information. A complicating factor is that any non-constant traveling wave possesses spectrum up to the imaginary axis. For various dissipative PDEs, such as reaction-diffusion systems, we employ the bounds on the linear solution operator to close a nonlinear argument via iterative estimates on the Duhamel formula. For traveling waves in Hamiltonian PDEs, such as the NLS or KdV equation, we describe a different route towards stability based on the variational arguments of Grillakis, Shatah and Strauss.

**Module grade calculation**

After passing the oral exam at the end of the semester, the final grade is  $\min(0.7X + 0.3Y, X)$ , where  $X$  is the grade for the oral exam and  $Y$  is the grade obtained by voluntarily working out and presenting a model problem during one of the exercise classes.



**Workload**

Total workload: 180 hours

Attendance: 60 hours

- lectures, problem classes, and examination

Self-studies: 120 hours

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

**Recommendation**

The following background is strongly recommended: Analysis 1-4.

**Literature**

Kapitula, Todd; Promislow, Keith. Spectral and dynamical stability of nonlinear waves. Applied Mathematical Sciences, 185. Springer, New York, 2013.

## M

## 3.181 Module: Uncertainty Quantification [M-MATH-104054]

**Responsible:** Prof. Dr. Martin Frank

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
4

**Grading scale**  
Grade to a tenth

**Recurrence**  
Each summer term

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-108399	<a href="#">Uncertainty Quantification</a>	4 CR	Frank

#### Prerequisites

None

#### Competence Goal

After successfully taking part in the module's classes and exams, students have gained knowledge and abilities as described in the "Inhalt" section.

Specifically, students know several parametrization methods for uncertainties. Furthermore, students are able to describe the basics of several solution methods (stochastic collocation, stochastic Galerkin, Monte-Carlo). Students can explain the so-called curse of dimensionality.

Students are able to apply numerical methods to solve engineering problems formulated as algebraic or differential equations with uncertainties. They can name the advantages and disadvantages of each method. Students can judge whether specific methods are applicable to the specific problem and discuss their results with specialists and colleagues. Finally, students are able to implement the above methods in computer codes.

#### Content

In this class, we learn to propagate uncertain input parameters through differential equation models, a field called Uncertainty Quantification (UQ). Given uncertain input (parameter values, initial or boundary conditions), how uncertain is the output? The first part of the course ("how to do it") gives an overview on techniques that are used. Among these are:

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

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

#### Recommendation

Numerical methods for differential equations

## M

## 3.182 Module: Variational Methods [M-MATH-105093]

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

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

Mandatory			
T-MATH-110302	<a href="#">Variational Methods</a>	8 CR	Reichel

**Competence Certificate**

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

**Competence Goal**

Graduates will be able to

- assess the significance of variational problems in relation to their applications in the natural sciences, engineering or geometry and illustrate them using examples,
- formulate variational problems independently,
- recognize the specific difficulties within the calculus of variations,
- analyze and solve concrete, prototypical problems,
- use techniques to prove the existence of solutions to certain classes of variational problems and calculate these solutions in special cases.

**Content**

- one-dimensional variational problems
- Euler-Lagrange equation
- necessary and sufficient criteria
- multidimensional variational problems
- direct methods of the calculus of variations
- existence of critical points of functionals

**Module grade calculation**

The module grade is the grade of the oral exam.

**Workload**

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

**Recommendation**

The contents of the courses Functional Analysis, Classical Methods for Partial Differential Equations, or Boundary and Eigenvalue problems are recommended.

## M

## 3.183 Module: Wavelets [M-MATH-102895]

**Responsible:** Prof. Dr. Andreas Rieder

**Organisation:** KIT Department of Mathematics

**Part of:** [Mathematical Methods \(Analysis or Applied and Numerical Mathematics, Optimization\)](#)  
Elective Field

**Credits**  
8

**Grading scale**  
Grade to a tenth

**Recurrence**  
Irregular

**Duration**  
1 term

**Level**  
4

**Version**  
1

Mandatory			
T-MATH-105838	<a href="#">Wavelets</a>	8 CR	Rieder

### Competence Certificate

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

### Prerequisites

none

### Competence Goal

Graduates are able

- to name, discuss and analyze the functional-analytical principles of continuous and discrete wavelet transforms,
- to apply the wavelet transform as an analysis tool in signal and image processing and evaluate the results obtained,
- to explain design aspects for wavelet systems.

### Content

- Short-time Fourier transform
- Integral wavelet transform
- Wavelet frames
- Wavelet basis
- Fast wavelet transform
- Construction of orthogonal and bi-orthogonal wavelet systems
- Applications in signal and image processing

### Module grade calculation

The module grade is the grade of the oral exam.

### Workload

Total workload: 240 hours

Attendance: 90 hours

- lectures, problem classes, and examination

Self-studies: 150 hours

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

### Recommendation

The course "Functional analysis" is recommended.

## 4 Courses

T

## 4.1 Course: Adaptive Finite Element Methods [T-MATH-105898]

**Responsible:** Prof. Dr. Willy Dörfler

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102900 - Adaptive Finite Elemente Methods](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

Events					
ST 2024	0160610	<a href="#">Tutorial for 0160600 (Numerical Methods in Fluidmechanics)</a>	1 SWS	Practice	Dörfler

**Prerequisites**

none

## T

## 4.2 Course: Advanced Corporate Finance [T-WIWI-113469]

**Responsible:** Prof. Dr. Martin Ruckes  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)  
[M-WIWI-101502 - Economic Theory and its Application in Finance](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2530214	<a href="#">Advanced Corporate Finance</a>	2 SWS	Lecture / 	Ruckes
Exams					
ST 2024	7900073	<a href="#">Advanced Corporate Finance</a>			Ruckes

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

The assessment of this course is a written examination (following §4(2), 1 SPO) of 60 mins.

The exam is offered each semester.

Below you will find excerpts from events related to this course:

## V

## Advanced Corporate Finance

2530214, SS 2024, 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-conceptual 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

## 4.3 Course: Advanced Empirical Asset Pricing [T-WIWI-110513]

**Responsible:** TT-Prof. Dr. Julian Thimme  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Exams			
ST 2024	7900321	<a href="#">Advanced Empirical Asset Pricing</a>	Thimme
WT 24/25	7900319	<a href="#">Advanced Empirical Asset Pricing</a>	Thimme

**Competence Certificate**

The success control takes place in form of a written examination (60 min) during the semester break. If the number of participants is low, an oral examination may also be offered. The examination is offered every semester and can be repeated at any regular examination date.

A bonus can be acquired by submitting exercise solutions to 80% of the assigned exercise tasks. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

**Recommendation**

We strongly recommend knowledge of the basic topics in investments (bachelor course), which will be necessary to be able to follow the course. In addition, prior participation in the Asset Pricing Master course is strongly recommended.

**Annotation**

New course from winter semester 2019/2020.

## T

## 4.4 Course: Advanced Game Theory [T-WIWI-102861]

**Responsible:** Prof. Dr. Karl-Martin Ehrhart  
Prof. Dr. Clemens Puppe  
Prof. Dr. Johannes Philipp Reiß

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-101500 - Microeconomic Theory](#)  
[M-WIWI-101502 - Economic Theory and its Application in Finance](#)  
[M-WIWI-102970 - Decision and Game Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2500037	<a href="#">Advanced Game Theory</a>	2 SWS	Lecture /	Puppe, Ammann
WT 24/25	2500038	<a href="#">Übung zu Advanced Game Theory</a>	1 SWS	Practice /	Puppe, Ammann
Exams					
ST 2024	7910001	<a href="#">Advanced Game Theory</a>			Reiß
WT 24/25	7900013	<a href="#">Advanced Game Theory</a>			Puppe

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes) (following §4(2), 1 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

**Prerequisites**

None

**Recommendation**

Basic knowledge of mathematics and statistics is assumed.

Below you will find excerpts from events related to this course:

## V

**Advanced Game Theory**

2500037, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site



**Content**

The course "Advanced Game Theory" deals with the formulation and solution concepts of games. A game is defined as a formal representation of a situation in which a number of individuals interact in a setting of strategic interdependence.

The first part of the course builds upon the topics of the bachelor's course "Introduction to Game Theory". In particular, in contrast to the bachelor's lecture, the course introduces a rigorous mathematical treatment of simultaneous move and dynamic games (noncooperative games) as well as their solution concepts.

The second part of the course deals with the topics of evolutionary and cooperative game theory. Both the models as well as the solution concepts of evolutionary stable strategies, the core, and the Shapley value are introduced.

The third part of the course embeds the topic of game theory in the more general context of mechanism design and concludes with the introduction of voting games and their solution concepts.

**Learning objectives:**

The student should learn

- to name and define the models and solution concepts of a variety of games in both mathematical-formal and precise verbal form.
- to solve games of different types and difficulties with the appropriate solution concepts.
- to prove and reason about simple statements on games and their solution concepts.
- to model strategic interdependencies in the real world as games in a formal mathematical way.

**Workload:**

Total workload for 4.5 credit points: approx. 135 hours

Attendance: 30 hours

Self-study: 105 hours

**Literature**

- Mas-Colell, A., Whinston, M. D. and Green, J. R. 1995. *Microeconomic Theory*. Oxford University Press.
- Osborne, M. J. and Rubinstein, A. 1998. *A Course in Game Theory*. 5. print. MIT Press.
- Myerson, R. B. 1997. *Game Theory: Analysis of Conflict*. Harvard University Press.

T

**4.5 Course: Advanced Inverse Problems: Nonlinearity and Banach Spaces [T-MATH-105927]**

**Responsible:** Prof. Dr. Andreas Rieder  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102955 - Advanced Inverse Problems: Nonlinearity and Banach Spaces](#)

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

**Prerequisites**  
none

T

## 4.6 Course: Advanced Lab Blockchain Hackathon (Master) [T-WIWI-111126]

**Responsible:** Prof. Dr. Ali Sunyaev  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Exams			
ST 2024	7900172	<a href="#">Lab Blockchain Hackathon (Master)</a>	Sunyaev

**Competence Certificate**

The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

**Prerequisites**

None

## T

## 4.7 Course: Advanced Lab Informatics (Master) [T-WIWI-110548]

**Responsible:** Professorenschaft des Instituts AIFB  
**Organisation:** KIT Department of Economics and Management  
**Part of:** M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Events					
ST 2024	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course / 🎧	Schiefer, Schüler, Toussaint
ST 2024	2512207	Lab Automation in Everyday Life (Master)	3 SWS	Practical course / 🎧	Oberweis, Forell, Frister, Rybinski, Schiefer
ST 2024	2512401	Advanced Lab Development of Sociotechnical Information Systems (Master)	3 SWS	Practical course / 🔄	Sunyaev, Leiser
ST 2024	2512403	Advanced Lab Blockchain Hackathon (Master)		Practical course / 📱	Sunyaev, Sturm, Kannengießer, Beyene
ST 2024	2512500	Project Lab Machine Learning	3 SWS	Practical course / 🔄	Daaboul, Zöllner, Schneider
ST 2024	2512555	Praktikum Security, Usability and Society (Master)	3 SWS	Practical course / 📱	Volkamer, Strufe, Mayer, Berens, Mossano, Hennig, Veit, Länge
WT 24/25	2512101	Seminar Digital Twins with Lego: Hands-on Workshop in Data-driven Simulation (Master)	2 SWS	Seminar / 🎧	Lazarova-Molnar, Götz, Khodadadi
WT 24/25	2512205	Lab Realisation of innovative services (Master)	3 SWS	Practical course / 🔄	Toussaint, Schiefer, Schüler
WT 24/25	2512314	Practical Course Linked Data and the Semantic Web (Master)	3 SWS	Practical course / 🎧	Käfer, Braun
WT 24/25	2512401	Practical Course Sociotechnical Information Systems Development (Master)	3 SWS	Practical course / 📱	Sunyaev, Leiser
WT 24/25	2512501	Practical Course Cognitive automobiles and robots (Master)	3 SWS	Practical course / 🔄	Zöllner, Daaboul
WT 24/25	2512600	Project lab Information Service Engineering (Master)	3 SWS	Practical course / 🎧	Sack
Exams					
ST 2024	7900020	Lab Automation in Everyday Life (Master)			Oberweis
ST 2024	7900086	Project Lab Machine Learning			Zöllner
ST 2024	7900148	Advanced Lab Realization of innovative services (Master)			Oberweis
ST 2024	7900172	Lab Blockchain Hackathon (Master)			Sunyaev
ST 2024	7900173	Advanced Lab Development of Sociotechnical Information Systems (Master)			Sunyaev
ST 2024	7900178	Practical Lab Security, Usability and Society (Master)			Volkamer
WT 24/25	7900035	Practical Course Digital Twins with Lego: Hands-on Workshop in Data-driven Simulation (Master)			Lazarova-Molnar
WT 24/25	7900046	Advanced Lab Security (Master)			Volkamer
WT 24/25	7900102	Advanced Lab Information Service Engineering (Master)			Sack
WT 24/25	7900107	Advanced Lab Cognitive Automobile and Robots (Master)			Zöllner
WT 24/25	7900143	Advanced Lab Development of Sociotechnical Information Systems (Master)			Sunyaev

WT 24/25	7900218	<a href="#">Advanced Lab Linked Data and the Semantic Web (Master)</a>	Käfer
WT 24/25	7900306	<a href="#">Advanced Lab Realization of Innovative Services (Master)</a>	Oberweis
WT 24/25	7900307	<a href="#">Advanced Lab Security, Usability and Society (Master)</a>	Volkamer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

### Competence Certificate

The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

### Prerequisites

None

### Annotation

The title of this course is a generic one. Specific titles and the topics of offered seminars will be announced before the start of a semester in the internet at <https://portal.wiwi.kit.edu>.

Below you will find excerpts from events related to this course:

V

**Lab Realisation of innovative services (Master)**  
2512205, SS 2024, 3 SWS, Language: German, [Open in study portal](#)

**Practical course (P)**  
**On-Site**

### Content

As part of the lab, the participants should work together in small groups to realize innovative services (mainly for students).

### Organizational issues

Informationen zu Themen und die Anmeldung erfolgt vor Praktikumsbeginn im Wiwi-Portal <https://portal.wiwi.kit.edu/ys>

V

**Lab Automation in Everyday Life (Master)**  
2512207, SS 2024, 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](mailto: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](mailto:fabian.rybinski@kit.edu) wenden.

V

**Advanced Lab Development of Sociotechnical Information Systems (Master)**  
2512401, SS 2024, 3 SWS, Language: German/English, [Open in study portal](#)

**Practical course (P)**  
**Blended (On-Site/Online)**

### Content

The aim of the lab is to get to know the development of socio-technical information systems in different application areas. In the event framework, you should develop a suitable solution strategy for your problem alone or in group work, collect requirements, and implement a software artifact based on it (for example, web platform, mobile apps, desktop application). Another focus of the lab is on the subsequent quality assurance and documentation of the implemented software artifact.

Registration information will be announced on the course page.

V

**Project Lab Machine Learning**  
2512500, SS 2024, 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.

**Praktikum Security, Usability and Society (Master)**

2512555, SS 2024, 3 SWS, Language: German/English, [Open in study portal](#)

Practical course (P)  
Online

**Content**

The Praktikum Security, Usability and Society will cover topics both of usable security and privacy programming, and how to conduct user studies. To reserve a place, please, register on the WiWi portal and send an email with your chosen topic, plus a back-up one, to [mattia.mossano@kit.edu](mailto:mattia.mossano@kit.edu). Topics are assigned first-come-first-served until all of them are filled. Topics in italics have been already assigned.

Application deadline 12.04.2024

Assignment 15.04.2024

Confirmation deadline 19.04.2024

**Important dates:**

Kick-off: 17.04.2024, 09:00 AM CET in Big Blue Button - [Link](#)

Report & code feedback deadline: 26.07.2024, 23:59 CET

Feedback on Report & code: 16.08.2024, 23:59 CET

Final report + code deadline: 01.09.2024, 23:59 CET

Presentation draft deadline: 06.09.2024, 23:59 CET

Feedback on presentation draft: 13.09.2024, 23:59 CET

Final presentation deadline: 17.09.2024, 23:59 CET

Presentation day: 18.09.2024, 09:00 CET

Topics:

**Privacy Friendly Apps**

In this area, students complete an app (or an extension of an app) among our Privacy-Friendly Apps. Please click the following link to know more about them: <https://secuso.aifb.kit.edu/english/105.php>. Students are provided with a point list of goals, containing both basic features mandatory to pass the course and more advanced ones that heighten the final grade.

Title: NoPhish App

Number of students: 2 Ba/Ma

Description: The NoPhish app was one of the first measures from the NoPhish concept. The app has been around for a long time and has not been updated since then. Accordingly, the task of the project is to make the app functional for the current Android version. The app is also to be optimised so that updates, e.g. new chapters, can be added easily.

**Programming Usable Security Intervention**

In this subject, students develop a part of coding, an extension, or another programming task dealing with various usable security interventions, eg as an extension. Eg TORPEDO ( <https://secuso.aifb.kit.edu/english/TORPEDO.php> ) or PassSec + ( <https://secuso.aifb.kit.edu/english/PassSecPlus.php> ). Just as before, students are provided with a point list of goals, containing both basic features mandatory to pass the course and more advanced ones that heighten the final grade.

Title: Hacking TORPEDO

Number of students: 1-2 Ba/Ma

Description: TORPEDO has existed for many years both as a Thunderbird add-on and as a web extension. TORPEDO is intended to help address various forms of phishing attacks and thereby protect the user, e.g. against various manipulations of the domain or additional tooltips. However, no targeted attacks on TORPEDO have yet been found. The aim of the work is to subject TORPEDO to a stress test and also to develop attacks that specifically target the implementation of TORPEDO.

Title: Making e-mails more visible by embedding moving images

Number of students: 1 Ma

Description: In case of a security incident, it is necessary to inform the affected persons about their vulnerabilities as soon as possible. Within the context of the INSPECTION project, we are currently informing website owners via e-mail about security related vulnerabilities on their websites. Although e-mails have been shown to be the most cost-efficient means to deliver such information, they have not lead to an appropriate remediation rate. While speaking to the affected website owners we learned that they would appreciate more information, although not being delivered as more text in the e-mail. Also, we learned that most e-mails were not read because they were considered spam. Thus, we need to find a way to make e-mail notifications more effective in raising peoples' awareness. Videos have been proven effective to raise awareness in the context of IT security. The goal of the project will be, to explore ways to embed videos in an e-mail via HTML (either as gifs or as preview to a YouTube video). The challenge is to make this e-mail readable for different clients and webmail as well as getting it delivered through spam filters.

**Designing Security User studies**

These topics are related to how to set up and conduct user studies of various types. Online studies, interviews and lab studies are possible. At the end of the semester, the students present a report / paper and a talk in which they present their methodologies and the results of small pre-studies.

Title: Usability of Password Managers in Virtual Reality

Number of students: 2 Ma

Description: The pre-dominant form of authentication in Virtual Reality (VR) are passwords. Passwords create a burden for users in the VR environment because of special input methods and the virtual keyboard [Stephenson, S. et al (2022). SoK: Authentication in Augmented and Virtual Reality]. Password Managers (PMs) can support the user with handling this problem [Mayer, P. et al. (2022). Why Users (Don't) Use Password Managers at a Large Educational Institution]. They offer auto-filling features, store credentials in an overview or generate complex and secure passwords. Especially in the VR context, where typing a password is slow and complex, PMs can be beneficial. We want to explore the different PMs in VR and test the usability to find challenges and possible solutions.

### Run Usable Security Studies and Results Analysis

These topics are related to run and analyse the results of user-studies. Online studies, interviews and lab studies are all possible, depending on the topic. At the end of the semester, the students present a report / paper with the analyses conducted and a talk in which they present the results.

Title: Visualization of Eye Gaze Patterns during Authentication Tasks

Number of students: 1 Ba/Ma

Description: In this project, students will analyze and visualize eye gaze data collected during two specific authentication tasks: the Dot Task and the Slider Task. The primary objective is to represent subjects' eye movements visually, enhancing the understanding of gaze patterns during the authentication process. \*Dot Task Visualization:\* For the Dot Task, participants were instructed to focus on a sequence of dots displayed on a screen. The dataset includes the positions of these dots and the corresponding gaze locations of the subjects. The student's task is to create a dynamic visualization that not only represents these positions accurately but also illustrates the sequence in which the dots were focused on by the subjects. \*Slider Task Visualization:\* The Slider Task involved presenting participants with a series of images, for which both the images' locations on the screen and the subjects' gaze locations are recorded. The challenge is to develop a heatmap visualization based on this data, effectively demonstrating the concentration and dispersion of gaze points across different images.

Title: How do website owners become aware that their website was hacked?

Number of student: 1 Ma

Description: We identified website owners that were affected by a hack on their website and sent them a notification. During the course of the notification process, we also identified several websites who seemingly remediated the hack before our notification. We now wanted to find out, how those website owners got aware of the hack. If they were notified by a third party, we would also like to know how and by whom they were notified and what their feelings were with respect to the notification. To answer these questions, a survey was designed and pre-tested with a sample of website owners. The study was run as an online survey using SosciSurvey. The aim of this lab topic will be to improve the survey based on the findings of the pre-study (<https://publikationen.bibliothek.kit.edu/1000160718>) and sent out invitations to the survey to around 100 website owners.

Title: Phishing through homographic attacks in messengers and social networks

Number of students: 1-2 Ba/Ma

Description: The task will be to test three types of attacks in messengers and social networks that work in some email clients. First is the link mismatch attack, where the link text differs from the actual link target. Second is an attack in which the actual link target is disguised by URL encoding [[https://en.wikipedia.org/wiki/URL\\_encoding](https://en.wikipedia.org/wiki/URL_encoding)], and finally homographic attacks which uses Internationalized Domain Names [[https://en.wikipedia.org/wiki/IDN\\_homograph\\_attack](https://en.wikipedia.org/wiki/IDN_homograph_attack)], in which Latin characters are replaced by characters of a different alphabet in the domain name. The attacks are predefined, so no knowledge of phishing techniques is required.

Title: Usability Study of Mobile Authentication for Elderly Users with Rheumatoid Arthritis (English only)

Number of students: 1 Ba/Ma

Description: Authentication is an ever important topic, especially in the mobile context. However, it becomes even more relevant when considering accessibility to it. Nowadays, a common authentication method is using a PIN. Yet, given the low hand mobility of users affected by rheumatoid arthritis, sometimes using PINs can be difficult. In this topic, the student will conduct several sessions of an already designed lab study with various participants using arthritis simulation gloves to evaluate three PIN-pad interfaces aimed at making authentication more accessible. The study will also investigate the preferences of users regarding PIN-pad interfaces through drawings and proposals of changes. The student will then analyse the results through inferential statistics. Depending on the quality of the outcome, the results will then be published in a paper and the student will be added to the authors list.

This event counts towards the KASTEL certificate. Further information on how to obtain the certificate can be found on the SECUSO website ([https://secuso.aifb.kit.edu/Studium\\_und\\_Lehre.php](https://secuso.aifb.kit.edu/Studium_und_Lehre.php)).



### Lab Realisation of innovative services (Master)

2512205, WS 24/25, 3 SWS, Language: German, [Open in study portal](#)

Practical course (P)  
Blended (On-Site/Online)

### Content

As part of the lab, the participants should work together in small groups to realize innovative services (mainly for students).



**Organizational issues**

Informationen zu Themen und die Anmeldung erfolgt vor Praktikumsbeginn im Wiwi-Portal

<https://portal.wiwi.kit.edu/ys>

**Practical Course Linked Data and the Semantic Web (Master)**

2512314, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

**Practical course (P)  
On-Site**

**Content**

Linked Data is a way of publishing data on the web in a machine-understandable fashion. The aim of this practical seminar is to build applications and devise algorithms that consume, provide, or analyse Linked Data.

The Linked Data principles are a set of practices for data publishing on the web. Linked Data builds on the web architecture and uses HTTP for data access, and RDF for describing data, thus aiming towards web-scale data integration. There is a vast amount of data available published according to those principles: recently, 4.5 billion facts have been counted with information about various domains, including music, movies, geography, natural sciences. Linked Data is also used to make web-pages machine-understandable, corresponding annotations are considered by the big search engine providers. On a smaller scale, devices on the Internet of Things can also be accessed using Linked Data which makes the unified processing of device data and data from the web easy.

In this practical seminar, students will build prototypical applications and devise algorithms that consume, provide, or analyse Linked Data. Those applications and algorithms can also extend existing applications ranging from databases to mobile apps.

For the seminar, programming skills or knowledge about web development tools/technologies are highly recommended. Basic knowledge of RDF and SPARQL are also recommended, but may be acquired during the seminar. Students will work in groups. Seminar meetings will take place as 'Block-Seminar'.

Topics of interest include, but are not limited to:

- Travel Security
- Geo data
- Linked News
- Social Media

The exact dates and information for registration will be announced at the event page.

**Practical Course Cognitive automobiles and robots (Master)**

2512501, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

**Practical course (P)  
Blended (On-Site/Online)**

**Content**

The lab is intended as a practical supplement to courses such as "Machine Learning 1/2".

Scientific topics, mostly in the area of autonomous driving and robotics, will be addressed in joint work with ML/KI methods. The goal of the internship is for participants to design, develop, and evaluate ML Software system.

In addition to the scientific goals, such as the study and application of methods, the aspects of project-specific teamwork in research (from specification to presentation of results) are also worked on in this internship.

The individual projects require the analysis of the set task, selection of appropriate methods, specification and implementation and evaluation of the solution approach. Finally, the selected solution is to be documented and presented in a short lecture.

**Learning Objectives:**

- Students will be able to practically apply theoretical knowledge from lectures on machine learning to a selected area of current research.
- Students will be proficient in analyzing and solving thematic problems.
- Students will be able to evaluate, document, and present their concepts and results.

**Recommendations:**

- Theoretical knowledge of machine learning and/or AI.
- Python knowledge
- Initial experience with deep learning frameworks such as PyTorch/Jax/Tensorflow may be beneficial.

**Workload:**

The workload of 5 credit points consists of practical implementation of the selected solution, as well as time for literature research and planning/specification of the selected solution. In addition, a short report and presentation of the work performed will be prepared.

**Organizational issues**

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

**Project lab Information Service Engineering (Master)**

2512600, WS 24/25, 3 SWS, Language: English, [Open in study portal](#)

**Practical course (P)  
On-Site**

**Content**

The ISE project lab is based on the summer semester lecture "Information Service Engineering". Goal of the course is to work on a given research problem in small groups (3-4 students) related to the ISE lecture topics, i.e. Natural Language Processing, Knowledge Graphs, and Machine Learning. The solution of the given research problem requires the development of a software implementation.

The project will be worked on in teams of 3-4 students each, guided by a tutor from the teaching staff.

Required coursework includes:

- Mid term presentation (5-10 min)
- Final presentation (10-15 min)
- Course report (c. 16 pages)
- Participation and contribution of the students during the course
- Software development and delivery

**Notes:**

The ISE project lab can also be credited as a **seminar** (if necessary).

The project will be worked on in teams of 3-4 students each, guided by a tutor from the teaching staff.

Participation will be restricted to 16 students.

Participation in the lecture "Information Service Engineering" (summer semester) is required. There are video recordings on our youtube channel.

**ISE Tutor Team:**

- Dr. Genet Asefa Gesese
- Dr. Shufan Jiang
- Dr. Anna Jacyszyn
- M. Sc. Ebrahim Norouzi
- M. Sc. Sarah Rebecca Ondraszek
- B. Sc. Tabea Tietz

**WS 2024/25 Tasks List:**

- Generating Competency Questions from ontologies using LLMs
- Ontology Verbalization and Categorization via LLMs
- Towards the Automated Extraction of Patterns from Ontologies with Large Language Models
- Leveraging Large Language Models for Artwork Recognition from Historical Texts
- Identification of mathematical definitions from Scientific Papers
- The Chronicles of Culture Knowledge Graphs: Creating Data Stories with Generative AI

**Literature**

ISE video channel on youtube: <https://www.youtube.com/channel/UCjkkhNSNuXrJpMYZoeSBw6Q/>

T

## 4.8 Course: Advanced Lab Realization of Innovative Services (Master) [T-WIWI-112914]

**Responsible:** Prof. Dr. Andreas Oberweis  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Events					
ST 2024	2512205	<a href="#">Lab Realisation of innovative services (Master)</a>	3 SWS	Practical course / 	Schiefer, Schüler, Toussaint
WT 24/25	2512205	<a href="#">Lab Realisation of innovative services (Master)</a>	3 SWS	Practical course / 	Toussaint, Schiefer, Schüler
Exams					
ST 2024	7900148	<a href="#">Advanced Lab Realization of innovative services (Master)</a>			Oberweis
WT 24/25	7900218	<a href="#">Advanced Lab Linked Data and the Semantic Web (Master)</a>			Käfer
WT 24/25	7900306	<a href="#">Advanced Lab Realization of Innovative Services (Master)</a>			Oberweis

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

### Annotation

As part of the lab, the participants should work together in small groups to produce innovative services (mainly for students). Further information can be found on the ILIAS page of the lab.

Below you will find excerpts from events related to this course:

V

### Lab Realisation of innovative services (Master)

2512205, SS 2024, 3 SWS, Language: German, [Open in study portal](#)

Practical course (P)  
On-Site

### Content

As part of the lab, the participants should work together in small groups to realize innovative services (mainly for students).

### Organizational issues

Informationen zu Themen und die Anmeldung erfolgt vor Praktikumsbeginn im Wiwi-Portal  
<https://portal.wiwi.kit.edu/ys>

V

### Lab Realisation of innovative services (Master)

2512205, WS 24/25, 3 SWS, Language: German, [Open in study portal](#)

Practical course (P)  
Blended (On-Site/Online)

### Content

As part of the lab, the participants should work together in small groups to realize innovative services (mainly for students).

### Organizational issues

Informationen zu Themen und die Anmeldung erfolgt vor Praktikumsbeginn im Wiwi-Portal  
<https://portal.wiwi.kit.edu/ys>

T

## 4.9 Course: Advanced Lab Security [T-WIWI-109786]

**Responsible:** Prof. Dr. Melanie Volkamer  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Irregular	2

Exams				
WT 24/25	7900046	<a href="#">Advanced Lab Security (Master)</a>		Volkamer

**Competence Certificate**

The alternative exam assessment consists of:

- a practical work
- a presentation and possibly
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

**Prerequisites**

None

**Recommendation**

Knowledge from the lecture "Information Security" is recommended.

**Annotation**

Form of teaching and learning: Advanced lab

## T

## 4.10 Course: Advanced Lab Security, Usability and Society [T-WIWI-108439]

**Responsible:** Prof. Dr. Melanie Volkamer  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	see Annotations	2

Events					
ST 2024	2512554	<a href="#">Practical lab Security, Usability and Society (Bachelor)</a>	3 SWS	Practical course / 📱	Volkamer, Strufe, Mayer, Berens, Mossano, Hennig, Veit, Länge
WT 24/25	2512554	<a href="#">Praktikum Security, Usability and Society (Bachelor)</a>	3 SWS	Practical course / 🔄	Volkamer, Strufe, Berens, Länge, Mossano, Hennig, Hilt, Veit
WT 24/25	2512555	<a href="#">Praktikum Security, Usability and Society (Master)</a>	3 SWS	Practical course / 🔄	Volkamer, Strufe, Berens, Länge, Mossano, Hennig, Hilt, Veit
Exams					
ST 2024	7900029	<a href="#">Practical lab Security, Usability and Society (Bachelor)</a>			Volkamer
WT 24/25	7900116	<a href="#">Advanced Lab Security, Usability and Society (Bachelor)</a>			Volkamer
WT 24/25	7900307	<a href="#">Advanced Lab Security, Usability and Society (Master)</a>			Volkamer

Legend: 📱 Online, 🔄 Blended (On-Site/Online), 📍 On-Site, ✕ Cancelled

### Competence Certificate

The alternative exam assessment consists of:

- a practical work
- a presentation and possibly
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

### Prerequisites

None

### Recommendation

Knowledge from the lecture "Information Security" is recommended.

### Annotation

The course will not be offered in the summer semester 2023.

Below you will find excerpts from events related to this course:

## V

### Practical lab Security, Usability and Society (Bachelor)

2512554, SS 2024, 3 SWS, Language: German/English, [Open in study portal](#)

Practical course (P)  
Online

**Content**

The Praktikum Security, Usability and Society will cover topics both of usable security and privacy programming, and how to conduct user studies. To reserve a place, please, register on the WiWi portal and send an email with your chosen topic, plus a back-up one, to [mattia.mossano@kit.edu](mailto:mattia.mossano@kit.edu). Topics are assigned first-come-first-served until all of them are filled. Topics in italics have already been assigned.

Application deadline 12.04.2024

Assignment 15.04.2024

Confirmation deadline 19.04.2024

**Important dates:**

Kick-off: 17.04.2024, 09:00 AM CET in Big Blue Button - [Link](#)

Report & code feedback deadline: 26.07.2024, 23:59 CET

Feedback on Report & code: 16.08.2024, 23:59 CET

Final report + code deadline: 01.09.2024, 23:59 CET

Presentation draft deadline: 06.09.2024, 23:59 CET

Feedback on presentation draft: 13.09.2024, 23:59 CET

Final presentation deadline: 17.09.2024, 23:59 CET

Presentation day: 18.09.2024, 09:00 CET

Topics:

**Privacy Friendly Apps**

In this area, students complete an app (or an extension of an app) among our Privacy-Friendly Apps. Please click the following link to know more about them: <https://secuso.aifb.kit.edu/english/105.php>. Students are provided with a point list of goals, containing both basic features mandatory to pass the course and more advanced ones that heighten the final grade.

Title: NoPhish App

Number of students: 2 Ba/Ma

Description: The NoPhish app was one of the first measures from the NoPhish concept. The app has been around for a long time and has not been updated since then. Accordingly, the task of the project is to make the app functional for the current Android version. The app is also to be optimised so that updates, e.g. new chapters, can be added easily.

**Programming Usable Security Intervention**

In this subject, students develop a part of coding, an extension, or another programming task dealing with various usable security interventions, e.g. as an extension like TORPEDO ( <https://secuso.aifb.kit.edu/english/TORPEDO.php> ) or PassSec + ( <https://secuso.aifb.kit.edu/english/PassSecPlus.php> ). Just as before, students are provided with a point list of goals, containing both basic features mandatory to pass the course and more advanced ones that heighten the final grade.

Title: Hacking TORPEDO

Number of students: 1-2 Ba/Ma

Description: TORPEDO has existed for many years both as a Thunderbird add-on and as a web extension. TORPEDO is intended to help address various forms of phishing attacks and thereby protect the user, e.g. against various manipulations of the domain or additional tooltips. However, no targeted attacks on TORPEDO have yet been found. The aim of the work is to subject TORPEDO to a stress test and also to develop attacks that specifically target the implementation of TORPEDO.

**Run Usable Security Studies and Results Analysis**

These topics are related to run and analyse the results of user-studies. Online studies, interviews and lab studies are all possible, depending on the topic. At the end of the semester, the students present a report / paper with the analyses conducted and a talk in which they present the results.

Title: Visualization of Eye Gaze Patterns during Authentication Tasks

Number of students: 1 Ba/Ma

Description: In this project, students will analyze and visualize eye gaze data collected during two specific authentication tasks: the Dot Task and the Slider Task. The primary objective is to represent subjects' eye movements visually, enhancing the understanding of gaze patterns during the authentication process. *\*Dot Task Visualization:\** For the Dot Task, participants were instructed to focus on a sequence of dots displayed on a screen. The dataset includes the positions of these dots and the corresponding gaze locations of the subjects. The student's task is to create a dynamic visualization that not only represents these positions accurately but also illustrates the sequence in which the dots were focused on by the subjects. *\*Slider Task Visualization:\** The Slider Task involved presenting participants with a series of images, for which both the images' locations on the screen and the subjects' gaze locations are recorded. The challenge is to develop a heatmap visualization based on this data, effectively demonstrating the concentration and dispersion of gaze points across different images.

Title: Compare BSI Phishing Game with the NoPhish Game

Number of students: 1 Ba

Description: The NoPhish app, one of the first implementations of the NoPhish concept, is a form of serious game. The BSI has also developed a game in the field of phishing. Both "games" use different approaches to impart knowledge from the same context. The aim is to evaluate the two games in terms of similarities and differences.

Title: Phishing Advice from Organizations (English Only)

Number of students: 1 Ba

Description: Many companies distribute information on how to recognise phishing via various channels such as e-mails, e.g. Amazon or Telekom. The question arises as to how helpful these tips are in reality. Are they too specific to the context of the company or so abstractly formulated that they are of no real help to users? The aim of the work is to collect various hints and then compare them with the hints of the NoPhish concept in order to find differences and similarities between the hints and the concept.

Title: Chatbots for Literature Reviews

Number of students: 1 Ba

Description: Chatbots are becoming increasingly popular and are already being used in various areas. But in what form can these bots be used for science? The variety of chatbots also raises the question of whether there are chatbots that are better suited to a scientific context. The aim is to identify a selection of chatbots and evaluate them in terms of their effectiveness for future literature research. To this end, the results of the chatbots will be compared with the ACM database in order to check their effectiveness for finding literature for a specific period of time.

Title: Phishing through homographic attacks in messengers and social networks

Number of students: 1-2 Ba/Ma

Description: The task will be to test three types of attacks in messengers and social networks that work in some email clients. First is the link mismatch attack, where the link text differs from the actual link target. Second is an attack in which the actual link target is disguised by URL encoding [[https://en.wikipedia.org/wiki/URL\\_encoding](https://en.wikipedia.org/wiki/URL_encoding)], and finally homographic attacks which uses Internationalized Domain Names [[https://en.wikipedia.org/wiki/IDN\\_homograph\\_attack](https://en.wikipedia.org/wiki/IDN_homograph_attack)], in which Latin characters are replaced by characters of a different alphabet in the domain name. The attacks are predefined, so no knowledge of phishing techniques is required.

Title: Usability Study of Mobile Authentication for Elderly Users with Rheumatoid Arthritis (English only)

Number of students: 1 Ba/Ma

Description: Authentication is an ever important topic, especially in the mobile context. However, it becomes even more relevant when considering accessibility to it. Nowadays, a common authentication method is using a PIN. Yet, given the low hand mobility of users affected by rheumatoid arthritis, sometimes using PINs can be difficult. In this topic, the student will conduct several sessions of an already designed lab study with various participants using arthritis simulation gloves to evaluate three PIN-pad interfaces aimed at making authentication more accessible. The study will also investigate the preferences of users regarding PIN-pad interfaces through drawings and proposals of changes. The student will then analyse the results through inferential statistics. Depending on the quality of the outcome, the results will then be published in a paper and the student will be added to the authors list.

This event counts towards the KASTEL certificate. Further information on how to obtain the certificate can be found on the SECUSO website ([https://secuso.aifb.kit.edu/Studium\\_und\\_Lehre.php](https://secuso.aifb.kit.edu/Studium_und_Lehre.php)).



### Praktikum Security, Usability and Society (Bachelor)

2512554, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

Practical course (P)  
Blended (On-Site/Online)

**Content**

The Praktikum Security, Usability and Society will cover topics both of usable security and privacy programming, and how to conduct user studies. To reserve a place, please, register on the WiWi portal and send an email with your chosen topic, plus a back-up one, to [mattia.mossano@kit.edu](mailto:mattia.mossano@kit.edu). Topics are assigned first-come-first-served until all of them are filled. Topics in italics have already been assigned.

**There are two rounds to apply:**

Summer round closes on 16.07.2023. Assignment will be done by 17.07.2023 and confirmation must be received by 21.07.2023.

Autumn round opens 11.09.2023 and closes on 08.10.2023. Assignment will be done by 09.10.2023 and confirmation must be received by 13.10.2023.

**Important dates:**

Kick-off: 05.10.2023, 09:00 AM CET in Big Blue Button - [Link](#)

Report & code feedback deadline: 01.03.2024, 23:59 CET

Feedback on Report & code: 08.03.2024, 23:59 CET

Final report + code deadline: 15.03.2024, 23:59 CET

Presentation draft deadline: 15.03.2024, 23:59 CET

Feedback on presentation draft: 19.03.2024, 23:59 CET

Final presentation deadline: 22.03.2024, 23:59 CET

Presentation day: 29.03.2024, 09:00 CET

Topics:

**Privacy Friendly apps**

In this subject, students complete an app (or an extension of an app) among our Privacy-Friendly Apps. Please click the following link to know more about them: <https://secuso.aifb.kit.edu/english/105.php>. Students are provided with a point list of goals, containing both basic features mandatory to pass the course and more advanced ones that heighten the final grade.

Title: *Notes 2.0*

Number of students: 1 Bachelor

Description: Update und Vorbereitung zur Veröffentlichung der Notes 2.0-App.

**Designing Security User studies**

These topics are related to how to set up and conduct user studies of various types. Online studies, interviews and lab studies are possible. At the end of the semester, the students present a report / paper and a talk in which they present their methodologies and the results of small pre-studies.

Title: Designing User Studies for Evaluating Biometric Authentication Systems

Number of students: 1 Bachelor or Master level

Description: The proposed topic focuses on designing and implementing a user study methodology to evaluate the usability and user perception of biometric authentication systems. Biometric authentication involves using unique physiological or behavioral characteristics, such as fingerprints, facial recognition, or voice patterns, to verify a user's identity. The goal of this research is to understand the factors that affect the effectiveness and acceptance of biometric authentication and provide insights for designing user-friendly and secure biometric authentication systems.

Title: How useful are security advice given by ChatGPT?

Number of students: 1-2 Bachelor level

Description: ChatGPT is nowadays used for multiple reasons. One of them is to obtain advice on security decision, asking the program how to be best defend oneself. However, what are these advice based on? And more importantly, is the quality of the advice in line with the best practices or are they misleading? The goal of this topic is to design an expert study where various advice given by ChatGPT on security topics (e.g., password policies, phishing, etc.) are compared against the advice of experts. The results then need to be analysed and classified to determine the quality of ChatGPT advice.

**Run Usable Security Studies and Results Analysis**

These topics are related to run and analyse the results of user-studies. Online studies, interviews and lab studies are all possible, depending on the topic. At the end of the semester, the students present a report / paper with the analyses conducted and a talk in which they present the results.

Title: Phishing through homographic attacks in messengers and social networks

Number of students: 1-2 Bachelor or Master level

Description: The task will be to test three types of attacks in messengers and social networks that work in some email clients. First is the link mismatch attack, where the link text differs from the actual link target. Second is an attack in which the actual link target is disguised by URL encoding [[https://en.wikipedia.org/wiki/URL\\_encoding](https://en.wikipedia.org/wiki/URL_encoding)], and finally homographic attacks which uses Internationalized Domain Names [[https://en.wikipedia.org/wiki/IDN\\_homograph\\_attack](https://en.wikipedia.org/wiki/IDN_homograph_attack)], in which Latin characters are replaced by characters of a different alphabet in the domain name. The attacks are predefined, so no knowledge of phishing techniques is required.



Title: Usability Study of Mobile Authentication for Elderly Users with Rheumatoid Arthritis (English only)

Number of students: 1 Bachelor or Master level

Description: Authentication is an ever important topic, especially in the mobile context. However, it becomes even more relevant when considering accessibility to it. Nowadays, a common authentication method is using a PIN. Yet, given the low hand mobility of users affected by rheumatoid arthritis, sometimes using PINs can be difficult. In this topic, the student will conduct several sessions of an already designed lab study with various participants using arthritis simulation gloves to evaluate three PIN-pad interfaces aimed at making authentication more accessible. The study will also investigate the preferences of users regarding PIN-pad interfaces through drawings and proposals of changes. The student will then analyse the results through inferential statistics. Depending on the quality of the outcome, the results will then be published in a paper and the student will be added to the authors list.

This event counts towards the KASTEL certificate. Further information on how to obtain the certificate can be found on the SECUSO website ([https://secuso.aifb.kit.edu/Studium\\_und\\_Lehre.php](https://secuso.aifb.kit.edu/Studium_und_Lehre.php)).



### Praktikum Security, Usability and Society (Master)

2512555, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

Practical course (P)  
Blended (On-Site/Online)

**Content**

The Praktikum Security, Usability and Society will cover topics both of usable security and privacy programming, and how to conduct user studies. To reserve a place, please, register on the WiWi portal and send an email with your chosen topic, plus a back-up one, to [mattia.mossano@kit.edu](mailto:mattia.mossano@kit.edu). Topics are assigned first-come-first-served until all of them are filled. Topics in italics have been already assigned.

**There are two deadlines:**

Summer round closes on 16.07.2023. Assignment will be done by 17.07.2023 and confirmation must be received by 21.07.2023.

Autumn round opens 11.09.2023 and closes on 08.10.2023. Assignment will be done by 09.10.2023 and confirmation must be received by 13.10.2023.

**Important dates:**

Kick-off: 05.10.2023, 09:00 AM CET in Big Blue Button - [Link](#)

Report & code feedback deadline: 01.03.2024, 23:59 CET

Feedback on Report & code: 08.03.2024, 23:59 CET

Final report + code deadline: 15.03.2024, 23:59 CET

Presentation draft deadline: 15.03.2024, 23:59 CET

Feedback on presentation draft: 19.03.2024, 23:59 CET

Final presentation deadline: 22.03.2024, 23:59 CET

Presentation day: 29.03.2024, 09:00 CET

**Topics:****Programming Usable Security Intervention**

In this subject, students develop a part of coding, an extension, or another programming task dealing with various usable security interventions, eg as an extension. Eg TORPEDO ( <https://secuso.aifb.kit.edu/english/TORPEDO.php> ) or PassSec + ( <https://secuso.aifb.kit.edu/english/PassSecPlus.php> ). Just as before, students are provided with a point list of goals, containing both basic features mandatory to pass the course and more advanced ones that heighten the final grade.

Title: Making e-mails more visible by embedding moving images

Number of students: 1 Master

Description: In case of a security incident, it is necessary to inform the affected persons about their vulnerabilities as soon as possible. Within the context of the INSPECTION project, we are currently informing website owners via e-mail about security related vulnerabilities on their websites. Although e-mails have been shown to be the most cost-efficient means to deliver such information, they have not lead to an appropriate remediation rate. While speaking to the affected website owners we learned that they would appreciate more information, although not being delivered as more text in the e-mail. Also, we learned that most e-mails were not read because they were considered spam. Thus, we need to find a way to make e-mail notifications more effective in raising peoples' awareness. Videos have been proven effective to raise awareness in the context of IT security. The goal of the project will be, to explore ways to embed videos in an e-mail via HTML (either as gifs or as preview to a YouTube video). The challenge is to make this e-mail readable for different clients and webmail as well as getting it delivered through spam filters.

**Designing Security User studies**

These topics are related to how to set up and conduct user studies of various types. Online studies, interviews and lab studies are possible. At the end of the semester, the students present a report / paper and a talk in which they present their methodologies and the results of small pre-studies.

Title: Designing User Studies for Evaluating Biometric Authentication Systems

Number of students: 1 Bachelor or Master level

Description: The proposed topic focuses on designing and implementing a user study methodology to evaluate the usability and user perception of biometric authentication systems. Biometric authentication involves using unique physiological or behavioral characteristics, such as fingerprints, facial recognition, or voice patterns, to verify a user's identity. The goal of this research is to understand the factors that affect the effectiveness and acceptance of biometric authentication and provide insights for designing user-friendly and secure biometric authentication systems.

Title: Can anxiety influences security advices

Number of students: 1 Master level

Description: Nowadays ChatGPT is used for a multitude of reasons. One is to ask advice on security topics. However, previous research showed that oftentimes ChatGPT creates answers based on previous interactions with it. Therefore, is it possible that also security advice change according to the previous interaction? And if this is the case, can more anxious props lead to completely different results? The student will have to read the previous literature on ChatGPT, find expert advice on security topics and create an experiment to determine if anxiety influenced the advice given by ChatGPT.

Title: Investigating ChatGPT privacy tradeoffs and users perception of them (English only)

Number of students: 1 Master level

Description: As ChatGPT grows in popularity, it becomes increasingly vital to examine the privacy trade-offs associated with its usage. The user's willingness to accept these trade-offs is instrumental in understanding the wider implications of employing AI language models. This topic involves a two-part exploration into the privacy trade-offs of using ChatGPT. Initially, the student will analyse ChatGPT's Terms and Conditions and conduct a short literature review to identify potential privacy trade-offs. The found trade-offs need to be categorised into a set of trade-offs that will be investigated. Subsequently, the student will design an online user study, incorporating various question types and a deception study, to gauge the willingness of ChatGPT users to accept these trade-offs. Finally, the student will test the designed online user study in the course of small pre-test.

### Run Usable Security Studies and Results Analysis

These topics are related to run and analyse the results of user-studies. Online studies, interviews and lab studies are all possible, depending on the topic. At the end of the semester, the students present a report / paper with the analyses conducted and a talk in which they present the results.

Title: Phishing through homographic attacks in messengers and social networks

Number of students: 1-2 Bachelor or Master level

Description: The task will be to test three types of attacks in messengers and social networks that work in some email clients. First is the link mismatch attack, where the link text differs from the actual link target. Second is an attack in which the actual link target is disguised by URL encoding [[https://en.wikipedia.org/wiki/URL\\_encoding](https://en.wikipedia.org/wiki/URL_encoding)], and finally homographic attacks which uses Internationalized Domain Names [[https://en.wikipedia.org/wiki/IDN\\_homograph\\_attack](https://en.wikipedia.org/wiki/IDN_homograph_attack)], in which Latin characters are replaced by characters of a different alphabet in the domain name. The attacks are predefined, so no knowledge of phishing techniques is required.

Title: Usability Study of Mobile Authentication for Elderly Users with Rheumatoid Arthritis (English only)

Number of students: 1 Bachelor or Master level

Description: Authentication is an ever important topic, especially in the mobile context. However, it becomes even more relevant when considering accessibility to it. Nowadays, a common authentication method is using a PIN. Yet, given the low hand mobility of users affected by rheumatoid arthritis, sometimes using PINs can be difficult. In this topic, the student will conduct several sessions of an already designed lab study with various participants using arthritis simulation gloves to evaluate three PIN-pad interfaces aimed at making authentication more accessible. The study will also investigate the preferences of users regarding PIN-pad interfaces through drawings and proposals of changes. The student will then analyse the results through inferential statistics. Depending on the quality of the outcome, the results will then be published in a paper and the student will be added to the authors list.

This event counts towards the KASTEL certificate. Further information on how to obtain the certificate can be found on the SECUSO website ([https://secuso.aifb.kit.edu/Studium\\_und\\_Lehre.php](https://secuso.aifb.kit.edu/Studium_und_Lehre.php)).

T

## 4.11 Course: Advanced Lab Sociotechnical Information Systems Development (Master) [T-WIWI-111125]

**Responsible:** Prof. Dr. Ali Sunyaev

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Events					
WT 24/25	2512401	<a href="#">Practical Course Sociotechnical Information Systems Development (Master)</a>	3 SWS	Practical course / 	Sunyaev, Leiser
Exams					
ST 2024	7900173	<a href="#">Advanced Lab Development of Sociotechnical Information Systems (Master)</a>			Sunyaev
WT 24/25	7900143	<a href="#">Advanced Lab Development of Sociotechnical Information Systems (Master)</a>			Sunyaev

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Practical work, presentation and written thesis are weighted according to the course.

### Prerequisites

None

T

## 4.12 Course: Advanced Machine Learning and Data Science [T-WIWI-111305]

**Responsible:** Prof. Dr. Maxim Ulrich  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-105659 - Advanced Machine Learning and Data Science](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	9	Grade to a third	Each term	4

Events					
ST 2024	2500016	<a href="#">Advanced Machine Learning and Data Science</a>	4 SWS	Project (P /  )	Ulrich
Exams					
ST 2024	7900378	<a href="#">Advanced Machine Learning and Data Science</a>			Ulrich
WT 24/25	7900291	<a href="#">Advanced Machine Learning and Data Science</a>			Ulrich

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment is carried out in form of a written thesis based on the course "Advanced Machine Learning and Data Science".

**Prerequisites**

The module Modeling the Dynamics of Financial Markets must be passed.

**Annotation**

The course is targeted to students with a major in Data Science and/or Machine Learning. It offers students the opportunity to develop hands-on knowledge on new developments in data science and machine learning. Please apply via the link: <https://portal.wiwi.kit.edu/forms/form/fbv-ulrich-msc-project>.

Below you will find excerpts from events related to this course:

V

**Advanced Machine Learning and Data Science**  
 2500016, SS 2024, 4 SWS, Language: English, [Open in study portal](#)

**Project (PRO)**  
**Blended (On-Site/Online)**

**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

**4.13 Course: Advanced Methods in Nonlinear Partial Differential Equations [T-MATH-113691]**

**Responsible:** Dr. Björn de Rijk  
Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-106822 - Advanced Methods in Nonlinear Partial Differential Equations](#)

Type	Credits	Grading scale	Version
Oral examination	3	Grade to a third	1

**Competence Certificate**

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

**Prerequisites**

none

**Recommendation**

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

T

## 4.14 Course: Advanced Statistics [T-WIWI-103123]

**Responsible:** Prof. Dr. Oliver Grothe  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101637 - Analytics and Statistics](#)  
[M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2550552	<a href="#">Advanced Statistics</a>	2 SWS	Lecture / 	Grothe
WT 24/25	2550553	<a href="#">Practice Advanced Statistics</a>	2 SWS	Practice / 	Kaplan
Exams					
WT 24/25	7900289	<a href="#">Advanced Statistics</a>			Grothe

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation. The exam is offered every semester. Re-examinations are offered only for repeaters.

**Prerequisites**

None

Below you will find excerpts from events related to this course:

V

**Advanced Statistics**

2550552, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Literature**

Skript zur Vorlesung

## T

## 4.15 Course: Advanced Stochastic Optimization [T-WIWI-106548]

**Responsible:** Prof. Dr. Steffen Rebennack  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	Irregular	2

Events					
WT 24/25	2500089	<a href="#">Advanced Stochastic Optimization</a>	2 SWS	Lecture / 📺	Rebennack
WT 24/25	2550468	<a href="#">Übung zu Advanced Stochastic Optimization</a>	1 SWS	Practice / 🔄	Rebennack
Exams					
ST 2024	7900034	<a href="#">Advanced Stochastic Optimization</a>			Rebennack
WT 24/25	7900025	<a href="#">Advanced Stochastic Optimization</a>			Rebennack

Legend: 📺 Online, 🔄 Blended (On-Site/Online), 📍 On-Site, ✕ Cancelled

**Competence Certificate**

The assessment consists of an oral exam (20 minutes). The exam is offered every semester.

**Prerequisites**

None.

**Recommendation**

It is recommended to attend the lecture "Introduction to Stochastic Optimization" before attending the lecture "Advanced Stochastic Optimization".

**Annotation**

Lectures and tutorials are offered irregularly.



## T

## 4.16 Course: Advanced Topics in Economic Theory [T-WIWI-102609]

**Responsible:** Prof. Dr. Kay Mitusch

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-101500 - Microeconomic Theory](#)  
[M-WIWI-101502 - Economic Theory and its Application in Finance](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Events					
ST 2024	2520527	<a href="#">Advanced Topics in Economic Theory</a>	2 SWS	Lecture / 🗎	Mitusch, Brumm
ST 2024	2520528	<a href="#">Übung zu Advanced Topics in Economic Theory</a>	1 SWS	Practice / 🗎	Pegorari, Corbo
Exams					
ST 2024	00227	<a href="#">Advanced Topics in Economic Theory</a>			Mitusch, Brumm
ST 2024	7900329	<a href="#">Advanced Topics in Economic Theory</a>			Mitusch, Brumm

Legend: 🗎 Online, 🗎 Blended (On-Site/Online), 🗎 On-Site, ✕ Cancelled

### Competence Certificate

The assessment consists of a written exam (60min) (following §4(2), 1 of the examination regulation) at the end of the lecture period or at the beginning of the following semester.

### Prerequisites

None

### Recommendation

This course is designed for advanced Master students with a strong interest in economic theory and mathematical models. Bachelor students who would like to participate are free to do so, but should be aware that the level is much more advanced than in other courses of their curriculum.

Below you will find excerpts from events related to this course:

## V

## Advanced Topics in Economic Theory

2520527, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

### Literature

Die Veranstaltung wird in englischer Sprache angeboten:

The course is based on the excellent textbook "Microeconomic Theory" (Chapters 1-5, 10, 13-20) by A.Mas-Colell, M.D.Whinston, and J.R.Green.

T

## 4.17 Course: Agent-Based Modelling and Simulation [T-WIWI-113629]

**Responsible:** Prof. Dr. Sanja Lazarova-Molnar  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2511102	<a href="#">Agent-Based Modelling and Simulation</a>	2 SWS	Lecture /	Lazarova-Molnar, Ghasemi
WT 24/25	2511103	<a href="#">Exercises Agent-Based Modelling and Simulation</a>	1 SWS	Practice /	Lazarova-Molnar, Ghasemi
Exams					
WT 24/25	79AIFB_ABMS_A3	<a href="#">Agent-Based Modelling and Simulation</a>	Lazarova-Molnar		

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The exam will be offered as an oral exam (approx.20 min).

The exam takes place every semester and can be repeated at every regular examination date.

**Prerequisites**

None

**Annotation**

Instruction is in the form of lectures and exercises. A detailed course schedule will be published before the start of the semester.

Below you will find excerpts from events related to this course:

V

**Agent-Based Modelling and Simulation**

2511102, WS 24/25, 2 SWS, [Open in study portal](#)

Lecture (V)  
On-Site

**Content****Inhalt**

This course on Agent-Based Modeling and Simulation (ABMS) provides an in-depth exploration of both theoretical and practical aspects of the field. Designed for students with a foundational understanding of programming, mathematics, and computational models, the course equips participants with the knowledge and skills to develop, simulate, and analyze agent-based models. Throughout the course, students will explore fundamental concepts, key theories, and the principles of ABMS. Practical sessions will focus on implementing models using Python and the Mesa library, covering essential topics such as agent behaviors, complex systems, emergent phenomena, and game theory. The course also emphasizes model validation, verification, and calibration, as well as simulation optimization techniques. Advanced topics include multi-agent systems, performance scalability, and the integration of data. We will explore example models from relevant application areas, including smart manufacturing, supply chain digitalization, and other fields where ABMS can provide significant insights. The curriculum will feature practice-oriented student projects, allowing participants to apply the course's learning to real-world problems and present their findings. Ethical considerations and future directions in ABMS are also discussed, ensuring a well-rounded educational experience.

**Competence Certificate**

Depending on the number of course participants, the exam will be offered 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:**

By the end of the course, students will be able to:

- Explain fundamental concepts of Agent-Based Modeling & Simulation (ABMS) and its applications in various fields.
- Describe components and structures of Agent-Based Models (ABMs), including agents, environments, and interactions.
- Differentiate between distinct types of simulation models and understand when to use ABMs.
- Discuss principles of model validation, verification, and calibration in the context of ABMS.
- Understand basics of complex systems and emergent behavior in the context of ABMs.
- Understand basics of Game Theory, Simulation Optimization, and Machine Learning within the domain of ABMS.
- Analyze theoretical frameworks and methodologies for developing ABMs.
- Evaluate ethical implications of ABM in research and application.

- **Competences:**

By the end of the course, students will be able to:

- Design and implement ABMs using Python with the Mesa library.
- Develop, debug, and test ABMs to ensure they accurately represent systems being modeled.
- Use Python and relevant libraries to simulate and visualize agent behaviors and system dynamics.
- Analyze and interpret results of simulations to draw meaningful conclusions.
- Communicate modeling results effectively through written reports and oral presentations.
- Apply ethical considerations in the development and use of AB simulation models.

**Prerequisites**

- **Basic Programming Knowledge**

- Understanding of fundamental programming concepts such as variables, loops, conditionals, and functions (preferably in Python).

- **Basic Mathematics and Statistics**
  - Familiarity with basic mathematical concepts (algebra, functions) and statistical concepts (mean, median, standard deviation).
- **Basic Understanding of Computational Models**
  - General knowledge of what models are and their purposes in different scientific fields.

### Form of Instruction

Lectures and exercises. A detailed course plan will be published before the start of semester.

### Literature

- Wilensky, U., & Rand, W. (2015). An introduction to agent-based modeling: Modeling natural, social, and engineered complex systems with NetLogo. Massachusetts: MIT Press.
- Grimm, V., & Railsback, S. F. (2012). Agent-based and individual based modeling: a practical introduction. New Jersey: Princeton University Press.
- North, Michael J., Macal, Charles M, and Oxford University Press. Managing Business Complexity Discovering Strategic Solutions with Agent-Based Modeling and Simulation. New York: Oxford UP, 2007. Oxford Scholarship Online.

T

## 4.18 Course: Algebra [T-MATH-102253]

**Responsible:** PD Dr. Stefan Kühnlein  
Prof. Dr. Roman Sauer

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-101315 - Algebra](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

Events					
WT 24/25	0102200	<a href="#">Algebra</a>	4 SWS	Lecture / 	Sauer
WT 24/25	0102210	<a href="#">Tutorial for 0102200 (Algebra)</a>	2 SWS	Practice / 	Sauer
Exams					
ST 2024	7700134	<a href="#">Algebra</a>			Sauer

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

T

## 4.19 Course: Algebraic Geometry [T-MATH-103340]

**Responsible:** Prof. Dr. Frank Herrlich  
PD Dr. Stefan Kühnlein

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-101724 - Algebraic Geometry](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2024	0152000	<a href="#">Algebraische Geometrie</a>	4 SWS	Lecture	Herrlich
ST 2024	0152010	<a href="#">Übungen zu 0152000 (Algebraische Geometrie)</a>	2 SWS	Practice	Herrlich
Exams					
ST 2024	7715200	<a href="#">Algebraic Geometry</a>			Herrlich

T

**4.20 Course: Algebraic Number Theory [T-MATH-103346]**

**Responsible:** Prof. Dr. Frank Herrlich  
PD Dr. Stefan Kühnlein

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-101725 - Algebraic Number Theory](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

**Competence Certificate**

oral examination of ca. 30 minutes

**Prerequisites**

none

T

**4.21 Course: Algebraic Topology [T-MATH-105915]**

**Responsible:** TT-Prof. Dr. Manuel Krannich  
Prof. Dr. Roman Sauer

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102948 - Algebraic Topology](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Irregular	1

**Prerequisites**  
none



T

**4.22 Course: Algebraic Topology II [T-MATH-105926]**

**Responsible:** Prof. Dr. Roman Sauer  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102953 - Algebraic Topology II](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Irregular	1

**Prerequisites**  
none

T

**4.23 Course: Analytical and Numerical Homogenization [T-MATH-111272]**

**Responsible:** Prof. Dr. Marlis Hochbruck  
TT-Prof. Dr. Roland Maier

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-105636 - Analytical and Numerical Homogenization](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

**Prerequisites**

none

T

**4.24 Course: Applications of Topological Data Analysis [T-MATH-111290]****Responsible:** Dr. Andreas Ott**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-105651 - Applications of Topological Data Analysis](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

**Prerequisites**

none

**4.25 Course: Applied Econometrics [T-WIWI-111388]**

**Responsible:** Prof. Dr. Melanie Schienle  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101638 - Econometrics and Statistics I](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2520020	<a href="#">Applied Econometrics</a>	2 SWS	Lecture /	Krüger, Eberl
WT 24/25	2520021	<a href="#">Tutorial in Applied Econometrics</a>	2 SWS	Practice /	Eberl, Krüger
Exams					
ST 2024	7900007	<a href="#">Applied Econometrics</a>			Krüger

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment of this course is a written examination (90 min).

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Applied Econometrics**

2520020, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

The course starts with a concise review of core econometric topics (in particular, the linear regression model). It then presents methods for causal inference: The potential outcomes approach, methods for analyzing randomized controlled trials, and methods for analyzing observational data (e.g., regression discontinuity). Empirical examples and R code are used to illustrate the methodological concepts.

*Learning goals*

Students understand the properties of various econometric estimators and research designs, and can implement econometric estimators using R software.

*Workload*

The total workload for this course (4.5 credit points) is approximately 135 hours.

**Literature**

The following book is the main reference for the course:

Ding, P. (2024). A First Course in Causal Inference. Routledge.

Further literature will be announced in class.

T

## 4.26 Course: Applied Informatics – Principles of Internet Computing: Foundations for Emerging Technologies and Future Services [T-WIWI-110339]

**Responsible:** Prof. Dr. Ali Sunyaev

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2511032	<a href="#">Applied Informatics - Internet Computing</a>	2 SWS	Lecture / 🗣️	Sunyaev
ST 2024	2511033	<a href="#">Übungen zu Angewandte Informatik - Internet Computing</a>	1 SWS	Practice / 🔄	Sunyaev, Rank, Guse
Exams					
ST 2024	79AIFB_AI2_A2	<a href="#">Applied Informatics - Internet Computing (Registration until 21 July 2024)</a>			Sunyaev
WT 24/25	79AIFB_AI-IC_B4	<a href="#">Applied Informatics – Principles of Internet Computing: Foundations for Emerging Technologies and Future Services</a>			Sunyaev

Legend: 📺 Online, 🔄 Blended (On-Site/Online), 🗣️ On-Site, ✖ Canceled

### Competence Certificate

The assessment consists of a written exam (60 min) according to Section 4(2), 1 of the examination regulation. The successful completion of the exercises is recommended for the written exam, which is offered at the end of the winter semester and at the end of the summer semester.

Successful participation in the exercise by submitting correct solutions to 50% of the exercises can earn a grade bonus. 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

Below you will find excerpts from events related to this course:

V

### Applied Informatics - Internet Computing

2511032, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

The lecture Applied Computer Science - Internet Computing provides insights into fundamental concepts and future technologies of distributed systems and Internet computing. Students should be able to select, design and apply the presented concepts and technologies. The course first introduces basic concepts of distributed systems (e.g. design of architectures for distributed systems, internet architectures, web services, middleware).

In the second part of the course, emerging technologies of Internet computing will be examined in depth. These include, among others:

- Cloud Computing
- Edge & Fog Computing
- Internet of Things
- Blockchain
- Artificial Intelligence

**Learning objectives:**

The student learns about basic concepts and emerging technologies of distributed systems and internet computing. Practical topics will be deepened in lab classes.

**Recommendations:**

Knowledge of content of the module [WI1INFO].

**Workload:**

The total workload for this course is approximately 135-150 hours.

**Literature**

Wird in der Vorlesung bekannt gegeben

T

## 4.27 Course: Applied material flow simulation [T-MACH-112213]

**Responsible:** Dr.-Ing. Marion Baumann

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** [M-WIWI-102805 - Service Operations](#)  
[M-WIWI-102832 - Operations Research in Supply Chain Management](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2117054	<a href="#">Applied material flow simulation</a>	3 SWS	Lecture / Practice (/	Baumann

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

### Competence Certificate

The assessment consists of an oral exam (20 min.) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

### Prerequisites

None

### Recommendation

- Basic statistical knowledge and understanding
- Knowledge of a common programming language (Java, Python, ...)
- Recommended course: T-WIWI-102718 - Discrete Event Simulation in Production and Logistics

Below you will find excerpts from events related to this course:

V

### Applied material flow simulation

2117054, WS 24/25, 3 SWS, Language: German, [Open in study portal](#)

Lecture / Practice (VÜ)  
On-Site

**Content****Learning Content:**

- Methods of modeling a simulation such as:
  - Discrete-event simulation
  - Agent based simulation
- Design of a simulation model of a material flow system
- Data exchange in simulation models
- Verification and validation of simulation models
- Execution of simulation studies
- Statistical evaluation and parameter study

This is an application-oriented course in which the course contents are applied and deepened using the Anylogic software.

**Learning Goals:**

Students are able to:

- select the appropriate simulation modeling method depending on a modeling objective and build a suitable simulation model for material flow systems,
- extend a simulation model in a meaningful way with data import and export,
- verify and validate a simulation model,
- conduct a simulation study efficiently and with meaningful results, and
- design and conduct a parameter study and statistically analyze and evaluate the results.

**Requirements:**

- Basic knowledge of the Java programming language

**Recommendations:**

- Basic statistical skills
- Recommended course: T-WIWI-102718 - Discrete Event Simulation in Production and Logistics

**Workload for 4,5 ECTS (135 h):**

- regular attendance: 21 hours
- self-study: 114 hours

**Organizational issues**

- **Im Wintersemester 2024/2025 ist die Veranstaltung auf maximal 30 Teilnehmer beschränkt.**
- **Die Anmeldung ist durch Beitritt zum ILIAS-Kurs und Ausfüllen des Anmeldeformulars (erforderliche Felder beim Beitritt zum ILIAS-Kurs) möglich.**
- **Die Anmeldung ist vom 01.09.2024 bis zum 30.09.2024 möglich.**

**Literature**

Borshev, A. (2022): The Big Book of Simulation Modeling - Multimethod Modeling with AnyLogic 8, <https://www.anylogic.de/resources/books/big-book-of-simulation-modeling/>.

Grigoryev, I. (2021): AnyLogic8 in Three Days, 5. Aufl., <https://www.anylogic.de/resources/books/free-simulation-book-and-modeling-tutorials/>.

Gutenschwager, K. et. al. (2017): Simulation in Produktion und Logistik, Springer Vieweg, Berlin.

VDI (2014): Simulation von Logistik-, Materialfluss- und Produktionssystemen - Grundlagen. VDI Richtlinie 3633, Blatt 1, VDI-Verlag, Düsseldorf.

VDI (2016): Simulation von Logistik-, Materialfluss- und Produktionssystemen - Simulation und Optimierung. VDI Richtlinie 3633, Blatt 12, VDI-Verlag, Düsseldorf



T

## 4.28 Course: Asset Pricing [T-WIWI-102647]

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

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101482 - Finance 1](#)  
[M-WIWI-101483 - Finance 2](#)  
[M-WIWI-101502 - Economic Theory and its Application in Finance](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2530555	<a href="#">Asset Pricing</a>	2 SWS	Lecture / 	Uhrig-Homburg, Müller
ST 2024	2530556	<a href="#">Asset Pricing</a>	1 SWS	Practice / 	Böll, Uhrig-Homburg, Müller
Exams					
ST 2024	7900110	<a href="#">Asset Pricing</a>			Uhrig-Homburg, Thimme
WT 24/25	7900056	<a href="#">Asset Pricing</a>			Uhrig-Homburg

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Depending on further pandemic developments, the examination will be offered either as a 60-minute written examination or as an open-book examination (alternative exam assessment).

A bonus can be earned by correctly solving at least 50% of the posed bonus exercises. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

**Prerequisites**

None

**Recommendation**

We strongly recommend knowledge of the basic topics in investments (bachelor course), which will be necessary to be able to follow the course.

Below you will find excerpts from events related to this course:

V

**Asset Pricing**

2530556, SS 2024, 1 SWS, Language: German, [Open in study portal](#)

Practice (Ü)  
On-Site

## T

## 4.29 Course: Auction Theory [T-WIWI-102613]

**Responsible:** Prof. Dr. Karl-Martin Ehrhart  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101500 - Microeconomic Theory](#)  
[M-WIWI-102970 - Decision and Game Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2520408	<a href="#">Auction Theory</a>	2 SWS	Lecture	Ehrhart
WT 24/25	2520409	<a href="#">Auction Theory Exercise</a>	1 SWS	Practice	Ehrhart
Exams					
ST 2024	7900255	<a href="#">Auction Theory</a>			Ehrhart
WT 24/25	7900028	<a href="#">Auction Theory</a>			Ehrhart

**Competence Certificate**

The assessment of this course is a written examination (following §4(2), 1 SPO) of 60 mins.

The exam is offered each semester.

**Prerequisites**

None

*Below you will find excerpts from events related to this course:*

## V

**Auction Theory**

2520408, WS 24/25, 2 SWS, [Open in study portal](#)

Lecture (V)

**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

## 4.30 Course: Bayesian Inverse Problems with Connections to Machine Learning [T-MATH-112842]

**Responsible:** TT-Prof. Dr. Sebastian Krumscheid

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-106328 - Bayesian Inverse Problems with Connections to Machine Learning](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	4	Grade to a third	Each summer term	1 terms	1

Exams			
ST 2024	7700131	<a href="#">Bayesian Inverse Problems with Connections to Machine Learning</a>	Krumscheid

### Competence Certificate

oral exam of ca. 30 min

### Prerequisites

none

T

**4.31 Course: Bifurcation Theory [T-MATH-106487]**

**Responsible:** Dr. Rainer Mandel  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-103259 - Bifurcation Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

**Prerequisites**  
None

## T 4.32 Course: Bond Markets [T-WIWI-110995]

**Responsible:** Prof. Dr. Marliese Uhrig-Homburg  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2530560	<a href="#">Bond Markets</a>	3 SWS	Lecture / Practice (/	Uhrig-Homburg, Molnar
Exams					
ST 2024	7900280	<a href="#">Bond Markets</a>			Uhrig-Homburg
WT 24/25	7900311	<a href="#">Bond Markets</a>			Uhrig-Homburg

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

### Competence Certificate

The assessment consists of a written exam (75min.)

A bonus can be earned by correctly solving at least 50% of the posed bonus exercises. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one level (0.3 or 0.4). The examination is offered in each semester and can be repeated at any regular examination date.

Depending on further pandemic developments, the examination will be offered as an open-book examination (alternative exam assessment).

### Annotation

This course will be held in English.

Below you will find excerpts from events related to this course:

	<b>Bond Markets</b> 2530560, WS 24/25, 3 SWS, Language: English, <a href="#">Open in study portal</a>	Lecture / Practice (VÜ) On-Site
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### 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 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.

Students deepen their knowledge of national and international bond markets. They gain knowledge of the traded instruments and their key figures for describing default risk such as ratings, default probabilities or credit spreads.

### Organizational issues

Die Veranstaltung wird freitags in der ersten Semesterhälfte am Campus B (Geb. 09.21) im Raum 124 angeboten. Die Klausur findet am 08.01.25 statt.

T

## 4.33 Course: Bond Markets - Models &amp; Derivatives [T-WIWI-110997]

**Responsible:** Prof. Dr. Marliese Uhrig-Homburg  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each winter term	1

Events					
WT 24/25	2530565	<a href="#">Bond Markets - Models &amp; Derivatives</a>	2 SWS	Block /	Grauer, Uhrig-Homburg
Exams					
ST 2024	7900313	<a href="#">Bond Markets - Models &amp; Derivatives</a>			Uhrig-Homburg
WT 24/25	7900318	<a href="#">Bond Markets - Models &amp; Derivatives</a>			Uhrig-Homburg

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment of success consists in equal parts of a written thesis and an oral exam including a discussion of one's own work. The main examination is offered once a year, re-examinations every semester.

**Recommendation**

Knowledge of "Bond Markets" and "Derivatives" courses is very helpful.

**Annotation**

This course will be held in English.

Below you will find excerpts from events related to this course:

V

**Bond Markets - Models & Derivatives**

2530565, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

**Block (B)**  
**On-Site**

**Content**

- **Competence Certificate:** The assessment of success consists in equal parts of a written thesis and an oral exam (according to §4(2), 3 SPO) including a discussion of one's own work. The main examination is offered once a year, re-examinations every semester.
- **Competence Goal:** Students deepen their knowledge of national and international bond markets. They are able to apply the knowledge they have gained about traded instruments and common valuation models for pricing derivative financial instruments.
- **Prerequisites:**
- **Content:** The lecture "Bond Markets – Models & Derivatives" deepens the content of the lecture "Bond Markets". The modelling of the dynamics of yield curves and the management of credit risks forms the theoretical foundation for the valuation of interest rate and credit derivatives to be discussed. In this course, students deal intensively with selected topics and acquire the relevant knowledge on their own.
- **Recommendation:** Knowledge of "Bond Markets" and "Derivatives" courses is very helpful.
- **Workload:** The total workload for this course is approximately 90 hours (3.0 credits).

**Organizational issues**

Die Veranstaltung mit Seminarcharakter und dem Ziel, ein selbstgewähltes Themenfeld in Form einer schriftlichen Ausarbeitung eigenständig zu erarbeiten, findet in der 2. Semesterhälfte statt.

## T

## 4.34 Course: Bond Markets - Tools &amp; Applications [T-WIWI-110996]

**Responsible:** Prof. Dr. Marliese Uhrig-Homburg  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	1,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2530562	<a href="#">Bond Markets - Tools &amp; Applications</a>	1 SWS	Block / 	Uhrig-Homburg, Grauer
Exams					
WT 24/25	7900317	<a href="#">Bond Markets - Tools &amp; Applications</a>	Uhrig-Homburg		

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

The assessment consists of an empirical case study with written elaboration and presentation. The main examination is offered once a year, re-examinations every semester.

### Recommendation

Knowledge of the "Bond Markets" course is very helpful.

### Annotation

This course will be held in English.

Below you will find excerpts from events related to this course:

	<b>Bond Markets - Tools &amp; Applications</b> 2530562, WS 24/25, 1 SWS, Language: English, <a href="#">Open in study portal</a>	<b>Block (B)</b> <b>On-Site</b>
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### 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

**4.35 Course: Bott Periodicity [T-MATH-108905]**

**Responsible:** Prof. Dr. Wilderich Tuschmann  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-104349 - Bott Periodicity](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

**Prerequisites**  
none



T

## 4.36 Course: Boundary and Eigenvalue Problems [T-MATH-105833]

**Responsible:** Prof. Dr. Dorothee Frey  
 Prof. Dr. Dirk Hundertmark  
 Prof. Dr. Tobias Lamm  
 Prof. Dr. Michael Plum  
 Prof. Dr. Wolfgang Reichel  
 Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102871 - Boundary and Eigenvalue Problems](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2024	0157500	<a href="#">Boundary and Eigenvalue Problems</a>	4 SWS	Lecture	Lewintan
ST 2024	0157510	<a href="#">Tutorial for 0157500 (Boundary and Eigenvalue Problems)</a>	2 SWS	Practice	Lewintan
Exams					
ST 2024	7700062	<a href="#">Boundary and Eigenvalue Problems</a>			Reichel, Liao, Lamm, Hundertmark, Lewintan

Below you will find excerpts from events related to this course:

V

## Boundary and Eigenvalue Problems

0157500, SS 2024, 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

**4.37 Course: Boundary Element Methods [T-MATH-109851]**

**Responsible:** PD Dr. Tilo Arens  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-103540 - Boundary Element Methods](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

**Prerequisites**  
none

T

**4.38 Course: Brownian Motion [T-MATH-105868]**

**Responsible:** Prof. Dr. Nicole Bäuerle  
Prof. Dr. Vicky Fasen-Hartmann  
Prof. Dr. Günter Last

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102904 - Brownian Motion](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

**Prerequisites**

none

**4.39 Course: Business Intelligence Systems [T-WIWI-105777]**

**Responsible:** Prof. Dr. Alexander Mädche  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-104068 - Information Systems in Organizations](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2540422	<a href="#">Business Intelligence Systems</a>	3 SWS	Lecture /	Mädche
Exams					
ST 2024	7900149	<a href="#">Business Intelligence Systems</a>			Mädche
WT 24/25	7900224	<a href="#">Business Intelligence Systems</a>			Mädche

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Alternative exam assessment. The assessment consists of a one-hour exam and the implementation of a Capstone project. Details will be announced at the beginning of the course.

**Prerequisites**

None

**Recommendation**

Basic knowledge on database systems is helpful.

Below you will find excerpts from events related to this course:

**Business Intelligence Systems**

2540422, WS 24/25, 3 SWS, Language: English, [Open in study portal](#)

**Lecture (V)**  
**Blended (On-Site/Online)**

**Content**

In most modern enterprises, Business Intelligence & Analytics (BI&A) Systems represent a core enabler of decision-making in that they are supplying 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. The aim of this course is to introduce theoretical foundations, concepts, tools, and current practice of BI&A Systems from a managerial and technical perspective.

The course is complemented with an engineering capstone project, where students work in a team with real-world use cases and data in order to create running Business intelligence & Analytics system prototypes.

**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 a capacity of 50 places. The capacity limitation is due to the attractive format of the accompanying engineering capstone project. Strong analytical abilities and profound skills in SQL as wells as Python and/or R are required. Students have to apply with their CV and transcript of records. All organizational details and the underlying registration process of the lecture and the capstone project will be presented in the first lecture. The teaching language is English.

**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

## 4.40 Course: Business Process Modelling [T-WIWI-102697]

**Responsible:** Prof. Dr. Andreas Oberweis  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2511210	<a href="#">Business Process Modelling</a>	2 SWS	Lecture / 🗣️	Oberweis
WT 24/25	2511211	<a href="#">Exercise Business Process Modelling</a>	1 SWS	Practice / 🗣️	Oberweis, Schüler
Exams					
ST 2024	79AIFB_MvG_B4	<a href="#">Business Process Modelling (Registration until 15 July 2024)</a>			Oberweis
WT 24/25	79AIFB_MvG_C2	<a href="#">Business Process Modelling</a>			Oberweis

Legend: 🗣️ Online, 🗣️🗣️ Blended (On-Site/Online), 🗣️ On-Site, ✕ Cancelled

### Competence Certificate

The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation in the first week after lecture period.

### Prerequisites

None

Below you will find excerpts from events related to this course:

## V

## Business Process Modelling

2511210, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

### Content

The proper modeling of relevant aspects of business processes is essential for an efficient and effective design and implementation of processes. This lecture presents different classes of modeling languages and discusses the respective advantages and disadvantages of using actual application scenarios. For that simulative and analytical methods for process analysis are introduced. In the accompanying exercise the use of process modeling tools is practiced.

### Learning objectives:

Students

- describe goals of business process modeling and apply 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 models 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.

**4.41 Course: Challenges in Supply Chain Management [T-WIWI-102872]**

**Responsible:** Esther Mohr  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-102805 - Service Operations](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2550494	<a href="#">Challenges in Supply Chain Management</a>	3 SWS	Lecture /	Mohr
Exams					
ST 2024	00030	<a href="#">Challenges in Supply Chain Management</a>			Nickel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written paper and an oral exam of ca. 30-40 min.

**Prerequisites**

None

**Recommendation**

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

**Annotation**

The number of course participants is limited to 12 participants due to joint work in BASF project teams. Due to these capacity restrictions, registration before course start is required. For further information see the webpage of the course.

The course is offered irregularly. The planned lectures and courses for the next three years are announced online.

Below you will find excerpts from events related to this course:

**Challenges in Supply Chain Management**

2550494, SS 2024, 3 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
Blended (On-Site/Online)

**Content**

The course consists of case studies of BASF which cover future challenges of supply chain management. Thus, the course aims at a case-study based presentation, critical evaluation and exemplary discussion of recent questions in supply chain management. The focus lies on future challenges and trends, also with regard to their applicability in practical cases (especially in the chemical industry).

The main part of the course is working on a project together with BASF in Ludwigshafen. The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the project topic.

This course will include working on cutting edge supply chain topics like Industry 4.0 / "Internet of Everything in production", supply chain analytics, risk management, procurement and production in SCM. The team essays / project reports will be linked to industry-related challenges as well as to upcoming theoretical concepts. The topics of the seminar will be announced at the beginning of the term in a preliminary meeting.

**Organizational issues**

Bewerbung über das Wiwi-Portal möglich:

<http://go.wiwi.kit.edu/ChallengesSCM>

(Bewerbungszeitraum: 01.03.2024 - 18.03.2024)

**Literature**

Wird in Abhängigkeit vom Thema in den Projektteams bekanntgegeben.



T

## 4.42 Course: Classical Methods for Partial Differential Equations [T-MATH-105832]

**Responsible:** Prof. Dr. Dorothee Frey  
 Prof. Dr. Dirk Hundertmark  
 Prof. Dr. Tobias Lamm  
 Prof. Dr. Michael Plum  
 Prof. Dr. Wolfgang Reichel  
 Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102870 - Classical Methods for Partial Differential Equations](#)

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	1

Events					
WT 24/25	0105300	<a href="#">Classical Methods for Partial Differential Equations</a>	4 SWS	Lecture	Zillinger
WT 24/25	0105310	<a href="#">Tutorial for 0105300 (Classical Methods for Partial Differential Equations)</a>	2 SWS	Practice	Zillinger
Exams					
ST 2024	7700052	<a href="#">Classical Methods for Partial Differential Equations</a>			Reichel, Liao, Hundertmark, Lewintan

T

## 4.43 Course: Collective Perception in Autonomous Driving [T-WIWI-113363]

**Responsible:** Prof. Dr. Alexey Vinel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2511456	<a href="#">Collective Perception in Autonomous Driving</a>	2 SWS	Lecture / 	Bied, Zhao , Vinel
ST 2024	2511457	<a href="#">Exercise Collective Perception in Autonomous Driving</a>	1 SWS	Practice / 	Bied, Zhao , Lucena
Exams					
ST 2024	79AIFB_CPAD_C3	<a href="#">Collective Perception in Autonomous Driving (Registration until 15 July 2024)</a>			Vinel
WT 24/25	79AIFB_CPAD_B3	<a href="#">Collective Perception in Autonomous Driving</a>			Vinel

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The default assessment of this course is a written examination (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

**Prerequisites**

None.

T

**4.44 Course: Combinatorics [T-MATH-105916]**

**Responsible:** Prof. Dr. Maria Aksenovich  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102950 - Combinatorics](#)

**Type**  
Written examination

**Credits**  
8

**Grading scale**  
Grade to a third

**Recurrence**  
see Annotations

**Version**  
3

Events					
ST 2024	0150300	<a href="#">Combinatorics</a>	4 SWS	Lecture	Aksenovich
ST 2024	0150310	<a href="#">Tutorial for 0150300 (Combinatorics)</a>	2 SWS	Practice	Liu
Exams					
ST 2024	7700085	<a href="#">Combinatorics</a>			Aksenovich

**Prerequisites**  
none

**Annotation**  
The course is offered every second year.

*Below you will find excerpts from events related to this course:*

V

**Combinatorics**

0150300, SS 2024, 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, twelfold way, generating functions, arrangements, Young tableaux, partitions, recursions, partially ordered sets, extremal set theory, and combinatorial designs.

T

**4.45 Course: Comparison Geometry [T-MATH-105917]**

**Responsible:** Prof. Dr. Wilderich Tuschmann  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102940 - Comparison Geometry](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

**Prerequisites**  
Keine

T

**4.46 Course: Complex Analysis [T-MATH-105849]**

**Responsible:** PD Dr. Gerd Herzog  
Prof. Dr. Michael Plum  
Prof. Dr. Wolfgang Reichel  
Prof. Dr. Roland Schnaubelt  
Dr. rer. nat. Patrick Tolksdorf

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102878 - Complex Analysis](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T

**4.47 Course: Complex Geometry [T-MATH-113614]**

**Responsible:** Jun.-Prof. Dr. Claudio Llosa Isenrich  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106776 - Complex Geometry](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

**Competence Certificate**

oral exam (ca. 30 min)

**Prerequisites**

none

T

**4.48 Course: Compressive Sensing [T-MATH-105894]**

**Responsible:** Prof. Dr. Andreas Rieder  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102935 - Compressive Sensing](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

**4.49 Course: Computational Economics [T-WIWI-102680]**

**Responsible:** Prof. Dr. Pradyumn Kumar Shukla  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	see Annotations	3

Events					
WT 24/25	2590458	<a href="#">Computational Economics</a>	2 SWS	Lecture /	Shukla
WT 24/25	2590459	<a href="#">Exercices to Computational Economics</a>	1 SWS	Practice /	Shukla
Exams					
ST 2024	79AIFB_CE_C6	<a href="#">Computational Economics (Registration until 15 July 2024)</a>			Shukla
WT 24/25	79AIFB_CE_B1	<a href="#">Computational Economics</a>			Shukla

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Please note: the lecture will not take place in the winter semester 2023/2024. Also an exam cannot be offered.

**Prerequisites**

None

**Annotation**

The lecture is currently suspended. An exam cannot be offered.

Below you will find excerpts from events related to this course:

**Computational Economics**

2590458, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
Blended (On-Site/Online)

**Content**

Examining complex economic problems with classic analytical methods usually requires making numerous simplifying assumptions, for example that agents behave rationally or homogeneously. Recently, widespread availability of computing power gave rise to a new field in economic research that allows the modeling of heterogeneity and forms of bounded rationality: Computational Economics. Within this new discipline, computer based simulation models are used for analyzing complex economic systems. In short, an artificial world is created which captures all relevant aspects of the problem under consideration. Given all exogenous and endogenous factors, the modelled economy evolves over time and different scenarios can be analyzed. Thus, the model can serve as a virtual testbed for hypothesis verification and falsification.

**Learning objectives:**

The student

- understands the methods of Computational Economics and applies them on practical issues,
- evaluates agent models considering bounded rational behaviour and learning algorithms,
- analyses agent models based on mathematical basics,
- knows the benefits and disadvantages of the different models and how to use them,
- examines and argues the results of a simulation with adequate statistical methods,
- is able to support the chosen solutions with arguments and can explain them.



**Literature**

- R. Axelrod: "Advancing the art of simulation in social sciences". R. Conte u.a., Simulating Social Phenomena, Springer, S. 21-40, 1997.
- R. Axtel: "Why agents? On the varied motivations for agent computing in the social sciences". CSED Working Paper No. 17, The Brookings Institution, 2000.
- K. Judd: "Numerical Methods in Economics". MIT Press, 1998, Kapitel 6-7.
- A. M. Law and W. D. Kelton: "Simulation Modeling and Analysis", McGraw-Hill, 2000.
- R. Sargent: "Simulation model verification and validation". Winter Simulation Conference, 1991.
- L. Tesfation: "Notes on Learning", Technical Report, 2004.
- L. Tesfatsion: "Agent-based computational economics". ISU Technical Report, 2003.

**Weiterführende Literatur:**

- Amman, H., Kendrick, D., Rust, J.: "Handbook of Computational Economics". Volume 1, Elsevier North-Holland, 1996.
- Tesfatsion, L., Judd, K.L.: "Handbook of Computational Economics". Volume 2: Agent-Based Computational Economics, Elsevier North-Holland, 2006.
- Marimon, R., Scott, A.: "Computational Methods for the Study of Dynamic Economies". Oxford University Press, 1999.
- Gilbert, N., Troitzsch, K.: "Simulation for the Social Scientist". Open University Press, 1999.

T

**4.50 Course: Computational Fluid Dynamics and Simulation Lab [T-MATH-113373]**

**Responsible:** PD Dr. Mathias Krause  
PD Dr. Gudrun Thäter

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-106634 - Computational Fluid Dynamics and Simulation Lab](#)

Type	Credits	Grading scale	Version
Examination of another type	4	Grade to a third	1

Events					
ST 2024	0161700	<a href="#">Computational Fluid Dynamics and Simulation Lab</a>	4 SWS	Practical course	Thäter, Krause, Simonis
Exams					
ST 2024	7700108	<a href="#">Computational Fluid Dynamics and Simulation Lab</a>			Thäter

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

V

**Computational Fluid Dynamics and Simulation Lab**

0161700, SS 2024, 4 SWS, Language: German/English, [Open in study portal](#)

**Practical course (P)**

**Content**

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

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

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

T

**4.51 Course: Computational Risk and Asset Management [T-WIWI-102878]**

**Responsible:** Prof. Dr. Maxim Ulrich  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-105032 - Data Science for Finance](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Irregular	5

**Competence Certificate**

The module examination takes the form of an alternative exam assessment.

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

**Prerequisites**

None.

**Recommendation**

Basic knowledge of capital markt theory.

T

**4.52 Course: Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems [T-MATH-105854]****Responsible:** Prof. Dr. Michael Plum**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102883 - Computer-Assisted Analytical Methods for Boundary and Eigenvalue Problems](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

**4.53 Course: Continuous Time Finance [T-MATH-105930]**

**Responsible:** Prof. Dr. Nicole Bäuerle  
 Prof. Dr. Vicky Fasen-Hartmann  
 Prof. Dr. Mathias Trabs

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102860 - Continuous Time Finance](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2024	0159400	<a href="#">Continuous Time Finance</a>	4 SWS	Lecture	Fasen-Hartmann
ST 2024	0159410	<a href="#">Tutorial for 0159400 (Continuous Time Finance)</a>	2 SWS	Practice	Fasen-Hartmann
Exams					
ST 2024	7700092	<a href="#">Continuous Time Finance (Exam July)</a>			Fasen-Hartmann
ST 2024	7700144	<a href="#">Continuous Time Finance (Exam August)</a>			Fasen-Hartmann
ST 2024	7700145	<a href="#">Continuous Time Finance (Exam September)</a>			Fasen-Hartmann
ST 2024	7700161	<a href="#">Continuous Time Finance</a>			Fasen-Hartmann

**Competence Certificate**

oral exam of ca. 30 minutes

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Continuous Time Finance**0159400, SS 2024, 4 SWS, [Open in study portal](#)

Lecture (V)

**Content**

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

**Topics:**

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

T

**4.54 Course: Control Theory [T-MATH-105909]**

**Responsible:** Prof. Dr. Roland Schnaubelt  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102941 - Control Theory](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

**Prerequisites**  
none

T

**4.55 Course: Convex Analysis [T-WIWI-102856]**

**Responsible:** Prof. Dr. Oliver Stein  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101473 - Mathematical Programming](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

**Competence Certificate**

The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

**Prerequisites**

None

**Recommendation**

It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

**Annotation**

The lecture is offered irregularly. The curriculum of the next three years is available online ([www.ior.kit.edu](http://www.ior.kit.edu)).

T

**4.56 Course: Convex Geometry [T-MATH-105831]**

**Responsible:** Prof. Dr. Daniel Hug  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102864 - Convex Geometry](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1



T

## 4.57 Course: Cooperative Autonomous Vehicles [T-WIWI-112690]

**Responsible:** Prof. Dr. Alexey Vinel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2511450	<a href="#">Cooperative Autonomous Vehicles</a>	2 SWS	Lecture / 	Vinel
ST 2024	2511451	<a href="#">Exercise Cooperative Autonomous Vehicles</a>	1 SWS	Practice / 	Vinel
Exams					
ST 2024	79AIFB_CAV_B5	<a href="#">Cooperative Autonomous Vehicles (Registration until 15 July 2024)</a>			Vinel
WT 24/25	79AIFB_CAV_A3	<a href="#">Cooperative Autonomous Vehicles</a>			Vinel

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The default assessment of this course is a written examination (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

**Prerequisites**

None.

T

## 4.58 Course: Corporate Risk Management [T-WIWI-109050]

**Responsible:** Prof. Dr. Martin Ruckes  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)  
[M-WIWI-101502 - Economic Theory and its Application in Finance](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

### Competence Certificate

The assessment consists of a written exam (60 min.) according to § 4 paragraph 2 Nr. 1 of the examination regulation. If there are only a small number of participants registered for the exam, we reserve the right to hold an oral examination instead of a written one.

Please note that the exam is only offered in the semester of the lecture as well as in the following semester.

### Prerequisites

None

### Recommendation

None

### Annotation

The course will be held again in the summer term 2023 at the earliest. Please pay attention to the announcements on our website.

T

**4.59 Course: Critical Information Infrastructures [T-WIWI-109248]**

**Responsible:** Prof. Dr. Ali Sunyaev  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	4

**Competence Certificate**

The alternative exam assessment consists of

- the preparation of a written elaboration as well as
- an oral examination as part of a presentation of the work.

Details of the grades will be announced at the beginning of the course.

The examination is only offered to first-time students in the winter semester, but can be repeated in the following summer semester.

**Prerequisites**

None.

**Annotation**

New lecture from winter semester 2018/2019.

T

## 4.60 Course: Curves on Surfaces [T-MATH-113364]

**Responsible:** Dr. Elia Fioravanti  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106632 - Curves on Surfaces](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Irregular	1

Exams			
ST 2024	7700153	<a href="#">Curves on Surfaces</a>	Fioravanti
ST 2024	7700162	<a href="#">Curves on Surfaces</a>	Fioravanti

**Competence Certificate**  
 oral exam (ca. 20-30 min)

**Prerequisites**  
 none

**4.61 Course: Database Systems and XML [T-WIWI-102661]**

**Responsible:** Prof. Dr. Andreas Oberweis  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2511202	<a href="#">Database Systems and XML</a>	2 SWS	Lecture /	Oberweis
WT 24/25	2511203	<a href="#">Exercises Database Systems and XML</a>	1 SWS	Practice /	Oberweis, Fritsch
Exams					
ST 2024	79AIFB_DBX_A3	<a href="#">Database Systems and XML (Registration until 15 July 2024)</a>			Oberweis
WT 24/25	79AIFB_DBX_A4	<a href="#">Database Systems and XML</a>			Oberweis

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Database Systems and XML**

2511202, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
Blended (On-Site/Online)

**Content**

Databases are a proven technology for managing large amounts of data. The oldest database model, the hierarchical model, was replaced by different models such as the relational or the object-oriented data model. The hierarchical model became particularly more important with the emergence of the extensible Markup Language XML. XML is a data format for structured, semi-structured, and unstructured data. In order to store XML documents consistently and reliably, databases or extensions of existing data base systems are required. Among other things, this lecture covers the data model of XML, concepts of XML query languages, aspects of storage of XML documents, and XML-oriented database systems.

**Note on the event format:**

The course Database Systems and XML will be held in WS 23/24 in a "Flipped Classroom" format. Videos and supporting materials are provided for the lecture content, which students can work through independently and at their own pace. During the semester, interactive classroom sessions are held at regular intervals to practice and reinforce the lecture content.

**Learning objectives:**

Students

- know the basics of XML and generate XML documents,
- are able to use XML database systems and to formulate queries to XML documents,
- know to assess the use of XML in operational practice in different application contexts.

**Workload:**

- Lecture 30h
- Exercise 15h
- Preparation of lecture 24h
- Preparation of exercises 25h
- Exam preparation 40h
- Exam 1h

**Literature**

- M. Klettke, H. Meyer: XML & Datenbanken: Konzepte, Sprachen und Systeme. dpunkt.verlag 2003
- H. Schöning: XML und Datenbanken: Konzepte und Systeme. Carl Hanser Verlag 2003
- W. Kazakos, A. Schmidt, P. Tomchyk: Datenbanken und XML. Springer-Verlag 2002
- R. Elmasri, S. B. Navathe: Grundlagen der Datenbanksysteme. 2009
- G. Vossen: Datenbankmodelle, Datenbanksprachen und Datenbankmanagementsysteme. Oldenbourg 2008

Weitere Literatur wird in der Vorlesung bekannt gegeben.

T

## 4.62 Course: Demand-Driven Supply Chain Planning [T-WIWI-110971]

**Responsible:** Dr. Iris Heckmann  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-102805 - Service Operations](#)

**Type**  
Written examination

**Credits**  
4,5

**Grading scale**  
Grade to a third

**Recurrence**  
Each winter term

**Version**  
1

Events					
WT 24/25	2550510	<a href="#">Demand-Driven Supply Chain Planning</a>		Lecture / 	Packowski
Exams					
WT 24/25	7900031	<a href="#">Demand-Driven Supply Chain Planning</a>			Packowski

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment consists of a written exam.

**Annotation**

Due to capacity restrictions, registration before course start is required. For further information see the webpage of the course. The course is planned to be held every winter term. The planned lectures and courses for the next three years are announced online.

T

## 4.63 Course: Derivatives [T-WIWI-102643]

**Responsible:** Prof. Dr. Marliese Uhrig-Homburg  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101482 - Finance 1](#)  
[M-WIWI-101483 - Finance 2](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2530550	<a href="#">Derivatives</a>	2 SWS	Lecture / 🗎	Uhrig-Homburg
ST 2024	2530551	<a href="#">Übung zu Derivate</a>	1 SWS	Practice / 🗎	Dinger, Uhrig-Homburg
Exams					
ST 2024	7900111	<a href="#">Derivatives</a>			Uhrig-Homburg
WT 24/25	7900051	<a href="#">Derivatives</a>			Uhrig-Homburg

Legend: 🗎 Online, 🗎 Blended (On-Site/Online), 🗎 On-Site, ✕ Cancelled

**Competence Certificate**

Depending on further pandemic developments, the examination will be offered either as a 60-minute written examination or as an open-book examination (alternative exam assessment).

A bonus can be earned by correctly solving at least 50% of the posed bonus exercises. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

**Prerequisites**

None

**Recommendation**

None

Below you will find excerpts from events related to this course:

<b>V</b>	<b>Derivatives</b> 2530550, SS 2024, 2 SWS, Language: German, <a href="#">Open in study portal</a>	<b>Lecture (V)</b> <b>On-Site</b>
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**Literature**

- Hull (2012): Options, Futures, & Other Derivatives, Prentice Hall, 8th Edition

**Weiterführende Literatur:**

Cox/Rubinstein (1985): Option Markets, Prentice Hall



T

## 4.64 Course: Designing Interactive Systems: Human-AI Interaction [T-WIWI-113465]

**Responsible:** Prof. Dr. Alexander Mädche  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-104068 - Information Systems in Organizations](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2540558	<a href="#">Designing Interactive Systems: Human-AI Interaction</a>	3 SWS	Lecture / 	Mädche, Seitz
Exams					
ST 2024	7900299	<a href="#">Designing Interactive Systems: Human-AI Interaction</a>	Mädche		

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

Alternative exam assessment. The assessment consists of a one-hour exam and the implementation of a Capstone project. Details will be announced at the beginning of the course.

### Annotation

The course is held in english.

Below you will find excerpts from events related to this course:

V

### Designing Interactive Systems: Human-AI Interaction

2540558, SS 2024, 3 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
Blended (On-Site/Online)

### Content

#### Description

Computers have evolved from batch processors towards highly interactive systems. With the rapid progress in the field of artificial intelligence, computers can now learn and adapt to their environment, simulate human intelligence processes as well as support or even take over tasks from humans. This offers great possibilities, but at the same time raises new challenges for the successful design of interactive systems.

The aim of this course is to introduce advanced concepts and theories as well as current practice of designing interactive systems. A specific focus is set on designing AI-based interactive systems for individuals and groups at work ranging from personal productivity assistants to AI-augmented virtual collaboration.

The course is complemented with hands-on exercises and a design capstone project in cooperation with an industry partner. In the project, students in a team effort apply state-of-the-art design methods & techniques and create an interactive system design prototype with a specific focus on human-AI interaction.

#### Learning objectives

- Explain what interactive systems are and how they can be conceptualized
- Describe the unique characteristics of human-AI interaction and their impact on designing interactive systems
- Understand the human-centered design process and know how to apply corresponding methods and tools
- Understand the concepts and theoretical foundations that guide the design of interactive systems
- Know key concepts, design principles and design methods for contemporary interactive systems focusing on human-AI interaction
- Get hands-on experience by applying lecture content in a design capstone project

#### Prerequisites

No specific prerequisites are required for the lecture

**Literature**

Die Vorlesung basiert zu einem großen Teil auf

· Benyon, D. (2014). Designing interactive systems: A comprehensive guide to HCI, UX and interaction design (3. ed.). Harlow: Pearson.

Weiterführende Literatur wird in der Vorlesung bereitgestellt.

## T

## 4.65 Course: Differential Geometry [T-MATH-102275]

**Responsible:** Prof. Dr. Wilderich Tuschmann  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-101317 - Differential Geometry](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Each summer term	1

Events					
ST 2024	0100300	<a href="#">Differential Geometry</a>	4 SWS	Lecture	Sorcar
ST 2024	0100310	<a href="#">Tutorial for 0100300 (Differential Geometry)</a>	2 SWS	Practice	Kupper, Sorcar
Exams					
ST 2024	7700033	<a href="#">Differential Geometry - Exam</a>			Tuschmann

Below you will find excerpts from events related to this course:

## V

## Differential Geometry

0100300, SS 2024, 4 SWS, Language: English, [Open in study portal](#)

Lecture (V)

## Content

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

T

## 4.66 Course: Digital Health [T-WIWI-109246]

**Responsible:** Prof. Dr. Ali Sunyaev  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2511402	<a href="#">Digital Health</a>	2 SWS	Lecture / 	Sunyaev, Thiebes, Schmidt-Kraepelin

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Alternative exam assessment (written elaboration, presentation, peer review, oral participation) according to §4(2),3 of the examination regulation. Details of the grading will be announced at the beginning of the course. The examination is only offered to first-time writers in the winter semester, but can be repeated in the following summer semester.

**Prerequisites**

None.

## T

## 4.67 Course: Digital Marketing [T-WIWI-112693]

**Responsible:** Prof. Dr. Ann-Kristin Kupfer  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-105312 - Marketing and Sales Management](#)  
[M-WIWI-106258 - Digital Marketing](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2571185	<a href="#">Digital Marketing</a>	2 SWS	Lecture / 🗎	Kupfer
ST 2024	2571186	<a href="#">Digital Marketing Exercise</a>	1 SWS	Practice / 🗎	Daumann
Exams					
ST 2024	7900064	<a href="#">Digital Marketing</a>			Kupfer
ST 2024	7900070	<a href="#">Digital Marketing</a>			Kupfer

Legend: 🗎 Online, 🗎 Blended (On-Site/Online), 🗎 On-Site, ✕ Cancelled

### Competence Certificate

The control of success is done by the elaboration and presentation of a group task as well as a written exam. Further details on the design of the performance review will be announced during the lecture.

### Prerequisites

None

### Recommendation

Students are highly encouraged to actively participate in class.

Below you will find excerpts from events related to this course:

## V

### Digital Marketing

2571185, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

### Content

Students learn the theoretical foundations of digital marketing and its most important concepts. They develop an understanding both for the digital consumer and the digital environment. Special emphasis will be given to digital marketing strategies and practices, such as content marketing and influencer marketing. A tutorial offers the opportunity to apply the key learnings of the lecture as part of a group work.

The learning objectives are as follows:

- Getting to know the theoretical foundations of digital marketing
- Evaluating digital marketing strategies and practices (e.g., in the context of content marketing and influencer marketing)
- Fostering critical and analytical thinking skills and the application of knowledge to marketing problems
- Improving English skills

Total time required for 4.5 credit points: approx. 135 hours

Attendance time: 30 hours

Self-study: 105 hours

### Organizational issues

Termine werden bekannt gegeben.

T

## 4.68 Course: Digital Marketing and Sales in B2B [T-WIWI-106981]

**Responsible:** Prof. Dr. Martin Klarmann  
Anja Konhäuser

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-105312 - Marketing and Sales Management](#)  
[M-WIWI-106258 - Digital Marketing](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	1,5	Grade to a third	Each summer term	1

Events					
ST 2024	2571156	<a href="#">Digital Marketing and Sales in B2B</a>	1 SWS	Others (sons / ●)	Konhäuser
Exams					
ST 2024	7900297	<a href="#">Digital Marketing and Sales in B2B</a>			Klarmann

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Alternative exam assessment according to § 4 paragraph 2 Nr. 3 of the examination regulation. (team presentation of a case study with subsequent discussion totalling 30 minutes).

**Prerequisites**

None.

**Annotation**

This course will not take place in the summer term 2023, but is expected to be offered again on a regular basis starting in the summer term 2024.

Participation requires an application. The application period starts at the beginning of the semester. More information can be obtained on the website of the research group Marketing and Sales ([marketing.iism.kit.edu](http://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](http://marketing.iism.kit.edu)). Please note that only one of the 1.5-ECTS courses can be attended in this module.

Below you will find excerpts from events related to this course:

V

**Digital Marketing and Sales in B2B**

2571156, SS 2024, 1 SWS, Language: English, [Open in study portal](#)

Others (sonst.)  
On-Site

**Content**

## Learning Sessions:

The class gives insights into digital marketing strategies as well as the effects and potential of different channels (e.g., SEO, SEA, Social Media). After an overview of possible activities and leverages in the digital marketing field, including their advantages and limits, the focus will turn to the B2B markets. There are certain requirements in digital strategy specific to the B2B market, particularly in relation to the value chain, sales management and customer support. Therefore, certain digital channels are more relevant for B2B marketing than for B2C marketing.

Once the digital marketing and tactics for the B2B markets are defined, further insights will be given regarding core elements of a digital strategy: device relevance (mobile, tablet), usability concepts, website appearance, app decision, market research and content management. A major advantage of digital marketing is the possibility of being able to track many aspects of 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 115, Geb. 20.21, Termine werden noch bekannt gegeben

**Literature**

-

T

**4.69 Course: Discrete Dynamical Systems [T-MATH-110952]**

**Responsible:** PD Dr. Gerd Herzog  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105432 - Discrete Dynamical Systems](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Irregular	1

**Prerequisites**  
none



T

## 4.70 Course: Discrete Time Finance [T-MATH-105839]

**Responsible:** Prof. Dr. Nicole Bäuerle  
 Prof. Dr. Vicky Fasen-Hartmann  
 Prof. Dr. Mathias Trabs

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102919 - Discrete Time Finance](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Each winter term	1

Events					
WT 24/25	0108400	<a href="#">Finanzmathematik in diskreter Zeit</a>	4 SWS	Lecture /	Fasen-Hartmann
WT 24/25	0108500	<a href="#">Übungen zu 0108400 (Finanzmathematik in diskreter Zeit)</a>	2 SWS	Practice /	Fasen-Hartmann
Exams					
WT 24/25	7700038	<a href="#">Discrete Time Finance</a>			Fasen-Hartmann
WT 24/25	7700050	<a href="#">Discrete Time Finance</a>			Fasen-Hartmann

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Written exam of 2h.

**Prerequisites**

none

**Recommendation**

The contents of the module „Probability theory“ are strongly recommended.

T

**4.71 Course: Discrete-Event Simulation in Production and Logistics [T-WIWI-102718]**

**Responsible:** Hon.-Prof. Dr. Sven Spieckermann  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-102805 - Service Operations](#)  
[M-WIWI-102832 - Operations Research in Supply Chain Management](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2550488	<a href="#">Ereignisdiskrete Simulation in Produktion und Logistik</a>	3 SWS	Lecture / 	Spieckermann
Exams					
ST 2024	7900244	<a href="#">Discrete-Event Simulation in Production and Logistics</a>			Spieckermann

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment consists of a written paper and an oral exam of about 30-40 min (alternative exam assessment).

**Prerequisites**

None

**Recommendation**

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

**Annotation**

Due to capacity restrictions, registration before course start is required. For further information see the webpage of the course.

The course is planned to be held every summer term.

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

Below you will find excerpts from events related to this course:

V

**Ereignisdiskrete Simulation in Produktion und Logistik**

2550488, SS 2024, 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.iior.kit.edu](http://dol.iior.kit.edu)

**Literature**

- Gutenschwager K., Rabe M., Spieckermann S. und S. Wenzel (2017): Simulation in Produktion und Logistik, Springer, Berlin.
- Banks J., Carson II J. S., Nelson B. L., Nicol D. M. (2010) Discrete-event system simulation, 5.Aufl., Pearson, Upper Saddle River.
- Eley, M. (2012): Simulation in der Logistik - Einführung in die Erstellung ereignisdiskreter Modelle unter Verwendung des Werkzeuges "Plant Simulation", Springer, Berlin und Heidelberg
- Kosturiak, J. und M. Gregor (1995): Simulation von Produktionssystemen. Springer, Wien und New York.
- Law, A. M. (2015): Simulation Modeling and Analysis. 5th Edition, McGraw-Hill, New York usw.
- Liebl, F. (1995): Simulation. 2. Auflage, Oldenbourg, München.
- Noche, B. und S. Wenzel (1991): Marktspiegel Simulationstechnik. In: Produktion und Logistik. TÜV Rheinland, Köln.
- Pidd, M. (2004): Computer Simulation in Management Science. 5th Edition, Wiley, Chichester.
- Robinson S (2004) Simulation: the practice of model development and use. John Wiley & Sons, Chichester
- VDI (2014): Simulation von Logistik-, Materialfluß- und Produktionssystemen. VDI Richtlinie 3633, Blatt 1, VDI-Verlag, Düsseldorf.

T

**4.72 Course: Dispersive Equations [T-MATH-109001]**

**Responsible:** Prof. Dr. Wolfgang Reichel  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-104425 - Dispersive Equations](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

**Prerequisites**  
none

T

## 4.73 Course: Dynamic Macroeconomics [T-WIWI-109194]

**Responsible:** Prof. Dr. Johannes Brumm  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101478 - Innovation and Growth](#)  
[M-WIWI-101496 - Growth and Agglomeration](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2560402	<a href="#">Dynamic Macroeconomics</a>	2 SWS	Lecture / 	Brumm
WT 24/25	2560403	<a href="#">Übung zu Dynamic Macroeconomics</a>	1 SWS	Practice / 	Hußmann
Exams					
ST 2024	7900165	<a href="#">Dynamic Macroeconomics</a>			Brumm

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment is a written exam (60 min.).

**Prerequisites**

None.

Below you will find excerpts from events related to this course:

V

**Dynamic Macroeconomics**

2560402, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
Blended (On-Site/Online)

**Content**

This course addresses macroeconomic questions on an advanced level. The main focus of this course is on dynamic programming and its fundamental role in modern macroeconomics. In the first part of the course, the necessary mathematical tools are introduced as well as basic applications in labor economics, economic growth and business cycle analysis. In the second part of the course, these basic models are expanded to incorporate household heterogeneity in various forms: Models of economic inequality to analyze the distributional impact of tax policies and models of overlapping generations to analyze the impact of social security reforms or changes in government debt. Finally, advanced methods based on sparse grids or neural nets are introduced to solve high-dimensional models. The course pursues a hands-on approach so that students not only gain theoretical insights but also learn numerical tools to solve dynamic economic models using the programming language Python.

**Literature**

Literatur und Skripte werden in der Veranstaltung angegeben.

T

**4.74 Course: Dynamical Systems [T-MATH-106114]**

**Responsible:** Prof. Dr. Wolfgang Reichel  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-103080 - Dynamical Systems](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

**Prerequisites**  
none

T

## 4.75 Course: Economics of Innovation [T-WIWI-112822]

**Responsible:** Prof. Dr. Ingrid Ott  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101478 - Innovation and Growth](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2560236	<a href="#">Economics of Innovation</a>	2 SWS	Lecture / 	Ott
ST 2024	2560237	<a href="#">Exercises of Economics of Innovation</a>	1 SWS	Practice / 	Ott, Mirzoyan
Exams					
ST 2024	7900107	<a href="#">Economics of Innovation</a>			Ott
WT 24/25	7900077	<a href="#">Economics of Innovation</a>			Ott

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Depending on further pandemic developments, the examination will be offered either as a 60-minute written examination (written examination according to SPO § 4 Abs. 2, Pkt. 1) or as an open-book examination (alternative exam assessment according to SPO § 4 Abs. 2, Pkt. 3).

**Prerequisites**

None

**Recommendation**

Basic knowledge of micro- and macroeconomics is assumed, as taught in the courses Economics I [2600012], and Economics II [2600014]. In addition, an interest in quantitative-mathematical modeling is required.

Below you will find excerpts from events related to this course:

V

**Economics of Innovation**

2560236, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content****Learning objectives:**

Students shall be given the ability to

- identify the importance of alternative incentive mechanisms for the emergence and dissemination of innovations
- understand the relationships between market structure and the development of innovation
- explain, in which situations market interventions by the state, for example taxes and subsidies, can be legitimized, and evaluate them in the light of economic welfare

**Course content:****The course covers the following topics:**

- Incentives for the emergence of innovations
- Patents
- Diffusion
- Impact of technological progress
- Innovation Policy

**Recommendations:**

Basic knowledge of micro- and macroeconomics is assumed, as taught in the courses Economics I [2600012], and Economics II [2600014]. In addition, an interest in quantitative-mathematical modeling is required.

**Workload:**

The total workload for this course is approximately 135.0 hours. For further information see German version.

**Exam description:**

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. Re-examinations are offered at every ordinary examination date.

Students will be given the opportunity of writing and presenting a short paper during the lecture time to achieve a bonus on the exam grade. If the mandatory credit point exam is passed, the awarded bonus points will be added to the regular exam points. A deterioration is not possible by definition, and a grade does not necessarily improve, but is very likely to (not every additional point improves the total number of points, since a grade can not become better than 1). The voluntary elaboration of such a paper can not countervail a fail in the exam.

**Literature****Auszug:**

- Aghion, P., Howitt, P. (2009), *The Economics of Growth*, MIT Press, Cambridge MA.
- de la Fuente, A. (2000), *Mathematical Methods and Models for Economists*. Cambridge University Press, Cambridge, UK.
- Klodt, H. (1995), *Grundlagen der Forschungs- und Technologiepolitik*. Vahlen, München.
- Linde, R. (2000), *Allokation, Wettbewerb, Verteilung - Theorie*, UNIBUCH Verlag, Lüneburg.
- Ruttan, V. W. (2001), *Technology, Growth, and Development*. Oxford University Press, Oxford.
- Scotchmer, S. (2004), *Incentives and Innovation*, MIT Press.
- Tirole, Jean (1988), *The Theory of Industrial Organization*, MIT Press, Cambridge MA.



**4.76 Course: Efficient Energy Systems and Electric Mobility [T-WIWI-102793]**

**Responsible:** Prof. Dr. Patrick Jochem  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101452 - Energy Economics and Technology](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each summer term	1

Events					
ST 2024	2581006	<a href="#">Efficient Energy Systems and Electric Mobility</a>	2 SWS	Lecture /	Jochem
Exams					
ST 2024	7981006	<a href="#">Efficient Energy Systems and Electric Mobility</a>			Fichtner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

**Prerequisites**

None

**Recommendation**

None

Below you will find excerpts from events related to this course:

**Efficient Energy Systems and Electric Mobility**

2581006, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

This lecture series combines two of the most central topics in the field of energy economics at present, namely energy efficiency and electric mobility. The objective of the lecture is to provide an introduction and overview to these two subject areas, including theoretical as well as practical aspects, such as the technologies, political framework conditions and broader implications of these for national and international energy systems.

- Understand the concept of energy efficiency as applied to specific systems
- Obtain an overview of the current trends in energy efficiency
- Be able to determine and evaluate alternative methods of energy efficiency improvement
- Overview of technical and economical stylized facts on electric mobility
- Judging economical, ecological and social impacts through electric mobility

**Organizational issues**

s. Institutsaushang

**Literature**

Wird in der Vorlesung bekanntgegeben.

## T

## 4.77 Course: eFinance: Information Systems for Securities Trading [T-WIWI-110797]

**Responsible:** Prof. Dr. Christof Weinhardt  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2540454	<a href="#">eFinance: Information Systems for Securities Trading</a>	2 SWS	Lecture / 🗣️	Weinhardt
WT 24/25	2540455	<a href="#">Übungen zu eFinance: Information Systems for Securities Trading</a>	1 SWS	Practice / 🗣️	Motz, Motz
Exams					
ST 2024	7900269	<a href="#">eFinance: Information Systems for Securities Trading</a>			Weinhardt

Legend: 🗣️ Online, 🗣️🗣️ Blended (On-Site/Online), 🗣️ On-Site, ✖ Canceled

### Competence Certificate

Success is monitored by means of ongoing elaborations and presentations of tasks and an examination (60 minutes) at the end of the lecture period. The scoring scheme for the overall evaluation will be announced at the beginning of the course.

### Annotation

The course "eFinance: Information Systems for Securities Trading" covers different actors and their function in the securities industry in-depth, highlighting key trends in modern financial markets, such as Distributed Ledger Technology, Sustainable Finance, and Artificial Intelligence. Security prices evolve through a large number of bilateral trades, performed by market participants that have specific, well-regulated and institutionalized roles. Market microstructure is the subfield of financial economics that studies the price formation process. This process is significantly impacted by regulation and driven by technological innovation. Using the lens of theoretical economic models, this course reviews insights concerning the strategic trading behaviour of individual market participants, and models are brought market data. Analytical tools and empirical methods of market microstructure help to understand many puzzling phenomena in securities markets.

Below you will find excerpts from events related to this course:

## V

### eFinance: Information Systems for Securities Trading

2540454, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

### Literature

- Picot, Arnold, Christine Bortenlänger, Heiner Röhl (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

## 4.78 Course: Emerging Trends in Digital Health [T-WIWI-110144]

**Responsible:** Prof. Dr. Ali Sunyaev  
**Organisation:** KIT Department of Economics and Management  
**Part of:** M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2513404	<a href="#">Seminar Emerging Trends in Digital Health (Bachelor)</a>	2 SWS	Seminar / 	Sunyaev, Toussaint, Brecker, Danylak
ST 2024	2513405	<a href="#">Seminar Emerging Trends in Digital Health (Master)</a>	2 SWS	Seminar / 	Sunyaev, Toussaint, Brecker, Danylak
Exams					
ST 2024	7900146	<a href="#">Seminar Emerging Trends in Digital Health (Master)</a>			Sunyaev

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The alternative exam assessment consists of a final thesis.

**Prerequisites**

None.

**Annotation**

The course is usually held as a block course.

T

## 4.79 Course: Emerging Trends in Internet Technologies [T-WIWI-110143]

**Responsible:** Prof. Dr. Ali Sunyaev  
**Organisation:** KIT Department of Economics and Management  
**Part of:** M-WIWI-101472 - Informatics

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2513402	<a href="#">Seminar Emerging Trends in Internet Technologies (Bachelor)</a>	2 SWS	Seminar / 	Sunyaev, Toussaint, Brecker, Danylak
ST 2024	2513403	<a href="#">Seminar Emerging Trends in Internet Technologies (Master)</a>	2 SWS	Seminar / 	Sunyaev, Toussaint, Brecker, Danylak
Exams					
ST 2024	7900128	<a href="#">Seminar Emerging Trends in Internet Technologies (Master)</a>			Sunyaev

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The alternative exam assessment consists of a final thesis.

**Prerequisites**

None.

**Annotation**

The course is usually held as a block course.

T

## 4.80 Course: Energy and Environment [T-WIWI-102650]

**Responsible:** Ute Karl  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101452 - Energy Economics and Technology](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each summer term	2

Events					
ST 2024	2581003	<a href="#">Energy and Environment</a>	2 SWS	Lecture / 	Karl
Exams					
ST 2024	7900294	<a href="#">Energy and Environment NEW</a>			Karl
ST 2024	7981003	<a href="#">Energy and Environment</a>			Karl

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

**Prerequisites**

None.

Below you will find excerpts from events related to this course:

V

**Energy and Environment**

2581003, SS 2024, 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

## 4.81 Course: Energy Market Engineering [T-WIWI-107501]

**Responsible:** Prof. Dr. Christof Weinhardt  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101451 - Energy Economics and Energy Markets](#)  
[M-WIWI-103720 - eEnergy: Markets, Services and Systems](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2540464	<a href="#">Energy Market Engineering</a>	2 SWS	Lecture / 	Weinhardt, Miskiw
ST 2024	2540465	<a href="#">Übung zu Energy Market Engineering</a>	1 SWS	Practice / 	Semmelmann
Exams					
ST 2024	79852	<a href="#">Energy Market Engineering</a>			Weinhardt
WT 24/25	7900127	<a href="#">Energy Market Engineering</a>			Weinhardt

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 min) (according to §4(2), 1 of the examination regulations). By successful completion of the exercises (§4 (2), 3 SPO 2007 respectively §4 (3) SPO 2015) a bonus can be obtained. If the grade of the written exam is at least 4.0 and at most 1.3, the bonus will improve it by one grade level (i.e. by 0.3 or 0.4).

**Prerequisites**

None

**Recommendation**

None

**Annotation**

Former course title until summer term 2017: T-WIWI-102794 "eEnergy: Markets, Services, Systems".

The lecture has also been added in the IIP Module *Basics of Liberalised Energy Markets*.

Below you will find excerpts from events related to this course:

V

**Energy Market Engineering**

2540464, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
Blended (On-Site/Online)

### Content

The lecture "Energy Market Engineering" addresses the design and analysis of energy markets considering current developments and challenges. A particular focus is on the integration of renewable energies and the associated market mechanisms and regulations.

Specifically, the following topics are covered:

- **Introduction to Market Engineering:** What design elements do markets and specifically auctions have in general, and what influence does this have on participant behavior.
- **Introduction to Energy Markets:** Fundamentals and current trends in the energy system, including climate change and the expansion of renewable energies.
- **Market Design and Products:** Various pricing models such as nodal pricing, zonal pricing, and the structure of capacity markets.
- **Grid Expansion, Distribution Networks, and Flexibility Markets:** Analysis of distribution network markets and the role of flexibility options like demand response and storage technologies.
- **Intermittent Generation and Grid Stability:** Challenges posed by fluctuating renewable energies and strategies to ensure grid stability.
- **Digitalization and Market Transparency:** The role of digitalization in improving market transparency and efficiency, including the use of smart metering systems and data-driven approaches.
- **Current Research Projects and Developments:** Presentation of ongoing research projects and their significance for the future design of energy markets.

### 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

## 4.82 Course: Energy Networks and Regulation [T-WIWI-107503]

**Responsible:** Prof. Dr. Christof Weinhardt**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-103720 - eEnergy: Markets, Services and Systems](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2540495	<a href="#">Übung zu Energy Networks and Regulation</a>	1 SWS	Practice / 	Rogat, Miskiw
Exams					
ST 2024	7900272	<a href="#">Energy Networks and Regulation</a>			Weinhardt
WT 24/25	7900198	<a href="#">Energy Networks and Regulation</a>			Weinhardt

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled**Competence Certificate**

Success is assessed in the form of an oral examination (in accordance with §4(2), 1 SPO).

The examination is offered in the semester of the lecture.

**Prerequisites**

None

**Recommendation**

None



**4.83 Course: Energy Trading and Risk Management [T-WIWI-112151]**

**Responsible:** N.N.  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101451 - Energy Economics and Energy Markets](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each summer term	2

Events					
ST 2024	2581020	<a href="#">Energy Trading and Risk Management</a>	2 SWS	Lecture /	Kraft, Fichtner, Beranek
Exams					
ST 2024	7981020	<a href="#">Energy Trade and Risk Management</a>			Fichtner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The lecture "Energiehandel und Risikomanagement" will be held in English under the title "Energy Trading and Risk Management" from the summer semester 2022. The examination for the English-language lecture will be offered in English from the summer semester 2022.

The assessment consists of a written exam (60 minutes). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment).

**Prerequisites**

None

**Recommendation**

None

Below you will find excerpts from events related to this course:

**Energy Trading and Risk Management**

2581020, SS 2024, 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

**Literature****Weiterführende Literatur:**

Burger, M., Graeber, B., Schindlmayr, G. (2007): *Managing energy risk: An integrated view on power and other energy markets*, Wiley&Sons, Chichester, England

EEX (2010): *Einführung in den Börsenhandel an der EEX auf Xetra und Eurex*, [www.eex.de](http://www.eex.de)

Erdmann, G., Zweifel, P. (2008), *Energieökonomik, Theorie und Anwendungen*, Springer, ISBN: 978-3-540-71698-3

Hull, J.C. (2006): *Options, Futures and other Derivatives*, 6. Edition, Pearson Prentice Hall, New Jersey, USA

Borchert, J., Schlemm, R., Korth, S. (2006): *Stromhandel: Institutionen, Marktmodelle, Pricing und Risikomanagement (Gebundene Ausgabe)*, Schäffer-Poeschel Verlag

[www.riskglossary.com](http://www.riskglossary.com)

T

## 4.84 Course: Ergodic Theory [T-MATH-113086]

**Responsible:** Dr. Gabriele Link  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106473 - Ergodic Theory](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	8	Grade to a third	Irregular	1 terms	1

Exams			
ST 2024	7700114	<a href="#">Ergodic Theory</a>	<a href="#">Link</a>

**Competence Certificate**

Oral examination of ca. 20-30 minutes.

**Prerequisites**

none

**Recommendation**

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

T

## 4.85 Course: Evolution Equations [T-MATH-105844]

**Responsible:** Prof. Dr. Dorothee Frey  
apl. Prof. Dr. Peer Kunstmann  
Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102872 - Evolution Equations](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
ST 2024	7700118	<a href="#">Evolution Equations</a>	Schnaubelt

T

## 4.86 Course: Experimental Economics [T-WIWI-102614]

**Responsible:** Prof. Dr. Christof Weinhardt  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101505 - Experimental Economics](#)  
[M-WIWI-102970 - Decision and Game Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2540489	<a href="#">Experimental Economics</a>	2 SWS	Lecture / 🗎	Knierim
WT 24/25	2540493	<a href="#">Übung zu Experimental Economics</a>	1 SWS	Practice / 🗎	del Puppo
Exams					
ST 2024	7900258	<a href="#">Experimental Economics</a>			Weinhardt

Legend: 🗎 Online, 🔄 Blended (On-Site/Online), 🗎 On-Site, ✕ Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 min).

**Prerequisites**

None

**Annotation**

The lecture will be taught in English.

Below you will find excerpts from events related to this course:

V

**Experimental Economics**

2540489, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Literature**

- Strategische Spiele; S. Berninghaus, K.-M. Ehrhart, W. Güth; Springer Verlag, 2. Aufl. 2006.
- Handbook of Experimental Economics; J. Kagel, A. Roth; Princeton University Press, 1995.
- Experiments in Economics; J.D. Hey; Blackwell Publishers, 1991.
- Experimental Economics; D.D. Davis, C.A. Holt; Princeton University Press, 1993.
- Experimental Methods: A Primer for Economists; D. Friedman, S. Sunder; Cambridge University Press, 1994.

T

**4.87 Course: Exponential Integrators [T-MATH-107475]**

**Responsible:** Prof. Dr. Marlis Hochbruck  
Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-103700 - Exponential Integrators](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

**Prerequisites**  
none

T

**4.88 Course: Extremal Graph Theory [T-MATH-105931]**

**Responsible:** Prof. Dr. Maria Aksenovich  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102957 - Extremal Graph Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	2

**Prerequisites**  
none

T

## 4.89 Course: Extreme Value Theory [T-MATH-105908]

**Responsible:** Prof. Dr. Vicky Fassen-Hartmann**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102939 - Extreme Value Theory](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	2

Events					
ST 2024	0155600	<a href="#">Extremwerttheorie</a>	2 SWS	Lecture	Fassen-Hartmann
ST 2024	0155610	<a href="#">Übungen zu 0155600 (Extremwerttheorie)</a>	1 SWS	Practice	Fassen-Hartmann
Exams					
ST 2024	7700100	<a href="#">Extreme Value Theory</a>			Fassen-Hartmann
ST 2024	7700142	<a href="#">Extreme Value Theory</a>			Fassen-Hartmann
ST 2024	7700143	<a href="#">Extreme Value Theory</a>			Fassen-Hartmann

T

## 4.90 Course: Facility Location and Strategic Supply Chain Management [T-WIWI-102704]

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101413 - Applications of Operations Research](#)  
[M-WIWI-101414 - Methodical Foundations of OR](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2550486	<a href="#">Facility Location and Strategic Supply Chain Management</a>	2 SWS	Lecture /	Nickel
WT 24/25	2550487	<a href="#">Exercises for Facility Location and Strategic Supply Chain Management</a>	1 SWS	Practice /	Hoffmann
Exams					
ST 2024	7900027	<a href="#">Facility Location and Strategic Supply Chain Management</a>			Nickel
WT 24/25	7900091	<a href="#">Facility Location and Strategic Supply Chain Management</a>			Nickel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

### Competence Certificate

The assessment consists of a written exam (60 min) according to Section 4 (2), 1 of the examination regulation. The exam takes place in every semester. Prerequisite for admission to examination is the successful completion of the online assessments.

### Prerequisites

Prerequisite for admission to examination is the successful completion of the online assessments.

### Recommendation

None

### Annotation

The lecture is held in every winter term. The planned lectures and courses for the next three years are announced online.

Below you will find excerpts from events related to this course:

V

## Facility Location and Strategic Supply Chain Management

2550486, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

### Organizational issues

Für die Klausurzulassung müssen 4 von 5 Online-Tests bestanden sein.

Die Zulassung ist ein Jahr gültig, außer es handelt sich um einen Zweitversuch. In diesem Falle müssen die Online-Tests nicht erneut absolviert werden.

### Literature

#### Weiterführende Literatur:

- Daskin: Network and Discrete Location: Models, Algorithms, and Applications, Wiley, 1995
- Domschke, Drexl: Logistik: Standorte, 4. Auflage, Oldenbourg, 1996
- Francis, McGinnis, White: Facility Layout and Location: An Analytical Approach, 2nd Edition, Prentice Hall, 1992
- Love, Morris, Wesolowsky: Facilities Location: Models and Methods, North Holland, 1988
- Thonemann: Operations Management - Konzepte, Methoden und Anwendungen, Pearson Studium, 2005



**4.91 Course: Financial Analysis [T-WIWI-102900]**

**Responsible:** Dr. Torsten Luedecke  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2530205	<a href="#">Financial Analysis</a>	2 SWS	Lecture /	Luedecke
ST 2024	2530206	<a href="#">Übungen zu Financial Analysis</a>	2 SWS	Practice /	Luedecke
Exams					
ST 2024	7900075	<a href="#">Financial Analysis</a>			Luedecke
WT 24/25	7900059	<a href="#">Financial Analysis</a>			Ruckes, Luedecke

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

See German version.

**Prerequisites**

None

**Recommendation**

Basic knowledge in corporate finance, accounting, and valuation is required.

Below you will find excerpts from events related to this course:

**Financial Analysis**

2530205, SS 2024, 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.

**4.92 Course: Financial Econometrics [T-WIWI-103064]**

**Responsible:** Prof. Dr. Melanie Schienle  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101638 - Econometrics and Statistics I](#)  
[M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2520022	<a href="#">Financial Econometrics I</a>	2 SWS	Lecture /	Schienle, Buse
WT 24/25	2520023	<a href="#">Übungen zu Financial Econometrics I</a>	2 SWS	Practice /	Schienle, Buse
Exams					
ST 2024	7900223	<a href="#">Financial Econometrics</a>			Schienle
WT 24/25	7900123	<a href="#">Financial Econometrics II</a>			Schienle
WT 24/25	7900126	<a href="#">Financial Econometrics</a>			Schienle

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written exam (90 minutes) (following §4(2), 1 of the examination regulation).

**Prerequisites**

The course T-MATH-105874 "Time Series Analysis" may not be chosen.

**Recommendation**

Knowledge of the contents covered by the course "Economics III: Introduction in Econometrics"[2520016]

**Annotation**

The next lecture will take place in the winter semester 2022/23.

Below you will find excerpts from events related to this course:

**Financial Econometrics I**

2520022, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content****Learning objectives:**

The student

- shows a broad knowledge of financial 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

## 4.93 Course: Financial Econometrics II [T-WIWI-110939]

**Responsible:** Prof. Dr. Melanie Schienle  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101638 - Econometrics and Statistics I](#)  
[M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2024	2521302	<a href="#">Financial Econometrics II</a>	2 SWS	Lecture / 	Schienle, Buse
ST 2024	2521303	<a href="#">Übung zu Financial Econometrics II</a>	1 SWS	Practice / 	Buse, Schienle
Exams					
ST 2024	7900081	<a href="#">Financial Econometrics II</a>			Schienle

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Written examination (90 minutes). If the number of participants is low, an oral examination will be held instead.

**Prerequisites**

None

**Recommendation**

Knowledge of the contents covered by the course "Financial Econometrics"

**Annotation**

Course language is English

The next lecture will take place in the summer semester of 2023.

T

## 4.94 Course: Financial Intermediation [T-WIWI-102623]

**Responsible:** Prof. Dr. Martin Ruckes  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)  
[M-WIWI-101502 - Economic Theory and its Application in Finance](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2530232	<a href="#">Financial Intermediation</a>	2 SWS	Lecture / 	Ruckes
WT 24/25	2530233	<a href="#">Übung zu Finanzintermediation</a>	1 SWS	Practice	Ruckes, Benz
Exams					
ST 2024	7900078	<a href="#">Financial Intermediation</a>			Ruckes
WT 24/25	7900063	<a href="#">Financial Intermediation</a>			Ruckes

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment of this course is a written examination (following §4(2), 1 SPO) of 60 mins.

The exam is offered each semester.

**Prerequisites**

None

**Recommendation**

None

Below you will find excerpts from events related to this course:

V

**Financial Intermediation**

2530232, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Organizational issues**

Terminankündigungen des Instituts beachten

**Literature****Weiterführende Literatur:**

- Hartmann-Wendels/Pfingsten/Weber (2014): Bankbetriebslehre, 6. Auflage, Springer Verlag.
- Freixas/Rochet (2008): Microeconomics of Banking, 2. Auflage, MIT Press.

T

## 4.95 Course: Finite Element Methods [T-MATH-105857]

**Responsible:** Prof. Dr. Willy Dörfler  
 Prof. Dr. Marlis Hochbruck  
 Prof. Dr. Tobias Jahnke  
 TT-Prof. Dr. Roland Maier  
 Prof. Dr. Andreas Rieder  
 Prof. Dr. Christian Wieners

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102891 - Finite Element Methods](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0110300	<a href="#">Finite Element Methods</a>	4 SWS	Lecture	Maier
WT 24/25	0110310	<a href="#">Tutorial for 0110300 (Finite Element Methods)</a>	2 SWS	Practice	Maier

Below you will find excerpts from events related to this course:

V

## Finite Element Methods

0110300, WS 24/25, 4 SWS, [Open in study portal](#)

Lecture (V)

**Content**

This course is about numerically solving elliptic boundary value problems using the finite element method. We will introduce necessary basic definitions and then discuss the method in its various aspects. In particular, we will study grid generation, error estimates, and the practical realization of the approach.

## T

## 4.96 Course: Forecasting: Theory and Practice [T-MATH-105928]

**Responsible:** Prof. Dr. Tilmann Gneiting  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102956 - Forecasting: Theory and Practice](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

Events					
WT 24/25	0123100	<a href="#">Forecasting: Theory and Praxis</a>	2 SWS	Lecture	Gneiting
WT 24/25	0123110	<a href="#">Tutorial for 0123100 (Forecasting: Theory and Praxis)</a>	2 SWS	Practice	Gneiting

Below you will find excerpts from events related to this course:

## V

## Forecasting: Theory and Praxis

0123100, WS 24/25, 2 SWS, [Open in study portal](#)

Lecture (V)

## Content

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

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

T

**4.97 Course: Foundations of Continuum Mechanics [T-MATH-107044]**

**Responsible:** Prof. Dr. Christian Wieners  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-103527 - Foundations of Continuum Mechanics](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Once	1

**Prerequisites**  
none



T

**4.98 Course: Fourier Analysis and its Applications to PDEs [T-MATH-109850]****Responsible:** TT-Prof. Dr. Xian Liao**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-104827 - Fourier Analysis and its Applications to PDEs](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	3

**Prerequisites**

none

T

**4.99 Course: Fractal Geometry [T-MATH-111296]**

**Responsible:** PD Dr. Steffen Winter  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105649 - Fractal Geometry](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

**Prerequisites**  
none

## T

## 4.100 Course: Functional Analysis [T-MATH-102255]

**Responsible:** Prof. Dr. Dorothee Frey  
 PD Dr. Gerd Herzog  
 Prof. Dr. Dirk Hundertmark  
 Prof. Dr. Tobias Lamm  
 TT-Prof. Dr. Xian Liao  
 Prof. Dr. Wolfgang Reichel  
 Prof. Dr. Roland Schnaubelt  
 Dr. rer. nat. Patrick Tolksdorf

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-101320 - Functional Analysis](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Each winter term	3

Events					
WT 24/25	0104800	<a href="#">Functional Analysis</a>	4 SWS	Lecture /	Reichel
WT 24/25	0104810	<a href="#">Tutorial for 0104800 (Functional Analysis)</a>	2 SWS	Practice /	Reichel
Exams					
ST 2024	7700078	<a href="#">Functional Analysis</a>			Frey, Hundertmark, Liao

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

### Competence Certificate

Written examination of 120 minutes.

### Prerequisites

none

Below you will find excerpts from events related to this course:

## V

## Functional Analysis

0104800, WS 24/25, 4 SWS, [Open in study portal](#)

Lecture (V)  
On-Site

### Content

The lecture deals with Banach and Hilbert spaces and the linear operators on these spaces. Typical examples are spaces of continuous or integrable functions, and linear operators on these spaces occur in the study of integral and differential equations. The development of functional analysis in the 20th century contributed significantly to the modern theory of differential equations. Today, functional analysis is a fundamental discipline of modern analysis and is widely used, for example, in the theory of partial differential equations, numerical mathematics, mathematical physics and many other areas of application.

Topics of the lecture:

basic properties and examples of metric spaces and Banach spaces, continuous linear operators on Banach spaces, uniform boundedness principle, homomorphism theorem, Hilbert spaces, orthonormal bases, Sobolev spaces, dual spaces, Hahn-Banach theorem, weak convergence, Banach-Alaoglu theorem, reflexivity, compact linear operators

The contents of the basic lectures Analysis 1-3 and Linear Algebra 1+2 are assumed.

**Literature**

- D. Werner: Funktionalanalysis.
- H.W. Alt: Lineare Funktionalanalysis.
- H. Brezis: Functional Analysis, Sobolev Spaces and Partial Differential Equations.
- J.B. Conway: A Course in Functional Analysis.
- M. Reed, B. Simon: Functional Analysis.
- W. Rudin: Functional Analysis.
- A.E. Taylor, D.C. Lay: Introduction to Functional Analysis.
- J. Wloka: Funktionalanalysis und Anwendungen.

T

## 4.101 Course: Functional Data Analysis [T-MATH-113102]

**Responsible:** Dr. rer. nat. Bruno Ebner  
 PD Dr. Bernhard Klar  
 Prof. Dr. Mathias Trabs

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-106485 - Functional Data Analysis](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Exams			
ST 2024	7700148	<a href="#">Functional Data Analysis</a>	Ebner

**Competence Certificate**

Oral examination of ca. 25 minutes.

**Prerequisites**

none

**Recommendation**

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

T

## 4.102 Course: Functions of Matrices [T-MATH-105906]

**Responsible:** PD Dr. Volker Grimm**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102937 - Functions of Matrices](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
ST 2024	00054	<a href="#">Functions of Matrices</a>	Grimm
WT 24/25	00017	<a href="#">Functions of Matrices</a>	Grimm

**Prerequisites**

none

T

**4.103 Course: Functions of Operators [T-MATH-105905]****Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102936 - Functions of Operators](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

T

## 4.104 Course: Fundamentals for Financial -Quant and -Machine Learning Research [T-WIWI-111846]

**Responsible:** Prof. Dr. Maxim Ulrich

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-105894 - Foundations for Advanced Financial -Quant and -Machine Learning Research](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	9	Grade to a third	see Annotations	1

### Competence Certificate

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

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

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

### Recommendation

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

### Annotation

Teaching and learning format: Lecture and exercise.

The course is offered every second year.



T

## 4.105 Course: Generalized Regression Models [T-MATH-105870]

**Responsible:** Dr. rer. nat. Bruno Ebner  
 Prof. Dr. Vicky Fasen-Hartmann  
 PD Dr. Bernhard Klar  
 Prof. Dr. Mathias Trabs

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102906 - Generalized Regression Models](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	3

Events					
ST 2024	0161400	<a href="#">Generalisierte Regressionsmodelle</a>	2 SWS	Lecture	Klar
ST 2024	0161410	<a href="#">Übungen zu 0161400 (generalisierte Regressionsmodelle)</a>	1 SWS	Practice	Klar
Exams					
ST 2024	7700128	<a href="#">Generalized Regression Models (Termin 1)</a>			Klar
ST 2024	7700129	<a href="#">Generalized Regression Models (Termin 2)</a>			Klar
WT 24/25	7700066	<a href="#">Generalized Regression Models (Termin 3)</a>			Klar

**4.106 Course: Geometric Group Theory [T-MATH-105842]**

**Responsible:** Prof. Dr. Frank Herrlich  
 Dr. Gabriele Link  
 Jun.-Prof. Dr. Claudio Llosa Isenrich  
 Prof. Dr. Roman Sauer  
 Prof. Dr. Wilderich Tuschmann

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102867 - Geometric Group Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Irregular	1

Events					
ST 2024	0153300	<a href="#">Geometric Group Theory</a>	4 SWS	Lecture	<a href="#">Link</a>
ST 2024	0153310	<a href="#">Tutorial for 0153300 (Geometric Group Theory)</a>	2 SWS	Practice	<a href="#">Link</a>
Exams					
ST 2024	7700149	<a href="#">Geometric Group Theory</a>			<a href="#">Link</a>
WT 24/25	7700112	<a href="#">Geometric Group Theory</a>			<a href="#">Link</a>

Below you will find excerpts from events related to this course:

**Geometric Group Theory**

0153300, SS 2024, 4 SWS, Language: English, [Open in study portal](#)

Lecture (V)

**Content**

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

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

In particular, we will learn about

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

Prerequisites are:

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

T

**4.107 Course: Geometric Numerical Integration [T-MATH-105919]**

**Responsible:** Prof. Dr. Marlis Hochbruck  
Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102921 - Geometric Numerical Integration](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

**Prerequisites**  
none

T

**4.108 Course: Geometric Variational Problems [T-MATH-113418]****Responsible:** Prof. Dr. Tobias Lamm**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-106667 - Geometric Variational Problems](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Exams			
ST 2024	7700133	<a href="#">Geometric Variational Problems</a>	Lamm

**Competence Certificate**

oral exam of ca. 30 min

**Prerequisites**

none

T

## 4.109 Course: Geometry of Schemes [T-MATH-105841]

**Responsible:** Prof. Dr. Frank Herrlich  
PD Dr. Stefan Kühnlein

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102866 - Geometry of Schemes](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0102600	<a href="#">Geometrie der Schemata</a>	4 SWS	Lecture	Herrlich
WT 24/25	0102700	<a href="#">Übungen zu 0102600 (Geometrie der Schemata)</a>	2 SWS	Practice	Herrlich

T

**4.110 Course: Global Differential Geometry [T-MATH-105885]**

**Responsible:** Prof. Dr. Wilderich Tuschmann  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102912 - Global Differential Geometry](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

**Prerequisites**  
none

T

## 4.111 Course: Global Optimization I [T-WIWI-102726]

**Responsible:** Prof. Dr. Oliver Stein  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101413 - Applications of Operations Research](#)  
[M-WIWI-101414 - Methodical Foundations of OR](#)  
[M-WIWI-101473 - Mathematical Programming](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2550134	<a href="#">Global Optimization I</a>	2 SWS	Lecture / 	Stein
Exams					
ST 2024	7900205_SS2024_HK	<a href="#">Global Optimization I</a>			Stein
WT 24/25	7900004_WS2425_NK	<a href="#">Global Optimization I</a>			Stein

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Success is in the form of a written examination (60 min.) (according to § 4(2), 1 SPO). The successful completion of the exercises is required for admission to the written exam.

The exam is offered in the lecture of semester and the following semester.

The success check can be done also with the success control for "Global optimization II". In this case, the duration of the written exam is 120 min.

**Prerequisites**

None

**Recommendation**

None

**Annotation**

Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from events related to this course:

V

**Global Optimization I**

2550134, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

In many optimization problems from economics, engineering and natural sciences, solution algorithms are only able to efficiently identify *local* optimizers, while it is much harder to find *globally* optimal points. This corresponds to the fact that by local search it is easy to find the summit of the closest mountain, but that the search for the summit of Mount Everest is rather elaborate.

The lecture treats methods for global optimization of convex functions under convex constraints. It is structured as follows:

- Introduction, examples, and terminology
- Existence results for optimal points
- Optimality in convex optimization
- Duality, bounds, and constraint qualifications
- Algorithms (Kelley's cutting plane method, Frank-Wolfe method, primal-dual interior point methods)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

**Remark:**

The treatment of *nonconvex* optimization problems forms the contents of the lecture "Global Optimization II". The lectures "Global Optimization I" and "Global Optimization II" are held consecutively *in the same semester*.

**Learning objectives:**

The student

- knows and understands the fundamentals of deterministic global optimization in the convex case,
- is able to choose, design and apply modern techniques of deterministic global optimization in the convex case in practice.

**Literature**

O. Stein, Grundzüge der Globalen Optimierung, SpringerSpektrum, 2018.

**Weiterführende Literatur:**

- W. Alt, Numerische Verfahren der konvexen, nichtglatten Optimierung, Teubner, 2004
- C.A. Floudas, Deterministic Global Optimization, Kluwer, 2000
- R. Horst, H. Tuy, Global Optimization, Springer, 1996
- A. Neumaier, Interval Methods for Systems of Equations, Cambridge University Press, 1990



T

## 4.112 Course: Global Optimization I and II [T-WIWI-103638]

**Responsible:** Prof. Dr. Oliver Stein  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101414 - Methodical Foundations of OR](#)  
[M-WIWI-101473 - Mathematical Programming](#)

**Type**  
Written examination

**Credits**  
9

**Grading scale**  
Grade to a third

**Recurrence**  
Each summer term

**Version**  
1

Events					
ST 2024	2550134	<a href="#">Global Optimization I</a>	2 SWS	Lecture / 	Stein
ST 2024	2550135	<a href="#">Exercise to Global Optimization I and II</a>	2 SWS	Practice / 	Stein, Beck
ST 2024	2550136	<a href="#">Global Optimization II</a>	2 SWS	Lecture / 	Stein
Exams					
ST 2024	7900207_SS2024_HK	<a href="#">Global Optimization I and II</a>			Stein
WT 24/25	7900006_WS2425_NK	<a href="#">Global Optimization I and II</a>			Stein

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment of the lecture is a written examination (120 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

**Prerequisites**

None

**Recommendation**

None

**Annotation**

Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from events related to this course:

V

**Global Optimization I**

2550134, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

In many optimization problems from economics, engineering and natural sciences, solution algorithms are only able to efficiently identify *local* optimizers, while it is much harder to find *globally* optimal points. This corresponds to the fact that by local search it is easy to find the summit of the closest mountain, but that the search for the summit of Mount Everest is rather elaborate.

The lecture treats methods for global optimization of convex functions under convex constraints. It is structured as follows:

- Introduction, examples, and terminology
- Existence results for optimal points
- Optimality in convex optimization
- Duality, bounds, and constraint qualifications
- Algorithms (Kelley's cutting plane method, Frank-Wolfe method, primal-dual interior point methods)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

**Remark:**

The treatment of *nonconvex* optimization problems forms the contents of the lecture "Global Optimization II". The lectures "Global Optimization I" and "Global Optimization II" are held consecutively *in the same semester*.

**Learning objectives:**

The student

- knows and understands the fundamentals of deterministic global optimization in the convex case,
- is able to choose, design and apply modern techniques of deterministic global optimization in the convex case in practice.

**Literature**

O. Stein, Grundzüge der Globalen Optimierung, SpringerSpektrum, 2018.

**Weiterführende Literatur:**

- W. Alt, Numerische Verfahren der konvexen, nichtglatten Optimierung, Teubner, 2004
- C.A. Floudas, Deterministic Global Optimization, Kluwer, 2000
- R. Horst, H. Tuy, Global Optimization, Springer, 1996
- A. Neumaier, Interval Methods for Systems of Equations, Cambridge University Press, 1990

**Global Optimization II**

2550136, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

In many optimization problems from economics, engineering and natural sciences, solution algorithms are only able to efficiently identify *local* optimizers, while it is much harder to find *globally* optimal points. This corresponds to the fact that by local search it is easy to find the summit of the closest mountain, but that the search for the summit of Mount Everest is rather elaborate.

The lecture treats methods for global optimization of nonconvex functions under nonconvex constraints. It is structured as follows:

- Introduction and examples
- Convex relaxation
- Interval arithmetic
- Convex relaxation via alphaBB method
- Branch-and-bound methods
- Lipschitz optimization

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

**Remark:**

The treatment of *convex* optimization problems forms the contents of the lecture "Global Optimization I". The lectures "Global Optimization I" and "Global Optimization II" are held consecutively *in the same semester*.

**Learning objectives:**

The student

- knows and understands the fundamentals of deterministic global optimization in the nonconvex case,
- is able to choose, design and apply modern techniques of deterministic global optimization in the nonconvex case in practice.

**Literature**

O. Stein, Grundzüge der Globalen Optimierung, SpringerSpektrum, 2018.

**Weiterführende Literatur:**

- W. Alt, Numerische Verfahren der konvexen, nichtglatten Optimierung, Teubner, 2004
- C.A. Floudas, Deterministic Global Optimization, Kluwer, 2000
- R. Horst, H. Tuy, Global Optimization, Springer, 1996
- A. Neumaier, Interval Methods for Systems of Equations, Cambridge University Press, 1990

T

## 4.113 Course: Global Optimization II [T-WIWI-102727]

**Responsible:** Prof. Dr. Oliver Stein  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101414 - Methodical Foundations of OR](#)  
[M-WIWI-101473 - Mathematical Programming](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2550136	<a href="#">Global Optimization II</a>	2 SWS	Lecture / 	Stein
Exams					
ST 2024	7900206_SS2024_HK	<a href="#">Global Optimization II</a>			Stein
WT 24/25	7900005_WS2425_NK	<a href="#">Global Optimization II</a>			Stein

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

The examination can also be combined with the examination of "Global optimization I". In this case, the duration of the written examination takes 120 minutes.

**Prerequisites**

None

**Annotation**

Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from events related to this course:

V

**Global Optimization II**

2550136, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

In many optimization problems from economics, engineering and natural sciences, solution algorithms are only able to efficiently identify *local* optimizers, while it is much harder to find *globally* optimal points. This corresponds to the fact that by local search it is easy to find the summit of the closest mountain, but that the search for the summit of Mount Everest is rather elaborate.

The lecture treats methods for global optimization of nonconvex functions under nonconvex constraints. It is structured as follows:

- Introduction and examples
- Convex relaxation
- Interval arithmetic
- Convex relaxation via alphaBB method
- Branch-and-bound methods
- Lipschitz optimization

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

**Remark:**

The treatment of *convex* optimization problems forms the contents of the lecture "Global Optimization I". The lectures "Global Optimization I" and "Global Optimization II" are held consecutively *in the same semester*.

**Learning objectives:**

The student

- knows and understands the fundamentals of deterministic global optimization in the nonconvex case,
- is able to choose, design and apply modern techniques of deterministic global optimization in the nonconvex case in practice.

**Literature**

O. Stein, Grundzüge der Globalen Optimierung, SpringerSpektrum, 2018.

**Weiterführende Literatur:**

- W. Alt, Numerische Verfahren der konvexen, nichtglatten Optimierung, Teubner, 2004
- C.A. Floudas, Deterministic Global Optimization, Kluwer, 2000
- R. Horst, H. Tuy, Global Optimization, Springer, 1996
- A. Neumaier, Interval Methods for Systems of Equations, Cambridge University Press, 1990

T

**4.114 Course: Graph Theory [T-MATH-102273]**

**Responsible:** Prof. Dr. Maria Aksenovich  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-101336 - Graph Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	8	Grade to a third	Irregular	2

Exams			
ST 2024	7700087	<a href="#">Graph Theory</a>	Aksenovich

**Prerequisites**

None

T

**4.115 Course: Graph Theory and Advanced Location Models [T-WIWI-102723]****Responsible:** Prof. Dr. Stefan Nickel**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-102832 - Operations Research in Supply Chain Management](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	2

Exams			
ST 2024	7900283	<a href="#">Graph Theory and Advanced Location Models</a>	Nickel

**Competence Certificate**

The assessment is a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

The examination is held in the term of the lecture and the following lecture.

**Prerequisites**

None

**Recommendation**

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

**Annotation**

The course is offered irregularly. Planned lectures for the next three years can be found in the internet at <http://dol.iior.kit.edu/english/Courses.php>.

T

**4.116 Course: Group Actions in Riemannian Geometry [T-MATH-105925]****Responsible:** Prof. Dr. Wilderich Tuschmann**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102954 - Group Actions in Riemannian Geometry](#)

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

**Prerequisites**

none



T

## 4.117 Course: Growth and Development [T-WIWI-112816]

**Responsible:** Prof. Dr. Ingrid Ott  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101478 - Innovation and Growth](#)  
[M-WIWI-101496 - Growth and Agglomeration](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2561503	<a href="#">Growth and Development</a>	2 SWS	Lecture / 🗎	Ott
WT 24/25	2561504	<a href="#">Exercise for Growth and Development</a>	1 SWS	Practice / 🗎	Ott, Ghoniem
Exams					
ST 2024	7900105	<a href="#">Growth and Development</a>			Ott
WT 24/25	7900078	<a href="#">Growth and Development</a>			Ott

Legend: 🗎 Online, 🗎 Blended (On-Site/Online), 🗎 On-Site, ✕ Cancelled

**Competence Certificate**

Depending on further pandemic developments, the examination will be offered either as an open-book examination or as a 60-minute written examination.

**Prerequisites**

None

**Recommendation**

Basic knowledge of micro- and macroeconomics is assumed, as taught in the courses Economics I [2600012], and Economics II [2600014]. In addition, an interest in quantitative-mathematical modeling is required.

Below you will find excerpts from events related to this course:

V

**Growth and Development**

2561503, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

This course is intended as an introduction to the field of advanced macroeconomics with a special focus on economic growth. Lectures aim to deal with the theoretical foundations of exogenous and endogenous growth models. The importance of growth for nations and discussion of some (well-known) growth theories together with the role of innovation, human capital and environment will therefore be primary focuses of this course.

**Learning objective:**

Students shall be given the ability to understand, analyze and evaluate selected models of endogenous growth theory.

**Course content:**

- Intertemporal consumption decision
- Growth models with exogenous saving rates: Solow
- Growth models with endogenous saving rates: Ramsey
- Growth and environmental resources
- Basic models of endogenous growth
- Human capital and economic growth
- Modelling of technological progress
- Diversity Models
- Schumpeterian growth
- Directional technological progress
- Diffusion of technologies

**Recommendations:**

Basic knowledge of micro- and macroeconomics is assumed, as taught in the courses Economics I [2600012], and Economics II [2600014]. In addition, an interest in quantitative-mathematical modeling is required.

**Workload:**

The total workload for this course is approximately 135.0 hours. For further information see German version.

**Exam description:**

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. Re-examinations are offered at every ordinary examination date.

Students will be given the opportunity of writing and presenting a short paper during the lecture time to achieve a bonus on the exam grade. If the mandatory credit point exam is passed, the awarded bonus points will be added to the regular exam points. A deterioration is not possible by definition, and a grade does not necessarily improve, but is very likely to (not every additional point improves the total number of points, since a grade can not become better than 1). The voluntary elaboration of such a paper can not countervail a fail in the exam.

**Literature**

Auszug:

- Acemoglu, D. (2009): Introduction to modern economic growth. Princeton University Press, New Jersey.
- Aghion, P., Howitt, P. (2009): Economics of growth, MIT-Press, Cambridge/MA.
- Barro, R.J., Sala-i-Martin, X. (2003): Economic Growth. MIT-Press, Cambridge/MA.
- Sydsaeter, K., Hammond, P. (2008): Essential mathematics for economic analysis. Prentice Hall International, Harlow.
- Sydsæter, K., Hammond, P., Seierstad, A., Strom, A., (2008): Further Mathematics for Economic Analysis, Second Edition, Pearson Education Limited, Essex.

T

**4.118 Course: Harmonic Analysis [T-MATH-111289]**

**Responsible:** Prof. Dr. Dorothee Frey  
apl. Prof. Dr. Peer Kunstmann  
Prof. Dr. Roland Schnaubelt  
Dr. rer. nat. Patrick Tolksdorf

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-105324 - Harmonic Analysis](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T

## 4.119 Course: Harmonic Analysis 2 [T-MATH-113103]

**Responsible:** Prof. Dr. Dorothee Frey  
apl. Prof. Dr. Peer Kunstmann  
Dr. rer. nat. Patrick Tolksdorf

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-106486 - Harmonic Analysis 2](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
ST 2024	7700115	<a href="#">Harmonic Analysis 2</a>	Kunstmann

**Competence Certificate**

oral examination of ca. 30 minutes.

**Prerequisites**

none

**Recommendation**

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

T

## 4.120 Course: Heat Economy [T-WIWI-102695]

**Responsible:** Prof. Dr. Wolf Fichtner  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101452 - Energy Economics and Technology](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each summer term	2

Events					
ST 2024	2581001	<a href="#">Heat Economy</a>	2 SWS	Lecture / 	Fichtner
Exams					
ST 2024	7981001	<a href="#">Heat Economy</a>			Fichtner

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment consists of a written (60 minutes) or oral exam (30 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

**Prerequisites**

None.

**Recommendation**

None

**Annotation**

See German version.

Below you will find excerpts from events related to this course:

V

**Heat Economy**

2581001, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Organizational issues**

Block, Seminarraum Standort West - siehe Institutsaushang

T

**4.121 Course: Homotopy Theory [T-MATH-105933]**

**Responsible:** Prof. Dr. Roman Sauer  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102959 - Homotopy Theory](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T

## 4.122 Course: Human Factors in Autonomous Driving [T-WIWI-113059]

**Responsible:** Prof. Dr. Alexey Vinel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2511452	<a href="#">Human Factors in Autonomous Driving</a>	2 SWS	Lecture / 🔄	Vinel, Bied, Schrapel
WT 24/25	2511453	<a href="#">Exercises Human Factors in Autonomous Driving</a>	1 SWS	Practice / 🔄	Vinel, Bied, Schrapel
Exams					
ST 2024	7900360	<a href="#">Human Factors in Autonomous Driving</a>			Vinel
WT 24/25	79AIFB_HFAD_C6	<a href="#">Human Factors in Autonomous Driving</a>			Vinel

Legend: 📺 Online, 🔄 Blended (On-Site/Online), 📍 On-Site, ✕ Cancelled

**Competence Certificate**

The assessment of this course is a written examination (60 min) or an oral exam (20 min).

The exam takes place every semester and can be repeated at every regular examination date.



## 4.123 Course: Human Factors in Security and Privacy [T-WIWI-109270]

**Responsible:** Prof. Dr. Melanie Volkamer  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	3

Exams			
WT 24/25	79AIFB_HFSP_A1	<a href="#">Human Factors in Security and Privacy</a>	Volkamer

### Competence Certificate

The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation or an oral exam (30 min) following §4, Abs. 2, 2 of the examination regulation. Only those who have successfully participated in the exercises and the lecture will be admitted to the examination.

### Prerequisites

Both need to be done:

- Pass Quiz on Paper for Graphical Passwords
- Presentation of Results Exercise 2

+ 9 of the following 11 need to be done:

- Submit ILIAS certificate until Oct 24
- Pass Quiz on InfoSec Lecture
- Active participation exercise 1 Part 1 - Evaluation and analyses methods
- Pass Quiz Paper Discussion 1 - User Behaviour and motivation theories
- Active participation exercise 1 Part 2
- Pass Quiz Paper Discussion 2 - User Behaviour and motivation theories
- Pass Quiz Paper Discussion 3 - Security Awareness
- Active participation exercise 1 Part 3
- Pass Quiz Paper Discussion 4 - Graphical Authentication
- Pass Quiz Paper Discussion 5 - Shoulder Surfing Authentication
- Active participation exercise 2

### Recommendation

The prior attendance of the lecture "Information Security" is strongly recommended.

### Annotation

The lecture will not be offered in winter semester 2020/21.

Some lectures are in English, some in German.



T

## 4.124 Course: Incentives in Organizations [T-WIWI-105781]

**Responsible:** Prof. Dr. Petra Nieken  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101500 - Microeconomic Theory](#)  
[M-WIWI-101505 - Experimental Economics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2573003	<a href="#">Incentives in Organizations</a>	2 SWS	Lecture / 🗣️	Nieken
ST 2024	2573004	<a href="#">Übung zu Incentives in Organizations</a>	2 SWS	Practice / 🗣️	Nieken, Mitarbeiter, Walther, Gorny
Exams					
ST 2024	7900132	<a href="#">Incentives in Organizations</a>			Nieken
WT 24/25	7900201	<a href="#">Incentives in Organizations</a>			Nieken

Legend: 🗣️ Online, 🗣️🗣️ Blended (On-Site/Online), 🗣️ On-Site, ✕ Cancelled

**Competence Certificate**

The assessment of this course is a written examination (60 min). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. In case of a small number of registrations, we might offer an oral exam instead of a written exam.

**Prerequisites**

None

**Recommendation**

Knowledge of microeconomics, game theory, and statistics is assumed.

Below you will find excerpts from events related to this course:

V

**Incentives in Organizations**

2573003, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

The students acquire profound knowledge about the design and the impact of different incentive and compensation systems. Topics covered are, for instance, performance based compensation, team work, intrinsic motivation, multitasking, and subjective performance evaluations. We will use microeconomic or behavioral models as well as empirical data to analyze incentive systems. We will investigate several widely used compensation schemes and their relationship with corporate strategy. Students will learn to develop practical implications which are based on the acquired knowledge of this course.

**Aim**

The student

- develops a strategic understanding about incentives systems and how they work.
- analyzes models from personnel economics.
- understands how econometric methods can be used to analyze performance and compensation data.
- knows incentive schemes that are used in companies and is able to evaluate them critically.
- can develop practical implications which are based on theoretical models and empirical data from companies.
- understands the challenges of managing incentive and compensation systems and their relationship with corporate strategy.

**Workload**

The total workload for this course is: approximately 135 hours.

Lecture: 32 hours

Preparation of lecture: 52 hours

Exam preparation: 51 hours

**Literature**

Slides, Additional case studies and research papers will be announced in the lecture.

Literature (complementary):

Managerial Economics and Organizational Architecture, Brickley / Smith / Zimmerman, McGraw-Hill Education, 2015

Behavioral Game Theory, Camerer, Russell 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

## 4.125 Course: Information Service Engineering [T-WIWI-106423]

**Responsible:** Prof. Dr. Harald Sack  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

**Type**  
Written examination

**Credits**  
4,5

**Grading scale**  
Grade to a third

**Recurrence**  
Each summer term

**Version**  
2

Events					
ST 2024	2511606	<a href="#">Information Service Engineering</a>	2 SWS	Lecture / 	Sack
ST 2024	2511607	<a href="#">Exercises to Information Service Engineering</a>	1 SWS	Practice / 	Sack
Exams					
ST 2024	79AIFB_ISE_B3	<a href="#">Information Service Engineering (Registration until 15 July 2024)</a>			Sack
WT 24/25	79AIFB_ISE_B2	<a href="#">Information Service Engineering</a>			Sack

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation or an oral exam (20 min) following §4, Abs. 2, 2 of the examination regulation.

The exam takes place every semester and can be repeated at every regular examination date.

**Prerequisites**

None

Below you will find excerpts from events related to this course:

V

**Information Service Engineering**

2511606, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content****- The Art of Understanding**

- From Numbers to Insights
- Data, Information, and Knowledge
- Natural Language
- What is Successful Communication?
- The Art of Understanding

**- Natural Language Processing**

- NLP and Basic Linguistic Knowledge
- NLP Applications, Techniques and Challenges
- How to evaluate an NLP Experiment?
- Tokenization and Word Normalisation
- Statistical Language Models (N-Gram Model)
- Naive Bayes Text Classification
- Distributional Semantics and Word Vectors

**- Knowledge Graphs**

- Knowledge Representations and Ontologies
- Resource Description Framework (RDF)
- Modeling with RDFS
- Querying RDF(S) with SPARQL
- Popular Knowledge Graphs - Wikidata and DBpedia
- Ontologies with the Web Ontology Language (OWL)
- Linked Data Quality Assurance with SHACL
- From Linked Data to Knowledge Graphs

**- Basic Machine Learning**

- Machine Learning Fundamentals
- Evaluation and Generalization Problems
- Linear Regression
- Decision Trees
- Unsupervised Learning
- Neural Networks and Deep Learning
- Word Embeddings
- Knowledge Graph Embeddings

**- ISE Applications**

- Knowledge Graph Completion
- Knowledge Graphs and Large Language Models
- Semantic and Exploratory Search
- Semantic Recommender Systems

**Learning objectives:**

- The students know the fundamentals and measures of information theory and are able to apply those in the context of Information Service Engineering.
- The students have basic skills of natural language processing and are enabled to apply natural language processing technology to solve and evaluate simple text analysis tasks.
- The students have fundamental skills of knowledge representation with ontologies as well as basic knowledge of Semantic Web and Linked Data technologies. The students are able to apply these skills for simple representation and analysis tasks.
- The students have fundamental skills of information retrieval and are enabled to conduct and to evaluate simple information retrieval tasks.
- The students apply their skills of natural language processing, Linked Data engineering, and Information Retrieval to conduct and evaluate simple knowledge mining tasks.
- The students know the fundamentals of recommender systems as well as of semantic and exploratory search.

**Literature**

- D. Jurafsky, J.H. Martin, Speech and Language Processing, 2nd ed. Pearson Int., 2009.
- A. Hogan, The Web of Data, Springer, 2020.
- G. Rebal, A. Ravi, S. Churiwala, An Introduction to Machine Learning, Springer, 2019.

T

## 4.126 Course: Integral Equations [T-MATH-105834]

**Responsible:** PD Dr. Tilo Arens  
 Prof. Dr. Roland Griesmaier  
 PD Dr. Frank Hettlich

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102874 - Integral Equations](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

Events					
ST 2024	0160510	<a href="#">Übungen zu 0160500 (Integralgleichungen)</a>	2 SWS	Practice	Hettlich
Exams					
ST 2024	7700146	<a href="#">Integral Equations</a>			Hettlich

T

## 4.127 Course: International Business Development and Sales [T-WIWI-110985]

**Responsible:** Erice Casenave  
Prof. Dr. Martin Klarmann  
Prof. Dr. Orestis Terzidis

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-105312 - Marketing and Sales Management](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	6	Grade to a third	see Annotations	1

Events					
WT 24/25	2572189	<a href="#">International Business Development and Sales</a>	4 SWS	Block / 	Klarmann, Terzidis, Schmitt

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Non exam assessment. The grade is based on the presentation, the subsequent discussion and the written elaboration.

**Annotation**

Please contact the Marketing and Sales Research Group for further information.

*Below you will find excerpts from events related to this course:*

V

**International Business Development and Sales**

2572189, WS 24/25, 4 SWS, Language: English, [Open in study portal](#)

**Block (B)  
On-Site**

**Content**

This course is offered as part of the EUCOR programme in cooperation with EM Strasbourg. Max. 10 students of KIT and max. 10 students of EM Strasbourg will develop a sales presentation in tandems (teams of 2). This is based on the value proposition of a business model.

- An application is required to participate in this event. The application phase usually takes place at the beginning of the lecture period. Further information on the application process can be found on the website of the Marketing and Sales Research Group ([marketing.iism.kit.edu](http://marketing.iism.kit.edu)) shortly before the start of the lecture period.

Total workload for 6 ECTS: about 180 hours.

T

## 4.128 Course: International Finance [T-WIWI-102646]

**Responsible:** Prof. Dr. Marliese Uhrig-Homburg  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101483 - Finance 2](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	3	Grade to a third	see Annotations	1

Events					
ST 2024	2530570	<a href="#">International Finance</a>	2 SWS	Lecture / 	Walter, Uhrig-Homburg
Exams					
ST 2024	7900097	<a href="#">International Finance</a>			Uhrig-Homburg
WT 24/25	7900052	<a href="#">International Finance</a>			Uhrig-Homburg

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The success control takes place in form of a written examination (60 min). If the number of participants is low, an oral examination may also be offered. The examination is offered every semester and can be repeated at any regular examination date.

**Prerequisites**

None

**Recommendation**

None

**Annotation**

The course is offered as a 14-day or block course.

Below you will find excerpts from events related to this course:

V

**International Finance**

2530570, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Organizational issues**

Kickoff am Mittwoch, 24.04.24, 15:45 - 19:00 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

**4.129 Course: Introduction into Particulate Flows [T-MATH-105911]**

**Responsible:** Prof. Dr. Willy Dörfler  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102943 - Introduction into Particulate Flows](#)

Type	Credits	Grading scale	Version
Oral examination	3	Grade to a third	1

**Prerequisites**  
none



T

**4.130 Course: Introduction to Aperiodic Order [T-MATH-110811]**

**Responsible:** Prof. Dr. Tobias Hartnick  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105331 - Introduction to Aperiodic Order](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Irregular	1

**Prerequisites**  
none

T

**4.131 Course: Introduction to Convex Integration [T-MATH-112119]****Responsible:** Dr. Christian Zillinger**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-105964 - Introduction to Convex Integration](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

**Competence Certificate**

oral examination of approx. 30 minutes

**Prerequisites**

none

**Recommendation**

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

T

**4.132 Course: Introduction to Dynamical Systems [T-MATH-113263]**

**Responsible:** Dr. Björn de Rijk  
Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-106591 - Introduction to Dynamical Systems](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

**Competence Certificate**  
oral exam of ca. 30 min

**Prerequisites**  
none

T

**4.133 Course: Introduction to Fluid Dynamics [T-MATH-111297]**

**Responsible:** Prof. Dr. Wolfgang Reichel  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105650 - Introduction to Fluid Dynamics](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Irregular	1

**Prerequisites**  
none

T

**4.134 Course: Introduction to Fluid Mechanics [T-MATH-112927]**

**Responsible:** TT-Prof. Dr. Xian Liao  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106401 - Introduction to Fluid Mechanics](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	6	Grade to a third	Irregular	1 terms	1

**Competence Certificate**

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

**Prerequisites**

none

**Recommendation**

The module *Functional Analysis* is strongly recommended.

T

**4.135 Course: Introduction to Geometric Measure Theory [T-MATH-105918]****Responsible:** PD Dr. Steffen Winter**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102949 - Introduction to Geometric Measure Theory](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

**Prerequisites**

none

T

**4.136 Course: Introduction to Homogeneous Dynamics [T-MATH-110323]****Responsible:** Prof. Dr. Tobias Hartnick**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-105101 - Introduction to Homogeneous Dynamics](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

**Prerequisites**

none

T

**4.137 Course: Introduction to Kinetic Equations [T-MATH-111721]**

**Responsible:** Dr. Christian Zillinger  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105837 - Introduction to Kinetic Equations](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

**Competence Certificate**

oral examination of circa 30 minutes

**Prerequisites**

none

**Recommendation**

The course "Classical Methods for Partial Differential Equations" should be studied beforehand.



T

## 4.138 Course: Introduction to Kinetic Theory [T-MATH-108013]

**Responsible:** Prof. Dr. Martin Frank  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-103919 - Introduction to Kinetic Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Each winter term	1

Events					
WT 24/25	0155450	<a href="#">Introduction to Kinetic Theory</a>	2 SWS	Lecture / 	Frank
WT 24/25	0155460	<a href="#">Tutorial for 0155450 (Introduction to Kinetic Theory)</a>	1 SWS	Practice	Frank
Exams					
ST 2024	7700158	<a href="#">Introduction to Kinetic Theory</a>			Frank

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Prerequisites**

none

Below you will find excerpts from events related to this course:

V

**Introduction to Kinetic Theory**

0155450, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

**Lecture (V)**  
**Blended (On-Site/Online)**

**Content**

Kinetic descriptions play an important role in a variety of physical, biological, and even social applications, for instance, in the description of gases, radiations, bacteria or financial markets. Typically, these systems are described locally not by a finite set of variables but instead by a probability density describing the distribution of a microscopic state. Its evolution is typically given by an integro-differential equation. Unfortunately, the large phase space associated with the kinetic description has made simulations impractical in most settings in the past. However, recent advances in computer resources, reduced-order modeling and numerical algorithms are making accurate approximations of kinetic models more tractable, and this trend is expected to continue in the future. On the theoretical mathematical side, two rather recent Fields medals (Pierre-Louis Lions 1994, Cédric Villani 2010) also indicate the continuing interest in this field, which was already the subject of Hilbert's sixth out of the 23 problems presented at the World Congress of Mathematicians in 1900.

This course gives an introduction to kinetic theory. Our purpose is to discuss the mathematical passage from a microscopic description of a system of particles, via a probabilistic description to a macroscopic view. This is done in a complete way for the linear case of particles that are interacting with a background medium. The nonlinear case of pairwise interacting particles is treated on a more phenomenological level.

An extremely broad range of mathematical techniques is used in this course. Besides mathematical modeling, we make use of statistics and probability theory, ordinary differential equations, hyperbolic partial differential equations, integral equations (and thus functional analysis) and infinite-dimensional optimization. Among the astonishing discoveries of kinetic theory are the statistical interpretation of the Second Law of Thermodynamics, induced by the Boltzmann-Grad limit, and the result that the macroscopic equations describing fluid motion (namely the Euler and Navier-Stokes equations) can be inferred from abstract geometrical properties of integral scattering operators.

**Organizational issues**

The course will be offered in flipped classroom format. Flipped classroom means that the lectures will be made available as videos. We will regularly meet for tutorials and discussion sessions.

T

**4.139 Course: Introduction to Microlocal Analysis [T-MATH-111722]****Responsible:** TT-Prof. Dr. Xian Liao**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-105838 - Introduction to Microlocal Analysis](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

**Competence Certificate**

oral examination of circa 30 minutes

**Prerequisites**

none

**Recommendation**

The courses "Classical Methods for Partial Differential Equations" and "Functional Analysis" should be studied beforehand.

T

## 4.140 Course: Introduction to Scientific Computing [T-MATH-105837]

**Responsible:** Prof. Dr. Willy Dörfler  
 Prof. Dr. Marlis Hochbruck  
 Prof. Dr. Tobias Jahnke  
 Prof. Dr. Andreas Rieder  
 Prof. Dr. Christian Wieners

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102889 - Introduction to Scientific Computing](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

Events					
ST 2024	0165000	<a href="#">Einführung in das Wissenschaftliche Rechnen</a>	3 SWS	Lecture	Wieners
ST 2024	0165010	<a href="#">Praktikum zu 0165000 (Einführung in das Wissenschaftliche Rechnen)</a>	3 SWS	Practical course	Wieners
Exams					
ST 2024	7731415	<a href="#">Introduction to Scientific Computing</a>			Wieners

T

**4.141 Course: Introduction to Stochastic Differential Equations [T-MATH-112234]**

**Responsible:** Josef Janák  
Prof. Dr. Mathias Trabs

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-106045 - Introduction to Stochastic Differential Equations](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

**Competence Certificate**

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

**Prerequisites**

none

**Recommendation**

The contents of the module "Probability Theory" are strongly recommended. The module "Continuous Time Finance" is recommended.

T

## 4.142 Course: Introduction to Stochastic Optimization [T-WIWI-106546]

**Responsible:** Prof. Dr. Steffen Rebennack**Organisation:** KIT Department of Economics and Management**Part of:** M-WIWI-101414 - Methodical Foundations of OR  
M-WIWI-102832 - Operations Research in Supply Chain Management  
M-WIWI-103289 - Stochastic Optimization

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2024	2550470	<a href="#">Introduction to Stochastic Optimization</a>	2 SWS	Lecture / 📺	Rebennack
ST 2024	2550471	<a href="#">Übung zur Einführung in die Stochastische Optimierung</a>	1 SWS	Practice / 🎧	Rebennack, Kandora
ST 2024	2550474	<a href="#">Rechnerübung zur Einführung in die Stochastische Optimierung</a>	2 SWS	Others (sons)	Rebennack, Kandora
Exams					
ST 2024	7900311	<a href="#">Introduction to Stochastic Optimization</a>			Rebennack
WT 24/25	7900242	<a href="#">Introduction to Stochastic Optimization</a>			Rebennack

Legend: 📺 Online, 🎧 Blended (On-Site/Online), 🎧 On-Site, ✕ Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes). The exam takes place in every semester.

**Prerequisites**

None.

T

## 4.143 Course: Inverse Problems [T-MATH-105835]

**Responsible:** PD Dr. Tilo Arens  
 Prof. Dr. Roland Griesmaier  
 PD Dr. Frank Hettlich  
 Prof. Dr. Andreas Rieder

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102890 - Inverse Problems](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0105100	<a href="#">Inverse Problems</a>	4 SWS	Lecture / 	Rieder
WT 24/25	0105110	<a href="#">Tutorial for 0105100 (Inverse Problems)</a>	2 SWS	Practice / 	Rieder

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**4.144 Course: Judgement and Decision Making [T-WIWI-111099]**

**Responsible:** Prof. Dr. Benjamin Scheibehenne  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-105312 - Marketing and Sales Management](#)  
[M-WIWI-106258 - Digital Marketing](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	4,5	Grade to a third	Each winter term	1 terms	2

Events					
WT 24/25	2500041	<a href="#">Exercise Judgment and Decision Making</a>	2 SWS	Practice /	Scheibehenne
WT 24/25	2540440	<a href="#">Judgment and Decision Making</a>	3 SWS	Lecture /	Scheibehenne
Exams					
ST 2024	7900001	<a href="#">Judgement and Decision Making</a>			Scheibehenne

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Alternative exam assessment. The grading includes the following aspects:

- a written exam (60 minutes)
- a presentation during the exercise.

The scoring system for the grading will be announced at the beginning of the course.

**Prerequisites**

Registration via the CAMPUS Portal is required for participation in the Übung. The Übung is a prerequisite for the exam.

**Annotation**

The judgments and decisions that we make can have long ranging and important consequences for our (financial) well-being and individual health. Hence, the goal of this lecture is to gain a better understanding of how people make judgments and decisions and the factors that influences their behavior. We will look into simple heuristics and mental shortcuts that decision makers use to navigate their environment, in particular so in an economic context. Following this the lecture will provide an overview into social and emotional influences on decision making. In the second half of the semester we will look into some more specific topics including self-control, nudging, and food choice. The last part of the lecture will focus on risk communication and risk perception. We will address these questions from an interdisciplinary perspective at the intersection of Psychology, Behavioral Economics, Marketing, Cognitive Science, and Biology. Across all topics covered in class, we will engage with basic theoretical work as well as with groundbreaking empirical research and current scientific debates.

The workload of the class is 4.5 ECTS. This consists of 3 ETCS for the lecture and 1.5 ETCS for the Übung. Details about the Übung will be communicated at the first day of the class.

Below you will find excerpts from events related to this course:

**Judgment and Decision Making**

2540440, WS 24/25, 3 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

In this lecture, students will be introduced to fundamental theories and key insights on human judgment and decision making. Topics include decision making under uncertainty, choice biases, simple heuristics, risk perception and -communication, as well as social and emotional influences on decision making, to name but a few. In the Wintersemester 20/21 this class will be held online. The lecture videos will be available for download and there will be regular online meetings to discuss the topics. The lecture will be held in English.

**Organizational issues**

**Eine Anmeldung zur Übung ist erforderlich.** (2500041 – Übung zur Vorlesung Judgment and Decision Making (WS 24/25)). Die Übung zur Vorlesung ist eine notwendige Voraussetzung, um die Klausur zu schreiben. Die Plätze sind begrenzt.

**Die Vorlesung findet Montags von 11:30 Uhr bis 13 Uhr in Raum 221 statt.**

**Registration for the Übung is required in order to attend the lecture and take the exam** (2500041 – Übung for the lecture Judgment and Decision Making (Winter Semester 24/25)). Participation is limited.

**The lecture takes place on Mondays from 11:30 AM to 1:00 PM in Room 221.**



T

**4.145 Course: Key Moments in Geometry [T-MATH-108401]**

**Responsible:** Prof. Dr. Wilderich Tuschmann  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-104057 - Key Moments in Geometry](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Irregular	1

**Prerequisites**  
none

T

## 4.146 Course: Knowledge Discovery [T-WIWI-102666]

**Responsible:** Dr.-Ing. Tobias Käfer  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	see Annotations	3

Events					
WT 24/25	2511303	<a href="#">Knowledge Discovery, Graph Neural Networks, and Language Models</a>	3 SWS	Lecture / Practice (/  )	Käfer, Shao

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The examination will be offered for the last time in the winter semester 2024/2025. The last examination opportunity (only for repeaters) will take place in the summer semester 2025.

Instead of a final written exam, the record of achievement will be measured via project work, exercise assignments, and presentations. Specifically, the students will collaborate in groups of 3-4 to complete a comprehensive project which included a project proposal, mid-term report, and final report, cumulatively contributing 50% to their overall grade. Additionally, students will showcase their understanding of course material through the timely submission of three short assignments (totaling 25% of their grade). During the course, students will showcase their proficiency in public speaking and critical analysis by delivering engaging class presentations and discussions (25% of the grade).

**Prerequisites**

None

**Annotation**

The course will no longer be offered from winter semester 2024/2025.

Below you will find excerpts from events related to this course:

V

**Knowledge Discovery, Graph Neural Networks, and Language Models**

2511303, WS 24/25, 3 SWS, Language: English, [Open in study portal](#)

Lecture / Practice (VÜ)  
Blended (On-Site/Online)

**Content**

The lecture provides a comprehensive overview of various approaches in machine learning and data mining for knowledge extraction. It explores multiple fields, including machine learning, natural language processing, and knowledge representation. The main focus is on discovering patterns and regularities in extensive data sets, particularly unstructured text found in news articles, publications, and social media. This process is known as knowledge discovery. The lecture delves into specific techniques, methods, challenges, as well as current and future research topics within this field.

One part of the lecture is dedicated to understanding large language models (LLMs), such as ChatGPT, by exploring their underlying principles, training methods, and applications. Additionally, the lecture dives into graph representation learning, which involves extracting meaningful representations from graph data. It covers the mathematical foundations of graph and geometric deep learning, highlighting the latest applications in areas like explainable recommender systems.

Moreover, the lecture highlights the integration of knowledge graphs with large language models, known as neurosymbolic AI. This integration aims to combine structured and unstructured data to enhance knowledge extraction and representation.

The content of the lecture encompasses the entire machine learning and data mining process. It covers topics on supervised and unsupervised learning techniques, as well as empirical evaluation. Various learning methods are explored, ranging from classical approaches like decision trees, support vector machines, and neural networks to more recent advancements such as graph neural networks.

**Learning objectives:**

Students

- know fundamentals of Machine Learning, Data Mining and Knowledge Discovery.
- are able to design, train and evaluate adaptive systems.
- conduct Knowledge Discovery projects in regards to algorithms, representations and applications.

**Workload:**

- The total workload for this course is approximately 135 hours
- Time of presentness: 45 hours
- Time of preparation and postprocessing: 60 hours
- Exam and exam preparation: 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

**4.147 Course: L2-Invariants [T-MATH-105924]**

**Responsible:** Dr. Holger Kammeyer  
Prof. Dr. Roman Sauer

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102952 - L2-Invariants](#)

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

**Prerequisites**  
none

T

## 4.148 Course: Large-scale Optimization [T-WIWI-106549]

**Responsible:** Prof. Dr. Steffen Rebennack**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-102832 - Operations Research in Supply Chain Management](#)  
[M-WIWI-103289 - Stochastic Optimization](#)**Type**  
Written examination**Credits**  
4,5**Grading scale**  
Grade to a third**Recurrence**  
Each summer term**Version**  
3

Events					
ST 2024	2550475	<a href="#">Large-Scale Optimization</a>	2 SWS	Lecture / 📺	Rebennack
ST 2024	2550476	<a href="#">Übung zu Large-Scale Optimization</a>	1 SWS	Practice / 🎧	Bijiga, Rebennack
ST 2024	2550477	<a href="#">Rechnerübung zu Large-scale Optimization</a>	2 SWS	Others (sons)	Rebennack, Bijiga
Exams					
ST 2024	7900291	<a href="#">Large-scale Optimization</a>			Rebennack
WT 24/25	7900244	<a href="#">Large-scale Optimization</a>			Rebennack

Legend: 📺 Online, 🎧 Blended (On-Site/Online), 🎧 On-Site, ✖ Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes). The exam takes place in every semester.

**Prerequisites**

None.

T

## 4.149 Course: Liberalised Power Markets [T-WIWI-107043]

**Responsible:** Prof. Dr. Wolf Fichtner  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101451 - Energy Economics and Energy Markets](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	5,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2581998	<a href="#">Liberalised Power Markets</a>	2 SWS	Lecture / 	Fichtner
WT 24/25	2581999	<a href="#">Übungen zu Liberalised Power Markets</a>	2 SWS	Practice / 	Signer, Fichtner, Beranek
Exams					
ST 2024	7900205	<a href="#">Liberalised Power Markets NEW</a>			Fichtner
ST 2024	7900253	<a href="#">Liberalised Power Markets</a>			Fichtner

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes) (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date. Depending on the respective pandemic situation, the exam may be offered as an open book exam (alternative exam assessment, following §4(2), 3 of the examination regulation).

**Recommendation**

None

Below you will find excerpts from events related to this course:

V

**Liberalised Power Markets**

2581998, WS 24/25, 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

**4.150 Course: Lie Groups and Lie Algebras [T-MATH-108799]**

**Responsible:** Prof. Dr. Tobias Hartnick  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-104261 - Lie Groups and Lie Algebras](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

T

**4.151 Course: Lie-Algebras (Linear Algebra 3) [T-MATH-111723]****Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-105839 - Lie-Algebras \(Linear Algebra 3\)](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	8	Grade to a third	Irregular	1 terms	1

**Prerequisites**

none

**4.152 Course: Machine Learning 1 - Basic Methods [T-WIWI-106340]**

**Responsible:** Prof. Dr.-Ing. Johann Marius Zöllner  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2511500	<a href="#">Machine Learning 1 - Fundamental Methods</a>	2 SWS	Lecture /	Zöllner
WT 24/25	2511501	<a href="#">Exercises to Machine Learning 1 - Fundamental Methods</a>	1 SWS	Practice /	Zöllner, Polley, Fechner, Daaboul
Exams					
ST 2024	79AIFB_ML1_C4	<a href="#">Machine Learning 1 - Basic Methods (Registration until 15 July 2024)</a>			Zöllner
WT 24/25	79AIFB_ML1_C5	<a href="#">Machine Learning 1 - Basic Methods</a>			Zöllner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Depending on further pandemic developments, the exam will be offered either as an open-book exam, or as a written exam (60 min):

The exam takes place every semester and can be repeated at every regular examination date.

A grade bonus can be earned by successfully completing practice exercises. If the grade of the written exam is between 4.0 and 1.3, the bonus improves the grade by up to one grade level (0.3 or 0.4). Details will be announced in the lecture.

**Prerequisites**

None.

Below you will find excerpts from events related to this course:

**Machine Learning 1 - Fundamental Methods**

2511500, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

The course prepares students for the rapidly evolving field of machine learning by providing a solid foundation, covering core concepts and techniques to get started in the field. Students delve into different methods in supervised, unsupervised, and reinforcement learning, as well as various model types, ranging from basic linear classifiers to more complex methods, such as deep neural networks. Topics include general learning theory, support vector machines, decision trees, neural network fundamentals, convolutional neural networks, recurrent neural networks, unsupervised learning, reinforcement learning, and Bayesian learning.

The course is accompanied by a corresponding exercise, where students gain hands-on experience by implementing and experimenting with different machine learning algorithms, helping them to apply machine learning algorithms on real world problems.

By the end of the course, students will have acquired a solid foundation in machine learning, enabling them to apply state-of-the-art algorithms to solve complex problems, contribute to research efforts, and explore advanced topics in the field.

**Learning objectives:**

- 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 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.**

**4.153 Course: Machine Learning 2 – Advanced Methods [T-WIWI-106341]**

**Responsible:** Prof. Dr.-Ing. Johann Marius Zöllner  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)  
[M-WIWI-101637 - Analytics and Statistics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	4

Events					
ST 2024	2511502	<a href="#">Machine Learning 2 - Advanced methods</a>	2 SWS	Lecture /	Zöllner, Fechner, Polley
ST 2024	2511503	<a href="#">Exercises for Machine Learning 2 - Advanced Methods</a>	1 SWS	Practice /	Zöllner, Fechner, Polley
Exams					
ST 2024	79AIFB_ML2_B1	<a href="#">Machine Learning 2 – Advanced Methods (Registration until 15 July 2024)</a>			Zöllner
WT 24/25	79AIFB_ML2_B8	<a href="#">Machine Learning 2 – Advanced Methods</a>			Zöllner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Depending on further pandemic developments, the exam will be offered either as an open-book exam, or as a written exam (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

**Prerequisites**

None.

Below you will find excerpts from events related to this course:

**Machine Learning 2 - Advanced methods**

2511502, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

The subject area of machine intelligence and, in particular, machine learning, taking into account real challenges of complex application domains, is a rapidly expanding field of knowledge and the subject of numerous research and development projects.

The lecture "Machine Learning 2" deals with modern advanced methods of machine learning such as semi-supervised, self-supervised and active learning, deep neural networks (deep learning, CNNs, GANs, diffusion models, transformer, adversarial attacks) and hierarchical approaches, e.g. reinforcement learning. Another focus is the embedding and application of machine learning methods in real systems.

The lecture introduces the latest basic principles as well as extended basic structures and elucidates previously developed algorithms. The structure and the mode of operation of the methods and methods are presented and explained by means of some application scenarios, especially in the field of technical (sub) autonomous systems (vehicles, robotics, neurorobotics, image processing, etc.).

**Learning objectives:**

- Students understand extended concepts of machine learning and their possible applications.
- Students can classify, formally describe and evaluate methods of machine learning.
- In detail, methods of machine learning can be embedded and applied in complex decision and inference systems.
- Students can use their knowledge to select suitable models and methods of machine learning for existing problems in the field of machine intelligence.

**Recommendations:**

Attending the lecture **Machine Learning 1** or a comparable lecture is very helpful in understanding this lecture.

**Literature**

Die Foliensätze sind als PDF verfügbar

**Weiterführende Literatur**

- Deep Learning - Ian Goodfellow
- Artificial Intelligence: A Modern Approach - Peter Norvig and Stuart J. Russell
- Machine Learning - Tom Mitchell
- Pattern Recognition and Machine Learning - Christopher M. Bishop
- Reinforcement Learning: An Introduction - Richard S. Sutton and Andrew G. Barto
- Deep Learning - Ian Goodfellow, Yoshua Bengio, Aaron Courville

**Weitere (spezifische) Literatur zu einzelnen Themen wird in der Vorlesung angegeben.**

T

## 4.154 Course: Machine Learning and Optimization in Energy Systems [T-WIWI-113073]

**Responsible:** Prof. Dr. Wolf Fichtner  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101452 - Energy Economics and Technology](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	3,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2581050	<a href="#">Machine Learning and Optimization in Energy Systems</a>	3 SWS	Lecture / Practice (/)	Dengiz, Yilmaz
Exams					
ST 2024	7900207	<a href="#">Machine Learning and Optimization in Energy Systems</a>			Fichtner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

### Competence Certificate

The assessment of this course is a written examination (60 min) or an oral exam (30 min) depending on the number of participants. A bonus can be acquired through successful participation in the computer exercise. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4). The exact criteria for awarding a bonus will be announced at the beginning of the exercises.

Below you will find excerpts from events related to this course:

V

### Machine Learning and Optimization in Energy Systems

2581050, WS 24/25, 3 SWS, Language: English, [Open in study portal](#)

Lecture / Practice (VÜ)  
On-Site

### Content

#### Goals:

Participants should know about the most common optimization and machine learning approaches for the application in energy systems. They should understand the basic principles of the methods and should be able to apply them for solving important problems of future energy systems with high shares of renewable energy sources.

#### Content:

In the beginning, the essential transition of the energy system into a smart grid and the need for methods from the field of optimization and machine learning are explained. The course can be subdivided into an optimization part and a larger machine learning part. In the optimization part, the basics of optimization approaches that are used in energy systems are shown. Further, heuristic methods and approaches from the field of multiobjective optimization are introduced. In the machine learning part, the most important methods from the field of unsupervised learning, supervised learning and reinforcement learning are introduced and their application in future energy systems are investigated.

Amongst the considered applications are power plant dispatch, intelligent heating with heat pumps, charging strategies for electric vehicles, clustering of energy data for energy system models and electricity demand and renewable generation forecasting.

We also offer a voluntary computer exercise that deepens the understanding of the methods and applications covered in the lecture. The students will have the opportunity to solve problems from the energy domain by using optimization and machine learning approaches implemented in the programming language Python.

The course's general focus is on the application of the methods in the energy field and not on the mathematical details of the different approaches.

The total workload for this course is approximately 105 hours:

- Attendance: 30 hours
- Self-study: 30 hours
- Exam preparation: 45 hours

T

## 4.155 Course: Market Research [T-WIWI-107720]

**Responsible:** Prof. Dr. Martin Klarmann**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-101647 - Data Science: Evidence-based Marketing](#)  
[M-WIWI-105312 - Marketing and Sales Management](#)  
[M-WIWI-106258 - Digital Marketing](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2024	2571150	<a href="#">Market Research</a>	2 SWS	Lecture / 	Klarmann
ST 2024	2571151	<a href="#">Market Research Tutorial</a>	1 SWS	Practice / 	Klarmann
Exams					
ST 2024	7900015	<a href="#">Market Research</a>			Klarmann

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled**Competence Certificate**

The assessment of success takes place through a written exam (70 minutes) with additional aids in the sense of an open book exam. Further details will be announced during the lecture.

**Prerequisites**

None

**Recommendation**

None

**Annotation**

Please note that this course has to be completed successfully by students interested in master thesis positions at the Marketing & Sales Research Group.

Below you will find excerpts from events related to this course:

V

**Market Research**2571150, SS 2024, 2 SWS, Language: English, [Open in study portal](#)Lecture (V)  
On-Site



**Content**

Within the lecture, essential statistical methods for measuring customer attitudes (e.g. satisfaction measurement), understanding customer behavior and making strategic decisions will be discussed. The practical use as well as the correct handling of different survey methods will be taught, such as experiments and surveys. To analyze the collected data, various analysis methods are presented, including hypothesis tests, factor analyses, cluster analyses, variance and regression analyses. Building on this, the interpretation of the results will be discussed.

Topics addressed in this course are for example:

- Theoretical foundations of market research
- Statistical foundations of market research
- Measuring customer attitudes
- Understanding customer reactions
- Strategical decision making

The aim of this lecture is to give an overview of essential statistical methods. In the lecture students learn the practical use as well as the correct handling of different statistical survey methods and analysis procedures. In addition, emphasis is put on the interpretation of the results after the application of an empirical survey. The derivation of strategic options is an important competence that is required in many companies in order to react optimally to customer needs.

The assessment is carried out (according to §4(2), 3 SPO) in the form of a written open book exam.

The total workload for this course is approximately 135.0 hours.

Presence time: 30 hours

Preparation and wrap-up of the course: 45.0 hours

Exam and exam preparation: 60.0 hours

Please note that this course has to be completed successfully by students interested in master thesis positions at the chair of marketing.

**Literature**

Homburg, Christian (2016), Marketingmanagement, 6. Aufl., Wiesbaden.

**4.156 Course: Marketing Analytics [T-WIWI-103139]****Responsible:** Prof. Dr. Martin Klarmann**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-101647 - Data Science: Evidence-based Marketing](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	5

Events					
WT 24/25	2572170	<a href="#">Marketing Analytics</a>	2 SWS	Lecture /	Klarmann
WT 24/25	2572171		1 SWS	Practice /	Martin

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Alternative (according to §4(2), 3 of the examination regulation) exam assessment (working on tasks in groups during the lecture).

**Prerequisites**

The prerequisite for taking the course is the successful completion of the course "Market Research".

**Recommendation**

It is strongly recommended to complete the course "Market Research" prior to taking the "Marketing Analytics" course.

**Annotation**

"Marketing Analytics" is offered as a block course with an alternative exam assessment.

Starting in the winter semester 22/23, the course will be scheduled to be completed after two thirds of the semester. For further information, please contact the Marketing and Sales Research Group ([marketing.iism.kit.edu](mailto:marketing.iism.kit.edu)). Exchange students can bypass the requirement of passing Market Research if they can prove that they possess sufficient statistical knowledge based on courses attended at their home institution. This will be examined individually by the Marketing and Sales Research Group.

Below you will find excerpts from events related to this course:

**Marketing Analytics**2572170, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)**Lecture (V)**  
**On-Site****Content**

In this course various relevant market research questions are addressed, as for example measuring and understanding customer attitudes, preparing strategic decisions and sales forecasting. In order to analyze these questions, students learn to handle social media data, panel data, nested observations and experimental design. To analyze the data, advanced methods, as for example multilevel modeling and return on marketing models are taught. Also, problems of causality are addressed in-depth. The lecture is accompanied by a computer-based exercise, in the course of which the methods are applied practically.

**Students**

- receive based on the course market research an overview of advanced empirical methods
- learn in the course of the lecture to handle advanced data collection and data analysis methods
- are based on the acquired knowledge able to interpret results and derive strategic implications

Total workload for 4.5 ECTS: ca. 135 hours.

In order to attend Marketing Analytics, students are required to have passed the course Market Research.

Exchange students can bypass the requirement of passing Market Research if they can prove that they possess sufficient statistical knowledge based on courses attended at their home institution. This will be examined individually by the Marketing &amp; Sales Research Group.

For further information please contact the Marketing and Sales Research Group ([marketing.iism.kit.edu](mailto: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.



2572171, WS 24/25, 1 SWS, Language: English, [Open in study portal](#)

**Practice (Ü)  
On-Site**

**Content**

Tasks parallel to the lecture to work on in a group of students.

**Organizational issues**

Blockveranstaltung: genaue Uhrzeiten und Raum werden noch bekannt gegeben

T

**4.157 Course: Markov Decision Processes [T-MATH-105921]**

**Responsible:** Prof. Dr. Nicole Bäuerle  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102907 - Markov Decision Processes](#)

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

**Prerequisites**  
none

T

**4.158 Course: Master's Thesis [T-MATH-105878]**

**Responsible:** PD Dr. Stefan Kühnlein  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102917 - Master's Thesis](#)

Type	Credits	Grading scale	Version
Final Thesis	30	Grade to a third	1

**Final Thesis**

This course represents a final thesis. The following periods have been supplied:

<b>Submission deadline</b>	6 months
<b>Maximum extension period</b>	3 months
<b>Correction period</b>	8 weeks

T

## 4.159 Course: Matching Theory [T-WIWI-113264]

**Responsible:** Prof. Dr. Clemens Puppe  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101500 - Microeconomic Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2500042	<a href="#">Matching Theory</a>	3 SWS	Lecture / Practice (/)	Okulicz
Exams					
ST 2024	7900260	<a href="#">Matching Theory</a>			Puppe

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Written examination (90 minutes)

Below you will find excerpts from events related to this course:

V

**Matching Theory**

2500042, WS 24/25, 3 SWS, Language: English, [Open in study portal](#)

Lecture / Practice (VÜ)  
On-Site

**Content**

How should we organize recruitment of students to schools? Could we improve the placement of doctors to hospitals? Why there always seems to be a better roommate to the one you currently have? Matching Theory answers all these questions and more. During the course we will formally study mathematical systems of allocating goods and people, and see their many real life applications from organizing kidney exchange to improving dating apps. The course will cover three main topics in Matching Theory and Market Design: (1) assignment problems (e.g., allocation of social housing), (2) two-sided matching (e.g., allocation of children to schools), (3) transferable-utility matching (e.g., labor market).

The students are expected to:

1. Understand the mathematical properties of allocations and commonly used mechanism
2. Understand the connection between Matching Theory and real-life allocation systems
3. Be able to use their knowledge to propose solutions for novel real-life problems

T

**4.160 Course: Mathematical Methods in Signal and Image Processing [T-MATH-105862]****Responsible:** Prof. Dr. Andreas Rieder**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102897 - Mathematical Methods in Signal and Image Processing](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

**Prerequisites**

none

T

## 4.161 Course: Mathematical Methods of Imaging [T-MATH-106488]

**Responsible:** Prof. Dr. Andreas Rieder**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-103260 - Mathematical Methods of Imaging](#)**Type**  
Oral examination**Credits**  
5**Grading scale**  
Grade to a third**Recurrence**  
Irregular**Version**  
1

Events					
ST 2024	0102900	<a href="#">Mathematische Methoden der Bildgebung</a>	2 SWS	Lecture	Rieder
ST 2024	0102910	<a href="#">Übungen zu 0102900 (mathematische Methoden der Bildgebung)</a>	2 SWS	Practice	Rieder
Exams					
ST 2024	7700091	<a href="#">Mathematical Methods of Imaging</a>			Rieder

**Prerequisites**

None



T

**4.162 Course: Mathematical Modelling and Simulation in Practise [T-MATH-105889]****Responsible:** PD Dr. Gudrun Thäter**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102929 - Mathematical Modelling and Simulation in Practise](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	2

T

## 4.163 Course: Mathematical Statistics [T-MATH-105872]

**Responsible:** Dr. rer. nat. Bruno Ebner  
 Prof. Dr. Vicky Fassen-Hartmann  
 PD Dr. Bernhard Klar  
 Prof. Dr. Mathias Trabs

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102909 - Mathematical Statistics](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

Exams			
ST 2024	7700112	<a href="#">Mathematical Statistics</a>	Fassen-Hartmann

**Prerequisites**

none

T

**4.164 Course: Mathematical Topics in Kinetic Theory [T-MATH-108403]**

**Responsible:** Prof. Dr. Dirk Hundertmark  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-104059 - Mathematical Topics in Kinetic Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

**Prerequisites**  
none

T

## 4.165 Course: Mathematics for High Dimensional Statistics [T-WIWI-111247]

**Responsible:** Prof. Dr. Oliver Grothe  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-101637 - Analytics and Statistics](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	Irregular	1

Exams			
ST 2024	7900362	<a href="#">Mathematics for High Dimensional Statistics</a>	Grothe

**Competence Certificate**

The assessment consists of an oral exam (approx. 30 min.) taking place in the recess period.

**Prerequisites**

None

**Recommendation**

Basic knowledge of mathematics and statistics is assumed.  
 Knowledge in multivariate statistics is an advantage, but not necessary for the course.

**Annotation**

Teaching and learning format: Lecture and exercise

T

**4.166 Course: Maxwell's Equations [T-MATH-105856]**

**Responsible:** PD Dr. Tilo Arens  
Prof. Dr. Roland Griesmaier  
PD Dr. Frank Hettlich

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102885 - Maxwell's Equations](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

**4.167 Course: Media Management [T-WIWI-112711]**

**Responsible:** Prof. Dr. Ann-Kristin Kupfer  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-106258 - Digital Marketing](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2572192	<a href="#">Media Management</a>	2 SWS	Lecture /	Kupfer
WT 24/25	2572193	<a href="#">Media Management Exercise</a>	1 SWS	Practice /	Mitarbeiter

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The control of success is done by the elaboration and presentation of a group task as well as a written exam. Further details on the design of the performance review will be announced during the lecture.

**Prerequisites**

None

**Recommendation**

Students are highly encouraged to actively participate in class.

**Annotation**

The course will take place in the winter term 23/24 for the first time.

Below you will find excerpts from events related to this course:

**Media Management**

2572192, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

Students learn the theoretical foundations of media management and its most important concepts. They learn both about the key characteristics of both media products and media markets. They further get to know essential business models of media markets. Special emphasis will be given to understanding media consumers and the marketing mix of media products. A tutorial offers the opportunity to apply the key learnings of the lecture.

The learning objectives are as follows:

- Getting to know the theoretical foundations of media management
- Evaluating strategies for media products and services as media-specific marketing mix instruments
- Fostering critical and analytical thinking skills and the application of knowledge to marketing problems
- Improvement of skills and competences in the area of project management within the framework of group work
- Improvement of foreign language skills (business English)

Total time required for 4.5 credit points: approx. 135 hours

Attendance time: 30 hours

Self-study: 105 hours

**Organizational issues**

Appointments to be announced.

T

**4.168 Course: Metric Geometry [T-MATH-111933]**

**Responsible:** Prof. Dr. Alexander Lytchak  
Dr. Artem Nepechiy

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-105931 - Metric Geometry](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

**Competence Certificate**

oral examination of circa 20 minutes

**Prerequisites**

none

T

## 4.169 Course: Minimal Surfaces [T-MATH-113417]

**Responsible:** Dr. Peter Lewintan  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106666 - Minimal Surfaces](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

Exams			
ST 2024	7700110	<a href="#">Minimal Surfaces</a>	Lewintan

**Prerequisites**

None



T

## 4.170 Course: Mixed Integer Programming I [T-WIWI-102719]

**Responsible:** Prof. Dr. Oliver Stein**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-102832 - Operations Research in Supply Chain Management](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Events					
ST 2024	2550140	<a href="#">Mixed-integer Programming II</a>	2 SWS	Lecture / 	Stein
Exams					
ST 2024	7900014_SS2024_NK	<a href="#">Mixed Integer Programming I</a>			Stein

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled**Competence Certificate**

The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

The examination can also be combined with the examination of *Mixed Integer Programming II* [25140]. In this case, the duration of the written examination takes 120 minutes.

**Prerequisites**

None

**Recommendation**

It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

**Annotation**

The lecture is offered irregularly. The curriculum of the next three years is available online ([kop.ior.kit.edu](http://kop.ior.kit.edu)).

Below you will find excerpts from events related to this course:

V

**Mixed-integer Programming II**2550140, SS 2024, 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

## 4.171 Course: Mixed Integer Programming II [T-WIWI-102720]

**Responsible:** Prof. Dr. Oliver Stein**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-102832 - Operations Research in Supply Chain Management](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Events					
ST 2024	2550140	<a href="#">Mixed-integer Programming II</a>	2 SWS	Lecture /	Stein
ST 2024	2550141	<a href="#">Exercise to Mixed-integer Programming II</a>	1 SWS	Practice /	Stein, Schwarze
Exams					
ST 2024	7900009_SS2024_HK	<a href="#">Mixed Integer Programming II</a>			Stein

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

The examination can also be combined with the examination of *Mixed Integer Programming I* [2550138]. In this case, the duration of the written examination takes 120 minutes.

**Prerequisites**

None

**Recommendation**

It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

**Annotation**

The lecture is offered irregularly. The curriculum of the next three years is available online ([kop.iior.kit.edu](http://kop.iior.kit.edu)).

Below you will find excerpts from events related to this course:

V

**Mixed-integer Programming II**2550140, SS 2024, 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.

**4.172 Course: Modeling and OR-Software: Advanced Topics [T-WIWI-106200]**

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-102832 - Operations Research in Supply Chain Management](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	4

Events					
WT 24/25	2550490	<a href="#">Modellieren und OR-Software: Fortgeschrittene Themen</a>	3 SWS	Practical course /	Pomes, Linner, Nickel
Exams					
ST 2024	7900188	<a href="#">Modeling and OR-Software: Advanced Topics</a>			Nickel
WT 24/25	7900071	<a href="#">Modeling and OR-Software: Advanced Topics</a>			Nickel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment is a written examination. The examination is held in every semester. The prerequisite can only be obtained in semesters in which the course exercises are offered.

**Prerequisites**

Prerequisite for admission to the exam is the successful participation in the exercises. This includes the processing and presentation of exercises.

**Recommendation**

Basic knowledge as conveyed in the module *Introduction to Operations Research* is assumed.  
 Successful completion of the course *Modeling and OR-Software: Introduction*.

**Annotation**

Due to the limited number of participants, please register in advance. Further information can be found on the website of the course. Registration in WS 24/25 takes place via the Wiwi-Portal: <https://portal.wiwi.kit.edu/ys/8209>.  
 The course is offered every semester. The range of courses planned for three academic years in advance can be found on the Internet.

Below you will find excerpts from events related to this course:

**Modellieren und OR-Software: Fortgeschrittene Themen**

2550490, WS 24/25, 3 SWS, Language: German, [Open in study portal](#)

Practical course (P)  
 Blended (On-Site/Online)

**Content**

The advanced course is designated for Master students that already attended the introductory course or gained equivalent experience elsewhere, e.g. during a seminar or bachelor thesis. We will work on advanced topics and methods in OR, among others cutting planes, column generation and constraint programming. The Software used for the exercises is IBM ILOG CPLEX Optimization Studio. The associated modelling programming languages are OPL and ILOG Script.

**Organizational issues**

Link zur Bewerbung:

[http://go.wiwi.kit.edu/OR\\_Bewerbung](http://go.wiwi.kit.edu/OR_Bewerbung)

Bewerberzeitraum:

01.09.2023 00:00 - 12.10.2023 23:55

T

## 4.173 Course: Modeling and OR-Software: Introduction [T-WIWI-106199]

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101413 - Applications of Operations Research](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	4

Events					
ST 2024	2550490	<a href="#">Modellieren und OR-Software: Einführung</a>	3 SWS	Practical course / 	Nickel, Linner, Pomes
Exams					
ST 2024	7900153	<a href="#">Modeling and OR-Software: Introduction</a>			Nickel
WT 24/25	7900081	<a href="#">Modeling and OR-Software: Introduction</a>			Nickel

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment is a written examination. The examination is held in every semester.

**Recommendation**

Firm knowledge of the contents from the lecture *Introduction to Operations Research I* [2550040] of the module *Operations Research*.

**Annotation**

Due to capacity restrictions, registration before course start is required. For further information see the webpage of the course.

The lecture is offered in every term. The planned lectures and courses for the next three years are announced online.

Below you will find excerpts from events related to this course:

V

**Modellieren und OR-Software: Einführung**

2550490, SS 2024, 3 SWS, Language: German, [Open in study portal](#)

Practical course (P)  
Blended (On-Site/Online)

**Content**

After an introduction to general concepts of modelling tools (implementation, data handling, result interpretation, ...), the software IBM ILOG CPLEX Optimization Studio and the corresponding modeling language OPL will be discussed which can be used to solve OR problems on a computer-aided basis. Subsequently, a broad range of exercises will be discussed. The main goals of the exercises from literature and practical applications are to learn the process of modeling optimization problems as linear or mixed-integer programs, to efficiently utilize the presented tools for solving these optimization problems and to implement heuristic solution procedures for mixed-integer programs.

**Organizational issues**

Die Teilnehmerzahl für diese Veranstaltung ist begrenzt.

Die Bewerbung erfolgt über das [Wiwi-Portal](#).

Der Bewerbungszeitraum ist vom 01.03.24 bis zum 18.03.24.

T

**4.174 Course: Modeling and Simulation [T-WIWI-112685]**

**Responsible:** Prof. Dr. Sanja Lazarova-Molnar  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2511100	<a href="#">Modeling and Simulation</a>	2 SWS	Lecture	Lazarova-Molnar
ST 2024	2511101	<a href="#">Exercises Modeling and Simulation</a>	1 SWS	Practice	Lazarova-Molnar
Exams					
ST 2024	79AIFB_MaS_C6	<a href="#">Modeling and Simulation (Registration until 15 July 2024)</a>			Lazarova-Molnar
WT 24/25	79AIFB_MaS_A6	<a href="#">Modeling and Simulation</a>			Lazarova-Molnar

**Competence Certificate**

Depending on the number of participants in the course, the exam will be offered either as an oral exam (20 min), or as a written exam (60 min).

The exam takes place every semester and can be repeated at every regular examination date.

**Prerequisites**

None

**Recommendation**

Some experience in programming and knowledge of basic mathematics and statistics.

**Annotation**

Instruction is in the form of lectures and exercises. A detailed course schedule will be published before the start of the semester.

*Below you will find excerpts from events related to this course:*

V

**Modeling and Simulation**

2511100, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)

**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

## 4.175 Course: Modeling the Dynamics of Financial Markets [T-WIWI-113414]

**Responsible:** Prof. Dr. Maxim Ulrich**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-106660 - Modeling the Dynamics of Financial Markets](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	9	Grade to a third	Each summer term	1

Events					
ST 2024	2600004	<a href="#">Essentials for Dynamic Financial Machine Learning</a>		Lecture / Practice (/) 🔄	Ulrich
ST 2024	2600257	<a href="#">Dynamic Capital Market Theory</a>		Lecture / Practice (/) 🔄	Ulrich
Exams					
ST 2024	7900332	<a href="#">Modeling the Dynamics of Financial Markets</a>			Ulrich
WT 24/25	7900024	<a href="#">Modeling the Dynamics of Financial Markets</a>			Ulrich

Legend: 🟩 Online, 🔄 Blended (On-Site/Online), 🟦 On-Site, ✖ Cancelled

**Competence Certificate**

The 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, Resesearch Frontier in Dynamic Capital Markets".

**Recommendation**

Recommendation: Knowledge in the fields of Advanced Statistics, Deep Learning, Financial Economics, Differential Equations, Optimization.

Below you will find excerpts from events related to this course:

V

**Essentials for Dynamic Financial Machine Learning**2600004, SS 2024, SWS, Language: English, [Open in study portal](#)Lecture / Practice (VÜ)  
Blended (On-Site/Online)**Content**

This course teaches students to work with financial data. Students learn algorithms that are used to learn key quantities of dynamic capital markets, such as time-varying risk premia, volatility and unobserved state variables. The course covers the following concepts:

- \* Multivariate time series modeling
- \* Dynamic volatility modeling
- \* Handling big financial data
- \* Estimating risk premia
- \* Kalman Filtering

Lectures develop all material on the whiteboard. Tutoriums solve and discuss python solutions to selected problems.

V

**Dynamic Capital Market Theory**2600257, SS 2024, SWS, [Open in study portal](#)Lecture / Practice (VÜ)  
Blended (On-Site/Online)

**Content**

This course offers an introduction to the dynamics of capital markets. Portfolios and asset prices move dynamically across time. This course teaches state-of-the-art models to help understand why this is the case. Describing and managing dynamic systems in engineering is done via dynamic programming and optimal control. This course develops the theory of dynamic programming in continuous time and applies it to solve portfolio choice and corporate investment decisions. These concepts are key for financial engineering and model-based reinforcement learning.

Students obtain proficiency in the following topics:

- \* Dynamic Asset Pricing and Portfolio Choice Theory
- \* Dynamic modeling in discrete and continuous time
- \* Stochastic Calculus
- \* Theory of Dynamic Programming
- \* Pricing of bond, equity, futures and option markets

Lectures develop all concepts on the whiteboard, while exercises are solved during weekly tutorials.

T

## 4.176 Course: Modelling and Simulation of Lithium-Ion Batteries [T-MATH-113382]

**Responsible:** Prof. Dr. Willy Dörfler**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-106640 - Modelling and Simulation of Lithium-Ion Batteries](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Events					
ST 2024	0166150	<a href="#">Modelling and Simulation of Li-Ion Batteries</a>	2 SWS	Lecture	Dörfler
Exams					
ST 2024	7700155	<a href="#">Modelling and Simulation of Lithium-Ion Batteries</a>			Dörfler

**Competence Certificate**

oral exam (ca. 20 min)

**Prerequisites**

None

*Below you will find excerpts from events related to this course:*

V

**Modelling and Simulation of Li-Ion Batteries**0166150, SS 2024, 2 SWS, [Open in study portal](#)

Lecture (V)

**Content**

In the past decades lithium-ion batteries (LIBs) have become a dominating energy storage technology. Important for the understanding and further development are models, mainly in terms of partial differential equations derived from first principles and experimentally obtained experience. To get insight in the processes numerical simulations are indispensable. We present some of the currently used models to describe the electrical mechanical and thermal effects and the numerical solution procedures (based on finite difference, finite elements or finite volumes). The type of problems compass linear and nonlinear systems of diffusion equations, free boundary value problems and contact problems.

T

## 4.177 Course: Monotonicity Methods in Analysis [T-MATH-105877]

**Responsible:** PD Dr. Gerd Herzog**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102887 - Monotonicity Methods in Analysis](#)

Type	Credits	Grading scale	Version
Oral examination	3	Grade to a third	1

Events					
WT 24/25	0106100	<a href="#">Monotoniemethoden in der Analysis</a>	2 SWS	Lecture	Herzog

**4.178 Course: Multicriteria Optimization [T-WIWI-111587]****Responsible:** Prof. Dr. Oliver Stein**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-102832 - Operations Research in Supply Chain Management](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	see Annotations	1

Events					
WT 24/25	2550155	<a href="#">Multicriteria Optimization</a>	2 SWS	Lecture /	Stein
WT 24/25	2550156	<a href="#">Exercises Multicriteria Optimization</a>		Practice /	Stein, Beck
Exams					
WT 24/25	7900009_WS2425_HK	<a href="#">Multicriteria Optimization</a>			Stein

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam. The examination is held in the semester of the lecture and in the following semester.

**Prerequisites**

None

**Recommendation**

It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

**Annotation**

The course is offered every second winter semester (starting WiSe 22/23). The curriculum of the next three years is available online ([www.iior.kit.edu](http://www.iior.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

Below you will find excerpts from events related to this course:

**Multicriteria Optimization**2550155, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)**Lecture (V)**  
On-Site

**Content**

Multicriteria optimization deals with optimization problems with multiple objective functions. In practice, the minimization or maximization of several objectives often conflict with each other, such as weight and stability of mechanical components, return and risk of stock portfolios, or cost and duration of transports. Various scalarization approaches allow one to formulate single-objective problems that can be solved using nonlinear or global optimization techniques, and whose optimal points have a reasonable interpretation for the underlying multicriteria problem.

However, some seemingly obvious scalarization approaches suffer from various drawbacks, so that regardless of scalarization approaches, it is necessary to clarify what is meant by the solution of a multicriteria optimization problem in the first place. For such Pareto-optimal points, optimality conditions and solution procedures based on them can be formulated. From the usually non-unique Pareto set, decision makers finally choose an alternative based on their subjective preferences.

The lecture gives a mathematically sound introduction to multicriteria optimization and is structured as follows:

- Introductory examples and terminology
- Solution concepts
- Methods for the determination of the Pareto set
- Selection of Pareto-optimal points under subjective preferences

**Learning objectives:**

The student

- knows and understands the fundamentals of multicriteria optimization,
- is able to choose, design and apply modern techniques of multicriteria optimization in practice.

**Literature**

- M. Ehrgott, Multicriteria Optimization, Second Edition, Springer, Berlin, 2005
- J. Jahn, Vector Optimization, Second Edition, Springer, Berlin, 2011
- K. Miettinen, Nonlinear Multiobjective Optimization, Springer, New York, 2004
- Y. Sawaragi, H. Nakayama, T. Tanino, Theory of Multiobjective Optimization, Academic Press, Orlando, FL, 1985

T

## 4.179 Course: Multivariate Statistical Methods [T-WIWI-103124]

**Responsible:** Prof. Dr. Oliver Grothe  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-101637 - Analytics and Statistics](#)  
[M-WIWI-101639 - Econometrics and Statistics II](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Events					
WT 24/25	2550554	<a href="#">Multivariate Verfahren</a>	2 SWS	Lecture / 	Grothe
WT 24/25	2550555	<a href="#">Practice Multivariate Statistical Methods</a>	2 SWS	Practice / 	Liu
Exams					
ST 2024	7900351	<a href="#">Multivariate Statistical Methods</a>			Grothe
WT 24/25	7900217	<a href="#">Multivariate Statistical Methods</a>			Grothe

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Written examination lasting 60 minutes.

The examination is offered during the examination period of the lecture semester. Only repeaters (and not first-time writers) are admitted to the repeat examination in the examination period of the following semester.

**Prerequisites**

None

**Recommendation**

The course covers highly advanced statistical methods with a quantitative focus. Hence, participants are necessarily expected to have advanced statistical knowledge, e.g. acquired in the course "Advanced Statistics". Without this, participation in the course is not advised.

Previous attendance of the course Analysis of Multivariate Data is recommended. Alternatively, the script can be provided to interested students.

**Annotation**

The course (lecture and exercise) is offered irregularly. Detailed information can be found on the chair's website.

T

## 4.180 Course: Nature-Inspired Optimization Methods [T-WIWI-102679]

**Responsible:** Prof. Dr. Pradyumn Kumar Shukla  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2511106	<a href="#">Nature-Inspired Optimization Methods</a>	2 SWS	Lecture / 	Shukla
ST 2024	2511107	<a href="#">Übungen zu Nature-Inspired Optimization Methods</a>	1 SWS	Practice / 	Shukla
Exams					
ST 2024	79AIFB_NOM_C1	<a href="#">Nature-Inspired Optimization Methods (Registration until 15 July 2024)</a>	Shukla		
WT 24/25	79AIFB_NOM_B5	<a href="#">Nature-Inspired Optimisation Methods</a>	Shukla		

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Please note: no exam can be offered in the winter semester 2023/2024.

**Prerequisites**

None

Below you will find excerpts from events related to this course:

V

**Nature-Inspired Optimization Methods**

2511106, SS 2024, 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

**4.181 Course: Non- and Semiparametrics [T-WIWI-103126]**

**Responsible:** Prof. Dr. Melanie Schienle  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101638 - Econometrics and Statistics I](#)  
[M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

**Competence Certificate**

The assessment consists of a written exam (90 minutes) (following §4(2), 1 of the examination regulation).

**Prerequisites**

None

**Recommendation**

Knowledge of the contents covered by the course "*Applied Econometrics*" [2520020]

**Annotation**

The course takes place every second winter semester: 2018/19 then 2020/21

T

**4.182 Course: Nonlinear Analysis [T-MATH-107065]**

**Responsible:** Prof. Dr. Tobias Lamm  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-103539 - Nonlinear Analysis](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

**Prerequisites**  
none

T

**4.183 Course: Nonlinear Maxwell Equations [T-MATH-110283]**

**Responsible:** Prof. Dr. Roland Schnaubelt  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105066 - Nonlinear Maxwell Equations](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

**Prerequisites**  
none

**4.184 Course: Nonlinear Optimization I [T-WIWI-102724]**

**Responsible:** Prof. Dr. Oliver Stein  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101414 - Methodical Foundations of OR](#)  
[M-WIWI-101473 - Mathematical Programming](#)

**Type**  
Written examination

**Credits**  
4,5

**Grading scale**  
Grade to a third

**Recurrence**  
Each winter term

**Version**  
4

Events					
WT 24/25	2550111	<a href="#">Nonlinear Optimization I</a>	2 SWS	Lecture /	Stein
WT 24/25	2550112	<a href="#">Exercises Nonlinear Optimization I + II</a>		Practice /	Stein, Schwarze
Exams					
ST 2024	7900202_SS2024_NK	<a href="#">Nonlinear Optimization I</a>			Stein
WT 24/25	7900001_WS2425_HK	<a href="#">Nonlinear Optimization I</a>			Stein

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes) according to Section 4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam. The exam takes place in the semester of the lecture and in the following semester.

The examination can also be combined with the examination of Nonlinear Optimization II [2550113]. In this case, the duration of the written examination takes 120 minutes.

**Prerequisites**

The module component exam T-WIWI-103637 "Nonlinear Optimization I and II" may not be selected.

**Annotation**

Part I and II of the lecture are held consecutively in the *same* semester.

Below you will find excerpts from events related to this course:

**Nonlinear Optimization I**

2550111, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

**Lecture (V)**  
**On-Site**

**Content**

The lecture treats the minimization of smooth nonlinear functions without constraints. For such problems, which occur very often in economics, engineering, and natural sciences, optimality conditions are derived and, based on them, solution algorithms are developed. The lecture is structured as follows:

- Introduction, examples, and terminology
- Existence results for optimal points
- First and second order optimality conditions
- Algorithms (line search, steepest descent method, variable metric methods, Newton method, Quasi Newton methods, CG method, trust region method)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

**Remark:**

The treatment of optimization problems *with* constraints forms the contents of the lecture "Nonlinear Optimization II". The lectures "Nonlinear Optimization I" and "Nonlinear Optimization II" are held consecutively *in the same semester*.

**Learning objectives:**

The student

- knows and understands fundamentals of unconstrained nonlinear optimization,
- is able to choose, design and apply modern techniques of unconstrained nonlinear optimization in practice.

**Literature**

O. Stein, Grundzüge der Nichtlinearen Optimierung, 2. Aufl., SpringerSpektrum, 2021

**Weiterführende Literatur:**

- W. Alt, Nichtlineare Optimierung, Vieweg, 2002
- M.S. Bazaraa, H.D. Sherali, C.M. Shetty, Nonlinear Programming, Wiley, 1993
- O. Güler, Foundations of Optimization, Springer, 2010
- H.Th. Jongen, K. Meer, E. Triesch, Optimization Theory, Kluwer, 2004
- J. Nocedal, S. Wright, Numerical Optimization, Springer, 2000

**4.185 Course: Nonlinear Optimization I and II [T-WIWI-103637]**

**Responsible:** Prof. Dr. Oliver Stein  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101414 - Methodical Foundations of OR](#)  
[M-WIWI-101473 - Mathematical Programming](#)

**Type**  
Written examination

**Credits**  
9

**Grading scale**  
Grade to a third

**Recurrence**  
Each winter term

**Version**  
6

Events					
WT 24/25	2550111	<a href="#">Nonlinear Optimization I</a>	2 SWS	Lecture /	Stein
WT 24/25	2550112	<a href="#">Exercises Nonlinear Optimization I + II</a>		Practice /	Stein, Schwarze
WT 24/25	2550113	<a href="#">Nonlinear Optimization II</a>	2 SWS	Lecture /	Stein
Exams					
ST 2024	7900204_SS2024_NK	<a href="#">Nonlinear Optimization I and II</a>			Stein
WT 24/25	7900003_WS2425_HK	<a href="#">Nonlinear Optimization I and II</a>			Stein

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written exam (120 minutes) according to Section 4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The exam takes place in the semester of the lecture and in the following semester.

**Prerequisites**

None.

**Annotation**

Part I and II of the lecture are held consecutively in the **same** semester.

Below you will find excerpts from events related to this course:

**Nonlinear Optimization I**

2550111, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

**Lecture (V)  
On-Site**

**Content**

The lecture treats the minimization of smooth nonlinear functions without constraints. For such problems, which occur very often in economics, engineering, and natural sciences, optimality conditions are derived and, based on them, solution algorithms are developed. The lecture is structured as follows:

- Introduction, examples, and terminology
- Existence results for optimal points
- First and second order optimality conditions
- Algorithms (line search, steepest descent method, variable metric methods, Newton method, Quasi Newton methods, CG method, trust region method)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

**Remark:**

The treatment of optimization problems *with* constraints forms the contents of the lecture "Nonlinear Optimization II". The lectures "Nonlinear Optimization I" and "Nonlinear Optimization II" are held consecutively *in the same semester*.

**Learning objectives:**

The student

- knows and understands fundamentals of unconstrained nonlinear optimization,
- is able to choose, design and apply modern techniques of unconstrained nonlinear optimization in practice.

**Literature**

O. Stein, Grundzüge der Nichtlinearen Optimierung, 2. Aufl., SpringerSpektrum, 2021

**Weiterführende Literatur:**

- W. Alt, Nichtlineare Optimierung, Vieweg, 2002
- M.S. Bazaraa, H.D. Sherali, C.M. Shetty, Nonlinear Programming, Wiley, 1993
- O. Güler, Foundations of Optimization, Springer, 2010
- H.Th. Jongen, K. Meer, E. Triesch, Optimization Theory, Kluwer, 2004
- J. Nocedal, S. Wright, Numerical Optimization, Springer, 2000

**Nonlinear Optimization II**

2550113, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

The lecture treats the minimization of smooth nonlinear functions under nonlinear constraints. For such problems, which occur very often in economics, engineering, and natural sciences, optimality conditions are derived and, based on them, solution algorithms are developed. The lecture is structured as follows:

- Topology and first order approximations of the feasible set
- Theorems of the alternative, first and second order optimality conditions
- Algorithms (penalty method, multiplier method, barrier method, interior point method, SQP method, quadratic optimization)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

**Remark:**

The treatment of optimization problems *without* constraints forms the contents of the lecture "Nonlinear Optimization I". The lectures "Nonlinear Optimization I" and "Nonlinear Optimization II" are held consecutively *in the same semester*.

**Learning objectives:**

The student

- knows and understands fundamentals of constrained nonlinear optimization,
- is able to choose, design and apply modern techniques of constrained nonlinear optimization in practice.

**Literature**

O. Stein, Grundzüge der Nichtlinearen Optimierung, 2. Aufl., SpringerSpektrum, 2021

**Weiterführende Literatur:**

- W. Alt, Nichtlineare Optimierung, Vieweg, 2002
- M.S. Bazaraa, H.D. Sherali, C.M. Shetty, Nonlinear Programming, Wiley, 1993
- O. Güler, Foundations of Optimization, Springer, 2010
- H.Th. Jongen, K. Meer, E. Triesch, Optimization Theory, Kluwer, 2004
- J. Nocedal, S. Wright, Numerical Optimization, Springer, 2000

**4.186 Course: Nonlinear Optimization II [T-WIWI-102725]**

**Responsible:** Prof. Dr. Oliver Stein  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101414 - Methodical Foundations of OR](#)  
[M-WIWI-101473 - Mathematical Programming](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2550112	<a href="#">Exercises Nonlinear Optimization I + II</a>		Practice /	Stein, Schwarze
WT 24/25	2550113	<a href="#">Nonlinear Optimization II</a>	2 SWS	Lecture /	Stein
Exams					
ST 2024	7900203_SS2024_NK	<a href="#">Nonlinear Optimization II</a>			Stein
WT 24/25	7900002_WS2425_HK	<a href="#">Nonlinear Optimization II</a>			Stein

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes) according to Section 4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The exam takes place in the semester of the lecture and in the following semester.

The exam can also be combined with the examination of *Nonlinear Optimization I* [2550111]. In this case, the duration of the written exam takes 120 minutes.

**Prerequisites**

None.

**Annotation**

Part I and II of the lecture are held consecutively in the same semester.

Below you will find excerpts from events related to this course:

**Nonlinear Optimization II**

2550113, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

The lecture treats the minimization of smooth nonlinear functions under nonlinear constraints. For such problems, which occur very often in economics, engineering, and natural sciences, optimality conditions are derived and, based on them, solution algorithms are developed. The lecture is structured as follows:

- Topology and first order approximations of the feasible set
- Theorems of the alternative, first and second order optimality conditions
- Algorithms (penalty method, multiplier method, barrier method, interior point method, SQP method, quadratic optimization)

The lecture is accompanied by exercises which, amongst others, offers the opportunity to implement and to test some of the methods on practically relevant examples.

**Remark:**

The treatment of optimization problems *without* constraints forms the contents of the lecture "Nonlinear Optimization I". The lectures "Nonlinear Optimization I" and "Nonlinear Optimization II" are held consecutively *in the same semester*.

**Learning objectives:**

The student

- knows and understands fundamentals of constrained nonlinear optimization,
- is able to choose, design and apply modern techniques of constrained nonlinear optimization in practice.



**Literature**

O. Stein, Grundzüge der Nichtlinearen Optimierung, 2. Aufl., SpringerSpektrum, 2021

**Weiterführende Literatur:**

- W. Alt, Nichtlineare Optimierung, Vieweg, 2002
- M.S. Bazaraa, H.D. Sherali, C.M. Shetty, Nonlinear Programming, Wiley, 1993
- O. Güler, Foundations of Optimization, Springer, 2010
- H.Th. Jongen, K. Meer, E. Triesch, Optimization Theory, Kluwer, 2004
- J. Nocedal, S. Wright, Numerical Optimization, Springer, 2000

T

**4.187 Course: Nonlinear Wave Equations [T-MATH-110806]**

**Responsible:** Prof. Dr. Wolfgang Reichel  
Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-105326 - Nonlinear Wave Equations](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

**Prerequisites**  
none

T

**4.188 Course: Nonparametric Statistics [T-MATH-105873]**

**Responsible:** Dr. rer. nat. Bruno Ebner  
Prof. Dr. Vicky Fasen-Hartmann  
PD Dr. Bernhard Klar  
Prof. Dr. Mathias Trabs

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102910 - Nonparametric Statistics](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	2

**Competence Certificate**

oral exam of ca. 20 minutes

T

**4.189 Course: Numerical Analysis of Helmholtz Problems [T-MATH-111514]**

**Responsible:** TT-Prof. Dr. Barbara Verfürth  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105764 - Numerical Analysis of Helmholtz Problems](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

T

## 4.190 Course: Numerical Analysis of Neural Networks [T-MATH-113470]

**Responsible:** TT-Prof. Dr. Roland Maier**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-106695 - Numerical Analysis of Neural Networks](#)

Type
Oral examination

Credits
6

Grading scale
Grade to a third

Version
1

Exams			
ST 2024	7700151	<a href="#">Numerical Analysis of Neural Networks (examination on August 7 to 9)</a>	Maier
ST 2024	7700152	<a href="#">Numerical Analysis of Neural Networks (examination on September 18) NEW: September 17 is also possible</a>	Maier

**Competence Certificate**

oral exam of ca. 30 minutes

**Prerequisites**

none

T

**4.191 Course: Numerical Complex Analysis [T-MATH-112280]**

**Responsible:** Prof. Dr. Marlis Hochbruck  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106063 - Numerical Complex Analysis](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	6	Grade to a third	Irregular	1 terms	1

**Competence Certificate**

oral exam of ca. 20 minutes

**Prerequisites**

none

**Recommendation**

Some basic knowledge of Complex Analysis is strongly recommended.

T

**4.192 Course: Numerical Linear Algebra for Scientific High Performance Computing [T-MATH-107497]****Responsible:** Prof. Dr. Hartwig Anzt**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-103709 - Numerical Linear Algebra for Scientific High Performance Computing](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	5	Grade to a third	Irregular	2

**Prerequisites**

none

T

## 4.193 Course: Numerical Linear Algebra in Image Processing [T-MATH-108402]

**Responsible:** PD Dr. Volker Grimm**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-104058 - Numerical Linear Algebra in Image Processing](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Exams			
ST 2024	00024	<a href="#">Numerical Linear Algebra in Image Processing</a>	Grimm

**Prerequisites**

none



T

## 4.194 Course: Numerical Methods for Differential Equations [T-MATH-105836]

**Responsible:** Prof. Dr. Willy Dörfler  
 Prof. Dr. Marlis Hochbruck  
 Prof. Dr. Tobias Jahnke  
 Prof. Dr. Andreas Rieder  
 Prof. Dr. Christian Wieners

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102888 - Numerical Methods for Differential Equations](#)

Type	Credits	Grading scale	Version
Written examination	8	Grade to a third	3

Events					
WT 24/25	0110700	<a href="#">Numerische Methoden für Differentialgleichungen</a>	4 SWS	Lecture / 	Hochbruck
WT 24/25	0110800	<a href="#">Übungen zu 0110700 (numerische Methoden für Differentialgleichungen)</a>	2 SWS	Practice / 	Hochbruck
Exams					
ST 2024	00020	<a href="#">Numerical Methods for Differential Equations</a>	Wieners		

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

T

**4.195 Course: Numerical Methods for Hyperbolic Equations [T-MATH-105900]****Responsible:** Prof. Dr. Willy Dörfler**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102915 - Numerical Methods for Hyperbolic Equations](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

**Prerequisites**

none

T

**4.196 Course: Numerical Methods for Integral Equations [T-MATH-105901]**

**Responsible:** PD Dr. Tilo Arens  
PD Dr. Frank Hettlich

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102930 - Numerical Methods for Integral Equations](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2024	0160500	<a href="#">Integralgleichungen</a>	4 SWS	Lecture	Hettlich
WT 24/25	0112600	<a href="#">Numerical Methods for Integral Equations</a>	4 SWS	Lecture	Arens
WT 24/25	0112610	<a href="#">Tutorial for 0112600 (Numerical Methods for Integral Equations)</a>	2 SWS	Practice	Arens

Below you will find excerpts from events related to this course:

V

**Numerical Methods for Integral Equations**

0112600, WS 24/25, 4 SWS, [Open in study portal](#)

Lecture (V)

**Content**

In this course, we will learn about a number of methods to numerically solve integral equations, such as Nyström, collocation and Galerkin methods. The lectures will be accompanied by a programming practical in which the methods will be implemented and tested.

T

**4.197 Course: Numerical Methods for Maxwell's Equations [T-MATH-105920]**

**Responsible:** Prof. Dr. Marlis Hochbruck  
Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102931 - Numerical Methods for Maxwell's Equations](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

T

## 4.198 Course: Numerical Methods for Oscillatory Differential Equations [T-MATH-113437]

**Responsible:** Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-106682 - Numerical Methods for Oscillatory Differential Equations](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
ST 2024	7700159	<a href="#">Numerical Methods for Oscillatory Differential Equations</a>	Jahnke

### Competence Certificate

oral exam of ca. 30 minutes

### Prerequisites

none

T

**4.199 Course: Numerical Methods for Time-Dependent Partial Differential Equations [T-MATH-105899]**

**Responsible:** Prof. Dr. Marlis Hochbruck  
Prof. Dr. Tobias Jahnke

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102928 - Numerical Methods for Time-Dependent Partial Differential Equations](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T

**4.200 Course: Numerical Methods in Computational Electrodynamics [T-MATH-105860]**

**Responsible:** Prof. Dr. Willy Dörfler  
Prof. Dr. Marlis Hochbruck  
Prof. Dr. Tobias Jahnke  
Prof. Dr. Andreas Rieder  
Prof. Dr. Christian Wieners

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102894 - Numerical Methods in Computational Electrodynamics](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

**Prerequisites**

none

T

## 4.201 Course: Numerical Methods in Fluid Mechanics [T-MATH-105902]

**Responsible:** Prof. Dr. Willy Dörfler  
PD Dr. Gudrun Thäter

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102932 - Numerical Methods in Fluid Mechanics](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Events					
ST 2024	0161600	<a href="#">Numerical Methods in Fluidmechanics</a>	2 SWS	Lecture	Dörfler
Exams					
ST 2024	7700154	<a href="#">Numerical Methods in Fluid Mechanics</a>			Dörfler

Below you will find excerpts from events related to this course:

V

## Numerical Methods in Fluidmechanics

0161600, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)

**Content**

Starting from basics we develop the continuum mechanical model that lead to the fundamental equations for incompressible flows. We will study in more detail potential flows, Stokes flows (on bounded or exterior domains) and (non-turbulent) Navier-Stokes flows. We will sketch existence theory and show how to get numerical solutions with the finite element method, including stability and error estimates.



T

## 4.202 Course: Numerical Methods in Mathematical Finance [T-MATH-105865]

**Responsible:** Prof. Dr. Tobias Jahnke**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102901 - Numerical Methods in Mathematical Finance](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0107800	<a href="#">Numerical methods in mathematical finance</a>	4 SWS	Lecture	Jahnke
WT 24/25	0107900	<a href="#">Tutorial for 0107800 (numerical methods for mathematical finance)</a>	2 SWS	Practice	Jahnke, Kirn

**Competence Certificate**

oral exam of ca. 30 minutes

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

V

**Numerical methods in mathematical finance**0107800, WS 24/25, 4 SWS, Language: English, [Open in study portal](#)**Lecture (V)****Content**

An option is a contract which gives its owner the right to buy or sell an underlying asset at a future time at a fixed price. The underlying asset is typically a stock of a company or a commodity, and since its value varies randomly, computing the fair price of the corresponding option is an important and interesting problem which yields a number of mathematical challenges. This lecture provides an introduction to a number of mathematical models for option pricing. The main goal, however, is the construction and analysis of numerical methods which approximate the solution of the corresponding differential equations in a stable, accurate and efficient way. The following topics will be treated:

- \* Options, arbitrage and other basic concepts
- \* Black-Scholes equation und Black-Scholes formulas
- \* Numerical methods for stochastic differential equations
- \* (Multilevel) Monte Carlo methods
- \* (Quasi-)Monte Carlo integration
- \* Numerical methods for Black-Scholes equations
- \* Numerical methods for American options

Prerequisites: Participants are expected to be familiar with stochastic differential equations, the Ito integral, and the Ito formula. A short introduction to these topics (approx. 25 pages) is provided for those students who wish to acquire the relevant background through self-study. Moreover, programming skills (MATLAB or Python) are strongly recommended for the programming exercises.

T

**4.203 Course: Numerical Optimisation Methods [T-MATH-105858]**

**Responsible:** Prof. Dr. Willy Dörfler  
Prof. Dr. Marlis Hochbruck  
Prof. Dr. Tobias Jahnke  
Prof. Dr. Andreas Rieder  
Prof. Dr. Christian Wieners

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102892 - Numerical Optimisation Methods](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T

**4.204 Course: Numerical Simulation in Molecular Dynamics [T-MATH-110807]****Responsible:** PD Dr. Volker Grimm**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-105327 - Numerical Simulation in Molecular Dynamics](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

**Prerequisites**

none

T

## 4.205 Course: Online Concepts for Karlsruhe City Retailers [T-WIWI-111848]

**Responsible:** Prof. Dr. Martin Klarmann  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-105312 - Marketing and Sales Management](#)  
[M-WIWI-106258 - Digital Marketing](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each summer term	2

Events					
ST 2024	2571184	<a href="#">Online concepts for Karlsruhe city retailers</a>	2 SWS	Others (sons/●)	Kupfer
Exams					
ST 2024	7900221	<a href="#">Online Concepts for Karlsruhe City Retailers</a>			Klarmann

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

### Competence Certificate

Alternative exam assessment:

- presentations in teams (in each case to the extent of approx. 15 minutes per team with subsequent discussio)
- delivery of a written elaboration per team.

### Annotation

Please note that an application is required to participate in this workshop. The application phase usually takes place at the beginning of the lecture period in the summer semester. More information on the application process is usually available on the Marketing and Sales Research Group website ([marketing.iism.kit.edu](http://marketing.iism.kit.edu)) shortly before the start of the lecture period in the summer semester.

Below you will find excerpts from events related to this course:

V

### Online concepts for Karlsruhe city retailers

2571184, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Others (sonst.)  
On-Site

### Content

#### Content

As part of a practical project in cooperation with the city marketing department of KME Karlsruhe Marketing und Event GmbH, students will have the opportunity to directly interact with retailers in Karlsruhe. Challenges of the digitalization of brick-and-mortar retailing will be analyzed and solutions will be developed and implemented.

In a theoretical part at the beginning of the event, students will gain an insight into the theoretical foundations of specific online marketing instruments. In cooperation with Karlsruhe City Marketing, students are taught application-oriented skills in online marketing tools, such as content management systems, social media platforms, search engine optimization or Google Ads campaigns.

In the practical part of the course, student teams cooperate with a real retailer in Karlsruhe's city center and learn how to analyze and optimize online presences and digital solutions based on key performance indicators. Possible use cases range from social media communication and website optimization to the introduction of innovative pricing and payment methods. In this way, students are given the tools for developing, maintaining and optimizing individual websites and digital solutions in stationary retailing.

Learning objectives result accordingly as follows:

- Learning of theoretical basics of central, application-oriented tools of online marketing
- Application and practical deep-dive of the acquired knowledge in a real case
- Concise and structured presentation of results

Total time required for 3 credit points: approx. 90.0 hours

Attendance time: 12 hours

Preparation and wrap-up of the course: 58 hours

Exam and exam preparation: 20 hours

T

## 4.206 Course: Operations Research in Health Care Management [T-WIWI-102884]

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-102805 - Service Operations](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each term	3

Events					
ST 2024	2550495	<a href="#">Operations Research in Health Care Management</a>	2 SWS	Lecture / 	Graß
ST 2024	2550496	<a href="#">Übungen zu OR im Health Care Management</a>	1 SWS	Practice / 	Graß
Exams					
ST 2024	7900229	<a href="#">Operations Research in Health Care Management</a>			Graß
WT 24/25	7900010	<a href="#">Operations Research in Health Care Management</a>			Graß
WT 24/25	7900032	<a href="#">Operations Research in Health Care Management</a>			Graß

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Success is assessed in the form of a 60-minute written examination (in accordance with §4(2), 1 SPO).

The examination is offered every semester.

**Prerequisites**

None

**Recommendation**

Basic knowledge as conveyed in the module "Introduction to Operations Research" is assumed.

**Annotation**

The course is offered irregularly. Planned lectures for the next three years can be found in the internet at <http://dol.iior.kit.edu/english/Courses.php>.

Below you will find excerpts from events related to this course:

V

**Operations Research in Health Care Management**

2550495, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
Online

**Literature****Weiterführende Literatur:**

- Fleßa: Grundzüge der Krankenhausbetriebslehre, Oldenbourg, 2007
- Fleßa: Grundzüge der Krankenhaussteuerung, Oldenbourg, 2008
- Hall: Patient flow: reducing delay in healthcare delivery, Springer, 2006

T

## 4.207 Course: Operations Research in Supply Chain Management [T-WIWI-102715]

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-102805 - Service Operations](#)  
[M-WIWI-102832 - Operations Research in Supply Chain Management](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	2

Exams			
ST 2024	7900249	<a href="#">Operations Research in Supply Chain Management</a>	Nickel

**Competence Certificate**

The assessment is a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

The examination is held in the term of the lecture and the following lecture.

**Prerequisites**

None

**Recommendation**

Basic knowledge as conveyed in the module Introduction to Operations Research and in the lectures Facility Location and Strategic SCM, Tactical and operational SCM is assumed.

**Annotation**

The course is offered irregularly. Planned lectures for the next three years can be found in the internet at <http://dol.iior.kit.edu/english/Courses.php>.

T

**4.208 Course: Optimisation and Optimal Control for Differential Equations [T-MATH-105864]****Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-102899 - Optimisation and Optimal Control for Differential Equations](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

**Prerequisites**

none

T

**4.209 Course: Optimization in Banach Spaces [T-MATH-105893]**

**Responsible:** Prof. Dr. Roland Griesmaier  
PD Dr. Frank Hettlich

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102924 - Optimization in Banach Spaces](#)

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	2

**Competence Certificate**

oral examination of approximately 30 minutes

**Prerequisites**

none

**Recommendation**

Some basic knowledge of finite dimensional optimization theory and functional analysis is desirable.



T

## 4.210 Course: Optimization under Uncertainty [T-WIWI-106545]

**Responsible:** Prof. Dr. Steffen Rebennack  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101413 - Applications of Operations Research](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2550464	<a href="#">Optimization Under Uncertainty</a>	2 SWS	Lecture / 	Rebennack
WT 24/25	2550465	<a href="#">Übungen zu Optimierungsansätze unter Unsicherheit</a>	1 SWS	Practice / 	Rebennack
WT 24/25	2550466		2 SWS	Others (sons)	Rebennack
Exams					
ST 2024	7900309	<a href="#">Optimization under Uncertainty</a>			Rebennack
WT 24/25	7900240	<a href="#">Optimization under Uncertainty</a>			Rebennack

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 minutes) according to Section 4(2), 1 of the examination regulation. The exam takes place in every the semester.

**Prerequisites**

None.

**4.211 Course: Panel Data [T-WIWI-103127]**

**Responsible:** apl. Prof. Dr. Wolf-Dieter Heller  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101638 - Econometrics and Statistics I](#)  
[M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2520320	<a href="#">Panel Data</a>	2 SWS	Lecture	Heller
ST 2024	2520321	<a href="#">Übungen zu Paneldaten</a>	2 SWS	Practice	Heller
Exams					
ST 2024	7900115	<a href="#">Panel Data</a>			Heller

**Competence Certificate**

The performance assessment is an alternative exam assessment in the form of a one-hour examination comprising a written and an oral part. The examination takes place as an individual examination or in groups of two.

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Panel Data**

2520320, SS 2024, 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

**4.212 Course: Parallel Computing [T-MATH-102271]**

**Responsible:** PD Dr. Mathias Krause  
Prof. Dr. Christian Wieners

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-101338 - Parallel Computing](#)

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

Events					
WT 24/25	0100055	<a href="#">Parallel Computing</a>	3 SWS	Lecture	Krause, Simonis

Below you will find excerpts from events related to this course:

V

**Parallel Computing**

0100055, WS 24/25, 3 SWS, Language: English, [Open in study portal](#)

Lecture (V)

**Content**

Modern computer hardware is massively and heterogeneously parallel. Only parallel algorithms enable us to take advantage of the exponentially increasing compute power. Therefore, parallel computing is the dominant paradigm to perform simulations of realistic phenomena in economics, natural and engineering sciences. Thus, novel physical insights, ground truth simulations or large-scale predictions are only achieved with highly efficient, massively parallel algorithms.

Topics covered in this course:

- Parallel programming models
- Parallel solving of linear equation systems
- Parallel finite elements, finite volumes finite differences, lattice Boltzmann methods
- Methods of domain decomposition
- Parallel matrix-matrix and matrix-vector operations
- Convergence and (parallel) cost analysis
- Load balancing strategies
- Applications in natural and engineering sciences

T

**4.213 Course: Parametric Optimization [T-WIWI-102855]**

**Responsible:** Prof. Dr. Oliver Stein  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101473 - Mathematical Programming](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

**Competence Certificate**

The assessment of the lecture is a written examination (60 minutes) according to §4(2), 1 of the examination regulation. The successful completion of the exercises is required for admission to the written exam.

The examination is held in the semester of the lecture and in the following semester.

**Prerequisites**

None

**Recommendation**

It is strongly recommended to visit at least one lecture from the Bachelor program of this chair before attending this course.

**Annotation**

The lecture is offered irregularly. The curriculum of the next three years is available online ([www.iior.kit.edu](http://www.iior.kit.edu)).

T

**4.214 Course: Percolation [T-MATH-105869]**

**Responsible:** Prof. Dr. Daniel Hug  
Prof. Dr. Günter Last  
PD Dr. Steffen Winter

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102905 - Percolation](#)

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	2

**Prerequisites**

none

T

## 4.215 Course: Poisson Processes [T-MATH-105922]

**Responsible:** Prof. Dr. Vicky Fasen-Hartmann  
 Prof. Dr. Daniel Hug  
 Prof. Dr. Günter Last  
 Dr. Franz Nestmann  
 PD Dr. Steffen Winter

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102922 - Poisson Processes](#)

Type	Credits	Grading scale	Version
Oral examination	5	Grade to a third	1

Events					
ST 2024	0152700	<a href="#">Der Poisson-Prozess</a>	2 SWS	Lecture	Nestmann
Exams					
ST 2024	7700011	<a href="#">Poisson Processes</a>			Nestmann, Last

**Prerequisites**

none

**4.216 Course: Portfolio and Asset Liability Management [T-WIWI-103128]**

**Responsible:** Dr. Mher Safarian  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2520357	<a href="#">Portfolio and Asset Liability Management</a>	2 SWS	Lecture	Safarian
ST 2024	2520358	<a href="#">Übungen zu Portfolio and Asset Liability Management</a>	2 SWS	Practice	Safarian
Exams					
ST 2024	7900357	<a href="#">Portfolio and Asset Liability Management</a>			Safarian

**Competence Certificate**

The assessment of this course consists of a written examination (following §4(2), 1 SPOs, 180 min.).

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Portfolio and Asset Liability Management**

2520357, SS 2024, 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

**4.217 Course: Potential Theory [T-MATH-105850]**

**Responsible:** PD Dr. Tilo Arens  
Prof. Dr. Roland Griesmaier  
PD Dr. Frank Hettlich  
Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102879 - Potential Theory](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1



T

## 4.218 Course: Practical Seminar: Health Care Management (with Case Studies) [T-WIWI-102716]

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-102805 - Service Operations](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	2

Events					
ST 2024	2550498	<a href="#">Practical seminar: Health Care Management</a>	3 SWS	Seminar / 	Nickel, Mitarbeiter
WT 24/25	2500008	<a href="#">Practical seminar: Health Care Management</a>	3 SWS	Others (sons / 	Nickel, Mitarbeiter
Exams					
ST 2024	7900361	<a href="#">Practical Seminar: Health Care Management (with Case Studies)</a>			Nickel
WT 24/25	7900105	<a href="#">Practical Seminar: Health Care Management (with Case Studies)</a>			Nickel

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

The assessment consists in a case study, the writing of a corresponding paper, and an oral exam (according to §4(2), 2 of the examination regulation).

### Prerequisites

None.

### Recommendation

Basic knowledge as conveyed in the module *Introduction to Operations Research* is assumed.

### Annotation

The credits have been reduced to 4,5 starting summer term 2016.

The lecture is offered every term.

The planned lectures and courses for the next three years are announced online.

T

**4.219 Course: Practical Seminar: Human-Centered Systems [T-WIWI-113459]**

**Responsible:** Prof. Dr. Alexander Mädche  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-104068 - Information Systems in Organizations](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

Events					
ST 2024	2540554	<a href="#">Practical Seminar: Human-Centered Systems</a>	3 SWS	Lecture / 	Mädche
WT 24/25	2540554	<a href="#">Practical Seminar: Human-Centered Systems</a>	3 SWS	Lecture / 	Mädche
Exams					
ST 2024	7900262	<a href="#">Practical Seminar: Human-Centered Systems</a>			Mädche
WT 24/25	7900341	<a href="#">Practical Seminar: Human-Centered Systems</a>			Mädche

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment of this course is in the form of a different type of examination. The assessment is carried out by a practical component, preparing written documentation and actively participating in the discussions. A total of 60 points can be achieved, of which:

- a maximum of 25 points for the written documentation
- a maximum of 25 points for the practical component
- a maximum of 10 points for active participation in the discussions

At least 30 points must be achieved to pass the performance assessment. Please note that a practical component such as conducting a survey or implementing an application is also part of the regular scope of the course in addition to the written documentation. The respective tasks can be found in the announcement on the institute's website <https://h-lab.iism.kit.edu>.

Below you will find excerpts from events related to this course:

V

**Practical Seminar: Human-Centered Systems**

2540554, SS 2024, 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.

V

**Practical Seminar: Human-Centered Systems**

2540554, WS 24/25, 3 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
Blended (On-Site/Online)

T

**4.220 Course: Predictive Mechanism and Market Design [T-WIWI-102862]**

**Responsible:** Prof. Dr. Johannes Philipp Reiß  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101505 - Experimental Economics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

**Competence Certificate**

The assessment consists of a written exam (60 minutes) (following §4(2), 1 of the examination regulation).

**Prerequisites**

None

**Annotation**

The course is given every second fall term, e.g., WS2017/18, WS2019/20, ...

The retake exam is given in the summer term subsequent to the fall term where the course (lecture and final exam) is given.

**4.221 Course: Predictive Modeling [T-WIWI-110868]**

**Responsible:** Prof. Dr. Fabian Krüger  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101638 - Econometrics and Statistics I](#)  
[M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	2

Events					
ST 2024	2521311	<a href="#">Predictive Modeling</a>	2 SWS	Lecture /	Krüger, Koster
ST 2024	2521312	<a href="#">Predictive Modeling (Tutorial)</a>	2 SWS	Practice /	Koster, Krüger
Exams					
ST 2024	7900298	<a href="#">Predictive Modeling</a>			Krüger
WT 24/25	7900014	<a href="#">Predictive Modeling</a>			Krüger

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment of this course is a written examination (90 minutes) according to §4(2), 1 of the examination regulation. A bonus can be acquired by successful completion of an assignment (written report + short in-class presentation) during the semester. If the grade of the written examination is between 4.0 and 1.3, the bonus improves the grade by one grade level (0.3 or 0.4).

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Predictive Modeling**

2521311, SS 2024, 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.

**Predictive Modeling (Tutorial)**

2521312, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Practice (Ü)  
On-Site

T

## 4.222 Course: Pricing [T-WIWI-102883]

**Responsible:** Prof. Dr. Martin Klarmann  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-105312 - Marketing and Sales Management](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2572199	<a href="#">Pricing</a>	3 SWS	Block / 	Bill, Klarmann, Schröder

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Alternative exam assessment. The examination (and thus the grade) is composed of three parts:

1. The design and execution of your own small experimental study around the topic of behavioral pricing (as group work).
2. The processing and presentation of a case study on pricing (as group work).
3. The execution of a simulated price negotiation based on a systematic preparation (usually in teams of two).

**Prerequisites**

Since the earlier course (a) "Pricing Excellence" and (b) "Price Negotiations and Sales Presentations" become parts of the Pricing course, Pricing cannot be taken if (a) and/or (b) have already been completed.

**Recommendation**

Students are highly encouraged to actively participate in class.

**Annotation**

A small application is required for participation in this class. The application phase usually takes place at the beginning of the lecture period in the winter semester. More information on the application process will be made available on the Marketing and Sales Research Group website ([marketing.iism.kit.edu](http://marketing.iism.kit.edu)) shortly before the start of the winter semester lecture period. This course is limited to 24 participants.

Below you will find excerpts from events related to this course:

V

**Pricing**

2572199, WS 24/25, 3 SWS, Language: English, [Open in study portal](#)

**Block (B)**  
**On-Site**

**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.

**4.223 Course: Probabilistic Time Series Forecasting Challenge [T-WIWI-111387]**

**Responsible:** Prof. Dr. Fabian Krüger  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101638 - Econometrics and Statistics I](#)  
[M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Irregular	2

Events					
WT 24/25	2500080	<a href="#">Probabilistic Time Series Forecasting Challenge</a>	2 SWS	Practice /	Bracher, Koster, Lerch, Krüger
WT 24/25	2500081	<a href="#">Probabilistic Time Series Forecasting Challenge</a>		Project (P /	Krüger, Bracher, Koster, Lerch

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Alternative exam assessment. Necessary conditions to pass the course:

- Weekly submission of statistical forecasts during the semester (excluding the Christmas break),
- Presentation (ca. 20 minutes) during the semester,
- Submission of a final report (5-10 pages) around the end of the semester.

Grading is based on the presentation (30%) and the final report (70%).

**Prerequisites**

Good methodological knowledge in statistics and data science.

Good knowledge in applied data analysis, incl. programming skills in R, Python or similar.

Knowledge of time series analysis is helpful, but not required.

**Annotation**

The course is limited in participation. Participants will be selected via the WIWI portal.

Below you will find excerpts from events related to this course:

**Probabilistic Time Series Forecasting Challenge**

2500081, WS 24/25, SWS, Language: English, [Open in study portal](#)

**Project (PRO)**  
**Blended (On-Site/Online)**

**Content**

Statistical forecasts are relevant across all fields of society. In this data science project, students make, evaluate and communicate their own statistical forecasts in a real-time setting. We consider probabilistic forecasts that involve a measure of uncertainty in addition to a point forecast. Students are asked to make forecasts of several real-world time series (including weather variables and the DAX stock market index). Historical data on all series are available from public sources that are updated as time proceeds. While the time series differ from each other in important ways, statistical methods can meaningfully be used for prediction in all cases. We focus on quantile forecasts which are useful to measure forecast uncertainty in a relatively simple way.

**Organizational issues****Short description**

In this data science project, students make and evaluate statistical forecasts in a realistic setup (involving real-time predictions and real-world time series data). A kickoff meeting will take place in person in mid October. During the semester, there will be a weekly online meeting in which students and instructors discuss the current state of the forecasting challenge.

**Prerequisites**

Students should have a good working knowledge of statistics and data science, including proficiency in a programming language like R, Python, or Matlab. Knowledge of time series analysis is helpful but not strictly required. Motivation and curiosity are particularly important in this course format that requires regular, active participation over the whole semester.

Please note that the number of participants is limited due to the interactive course format. Application takes place via the Wiwi portal, where further information is available.

**Examination rules**

The course counts for 4.5 credit points (Leistungspunkte). Examination is via an alternative exam assessment (§4(2), 3 SPO).

Necessary conditions to pass the course:

- 1) Weekly submission of statistical forecasts during the semester, excluding the Christmas break,
- 2) A presentation (approx. 20 minutes) during the semester,
- 3) Submission of a final report (5-10 pages) around the end of the semester.

The presentation and the final report should describe the forecasting methods and their statistical evaluation. Grading is based on the presentation (30%) and the final report (70%).



T

**4.224 Course: Probability Theory and Combinatorial Optimization [T-MATH-105923]**

**Responsible:** Prof. Dr. Daniel Hug  
Prof. Dr. Günter Last

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102947 - Probability Theory and Combinatorial Optimization](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

**Prerequisites**  
none

T

## 4.225 Course: Process Mining [T-WIWI-109799]

**Responsible:** Prof. Dr. Andreas Oberweis  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2511204	<a href="#">Process Mining</a>	2 SWS	Lecture / 	Oberweis
ST 2024	2511205	<a href="#">Exercise Process Mining</a>	1 SWS	Practice / 	Oberweis, Schreiber, Schüler, Rybinski
Exams					
ST 2024	79AIFB_PM_C2	<a href="#">Process Mining (Registration until 21 July 2024)</a>			Oberweis
WT 24/25	79AIFB_PM_A5	<a href="#">Process Mining</a>			Oberweis

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation in the first week after lecture period.

**Prerequisites**

None

**Annotation**

Former name (up to winter semester 2018/1019) "Workflow Management".

Below you will find excerpts from events related to this course:

V

**Process Mining**

2511204, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

The area of process mining covers approaches which aim at deducting new knowledge on the basis of logfiles generated by information systems. Such information systems are e.g., workflow-management-systems which are used for an efficient control of processes in enterprises and organisations. The lecture introduces the foundations of processes and respective modeling and analysis techniques. In the following, the foundations of process mining and the three classical types of approaches - discovery, conformance and enhancement - will be taught. In addition to the theoretical basics, tools, application scenarios in practice and open research questions are covered as well.

**Learning objectives:**

Students

- understand the concepts and approaches of process mining and know how they are applied,
- create and evaluate business process models,
- analyze static and dynamic properties of workflows,
- apply approaches and tools of process mining.

**Recommendations:**

Knowledge of course Applied Informatics - Modelling is expected.

**Workload:**

- Lecture 30h
- Exercise 15h
- Preparation of lecture 24h
- Preparation of exercises 25h
- Exam preparation 40h
- Exam 1h

**Literature**

- W. van der Aalst, H. van Kees: Workflow Management: Models, Methods and Systems, Cambridge, The MIT Press, 2002.
- W. van der Aalst: Process Mining: Data Science in Action. Springer, 2016.
- J. Carmona, B. van Dongen, A. Solti, M. Weidlich: Conformance Checking: Relating Processes and Models. Springer, 2018.
- A. Drescher, A. Koschmider, A. Oberweis: Modellierung und Analyse von Geschäftsprozessen: Grundlagen und Übungsaufgaben mit Lösungen. De Gruyter Studium, 2017.
- A. Oberweis: Modellierung und Ausführung von Workflows mit Petri-Netzen. Teubner-Reihe Wirtschaftsinformatik, B.G. Teubner Verlag, 1996.
- R. Peters, M. Nauroth: Process-Mining: Geschäftsprozesse: smart, schnell und einfach, Springer, 2019.
- F. Schönthaler, G.Vossen, A. Oberweis, T. Karle: Business Processes for Business Communities: Modeling Languages, Methods, Tools. Springer, 2012.
- M. Weske: Business Process Management: Concepts, Languages, Architectures. Springer, 2012.

Weitere Literatur wird in der Vorlesung bekannt gegeben.

**4.226 Course: Project Lab Cognitive Automobiles and Robots [T-WIWI-109985]**

**Responsible:** Prof. Dr.-Ing. Johann Marius Zöllner  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	5	Grade to a third	Each winter term	3

Events					
WT 24/25	2512501	<a href="#">Practical Course Cognitive automobiles and robots (Master)</a>	3 SWS	Practical course /	Zöllner, Daaboul
Exams					
WT 24/25	7900107	<a href="#">Advanced Lab Cognitive Automobile and Robots (Master)</a>			Zöllner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Details of the grade formation will be announced at the beginning of the course.

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Practical Course Cognitive automobiles and robots (Master)**

2512501, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

Practical course (P)  
Blended (On-Site/Online)

**Content**

The lab is intended as a practical supplement to courses such as "Machine Learning 1/2".

Scientific topics, mostly in the area of autonomous driving and robotics, will be addressed in joint work with ML/KI methods. The goal of the internship is for participants to design, develop, and evaluate ML Software system.

In addition to the scientific goals, such as the study and application of methods, the aspects of project-specific teamwork in research (from specification to presentation of results) are also worked on in this internship.

The individual projects require the analysis of the set task, selection of appropriate methods, specification and implementation and evaluation of the solution approach. Finally, the selected solution is to be documented and presented in a short lecture.

**Learning Objectives:**

- Students will be able to practically apply theoretical knowledge from lectures on machine learning to a selected area of current research.
- Students will be proficient in analyzing and solving thematic problems.
- Students will be able to evaluate, document, and present their concepts and results.

**Recommendations:**

- Theoretical knowledge of machine learning and/or AI.
- Python knowledge
- Initial experience with deep learning frameworks such as PyTorch/Jax/Tensorflow may be beneficial.

**Workload:**

The workload of 5 credit points consists of practical implementation of the selected solution, as well as time for literature research and planning/specification of the selected solution. In addition, a short report and presentation of the work performed will be prepared.

**Organizational issues**

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

T

## 4.227 Course: Project Lab Machine Learning [T-WIWI-109983]

**Responsible:** Prof. Dr.-Ing. Johann Marius Zöllner  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	5	Grade to a third	Each summer term	3

Events					
ST 2024	2512500	<a href="#">Project Lab Machine Learning</a>	3 SWS	Practical course / 	Daaboul, Zöllner, Schneider
Exams					
ST 2024	7900086	<a href="#">Project Lab Machine Learning</a>	Zöllner		

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

The alternative exam assessment consists of:

- a practical work
- a presentation and
- a written seminar thesis

Details of the grade formation will be announced at the beginning of the course.

### Prerequisites

None

Below you will find excerpts from events related to this course:

V

### Project Lab Machine Learning

2512500, SS 2024, 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

## 4.228 Course: Public Management [T-WIWI-102740]

**Responsible:** Prof. Dr. Berthold Wigger  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101504 - Collective Decision Making](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2561127	<a href="#">Public Management</a>	3 SWS	Lecture / Practice (/  )	Wigger
Exams					
ST 2024	790puma	<a href="#">Public Management</a>			Wigger
WT 24/25	790puma	<a href="#">Public Management</a>			Wigger

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

**Competence Certificate**

Depending on the further pandemic development the assessment will consist either of an open book exam (following Art. 4, para. 2, clause 3 of the examination regulation), or of an 1.5h written exam (following Art. 4, para. 2, clause 1 of the examination regulation).

**Prerequisites**

None

**Recommendation**

Basic knowledge of Public Finance is required.

Below you will find excerpts from events related to this course:

V

**Public Management**

2561127, WS 24/25, 3 SWS, Language: German, [Open in study portal](#)

Lecture / Practice (VÜ)  
Blended (On-Site/Online)

**Literature****Weiterführende Literatur:**

- Damkowski, W. und C. Precht (1995): Public Management; Kohlhammer
- Richter, R. und E.G. Furubotn (2003): Neue Institutionenökonomik; 3. Auflage, Mohr
- Schedler, K. und I. Proeller (2003): New Public Management; 2. Auflage; UTB
- Mueller, D.C. (2009): Public Choice III; Cambridge University Press
- Wigger, B.U. (2006): Grundzüge der Finanzwissenschaft; 2. Auflage; Springer

T

## 4.229 Course: Python for Computational Risk and Asset Management [T-WIWI-110213]

**Responsible:** Prof. Dr. Maxim Ulrich  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-105032 - Data Science for Finance](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	3

### Competence Certificate

The examination takes the form of an alternative exam assessment.

The alternative exam assessment consists of a Python-based "Takehome Exam". At the end of the third week of January, the student is given a "Takehome Exam" which he processes and sends back independently within 4 hours using Python. Precise instructions will be announced at the beginning of the course. The alternative exam assessment can be repeated a maximum of once. A timely repeat option takes place at the end of the third week in March of the same year. More detailed instructions will be given at the beginning of the course.

### Prerequisites

None.

### Recommendation

Good knowledge of statistics and basic programming skills



**4.230 Course: Quantitative Methods in Energy Economics [T-WIWI-107446]**

**Responsible:** Dr. Patrick Plötz  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101451 - Energy Economics and Energy Markets](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3,5	Grade to a third	Each winter term	3

Events					
WT 24/25	2581007	<a href="#">Quantitative Methods in Energy Economics</a>	2 SWS	Lecture /	Plötz
WT 24/25	2581008	<a href="#">Übungen zu Quantitative Methods in Energy Economics</a>	1 SWS	Practice /	Plötz, Britto
Exams					
ST 2024	7981007	<a href="#">Quantitative Methods in Energy Economics</a>			Fichtner
WT 24/25	7981007	<a href="#">Quantitative Methods in Energy Economics</a>			Fichtner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of an oral (app. 30 minutes) exam (following §4(2) of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

**Prerequisites**

None

**Recommendation**

None

Below you will find excerpts from events related to this course:

**Quantitative Methods in Energy Economics**

2581007, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

**Content**

Energy economics makes use of many quantitative methods in exploration and analysis of data as well as in simulations and modelling. This lecture course aims at introducing students of energy economics into the application of quantitative methods and techniques as taught in elementary courses to real problems in energy economics. The focus is mainly on regression, simulation, time series analysis and related statistical methods as applied in energy economics.

**Learning Goals:**

The student

- knows and understands selected quantitative methods of energy economics
- is able to use selected quantitative methods of energy economics
- understands they range of usage, limits and is autonomously able to adress new problems by them.

**Literature**

Wird in der Vorlesung bekannt gegeben.

T

**4.231 Course: Random Graphs and Networks [T-MATH-112241]**

**Responsible:** Prof. Dr. Daniel Hug  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106052 - Random Graphs and Networks](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

**Competence Certificate**

oral exam of ca. 30 min

**Prerequisites**

none

**Recommendation**

The contents of the module 'Probability Theory' are strongly recommended.

T

## 4.232 Course: Regularity for Elliptic Operators [T-MATH-113472]

**Responsible:** apl. Prof. Dr. Peer Kunstmann  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106696 - Regularity for Elliptic Operators](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	1

Events					
ST 2024	0156850	<a href="#">Regularity for Elliptic Operators</a>	3 SWS	Lecture	Kunstmann
Exams					
ST 2024	7700130	<a href="#">Regularity for Elliptic Operators</a>			Kunstmann

**Competence Certificate**  
 oral exam of ca. 30 minutes

**Prerequisites**  
 none

Below you will find excerpts from events related to this course:

V

## Regularity for Elliptic Operators

0156850, SS 2024, 3 SWS, [Open in study portal](#)

Lecture (V)

**Content**

Elliptic operators on  $\mathbb{R}^n$  or, complemented by suitable boundary conditions on domains, give rise to sectorial operators in Lebesgue spaces  $L^q$ .

In this lecture we study certain regularity properties for elliptic operators, e.g. boundedness of an  $H^\infty$  functional calculus, description of the domains of fractional powers, and maximal  $L^p$  regularity for the corresponding parabolic problem.

These properties have applications in the study of partial differential equations, e.g. of parabolic type.

T

## 4.233 Course: Regulation Theory and Practice [T-WIWI-102712]

**Responsible:** Prof. Dr. Kay Mitusch  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101451 - Energy Economics and Energy Markets](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4,5	Grade to a third	see Annotations	2

**Competence Certificate**

The lecture is not offered for an indefinite period of time.

Result of success is made by a 20-30 minutes oral examination. Examination is offered every semester and can be retried at any regular examination date.

**Prerequisites**

None

**Recommendation**

Basic knowledge and skills of microeconomics from undergraduate studies (bachelor's degree) are expected.

Particularly helpful but not necessary: Industrial Economics and Principal-Agent- or Contract theories. Prior attendance of the lecture *Competition in Networks* [26240] is helpful in any case but not considered a formal precondition.

**Annotation**

The lecture is not offered for an indefinite period of time.

T

**4.234 Course: Riemann Surfaces [T-MATH-113081]**

**Responsible:** Prof. Dr. Frank Herrlich  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106466 - Riemann Surfaces](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	8	Grade to a third	Irregular	1 terms	1

**Competence Certificate**

Oral examination of ca. 30 minutes.

**Prerequisites**

none

T

**4.235 Course: Ruin Theory [T-MATH-108400]****Responsible:** Prof. Dr. Vicky Fasen-Hartmann**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-104055 - Ruin Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

**Prerequisites**

none

T

**4.236 Course: Scattering Theory [T-MATH-105855]**

**Responsible:** PD Dr. Tilo Arens  
Prof. Dr. Roland Griesmaier  
PD Dr. Frank Hettlich

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102884 - Scattering Theory](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T

## 4.237 Course: Scattering Theory for Time-dependent Waves [T-MATH-113416]

**Responsible:** Prof. Dr. Roland Griesmaier**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-106664 - Scattering Theory for Time-dependent Waves](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Exams			
ST 2024	7700157	<a href="#">Scattering Theory for Time-dependent Waves</a>	Griesmaier

**Competence Certificate**

oral exam of ca. 30 min

**Prerequisites**

none



T

**4.238 Course: Selected Methods in Fluids and Kinetic Equations [T-MATH-111853]****Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-105897 - Selected Methods in Fluids and Kinetic Equations](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

**Competence Certificate**

oral examination of approx. 30 minutes

**Prerequisites**

none

**Recommendation**

The courses "Classical Methods for Partial Differential Equations" and "Functional Analysis" are recommended.

T

**4.239 Course: Selected Topics in Harmonic Analysis [T-MATH-109065]**

**Responsible:** Prof. Dr. Dirk Hundertmark  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-104435 - Selected Topics in Harmonic Analysis](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	3	Grade to a third	Irregular	1

**Prerequisites**  
none

**4.240 Course: Semantic Web Technologies [T-WIWI-110848]**

**Responsible:** Dr.-Ing. Tobias Käfer  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2511310	<a href="#">Semantic Web Technologies</a>	2 SWS	Lecture /	Färber, Käfer, Braun, Kinder
ST 2024	2511311	<a href="#">Exercises to Semantic Web Technologies</a>	1 SWS	Practice /	Färber, Käfer, Braun, Kinder
Exams					
ST 2024	79AIFB_SWebT_A4	<a href="#">Semantic Web Technologies (Registration until 15 July 2024)</a>			Käfer
WT 24/25	79AIFB_SWebT_A2	<a href="#">Semantic Web Technologies</a>			Käfer

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of an 1h written exam following §4, Abs. 2, 1 of the examination regulation or of an oral exam (20 min) following §4, Abs. 2, 2 of the examination regulation.

The exam takes place every semester and can be repeated at every regular examination date.

**Prerequisites**

None

**Recommendation**

Lectures on Informatics of the Bachelor on Information Systems (Semester 1-4) or equivalent are required.

Below you will find excerpts from events related to this course:

**Semantic Web Technologies**

2511310, SS 2024, 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 preparation and postprocessing: 60 hours
- Exam and exam preparation: 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.

**Exercises to Semantic Web Technologies**

2511311, SS 2024, 1 SWS, Language: English, [Open in study portal](#)

**Practice (Ü)  
On-Site**

**Content**

The exercises are related to the lecture Semantic Web Technologies.

Multiple exercises are held that capture the topics, held in the lecture Semantic Web Technologies, and discuss them in detail. Thereby, practical examples are given to the students in order to transfer theoretical aspects into practical implementation.

The following topics are covered:

- Resource Description Framework (RDF) and RDF Schema (RDFS)
- Web Architecture and Linked Data
- Web Ontology Language (OWL)
- Query language SPARQL
- Rule languages
- Applications

**Learning objectives:**

The student

- understands the motivation and foundational ideas behind Semantic Web and Linked Data technologies, and is able to analyse and realise systems
- demonstrates basic competency in the areas of data and system integration on the web
- masters advanced knowledge representation scenarios involving ontologies

**Recommendations:**

Lectures on Informatics of the Bachelor on Information Systems (Semester 1-4) or equivalent are required. Knowledge of modeling with UML is required.

**Organizational issues**

Die Übungen finden im Rahmen der Termine der Blockvorlesung statt.

**Literature**

- Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, York Sure: Semantic Web – Grundlagen. Springer, 2008.
- John Domingue, Dieter Fensel, James A. Hendler (Editors). Handbook of Semantic Web Technologies. Springer, 2011.

**Weitere Literatur**

- S. Staab, R. Studer (Editors). Handbook on Ontologies. International Handbooks in Information Systems. Springer, 2003.
- Tim Berners-Lee. Weaving the Web. Harper, 1999 geb. 2000 Taschenbuch.
- Ian Jacobs, Norman Walsh. Architecture of the World Wide Web, Volume One. W3C Recommendation 15 December 2004. <http://www.w3.org/TR/webarch/>
- Dean Allemang. Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL. Morgan Kaufmann, 2008.
- Tom Heath and Chris Bizer. Linked Data: Evolving the Web into a Global Data Space. Synthesis Lectures on the Semantic Web: Theory and Technology, 2011.

T

## 4.241 Course: Semigroup Theory for the Navier-Stokes Equations [T-MATH-113415]

**Responsible:** Dr. rer. nat. Patrick Tolksdorf**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-106663 - Semigroup Theory for the Navier-Stokes Equations](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

Exams			
ST 2024	7700156	<a href="#">Semigroup Theory for the Navier-Stokes Equations</a>	Tolksdorf

**Competence Certificate**

oral exam of ca. 30 min

**Prerequisites**

none

**4.242 Course: Seminar in Business Administration A (Master) [T-WIWI-103474]****Responsible:** Professorenschaft des Fachbereichs Betriebswirtschaftslehre**Organisation:** KIT Department of Economics and Management**Part of:** M-WIWI-102971 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2400121	Interactive Analytics Seminar	2 SWS	/ 📱	Beigl, Mädche
ST 2024	2500020	Digital Democracy - Challenges and opportunities of the digital society	2 SWS	Seminar / 🔄	Fegert
ST 2024	2500024	Biosignals in Information Systems & Marketing	2 SWS	Seminar / 🔄	Knierim, del Puppo
ST 2024	2500027	Design Seminar: Digital Citizen Science	2 SWS	Seminar	Berens, Volkamer, Mädche
ST 2024	2500036	Affective User Research for Human-AI Interaction	2 SWS	Seminar / 🔄	Mädche
ST 2024	2500056	ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems	2 SWS	Seminar / 🔄	Mädche
ST 2024	2500125	Human-Centered Systems Seminar: Engineering	3 SWS	Seminar / 🔄	Mädche
ST 2024	2530580	Seminar in Finance (Master)	2 SWS	Seminar / 🎧	Uhrig-Homburg, Müller
ST 2024	2540473	Business Data Analytics	2 SWS	Seminar	Hariharan
ST 2024	2540475	Platforms & Digital Experiences	2 SWS	Seminar	Knierim
ST 2024	2540478	Smart Grid Economics & Energy Markets	2 SWS	Seminar	Weinhardt
ST 2024	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar	Geyer-Schulz
ST 2024	2540553	User-Adaptive Systems Seminar	2 SWS	Seminar / 🔄	Mädche, Beigl
ST 2024	2540557	Human-Centered Systems Seminar: Research	3 SWS	Seminar / 🔄	Mädche
ST 2024	2545002	Entrepreneurship Research	2 SWS	Seminar / 🎧	Terzidis, Tittel, Rosales Bravo
ST 2024	2550493	Hospital Management	2 SWS	Block / 📱	Hansis
ST 2024	2571180	Seminar in Marketing and Sales (Master)	2 SWS	Seminar / 🎧	Klarmann, Mitarbeiter
ST 2024	2571182	Seminar "The Future of Marketing" (Master)	2 SWS	Seminar / 🎧	Kupfer
ST 2024	2579909	Seminar Management Accounting - Special Topics	2 SWS	Seminar / 🎧	Wouters, Jaedeke, Kepl
ST 2024	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar / 🎧	Letmathe
ST 2024	2581030	Seminar Energiewirtschaft IV	2 SWS	Seminar / 🎧	Fichtner, Sloot
ST 2024	2581977	Seminar Produktionswirtschaft und Logistik II	2 SWS	Seminar / 🎧	Volk, Schultmann
ST 2024	2581980	Seminar Energiewirtschaft II	2 SWS	Seminar / 🎧	Fichtner, Finck
WT 24/25	00063	Seminar Social Sentiment in Times of Crises	2 SWS	Seminar	Fegert
WT 24/25	2500006	Digital Citizen Science	2 SWS	Seminar / 🎧	Greif-Winzrieth
WT 24/25	2500045	Digital Democracy - Challenges and Opportunities of the Digital Society	2 SWS	Seminar / 🔄	Fegert, Stein, Bezzaoui, Pekkip

WT 24/25	2500125	Human-Centered Systems Seminar: Engineering	2 SWS	Seminar / ☼	Mädche
WT 24/25	2530293		2 SWS	Seminar / 📱	Ruckes, Benz, Luedecke, Kohl
WT 24/25	2530586			Seminar / 🎤	Uhrig-Homburg, Molnar
WT 24/25	2540473	Business Data Analytics	2 SWS	Seminar / 🎤	Hariharan, Grote, Schulz, Motz
WT 24/25	2540475	Positive Information Systems	2 SWS	Seminar / 🎤	Knierim, del Puppo
WT 24/25	2540478	Smart Grids and Energy Markets	2 SWS	Seminar / 🎤	Weinhardt, Semmelmann, Miskiw
WT 24/25	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar / ☼	Geyer-Schulz, Nazemi
WT 24/25	2540557	Human-Centered Systems Seminar: Research	2 SWS	Seminar / ☼	Mädche
WT 24/25	2550493	Hospital Management	2 SWS	Block / 📱	Hansis
WT 24/25	2571181	Seminar Digital Marketing (Master)	2 SWS	Seminar / 🎤	Kupfer
WT 24/25	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar / 🎤	Nieken, Mitarbeiter
WT 24/25	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar / 🎤	Nieken, Mitarbeiter
WT 24/25	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar / 🎤	Wouters, Dickemann
WT 24/25	2581030	Seminar in Energy Economics	2 SWS	Seminar / 🎤	Fichtner, Sloot
WT 24/25	2581976	Seminar in Production and Operations Management I	2 SWS	Seminar / 🎤	Schultmann, Rudi
WT 24/25	2581977	Seminar in Production and Operations Management II	2 SWS	Seminar / 🎤	Volk, Schultmann
WT 24/25	2581978	Seminar Produktionswirtschaft und Logistik III	2 SWS	Seminar / 🎤	Schultmann, Rosenberg
WT 24/25	2581979	Seminar in Energy Economics	2 SWS	Seminar / 🎤	Fichtner, Kleinebrahm
WT 24/25	2581980	Seminar in Energy Economics	2 SWS	Seminar / 🎤	Fichtner, Sandmeier
WT 24/25	2581981	Seminar in Energy Economics	2 SWS	Seminar / 🎤	Ardone, Fichtner, Slednev
<b>Exams</b>					
ST 2024	7900008	Hospital Management			Hansis
ST 2024	7900052	Entrepreneurship Research			Terzidis
ST 2024	7900127	Seminar in Finance (Master)			Uhrig-Homburg
ST 2024	7900167	Design Seminar: Digital Citizen Science			Volkamer, Mädche
ST 2024	7900190	Human-Centered Systems Seminar: Engineering			Mädche
ST 2024	7900214	Seminar Business Data Analytics			Weinhardt
ST 2024	7900233	Seminar in Marketing and Sales (Master)			Klarmann
ST 2024	7900240	Seminar "The Future of Marketing" (Master)			Kupfer
ST 2024	7900256	Seminar Positive Information Systems			Weinhardt
ST 2024	7900261	Human-Centered Systems Seminar: Research			Mädche
ST 2024	7900265	User-Adaptive Systems Seminar			Mädche
ST 2024	7900281	Affective User Research for Human-AI Interaction			Mädche
ST 2024	7900307	Service Design Thinking			Satzger
ST 2024	7900312	Practical Seminar Service Innovation			Satzger
ST 2024	7900313	Bond Markets - Models & Derivatives			Uhrig-Homburg
ST 2024	7900322	Practical Seminar: Data Science for Industrial Applications			Satzger
ST 2024	7900326	Market Design (MA)			Puppe
ST 2024	7900367	Barriers and Challenges to the Transition towards a Circular Ecosystem: A Systematic Literature Review			Satzger



ST 2024	7900370	<a href="#">ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems</a>	Mädche
ST 2024	79-2579909-M	<a href="#">Seminar Management Accounting - Special Topics (Master)</a>	Wouters
ST 2024	79-2579919-M	<a href="#">Seminar Management Accounting - Sustainability Topics (Master)</a>	Wouters
ST 2024	792581030	<a href="#">Seminar Energy Economics IV</a>	Fichtner
ST 2024	792581031	<a href="#">Seminar Energy Economics V</a>	Plötz
ST 2024	7981976	<a href="#">Seminar in Production and Operations Management I</a>	Schultmann
ST 2024	7981978	<a href="#">Seminar in Production and Operations Management III</a>	Schultmann
ST 2024	7981979	<a href="#">Seminar Energy Economics I</a>	Fichtner
ST 2024	7981980	<a href="#">Seminar Energy Economics II</a>	Fichtner
ST 2024	7981981	<a href="#">Seminar Energy Economics III</a>	Fichtner
WT 24/25	7900069	<a href="#">Human-Centered Systems Seminar: Engineering</a>	Mädche
WT 24/25	7900106	<a href="#">Hospital Management</a>	Hansis
WT 24/25	7900163	<a href="#">Seminar Human Resource Management (Master)</a>	Nieken
WT 24/25	7900164	<a href="#">Seminar Human Resources and Organizations (Master)</a>	Nieken
WT 24/25	7900184	<a href="#">Seminar in Finance (Master)</a>	Ruckes
WT 24/25	7900203	<a href="#">Seminar "Finance in a nutshell"</a>	Uhrig-Homburg
WT 24/25	7900233	<a href="#">Human-Centered Systems Seminar: Research</a>	Mädche
WT 24/25	7900318	<a href="#">Bond Markets - Models &amp; Derivatives</a>	Uhrig-Homburg
WT 24/25	7981977	<a href="#">Seminar in Production and Operations Management II</a>	Schultmann

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

### Prerequisites

None.

### Recommendation

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

### Annotation

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

Below you will find excerpts from events related to this course:

V

### Interactive Analytics Seminar

2400121, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Online

**Content**

Providing new and innovative ways for interacting with data is becoming increasingly important. In this seminar, an interdisciplinary team of students engineers a running software prototype of an advanced interactive system leveraging state-of-the-art hardware and software focusing on an analytical use case. The seminar is carried out in cooperation between Teco/Chair of Pervasive Computing Systems (Prof. Beigl) and the Institute of Information Systems and Marketing (Research Group ISSD, Prof. Mädche). This seminar follows an interdisciplinary approach. Students the fields of computer science, information systems and industrial engineering work together in teams.

**Learning Objectives**

- Explore and specify a data-driven interaction challenge
- Suggest and evaluate different design solutions for addressing the identified problem
- Build interactive analytics prototypes using advanced interaction concepts and pervasive computing technologies

**Prerequisites**

Strong analytic abilities and profound skills in SQL as wells as Python and/or R are required.

**Literature**

Further literature will be made available in the seminar.

**Organizational issues**

nach Vereinbarung

**Design Seminar: Digital Citizen Science**

2500027, SS 2024, 2 SWS, [Open in study portal](#)

Seminar (S)

**Content**

TBA

**Affective User Research for Human-AI Interaction**

2500036, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)

### Content

User research aims to understand users' needs, behaviors, and attitudes to effectively inform the design and development of products or services. It is a key endeavor to learn how users experience digital technologies, what is working well and what is not, and identify gaps and future needs in order to personalize and improve the user experience. To design for positive user experiences, investigating affective user reactions (e.g., emotions, stress, flow) is of particular interest. Therefore, affective user research collects and analyzes behavioral data and affective reactions of users when engaging with products or services. With the growing amount of data and computing capabilities, artificial intelligence (AI) technologies are increasingly used in user research for the prediction of affective user states when interacting with digital technology.

The recent advances in artificial intelligence (AI), however, may not only support affective user research as a method of inquire, but it also has found its way into our daily lives as humans interact with it every day, for example, in form of recommendation engines on social media, in health applications, or as personal assistants based on large language models (LLMs) to receive text output for code completion, ideation, or writing. Interacting with AI-based digital technologies also triggers affective user reactions. However, these affective user reactions in Human-AI Interactions are yet to be understood.

In this seminar, participants will apply methods for affective user research on a particular type of Human-AI Interaction, the prompting of LLMs. LLM prompting is expected to become the up-and-coming form of interacting with AI in the future. To receive output from an LLM, users must send a prompt to the LLM. Given a prompt, an LLM responds incrementally with "tokens" (e.g., groups of letters, numbers, punctuation) which build the output. Structuring the prompt and receiving output influences the affective reactions of the user. Precisely, these user reactions should be investigated by the students participating in this seminar.

In the "Affective User Research for Human-AI Interaction" seminar, participating students will learn how to apply AI-based user research methods with a specific emphasis on the affective dimension when interacting with AI-based digital technologies. The goal of this seminar is to provide students with a unique set of skills in (1) quantitative data analysis, (2) knowledge about Human-AI Interaction and, in particular, LLM prompting, and (3) prediction of affective user states (e.g., emotions, stress) using state-of-the-art machine learning (ML) techniques. Students will leverage a dataset on Human-AI Interaction and gain in-depth knowledge from it as part of the seminar. The seminar emphasizes the importance of applying the aforementioned affective user research methods in an ethically compliant form. The core activities include:

- Learn the fundamentals of AI-based affective user research methods.
- Explore a dataset on Human-AI Interaction with the specific focus on the interplay of user behavior and affective user reactions.
- Developing AI-based supervised machine learning techniques for predicting user activities and affective user states.
- Present findings and insights to the seminar audience and discuss the results.

The seminar is held by Dr. Ivo Benke in cooperation with Dr. Lennard Schmidt. Both are experts from industry in the fields of affective user research, quantitative data analysis, and Human-AI Interaction.

### Learning Objectives

- Understand the potential of combining user behavior and affective user reaction data for affective user research.
- Develop hands-on knowledge by applying AI-based affective user research methods on a real-world dataset.
- Develop a deeper understanding of a prominent form of Human-AI Interaction (e.g., LLM prompting).
- Deliver a presentation in a scientific context in front of an auditorium.



### ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems

2500056, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)

### Content

**Background:** In the ABBA Summer School Seminar hosted at the Karlsruhe Decision & Design Lab (KD<sup>2</sup>Lab) at KIT, we aim to enable students to explore biosignal sensors for designing user-adaptive systems. This comprehensive three-day program is designed for both bachelor's and master's students who want to gain an understanding of biosignal and the development of user-adaptive systems. The learning objective is to design human-centered biosignal-adaptive systems to address user needs in learning scenarios.

**Course Content:** Throughout the summer school, students will learn the foundations of biosignal-adaptive systems through a series of lectures and apply the knowledge in practical group work. For the group work, we offer students two contexts for their research topics: literature research during thesis writing and programming with LLM. Aiming to address user challenges in these two contexts, we provide two biosignal sensors: EEG or eye-tracking sensors. By collecting biosignal data with the sensors, we encourage students to integrate cutting-edge AI algorithms for their design and implementation. In the end, students should present their results to showcase the functionality, innovation, and a prototype of their biosignal-adaptive systems.

**Learning Outcome:** By successfully achieving the learning objective, students will receive a certificate from KIT and will have the opportunity to apply their acquired skills and knowledge for further research.

The seminar will be held in a three-day format from 23th to 25th September with 3 ECTS. For any questions, please ask Luke ([shi.liu@kit.edu](mailto:shi.liu@kit.edu)) for more information!



### Human-Centered Systems Seminar: Engineering

2500125, SS 2024, 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.

**Master Seminar in Data Science and Machine Learning**

2540510, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)

**User-Adaptive Systems Seminar**

2540553, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)**Content**

User-adaptive systems collect and analyze biosignals from users to recognize user states as a basis for adaptation. Thermic, mechanical, electric, acoustic, and optical signals are collected using sensors which are integrated in wearables, e.g. glasses, earphones, belts, or bracelets. The collected data is processed with analytics and machine learning techniques in order to determine short-term, evolving over time, and long-term user states in the form of user characteristics, affective-cognitive states, or behavior. Finally, the recognized user states are leveraged for realizing user-centric adaptations.

In this seminar, interdisciplinary teams of students design, develop, and evaluate a user-adaptive system prototype leveraging state-of-the-art hard- and software. This seminar follows an interdisciplinary approach. Students from the fields of computer science, information systems and industrial engineering & management collaborate in the prototype design, development, and evaluation.

The seminar is carried out in cooperation between Teco/Chair of Pervasive Computing Systems (Prof. Beigl) and the Institute of Information Systems and Marketing (h-lab, Prof. Mädche). It is offered as part of the DFG-funded graduate school "KD2School: Designing Adaptive Systems for Economic Decisions" (<https://kd2school.info/>)

**Learning objectives of the seminar**

- Explain what a user-adaptive system is and how it can be conceptualized
- Suggest and evaluate different design solutions for addressing the identified problem
- Build a user-adaptive system prototype using state-of-the-art hard- and software
- Perform a user-centric evaluation of the user-adaptive system prototype

**Prerequisites**

Strong analytical abilities and profound software development skills are required.

**Organizational issues**

Termine werden bekannt gegeben

**Literature**

Required literature will be made available in the seminar.

**Human-Centered Systems Seminar: Research**

2540557, SS 2024, 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

	<b>Entrepreneurship Research</b> 2545002, SS 2024, 2 SWS, Language: English, <a href="#">Open in study portal</a>	<b>Seminar (S)</b> <b>On-Site</b>
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**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**

Monday, 17.06.2024, 10.00-17.00

Thursday, 27.06.2024, 10.00-17.00

Thursday, 25.07.2024, 10.00-17.00

Registration is via the Wiwi-Portal.

**Literature**

Will be announced in the seminar.

**Hospital Management**2550493, SS 2024, 2 SWS, Language: German, [Open in study portal](#)**Block (B)  
Online****Content**

The seminar 'Hospital Management' presents internal organization structures, work conditions and work environments at the example of hospitals und relates this to common and expected conditions of other service industries.

Covered topics include normative environment, intra-organizational structure, personnel management, quality, external networking and market appearance. The course consists of two full-day sessions.

The assessment consists of attendance and a presentation or a case study.

**Organizational issues**

Das Seminar wird als Blockveranstaltung stattfinden. Die Termine werden bei der Anmeldung über das Wiwi-Portal bekanntgegeben.

**Seminar Management Accounting - Special Topics**2579909, SS 2024, 2 SWS, Language: English, [Open in study portal](#)**Seminar (S)  
On-Site****Content**

The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. You are to a large extent free to select your own topic. The seminar course is concentrated in four meetings that are spread throughout the semester.

**Learning objectives:**

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources).

**Workload:**

- The total workload for this course is approximately 90 hours. For further information see German version.

**Examination:**

- The performance review is carried out in the form of a "Prüfungsleistung anderer Art" (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

**Required prior Courses:**

- The course requires a basic knowledge of finance and accounting.

**Note:**

- Maximum of 16 students.

**Organizational issues**

Geb.05.20, 2A-12.1; Termine werden bekannt gegeben

**Literature**

Will be announced in the course.

**Seminar Management Accounting - Sustainability Topics**2579919, SS 2024, 2 SWS, Language: English, [Open in study portal](#)**Seminar (S)  
On-Site**

**Content**

The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. Topics are selectively prediscbed. The seminar course is concentrated in several meetings that are spread throughout the semester.

**Learning objectives:**

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources).

**Workload:**

- The total workload for this course is approximately 90 hours. For further information see German version.

**Examination:**

- The performance review is carried out in the form of a "Prüfungsleistung anderer Art" (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

**Required prior Courses:**

- The course requires a basic knowledge of finance and accounting.

**Note:**

- Maximum of 8 students.

**Organizational issues**

Geb.05.20, 2A-12.1; Termine werden bekannt gegeben

**Literature**

Will be announced in the course.



2530586, WS 24/25, SWS, Language: German, [Open in study portal](#)

**Seminar (S)**  
**On-Site**

**Content**

Within this seminar eLearning videos are produced to different topics out of the contents of our lectures. The student gets in touch with scientific work. Through profound working on a specific scientific topic the student is meant to learn the foundations of scientific research and reasoning in particular in finance. Through conduction of the video the student becomes familiar with the fundamental techniques for presentations and foundations of scientific reasoning. In addition, the student earns rhetorical skills.

The success is monitored by the development of an eLearning video and by the writing of a project report (according to §4(2), 3 SPO).

The overall grade is made up of these partial performances.

**Recommendations:**

Knowledge of the content of the modules *Essentials of Finance* [WW3BWLFBV1] (for bachelor students) and *F1 (Finance)* [WW4BWLFBV1] (for master students) is assumed.

The total workload for this course is approximately 90 hours. For further information see German version.

**Organizational issues**

Kickoff am 21.10.24 um 16 Uhr, Zwischenpräsentation am 10.12.24, 16 Uhr und Abschlusspräsentation am 21.01.25, 17:45 Uhr am Campus B (Geb. 09.21), Raum 209

**Business Data Analytics**

2540473, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)

**Seminar (S)**  
**On-Site**

**Content**

wird auf deutsch und englisch gehalten

**Organizational issues**

Blockveranstaltung, siehe WWW

	<b>Master Seminar in Data Science and Machine Learning</b> 2540510, WS 24/25, 2 SWS, Language: German, <a href="#">Open in study portal</a>	Seminar (S) Blended (On-Site/Online)
	<b>Hospital Management</b> 2550493, WS 24/25, 2 SWS, Language: German, <a href="#">Open in study portal</a>	Block (B) Online
	<b>Seminar Human Resource Management (Master)</b> 2573012, WS 24/25, 2 SWS, Language: German, <a href="#">Open in study portal</a>	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

	<b>Seminar Human Resources and Organizations (Master)</b> 2573013, WS 24/25, 2 SWS, Language: German, <a href="#">Open in study portal</a>	Seminar (S) On-Site
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**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

**Seminar Management Accounting - Sustainability Topics**

2579919, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

**Seminar (S)  
On-Site**

**Content**

The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. Topics are selectively prediscibed. The seminar course is concentrated in several meetings that are spread throughout the semester.

**Learning objectives:**

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources).

**Examination:**

- The performance review is carried out in the form of a "Prüfungsleistung anderer Art" (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

**Required prior Courses:**

- The course requires a basic knowledge of finance and accounting.

**Workload:**

- The total workload for this course is approximately 90 hours. For further information see German version.

**Note:**

- Maximum of 8 students.

**Organizational issues**

Ort und Zeit werden noch bekannt gegeben bzw. über ILIAS

**Literature**

Will be announced in the course.

**4.243 Course: Seminar in Business Administration B (Master) [T-WIWI-103476]****Responsible:** Professorenschaft des Fachbereichs Betriebswirtschaftslehre**Organisation:** KIT Department of Economics and Management**Part of:** M-WIWI-102972 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2500020	Digital Democracy - Challenges and opportunities of the digital society	2 SWS	Seminar / 🔄	Fegert
ST 2024	2500024	Biosignals in Information Systems & Marketing	2 SWS	Seminar / 🔄	Knierim, del Puppo
ST 2024	2500027	Design Seminar: Digital Citizen Science	2 SWS	Seminar	Berens, Volkamer, Mädche
ST 2024	2500036	Affective User Research for Human-AI Interaction	2 SWS	Seminar / 🔄	Mädche
ST 2024	2500056	ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems	2 SWS	Seminar / 🔄	Mädche
ST 2024	2500125	Human-Centered Systems Seminar: Engineering	3 SWS	Seminar / 🔄	Mädche
ST 2024	2530580	Seminar in Finance (Master)	2 SWS	Seminar / 🎧	Uhrig-Homburg, Müller
ST 2024	2540473	Business Data Analytics	2 SWS	Seminar	Hariharan
ST 2024	2540475	Platforms & Digital Experiences	2 SWS	Seminar	Knierim
ST 2024	2540478	Smart Grid Economics & Energy Markets	2 SWS	Seminar	Weinhardt
ST 2024	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar	Geyer-Schulz
ST 2024	2540553	User-Adaptive Systems Seminar	2 SWS	Seminar / 🔄	Mädche, Beigl
ST 2024	2540557	Human-Centered Systems Seminar: Research	3 SWS	Seminar / 🔄	Mädche
ST 2024	2545002	Entrepreneurship Research	2 SWS	Seminar / 🎧	Terzidis, Tittel, Rosales Bravo
ST 2024	2550493	Hospital Management	2 SWS	Block / 📱	Hansis
ST 2024	2571180	Seminar in Marketing and Sales (Master)	2 SWS	Seminar / 🎧	Klarmann, Mitarbeiter
ST 2024	2571182	Seminar "The Future of Marketing" (Master)	2 SWS	Seminar / 🎧	Kupfer
ST 2024	2579909	Seminar Management Accounting - Special Topics	2 SWS	Seminar / 🎧	Wouters, Jaedeke, Kepl
ST 2024	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar / 🎧	Letmathe
ST 2024	2581030	Seminar Energiewirtschaft IV	2 SWS	Seminar / 🎧	Fichtner, Sloot
ST 2024	2581977	Seminar Produktionswirtschaft und Logistik II	2 SWS	Seminar / 🎧	Volk, Schultmann
ST 2024	2581980	Seminar Energiewirtschaft II	2 SWS	Seminar / 🎧	Fichtner, Finck
WT 24/25	00063	Seminar Social Sentiment in Times of Crises	2 SWS	Seminar	Fegert
WT 24/25	2500006	Digital Citizen Science	2 SWS	Seminar / 🎧	Greif-Winzrieth
WT 24/25	2500045	Digital Democracy - Challenges and Opportunities of the Digital Society	2 SWS	Seminar / 🔄	Fegert, Stein, Bezzaoui, Pekkipp

WT 24/25	2500125	Human-Centered Systems Seminar: Engineering	2 SWS	Seminar / 🌀	Mädche
WT 24/25	2530293		2 SWS	Seminar / 📱	Ruckes, Benz, Luedecke, Kohl
WT 24/25	2530586			Seminar / 🎤	Uhrig-Homburg, Molnar
WT 24/25	2540473	Business Data Analytics	2 SWS	Seminar / 🎤	Hariharan, Grote, Schulz, Motz
WT 24/25	2540475	Positive Information Systems	2 SWS	Seminar / 🎤	Knierim, del Puppo
WT 24/25	2540478	Smart Grids and Energy Markets	2 SWS	Seminar / 🎤	Weinhardt, Semmelmann, Miskiw
WT 24/25	2540510	Master Seminar in Data Science and Machine Learning	2 SWS	Seminar / 🌀	Geyer-Schulz, Nazemi
WT 24/25	2540557	Human-Centered Systems Seminar: Research	2 SWS	Seminar / 🌀	Mädche
WT 24/25	2550493	Hospital Management	2 SWS	Block / 📱	Hansis
WT 24/25	2571181	Seminar Digital Marketing (Master)	2 SWS	Seminar / 🎤	Kupfer
WT 24/25	2573012	Seminar Human Resource Management (Master)	2 SWS	Seminar / 🎤	Nieken, Mitarbeiter
WT 24/25	2573013	Seminar Human Resources and Organizations (Master)	2 SWS	Seminar / 🎤	Nieken, Mitarbeiter
WT 24/25	2579919	Seminar Management Accounting - Sustainability Topics	2 SWS	Seminar / 🎤	Wouters, Dickemann
WT 24/25	2581030	Seminar in Energy Economics	2 SWS	Seminar / 🎤	Fichtner, Sloot
WT 24/25	2581976	Seminar in Production and Operations Management I	2 SWS	Seminar / 🎤	Schultmann, Rudi
WT 24/25	2581977	Seminar in Production and Operations Management II	2 SWS	Seminar / 🎤	Volk, Schultmann
WT 24/25	2581978	Seminar Produktionswirtschaft und Logistik III	2 SWS	Seminar / 🎤	Schultmann, Rosenberg
WT 24/25	2581979	Seminar in Energy Economics	2 SWS	Seminar / 🎤	Fichtner, Kleinebrahm
WT 24/25	2581980	Seminar in Energy Economics	2 SWS	Seminar / 🎤	Fichtner, Sandmeier
WT 24/25	2581981	Seminar in Energy Economics	2 SWS	Seminar / 🎤	Ardone, Fichtner, Slednev
<b>Exams</b>					
ST 2024	7900008	Hospital Management			Hansis
ST 2024	7900052	Entrepreneurship Research			Terzidis
ST 2024	7900127	Seminar in Finance (Master)			Uhrig-Homburg
ST 2024	7900167	Design Seminar: Digital Citizen Science			Volkamer, Mädche
ST 2024	7900190	Human-Centered Systems Seminar: Engineering			Mädche
ST 2024	7900214	Seminar Business Data Analytics			Weinhardt
ST 2024	7900233	Seminar in Marketing and Sales (Master)			Klarmann
ST 2024	7900240	Seminar "The Future of Marketing" (Master)			Kupfer
ST 2024	7900256	Seminar Positive Information Systems			Weinhardt
ST 2024	7900261	Human-Centered Systems Seminar: Research			Mädche
ST 2024	7900265	User-Adaptive Systems Seminar			Mädche
ST 2024	7900281	Affective User Research for Human-AI Interaction			Mädche
ST 2024	7900307	Service Design Thinking			Satzger
ST 2024	7900312	Practical Seminar Service Innovation			Satzger
ST 2024	7900313	Bond Markets - Models & Derivatives			Uhrig-Homburg
ST 2024	7900322	Practical Seminar: Data Science for Industrial Applications			Satzger
ST 2024	7900367	Barriers and Challenges to the Transition towards a Circular Ecosystem: A Systematic Literature Review			Satzger
ST 2024	7900370	ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems			Mädche

ST 2024	79-2579909-M	Seminar Management Accounting - Special Topics (Master)	Wouters
ST 2024	79-2579919-M	Seminar Management Accounting - Sustainability Topics (Master)	Wouters
ST 2024	792581030	Seminar Energy Economics IV	Fichtner
ST 2024	792581031	Seminar Energy Economics V	Plötz
ST 2024	7981976	Seminar in Production and Operations Management I	Schultmann
ST 2024	7981978	Seminar in Production and Operations Management III	Schultmann
ST 2024	7981979	Seminar Energy Economics I	Fichtner
ST 2024	7981980	Seminar Energy Economics II	Fichtner
ST 2024	7981981	Seminar Energy Economics III	Fichtner
WT 24/25	7900069	Human-Centered Systems Seminar: Engineering	Mädche
WT 24/25	7900106	Hospital Management	Hansis
WT 24/25	7900163	Seminar Human Resource Management (Master)	Nieken
WT 24/25	7900164	Seminar Human Resources and Organizations (Master)	Nieken
WT 24/25	7900184	Seminar in Finance (Master)	Ruckes
WT 24/25	7900203	Seminar "Finance in a nutshell"	Uhrig-Homburg
WT 24/25	7900233	Human-Centered Systems Seminar: Research	Mädche
WT 24/25	7900318	Bond Markets - Models & Derivatives	Uhrig-Homburg
WT 24/25	7981977	Seminar in Production and Operations Management II	Schultmann

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

### Prerequisites

None.

### Recommendation

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

### Annotation

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

Below you will find excerpts from events related to this course:



**Design Seminar: Digital Citizen Science**

2500027, SS 2024, 2 SWS, [Open in study portal](#)

**Seminar (S)**

### Content

TBA



**Affective User Research for Human-AI Interaction**

2500036, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

**Seminar (S)**  
**Blended (On-Site/Online)**

### Content

User research aims to understand users' needs, behaviors, and attitudes to effectively inform the design and development of products or services. It is a key endeavor to learn how users experience digital technologies, what is working well and what is not, and identify gaps and future needs in order to personalize and improve the user experience. To design for positive user experiences, investigating affective user reactions (e.g., emotions, stress, flow) is of particular interest. Therefore, affective user research collects and analyzes behavioral data and affective reactions of users when engaging with products or services. With the growing amount of data and computing capabilities, artificial intelligence (AI) technologies are increasingly used in user research for the prediction of affective user states when interacting with digital technology.

The recent advances in artificial intelligence (AI), however, may not only support affective user research as a method of inquire, but it also has found its way into our daily lives as humans interact with it every day, for example, in form of recommendation engines on social media, in health applications, or as personal assistants based on large language models (LLMs) to receive text output for code completion, ideation, or writing. Interacting with AI-based digital technologies also triggers affective user reactions. However, these affective user reactions in Human-AI Interactions are yet to be understood.

In this seminar, participants will apply methods for affective user research on a particular type of Human-AI Interaction, the prompting of LLMs. LLM prompting is expected to become the up-and-coming form of interacting with AI in the future. To receive output from an LLM, users must send a prompt to the LLM. Given a prompt, an LLM responds incrementally with "tokens" (e.g., groups of letters, numbers, punctuation) which build the output. Structuring the prompt and receiving output influences the affective reactions of the user. Precisely, these user reactions should be investigated by the students participating in this seminar.

In the "Affective User Research for Human-AI Interaction" seminar, participating students will learn how to apply AI-based user research methods with a specific emphasis on the affective dimension when interacting with AI-based digital technologies. The goal of this seminar is to provide students with a unique set of skills in (1) quantitative data analysis, (2) knowledge about Human-AI Interaction and, in particular, LLM prompting, and (3) prediction of affective user states (e.g., emotions, stress) using state-of-the-art machine learning (ML) techniques. Students will leverage a dataset on Human-AI Interaction and gain in-depth knowledge from it as part of the seminar. The seminar emphasizes the importance of applying the aforementioned affective user research methods in an ethically compliant form. The core activities include:

- Learn the fundamentals of AI-based affective user research methods.
- Explore a dataset on Human-AI Interaction with the specific focus on the interplay of user behavior and affective user reactions.
- Developing AI-based supervised machine learning techniques for predicting user activities and affective user states.
- Present findings and insights to the seminar audience and discuss the results.

The seminar is held by Dr. Ivo Benke in cooperation with Dr. Lennard Schmidt. Both are experts from industry in the fields of affective user research, quantitative data analysis, and Human-AI Interaction.

### Learning Objectives

- Understand the potential of combining user behavior and affective user reaction data for affective user research.
- Develop hands-on knowledge by applying AI-based affective user research methods on a real-world dataset.
- Develop a deeper understanding of a prominent form of Human-AI Interaction (e.g., LLM prompting).
- Deliver a presentation in a scientific context in front of an auditorium.



### ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems

2500056, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)

### Content

**Background:** In the ABBA Summer School Seminar hosted at the Karlsruhe Decision & Design Lab (KD<sup>2</sup>Lab) at KIT, we aim to enable students to explore biosignal sensors for designing user-adaptive systems. This comprehensive three-day program is designed for both bachelor's and master's students who want to gain an understanding of biosignal and the development of user-adaptive systems. The learning objective is to design human-centered biosignal-adaptive systems to address user needs in learning scenarios.

**Course Content:** Throughout the summer school, students will learn the foundations of biosignal-adaptive systems through a series of lectures and apply the knowledge in practical group work. For the group work, we offer students two contexts for their research topics: literature research during thesis writing and programming with LLM. Aiming to address user challenges in these two contexts, we provide two biosignal sensors: EEG or eye-tracking sensors. By collecting biosignal data with the sensors, we encourage students to integrate cutting-edge AI algorithms for their design and implementation. In the end, students should present their results to showcase the functionality, innovation, and a prototype of their biosignal-adaptive systems.

**Learning Outcome:** By successfully achieving the learning objective, students will receive a certificate from KIT and will have the opportunity to apply their acquired skills and knowledge for further research.

The seminar will be held in a three-day format from 23th to 25th September with 3 ECTS. For any questions, please ask Luke ([shi.liu@kit.edu](mailto:shi.liu@kit.edu)) for more information!



### Human-Centered Systems Seminar: Engineering

2500125, SS 2024, 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.

**Master Seminar in Data Science and Machine Learning**

2540510, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)

**User-Adaptive Systems Seminar**

2540553, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)

**Content**

User-adaptive systems collect and analyze biosignals from users to recognize user states as a basis for adaptation. Thermic, mechanical, electric, acoustic, and optical signals are collected using sensors which are integrated in wearables, e.g. glasses, earphones, belts, or bracelets. The collected data is processed with analytics and machine learning techniques in order to determine short-term, evolving over time, and long-term user states in the form of user characteristics, affective-cognitive states, or behavior. Finally, the recognized user states are leveraged for realizing user-centric adaptations.

In this seminar, interdisciplinary teams of students design, develop, and evaluate a user-adaptive system prototype leveraging state-of-the-art hard- and software. This seminar follows an interdisciplinary approach. Students from the fields of computer science, information systems and industrial engineering & management collaborate in the prototype design, development, and evaluation.

The seminar is carried out in cooperation between Teco/Chair of Pervasive Computing Systems (Prof. Beigl) and the Institute of Information Systems and Marketing (h-lab, Prof. Mädche). It is offered as part of the DFG-funded graduate school "KD2School: Designing Adaptive Systems for Economic Decisions" (<https://kd2school.info/>)

**Learning objectives of the seminar**

- Explain what a user-adaptive system is and how it can be conceptualized
- Suggest and evaluate different design solutions for addressing the identified problem
- Build a user-adaptive system prototype using state-of-the-art hard- and software
- Perform a user-centric evaluation of the user-adaptive system prototype

**Prerequisites**

Strong analytical abilities and profound software development skills are required.

**Organizational issues**

Termine werden bekannt gegeben

**Literature**

Required literature will be made available in the seminar.

**Human-Centered Systems Seminar: Research**

2540557, SS 2024, 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

	<p><b>Entrepreneurship Research</b> 2545002, SS 2024, 2 SWS, Language: English, <a href="#">Open in study portal</a></p>	<p><b>Seminar (S)</b> <b>On-Site</b></p>
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**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**

Monday, 17.06.2024, 10.00-17.00

Thursday, 27.06.2024, 10.00-17.00

Thursday, 25.07.2024, 10.00-17.00

Registration is via the Wiwi-Portal.

**Literature**

Will be announced in the seminar.

**Hospital Management**2550493, SS 2024, 2 SWS, Language: German, [Open in study portal](#)**Block (B)**  
**Online****Content**

The seminar 'Hospital Management' presents internal organization structures, work conditions and work environments at the example of hospitals und relates this to common and expected conditions of other service industries.

Covered topics include normative environment, intra-organizational structure, personnel management, quality, external networking and market appearance. The course consists of two full-day sessions.

The assessment consists of attendance and a presentation or a case study.

**Organizational issues**

Das Seminar wird als Blockveranstaltung stattfinden. Die Termine werden bei der Anmeldung über das Wiwi-Portal bekanntgegeben.

**Seminar Management Accounting - Special Topics**2579909, SS 2024, 2 SWS, Language: English, [Open in study portal](#)**Seminar (S)**  
**On-Site****Content**

The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. You are to a large extent free to select your own topic. The seminar course is concentrated in four meetings that are spread throughout the semester.

**Learning objectives:**

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources).

**Workload:**

- The total workload for this course is approximately 90 hours. For further information see German version.

**Examination:**

- The performance review is carried out in the form of a "Prüfungsleistung anderer Art" (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

**Required prior Courses:**

- The course requires a basic knowledge of finance and accounting.

**Note:**

- Maximum of 16 students.

**Organizational issues**

Geb.05.20, 2A-12.1; Termine werden bekannt gegeben

**Literature**

Will be announced in the course.

**Seminar Management Accounting - Sustainability Topics**2579919, SS 2024, 2 SWS, Language: English, [Open in study portal](#)**Seminar (S)**  
**On-Site**



**Content**

The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. Topics are selectively prediscbed. The seminar course is concentrated in several meetings that are spread throughout the semester.

**Learning objectives:**

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources).

**Workload:**

- The total workload for this course is approximately 90 hours. For further information see German version.

**Examination:**

- The performance review is carried out in the form of a "Prüfungsleistung anderer Art" (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

**Required prior Courses:**

- The course requires a basic knowledge of finance and accounting.

**Note:**

- Maximum of 8 students.

**Organizational issues**

Geb.05.20, 2A-12.1; Termine werden bekannt gegeben

**Literature**

Will be announced in the course.



2530586, WS 24/25, SWS, Language: German, [Open in study portal](#)

**Seminar (S)**  
**On-Site**

**Content**

Within this seminar eLearning videos are produced to different topics out of the contents of our lectures. The student gets in touch with scientific work. Through profound working on a specific scientific topic the student is meant to learn the foundations of scientific research and reasoning in particular in finance. Through conduction of the video the student becomes familiar with the fundamental techniques for presentations and foundations of scientific reasoning. In addition, the student earns rhetorical skills.

The success is monitored by the development of an eLearning video and by the writing of a project report (according to §4(2), 3 SPO).

The overall grade is made up of these partial performances.

**Recommendations:**

Knowledge of the content of the modules *Essentials of Finance* [WW3BWLFBV1] (for bachelor students) and *F1 (Finance)* [WW4BWLFBV1] (for master students) is assumed.

The total workload for this course is approximately 90 hours. For further information see German version.

**Organizational issues**

Kickoff am 21.10.24 um 16 Uhr, Zwischenpräsentation am 10.12.24, 16 Uhr und Abschlusspräsentation am 21.01.25, 17:45 Uhr am Campus B (Geb. 09.21), Raum 209

**Business Data Analytics**

2540473, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)

**Seminar (S)**  
**On-Site**

**Content**

wird auf deutsch und englisch gehalten

**Organizational issues**

Blockveranstaltung, siehe WWW

	<b>Master Seminar in Data Science and Machine Learning</b> 2540510, WS 24/25, 2 SWS, Language: German, <a href="#">Open in study portal</a>	Seminar (S) Blended (On-Site/Online)
	<b>Hospital Management</b> 2550493, WS 24/25, 2 SWS, Language: German, <a href="#">Open in study portal</a>	Block (B) Online
	<b>Seminar Human Resource Management (Master)</b> 2573012, WS 24/25, 2 SWS, Language: German, <a href="#">Open in study portal</a>	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

	<b>Seminar Human Resources and Organizations (Master)</b> 2573013, WS 24/25, 2 SWS, Language: German, <a href="#">Open in study portal</a>	Seminar (S) On-Site
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**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

**Seminar Management Accounting - Sustainability Topics**

2579919, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

**Seminar (S)  
On-Site**

**Content**

The course will be a mix of lectures, discussions, and student presentations. Students will write a paper in small groups, and present this in the final week. Topics are selectively prediscibed. The seminar course is concentrated in several meetings that are spread throughout the semester.

**Learning objectives:**

- Students are largely independently able to identify a distinct topic in Management Accounting,
- Students are capable to research the topic, analyze the information, to conceptualize and deduct fundamental principles and relationships from relatively unstructured information,
- Students can afterwards logically and systematically present the results in writing and as an oral presentation, following a scientific approach (structuring, terminology, sources).

**Examination:**

- The performance review is carried out in the form of a "Prüfungsleistung anderer Art" (following § 4 (2) No. 3 of the examination regulation), which in this case is an essay the seminar participants prepare in group work.
- The final grade is made up of the grade of the seminar paper, the presentation and the contributions in the seminar sessions.

**Required prior Courses:**

- The course requires a basic knowledge of finance and accounting.

**Workload:**

- The total workload for this course is approximately 90 hours. For further information see German version.

**Note:**

- Maximum of 8 students.

**Organizational issues**

Ort und Zeit werden noch bekannt gegeben bzw. über ILIAS

**Literature**

Will be announced in the course.

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## 4.244 Course: Seminar in Economics A (Master) [T-WIWI-103478]

**Responsible:** Professorenschaft des Fachbereichs Volkswirtschaftslehre**Organisation:** KIT Department of Economics and Management**Part of:** M-WIWI-102971 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2500004	Predictive Data Analytics - An Introduction to Statistical Machine Learning	2 SWS	Seminar / 🎧	Schienle, Lerch
ST 2024	2520367	Strategische Entscheidungen	2 SWS	Seminar / 🔄	Ehrhart
ST 2024	2520536	Seminar in Economic Theory II	2 SWS	Seminar / 🎧	Ammann, Kretz, Okulicz
ST 2024	2520563	Wirtschaftstheoretisches Seminar III	2 SWS	Seminar / 🎧	Ammann, Kretz, Okulicz
ST 2024	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher
ST 2024	2560130	Seminar Public Finance	2 SWS	Block / 🔄	Wigger, Schmelzer
ST 2024	2560282	Seminar in economic policy	2 SWS	Seminar / 🎧	Ott, Assistenten
ST 2024	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🔄	Brumm, Krause, Pegorari
ST 2024	2560552	Seminar Shaping AI and Digitization for Society (Master)	2 SWS	Seminar / 🔄	Zhao
WT 24/25	25000111	Statistics and Epidemics		Seminar / 🎧	Bracher
WT 24/25	2500024	Wirtschaftstheoretisches Seminar IV (Master)	2 SWS	Seminar / 🔄	Puppe, Kretz, Ammann, Okulicz
WT 24/25	2500047	Advanced Topics in Econometrics, Statistics and Data Science	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher
WT 24/25	2520405	Topics in Experimental Economics		Seminar / 🎧	Reiß, Peters
WT 24/25	2520500	Workshop on Economics, Finance and Statistics	2 SWS	Seminar	Puppe, Brumm, Nieken, Ott, Reiß, Ruckes, Schienle, Uhrig-Homburg, Wigger, Krüger
WT 24/25	2520563	Wirtschaftstheoretisches Seminar III (Master)	2 SWS	Seminar / 🔄	Puppe, Ammann, Kretz
WT 24/25	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Rüter
WT 24/25	2560130	Seminar Public Finance	2 SWS	Seminar / 🔄	Wigger, Schmelzer
WT 24/25	2560142	Seminar Game Theory and Behavioral Economics (Master)	2 SWS	Seminar / 🎧	Rau, Rosar
WT 24/25	2560143	AI and Digitization for Society (Master)	2 SWS	Seminar / 🔄	Zhao
WT 24/25	2560282	Seminar in Economic Policy	2 SWS	Seminar / 🎧	Ott, Assistenten
WT 24/25	2560400	Seminar in Macroeconomics I	2 SWS	Seminar / 🔄	Brumm, Pegorari, Frank
WT 24/25	2561208	Selected aspects of European transport planning and -modelling	2 SWS	Seminar	Szimba
Exams					
ST 2024	7900004	Predictive Data Analytics - An Introduction to Statistical Machine Learning			Lerch
ST 2024	7900051	Seminar in Economic Policy			Ott

ST 2024	7900131	<a href="#">Shaping AI and Digitization for Society (Master)</a>	Puppe
ST 2024	7900164	<a href="#">Seminar in Economics (Bachelor)</a>	Mitusch
ST 2024	7900318	<a href="#">Seminar in Economics A (Master)</a>	Ehrhart
ST 2024	7900331	<a href="#">Seminar: Networks in Economics (Master)</a>	Puppe
ST 2024	7900363	<a href="#">Seminar in Macroeconomics I: Macroeconomic Implications of Artificial Intelligence</a>	Brumm
ST 2024	7900369	<a href="#">Seminar on Topics in Digital Economics</a>	Reiß, Hillenbrand
ST 2024	79100005	<a href="#">Topics in Experimental Economics</a>	Reiß
ST 2024	79sefi2	<a href="#">Seminar Public Finance A (Master)</a>	Wigger
WT 24/25	7900090	<a href="#">Advanced Topics in Econometrics, Statistics and Data Science</a>	Schienle
WT 24/25	7900140	<a href="#">Seminar Game Theory and Behavioral Economics (Master)</a>	Puppe
WT 24/25	7900212	<a href="#">Seminar in Economic Policy</a>	Ott
WT 24/25	7900296	<a href="#">Seminar AI and Digitization for Society (Master)</a>	Puppe
WT 24/25	79sefi2	<a href="#">Seminar Public Finance A (Master)</a>	Wigger

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

### Competence Certificate

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

### Prerequisites

None.

### Recommendation

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

### Annotation

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

Below you will find excerpts from events related to this course:

**Predictive Data Analytics - An Introduction to Statistical Machine Learning**

2500004, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)

**Seminar (S)**  
On-Site

### Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben

**Advanced Topics in Econometrics**

2521310, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)

**Seminar (S)**

### Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben

**Seminar Public Finance**

2560130, SS 2024, 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.

**Seminar Shaping AI and Digitization for Society (Master)**

2560552, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

**Seminar (S)**  
**Blended (On-Site/Online)**

**Content**

Participation will be limited to 12 students.

For Master students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Econometrics.

Objective: The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see <http://polit.econ.kit.edu> or <https://portal.wiwi.kit.edu/Seminare>

The acceptance of students for the seminar via the platform <https://portal.wiwi.kit.edu/Seminare> is based on preferences and suitability for the topics. This includes theoretical and practical experience with Behavioral Economics as well as English skills.

Grading: Seminar Papers of 8–10 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%). Students can improve their grades by 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**

Registration via WiWi-Portal

Blockveranstaltungen:

Introductory Meeting April 17, 11.00 - 12.00 Uhr (online)

Seminar Presentations June 14, 2024, 14.00 - 18.30 Uhr (in person)

**Statistics and Epidemics**

25000111, WS 24/25, SWS, Language: English, [Open in study portal](#)

**Seminar (S)**  
**On-Site**

**Content****Motivation**

Infectious disease epidemiology gives rise to a large variety of real-time data streams. During the COVID-19 pandemic, the interpretation and statistical analysis of these data has proven crucial, but also highly challenging. In this seminar, students will get to know central concepts of infectious disease surveillance and modelling from a statistical perspective. Following an overview of various aspects in the form of blocked lectures, students will choose a more specific topic for their seminar thesis.

**Learning Goals**

Students develop an understanding of central modeling tasks and methods, including

- estimation of reproductive numbers
- compartment models of disease spread
- nowcasting and short-term forecasting of disease spread
- detection of outbreaks
- diagnostic testing

Moreover, they get to know various data types commonly used in the analysis of disease spread.

**Logistics**

The project seminar is worth 4.5 credit points (Leistungspunkte). There will be three blocked lectures (approx. 135 minutes each) in the beginning of the lecture period. For the various topics covered, subjects for seminar theses will be proposed (and students are allowed to propose their own topics). Towards the end of the semester, students present their progress on the chosen topics to the group. Grades will be based on this presentation (25%) and the final report (75%).

**Organizational issues****Prerequisites**

Students should have a very good working knowledge of statistics, including proficiency in a programming language for applied data analysis. The lecture VWL3 Introduction to Econometrics is a prerequisite for the project seminar. Most available software in the field is in R, but in principle Python can be used as well. Advanced knowledge of biology, medicine or epidemiology is not required.

**Application Procedure**

Please submit a transcript of records as well as a short letter of motivation (roughly 200 words) via WIWI-Portal: <https://portal.wiwi.kit.edu/ys/8223>

Application time frame: July 20th, 2024 to September, 30th, 2024.

**Advanced Topics in Econometrics, Statistics and Data Science**

2500047, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden bekannt gegeben

**Topics in Experimental Economics**

2520405, WS 24/25, SWS, Language: German/English, [Open in study portal](#)

Seminar (S)  
On-Site

**Organizational issues**

Blockseminar; Blücherstraße 17; Termine werden separat bekannt gegeben

**Literature**

Als Pflichtliteratur dienen ausgewählte Paper.

**Topics in Econometrics**2521310, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden auf Homepage und über Ilias bekannt gegeben

**Seminar Game Theory and Behavioral Economics (Master)**2560142, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)Seminar (S)  
On-Site**Content**

For Master students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Econometrics.

Objective: The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see <http://polit.econ.kit.edu> or <https://portal.wiwi.kit.edu/Seminare>

Seminar Papers of 8–10 pages are to be handed in.

Recommendation: Knowledge in the field of experimental economic research or behavioral economics as well as in the field of microeconomics and game theory may be helpful.

**Organizational issues**Application is possible via <https://portal.wiwi.kit.edu/Seminare>

Kick-off: 23.10.24, 14.00 - 15.30 h, Bdg. 01.85, KD2Lab (1. floor über Außentreppe), Team Room

Presentations: 13.01.2025, 14.00 - 18.00 h, Bdg. 01.85, KD2Lab (1. floor über Außentreppe), Team Room

**AI and Digitization for Society (Master)**2560143, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)Seminar (S)  
Blended (On-Site/Online)**Content**

For Master students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Econometrics.

The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see <http://polit.econ.kit.edu> or <https://portal.wiwi.kit.edu/Seminare>

Seminar Papers of 8–10 pages are to be handed in.

Recommendation: Knowledge in the field of experimental economic research or behavioral economics as well as in the field of microeconomics and game theory may be helpful.

**Organizational issues**Application is possible via <https://portal.wiwi.kit.edu/Seminare>

Kick-off: 23.10.2024, 11.00 - 12.00 (online)

Presentations: 17.01.2025, 14.00 - 18.00 h, Geb. 01.85, KD2Lab Team room



**4.245 Course: Seminar in Economics B (Master) [T-WIWI-103477]****Responsible:** Professorenschaft des Fachbereichs Volkswirtschaftslehre**Organisation:** KIT Department of Economics and Management**Part of:** M-WIWI-102972 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2500004	Predictive Data Analytics - An Introduction to Statistical Machine Learning	2 SWS	Seminar /	Schienle, Lerch
ST 2024	2520367	Strategische Entscheidungen	2 SWS	Seminar /	Ehrhart
ST 2024	2520536	Seminar in Economic Theory II	2 SWS	Seminar /	Ammann, Kretz, Okulicz
ST 2024	2520563	Wirtschaftstheoretisches Seminar III	2 SWS	Seminar /	Ammann, Kretz, Okulicz
ST 2024	2521310	Advanced Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher
ST 2024	2560130	Seminar Public Finance	2 SWS	Block /	Wigger, Schmelzer
ST 2024	2560259	Organisation and Management of Development Projects	2 SWS	Seminar /	Sieber
ST 2024	2560282	Seminar in economic policy	2 SWS	Seminar /	Ott, Assistenten
ST 2024	2560400	Seminar in Macroeconomics I	2 SWS	Seminar /	Brumm, Krause, Pegorari
ST 2024	2560552	Seminar Shaping AI and Digitization for Society (Master)	2 SWS	Seminar /	Zhao
WT 24/25	25000111	Statistics and Epidemics		Seminar /	Bracher
WT 24/25	2500024	Wirtschaftstheoretisches Seminar IV (Master)	2 SWS	Seminar /	Puppe, Kretz, Ammann, Okulicz
WT 24/25	2500047	Advanced Topics in Econometrics, Statistics and Data Science	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher
WT 24/25	2520405	Topics in Experimental Economics		Seminar /	Reiß, Peters
WT 24/25	2520500	Workshop on Economics, Finance and Statistics	2 SWS	Seminar	Puppe, Brumm, Nieken, Ott, Reiß, Ruckes, Schienle, Uhrig-Homburg, Wigger, Krüger
WT 24/25	2520563	Wirtschaftstheoretisches Seminar III (Master)	2 SWS	Seminar /	Puppe, Ammann, Kretz
WT 24/25	2521310	Topics in Econometrics	2 SWS	Seminar	Schienle, Krüger, Rüter
WT 24/25	2560130	Seminar Public Finance	2 SWS	Seminar /	Wigger, Schmelzer
WT 24/25	2560142	Seminar Game Theory and Behavioral Economics (Master)	2 SWS	Seminar /	Rau, Rosar
WT 24/25	2560282	Seminar in Economic Policy	2 SWS	Seminar /	Ott, Assistenten
WT 24/25	2560400	Seminar in Macroeconomics I	2 SWS	Seminar /	Brumm, Pegorari, Frank
WT 24/25	2561208	Selected aspects of European transport planning and -modelling	2 SWS	Seminar	Szimba
Exams					
ST 2024	7900004	Predictive Data Analytics - An Introduction to Statistical Machine Learning			Lerch
ST 2024	7900051	Seminar in Economic Policy			Ott

ST 2024	7900131	<a href="#">Shaping AI and Digitization for Society (Master)</a>	Puppe
ST 2024	7900164	<a href="#">Seminar in Economics (Bachelor)</a>	Mitusch
ST 2024	7900320	<a href="#">Seminar in Economics B (Master)</a>	Ehrhart
ST 2024	7900363	<a href="#">Seminar in Macroeconomics I: Macroeconomic Implications of Artificial Intelligence</a>	Brumm
ST 2024	7900369	<a href="#">Seminar on Topics in Digital Economics</a>	Reiß, Hillenbrand
ST 2024	79100005	<a href="#">Topics in Experimental Economics</a>	Reiß
ST 2024	79sefi3	<a href="#">Seminar Public Finance B (Master)</a>	Wigger
WT 24/25	7900090	<a href="#">Advanced Topics in Econometrics, Statistics and Data Science</a>	Schienle
WT 24/25	7900140	<a href="#">Seminar Game Theory and Behavioral Economics (Master)</a>	Puppe
WT 24/25	7900212	<a href="#">Seminar in Economic Policy</a>	Ott
WT 24/25	7900296	<a href="#">Seminar AI and Digitization for Society (Master)</a>	Puppe
WT 24/25	79sefi3	<a href="#">Seminar Public Finance B (Master)</a>	Wigger

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

### Prerequisites

None.

### Recommendation

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

### Annotation

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

Below you will find excerpts from events related to this course:



**Predictive Data Analytics - An Introduction to Statistical Machine Learning**

2500004, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)

**Seminar (S)**  
On-Site

### Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben



**Advanced Topics in Econometrics**

2521310, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)

**Seminar (S)**

### Organizational issues

Blockveranstaltung, Termine werden bekannt gegeben



**Seminar Public Finance**

2560130, SS 2024, 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.

**Seminar Shaping AI and Digitization for Society (Master)**

2560552, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)

**Content**

Participation will be limited to 12 students.

For Master students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Economathematics.

Objective: The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see <http://polit.econ.kit.edu> or <https://portal.wiwi.kit.edu/Seminare>

The acceptance of students for the seminar via the platform <https://portal.wiwi.kit.edu/Seminare> is based on preferences and suitability for the topics. This includes theoretical and practical experience with Behavioral Economics as well as English skills.

Grading: Seminar Papers of 8–10 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%). Students can improve their grades by 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**

Registration via WiWi-Portal

Blockveranstaltungen:

Introductory Meeting April 17, 11.00 - 12.00 Uhr (online)

Seminar Presentations June 14, 2024, 14.00 - 18.30 Uhr (in person)

**Statistics and Epidemics**

25000111, WS 24/25, SWS, Language: English, [Open in study portal](#)

Seminar (S)  
On-Site

**Content****Motivation**

Infectious disease epidemiology gives rise to a large variety of real-time data streams. During the COVID-19 pandemic, the interpretation and statistical analysis of these data has proven crucial, but also highly challenging. In this seminar, students will get to know central concepts of infectious disease surveillance and modelling from a statistical perspective. Following an overview of various aspects in the form of blocked lectures, students will choose a more specific topic for their seminar thesis.

**Learning Goals**

Students develop an understanding of central modeling tasks and methods, including

- estimation of reproductive numbers
- compartment models of disease spread
- nowcasting and short-term forecasting of disease spread
- detection of outbreaks
- diagnostic testing

Moreover, they get to know various data types commonly used in the analysis of disease spread.

**Logistics**

The project seminar is worth 4.5 credit points (Leistungspunkte). There will be three blocked lectures (approx. 135 minutes each) in the beginning of the lecture period. For the various topics covered, subjects for seminar theses will be proposed (and students are allowed to propose their own topics). Towards the end of the semester, students present their progress on the chosen topics to the group. Grades will be based on this presentation (25%) and the final report (75%).

**Organizational issues****Prerequisites**

Students should have a very good working knowledge of statistics, including proficiency in a programming language for applied data analysis. The lecture VWL3 Introduction to Econometrics is a prerequisite for the project seminar. Most available software in the field is in R, but in principle Python can be used as well. Advanced knowledge of biology, medicine or epidemiology is not required.

**Application Procedure**

Please submit a transcript of records as well as a short letter of motivation (roughly 200 words) via WIWI-Portal: <https://portal.wiwi.kit.edu/ys/8223>

Application time frame: July 20th, 2024 to September, 30th, 2024.

**Advanced Topics in Econometrics, Statistics and Data Science**

2500047, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden bekannt gegeben

**Topics in Experimental Economics**

2520405, WS 24/25, SWS, Language: German/English, [Open in study portal](#)

Seminar (S)  
On-Site**Organizational issues**

Blockseminar; Blücherstraße 17; Termine werden separat bekannt gegeben

**Literature**

Als Pflichtliteratur dienen ausgewählte Paper.

**Topics in Econometrics**

2521310, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden auf Homepage und über Ilias bekannt gegeben

**Seminar Game Theory and Behavioral Economics (Master)**

2560142, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
On-Site**Content**

For Master students of the fields Industrial Engineering and Management, Information Engineering and Management, Economics Engineering or Economathematics.

Objective: The student develops an own idea for an economic experiment in this research direction. Students work in groups. Changing topics each semester. For current topics, see <http://polit.econ.kit.edu> or <https://portal.wiwi.kit.edu/Seminare>

Seminar Papers of 8–10 pages are to be handed in.

Recommendation: Knowledge in the field of experimental economic research or behavioral economics as well as in the field of microeconomics and game theory may be helpful.

**Organizational issues**

Application is possible via <https://portal.wiwi.kit.edu/Seminare>

Kick-off: 23.10.24, 14.00 - 15.30 h, Bdg. 01.85, KD2Lab (1. floor über Außentreppe), Team Room

Presentations: 13.01.2025, 14.00 - 18.00 h, Bdg. 01.85, KD2Lab (1. floor über Außentreppe), Team Room

**4.246 Course: Seminar in Informatics A (Master) [T-WIWI-103479]**

**Responsible:** Professorenschaft des Instituts AIFB  
**Organisation:** KIT Department of Economics and Management  
**Part of:** M-WIWI-102973 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2513103	Seminar Digital Twins (Master)	2 SWS	Seminar	Lazarova-Molnar, Jungmann
ST 2024	2513211	Seminar Business Information Systems (Master)	2 SWS	Seminar / 🚫	Oberweis, Forell, Frister, Fritsch, Rybinski, Schreiber, Schüler, Ullrich
ST 2024	2513309	Seminar Knowledge Discovery and Data Mining (Master)	3 SWS	Seminar / 🚫	Färber, Noullet, Saier, Popovic, Qu, Shao, Käfer, Kinder
ST 2024	2513311	Seminar Data Science & Real-time Big Data Analytics (Master)	2 SWS	Seminar / 🚫	Färber, Käfer, Thoma
ST 2024	2513403	Seminar Emerging Trends in Internet Technologies (Master)	2 SWS	Seminar / 🔄	Sunyaev, Toussaint, Brecker, Danylak
ST 2024	2513405	Seminar Emerging Trends in Digital Health (Master)	2 SWS	Seminar / 🔄	Sunyaev, Toussaint, Brecker, Danylak
ST 2024	2513500	Cognitive Automobiles and Robots	2 SWS	Seminar / 🚫	Schneider, Zöllner, Daaboul
ST 2024	2513553	Seminar E-Voting (Master)	2 SWS	Seminar / 🚫	Beckert, Müller-Quade, Volkamer, Kirsten, Hilt, Dörre
WT 24/25	2400125	Security and Privacy Awareness	2 SWS	Seminar / 🔄	Seidel-Saul, Volkamer, Boehm, Aldag, Veit
WT 24/25	2513105	Seminar Advanced Analytics for Road Traffic Noise (Master)	2 SWS	Seminar / 🚫	Lazarova-Molnar, Demetgül
WT 24/25	2513107	Seminar Modeling and Simulation for Energy Systems (Master)	2 SWS	Seminar	Lazarova-Molnar, Mostafa
WT 24/25	2513313	Seminar Linked Data and the Semantic Web (Master)	3 SWS	Seminar / 🚫	Käfer, Braun
WT 24/25	2513314	Seminar Real-World Challenges in Data Science and Analytics (Bachelor)	3 SWS	/ 🚫	Käfer, Höllig, Thoma
WT 24/25	2513315	Seminar Real-World Challenges in Data Science and Analytics (Master)	3 SWS	/ 🚫	Käfer, Höllig, Thoma
WT 24/25	2513451	Seminar Cooperative Autonomous Vehicles (Master)	2 SWS	Seminar / 🔄	Vinel
WT 24/25	2513457	Seminar Collective Perception in Autonomous Driving (Master)	2 SWS	Seminar / 🔄	Vinel
WT 24/25	2513500	Seminar Cognitive Automobiles and Robots (Master)	2 SWS	Seminar / 🔄	Zöllner, Daaboul
WT 24/25	2513607	Seminar Knowledge Graphs and Large Language Models (Master)	2 SWS	Seminar / 🚫	Sack, Gesese, Vafaie, Norouzi, Tan
Exams					
ST 2024	7900031	Seminar Selected Issues in Critical Information Infrastructures (Master)			Sunyaev
ST 2024	7900088	Seminar Business Information Systems (Master)			Oberweis
ST 2024	7900128	Seminar Emerging Trends in Internet Technologies (Master)			Sunyaev

ST 2024	7900146	Seminar Emerging Trends in Digital Health (Master)	Sunyaev
ST 2024	7900147	Cognitive Automobiles and Robots	Zöllner
ST 2024	7900190	Human-Centered Systems Seminar: Engineering	Mädche
ST 2024	7900191	Seminar Human Factors in Autonomous Driving (Master)	Vinel
ST 2024	7900198	Seminar Data Science & Real-Time Big Data Analytics (Master)	Färber
ST 2024	7900202	Seminar Knowledge Discovery and Data Mining (Master)	Käfer
ST 2024	7900203	Seminar Machine Learning in Autonomous Driving (Master)	Vinel
ST 2024	7900261	Human-Centered Systems Seminar: Research	Mädche
ST 2024	7900301	Seminar Modeling and Simulation	Lazarova-Molnar
ST 2024	7900305	Seminar Digital Twins (Master)	Lazarova-Molnar
ST 2024	7900370	ABBA Summer School Seminar: Biosignal-Adaptive GenAI Systems	Mädche
WT 24/25	7900035	Practical Course Digital Twins with Lego: Hands-on Workshop in Data-driven Simulation (Master)	Lazarova-Molnar
WT 24/25	7900069	Human-Centered Systems Seminar: Engineering	Mädche
WT 24/25	7900102	Advanced Lab Information Service Engineering (Master)	Sack
WT 24/25	7900119	Seminar Cognitive Automobiles and Robots	Zöllner
WT 24/25	7900121	Security and Privacy Awareness	Volkamer
WT 24/25	7900209	Seminar Digital Twins with Lego: Hands-on Workshop in Data-driven Simulation (Master)	Lazarova-Molnar
WT 24/25	7900215	Seminar Knowledge Graphs and Large Language Models (Master)	Käfer
WT 24/25	7900226	Seminar Modeling and Simulation for Energy Systems (Master)	Lazarova-Molnar
WT 24/25	7900233	Human-Centered Systems Seminar: Research	Mädche
WT 24/25	7900236	Seminar Advanced Analytics for Road Traffic Noise (Master)	Lazarova-Molnar
WT 24/25	7900245	Seminar Cooperative Autonomous Vehicles (Master)	Vinel
WT 24/25	7900274	Seminar Real-World Challenges in Data Science and Analytics (Master)	Sure-Vetter, Färber
WT 24/25	7900279	Seminar Collective Perception in Autonomous Driving (Master)	Vinel
WT 24/25	7900304	Seminar Linked Data and the Semantic Web (Master)	Färber
WT 24/25	7900356	Seminar Real-World Challenges in Data Science and Analytics (Master)	Sure-Vetter, Färber
WT 24/25	79AIFB_AIAD_C4	Seminar Artificial Intelligence for Autonomous Driving (Master)	Vinel

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

### Prerequisites

None.

### Recommendation

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

### Annotation

Placeholder for seminars offered by the Institute AIFB.

Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

*Below you will find excerpts from events related to this course:*



**Seminar Digital Twins (Master)**

2513103, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

**Seminar (S)**

**Content****Name:** Digital Twins (Master)**Size:** 10 students (with 10 different topics)**Workload:**

- 2 Lectures
- One presentation delivered + attendance of the other students' presentations
- One report

**Responsible Persons:** Michelle Jungmann, Sanja Lazarova-Molnar**Deliverables for Grade:**

- 1 report per student and topic (7-8 pages, IEEE Template, usage of Reference Manager – Zotero or EndNote)
- 25 min presentation per student plus 20 min discussion (focus on the presentation topic + presentation skills) = 45 minutes for each student

**Credits:** 3 credits**Format/ Structure of the Seminar:**

- 2 lectures on beginning of semester
- Students have 1 week time to provide a priority list of 5 presentation topics, distribution will be decided based on first come – first serve, ensuring that core topics are covered
- 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
- Presentations are done in blocks of 2 students per class, starting mid-June, presentations will be submitted at the day of the scheduled presentation

**Description:**

The seminar focuses on Digital Twins and data-driven modeling, with an additional goal of improving scientific research and presentation skills for Master students. The seminar targets different topics around the structure and function of Digital Twins as well as their use cases in areas like manufacturing, energy systems, healthcare and others. Additional aspects that we consider in this seminar are cognitive Digital Twins, as well as how data and human expertise can be combined in Digital Twins.

The seminar is structured as a literature review seminar so that each student can select a topic out of a predefined set. The student then writes a paper, as well as delivers a presentation on that topic, based on the provided starting literature and additional research.

**Topics:****1. What is a Digital Twin? (core topic)**

References:

- Fuller, Aidan, et al. "Digital twin: Enabling technologies, challenges and open research." *IEEE access* 8 (2020): 108952-108971.
- Tao, Fei, et al. "Digital twin in industry: State-of-the-art." *IEEE Transactions on industrial informatics* 15.4 (2018): 2405-2415.
- Mihai, Stefan, et al. "Digital twins: A survey on enabling technologies, challenges, trends and future prospects." *IEEE Communications Surveys & Tutorials* (2022).

**2. Digital Twins Architectures (core topic)**

References:

- Ashtari Talkhestani, Behrang, et al. "An architecture of an intelligent digital twin in a cyber-physical production system." *at-Automatisierungstechnik* 67.9 (2019): 762-782.
- Harper, K. Eric, Somayeh Malakuti, and Christopher Ganz. "Digital twin architecture and standards." (2019).
- Minerva, Roberto, Gyu Myoung Lee, and Noel Crespi. "Digital twin in the IoT context: A survey on technical features, scenarios, and architectural models." *Proceedings of the IEEE* 108.10 (2020): 1785-1824.

**3. Validation of Digital Twins (core topic)**

References:

- Worden, K., et al. "On digital twins, mirrors, and virtualizations: Frameworks for model verification and validation." *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part B: Mechanical Engineering* 6.3 (2020): 030902.
- Hua, Edward Y., Sanja Lazarova-Molnar, and Deena P. Francis. "Validation of Digital Twins: Challenges and Opportunities." *2022 Winter Simulation Conference (WSC)*. IEEE, 2022.
- Darvishi, Hossein, Domenico Ciuonzo, and Pierluigi Salvo Rossi. "Exploring a modular architecture for sensor validation in digital twins." *2022 IEEE Sensors*. IEEE, 2022.

**4. Modeling Formalisms for Digital Twins (core topic)**

References:



- Magargle, Ryan, et al. "A Simulation-Based Digital Twin for Model-Driven Health Monitoring and Predictive Maintenance of an Automotive Braking System." *Modelica*. 2017.
- Liu, Qing, et al. "A comparative study on digital twin models." *AIP Conference Proceedings*. Vol. 2073. No. 1. AIP Publishing, 2019.
- Li, Haobin, et al. "Three Carriages Driving the Development of Intelligent Digital Twins-Simulation Plus Optimization and Learning." *2021 Winter Simulation Conference (WSC)*. IEEE, 2021.

#### 5. Digital Twins Data Requirements (core topic)

References:

- Durão, Luiz Fernando CS, et al. "Digital twin requirements in the context of industry 4.0." *Product Lifecycle Management to Support Industry 4.0: 15th IFIP WG 5.1 International Conference, PLM 2018, Turin, Italy, July 2-4, 2018, Proceedings 15*. Springer International Publishing, 2018.
- Qi, Qinglin, and Fei Tao. "Digital twin and big data towards smart manufacturing and industry 4.0: 360 degree comparison." *Ieee Access* 6 (2018): 3585-3593.

#### 6. 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.
- Kritzinger, Werner, et al. "Digital Twin in manufacturing: A categorical literature review and classification." *Ifac-PapersOnline* 51.11 (2018): 1016-1022.
- 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.

#### 7. Digital Twins for Energy Systems

References:

- Steindl, Gernot, et al. "Generic digital twin architecture for industrial energy systems." *Applied Sciences* 10.24 (2020): 8903.
- Granacher, Julia, et al. "Overcoming decision paralysis—A digital twin for decision making in energy system design." *Applied Energy* 306 (2022): 117954.
- Palensky, Peter, et al. "Digital twins and their use in future power systems." *Digital Twin* 1 (2022): 4.

#### 8. 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).
- Croatti, Angelo, et al. "On the integration of agents and digital twins in healthcare." *Journal of Medical Systems* 44 (2020): 1-8.
- 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.

#### 9. 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.
- 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.
- Mylonas, Georgios, et al. "Digital twins from smart manufacturing to smart cities: A survey." *Ieee Access* 9 (2021): 143222-143249.

#### 10. 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.
- Agalianos, K., et al. "Discrete event simulation and digital twins: review and challenges for logistics." *Procedia Manufacturing* 51 (2020): 1636-1641.
- 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.

#### 11. 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.

- 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.
- 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.

## 12. 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.
- 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.
- Todorovski, Ljupčo, and Sašo Džeroski. "Integrating knowledge-driven and data-driven approaches to modeling." *ecological modelling* 194.1-3 (2006): 3-13.



### Seminar Knowledge Discovery and Data Mining (Master)

2513309, SS 2024, 3 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](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/>.

Für weitere Fragen bezüglich des Seminar und der behandelten Themen wenden Sie sich bitte an die entsprechenden Verantwortlichen.

#### Literature

Detaillierte Referenzen werden zusammen mit den jeweiligen Themen 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.



### Seminar Data Science & Real-time Big Data Analytics (Master)

2513311, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
On-Site

#### Content

In this seminar, students will design applications in teams that use meaningful and creative Event Processing methods. Thereby, students have access to an existing record.

Event processing and real-time data are everywhere: financial market data, sensors, business intelligence, social media analytics, logistics. Many applications collect large volumes of data in real time and are increasingly faced with the challenge of being able to process them quickly and react promptly. The challenges of this real-time processing are currently also receiving a great deal of attention under the term "Big Data". The complex processing of real-time data requires both knowledge of methods for data analysis (data science) and their processing (real-time analytics). Seminar papers are offered on both of these areas as well as on interface topics, the input of own ideas is explicitly desired.

Further information to the practical seminar is given under the following Link:

<http://seminar-cep.fzi.de>

Questions are answered via the e-mail address [sem-ep@fzi.de](mailto:sem-ep@fzi.de).

#### Organizational issues

Questions are answered via the e-mail address [sem-ep@fzi.de](mailto:sem-ep@fzi.de).

**Cognitive Automobiles and Robots**2513500, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)**Seminar (S)**  
**On-Site****Content**

The seminar is intended as a theoretical supplement to lectures such as "Machine Learning". The theoretical basics will be deepened in the seminar. The aim of the seminar is that the participants work individually to analyze a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and theoretical evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

**Learning objectives:**

- Students can apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles for theoretical analysis.
- Students can evaluate, document and present their concepts and results.

**Recommendations:**

Attendance of the lecture machine learning

**Workload:**

The workload of 3 credit points consists of the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

**Organizational issues**

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

**Seminar E-Voting (Master)**2513553, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)**Seminar (S)**  
**On-Site****Content**

What should a voting procedure fulfill? When is a voting procedure secure? Which components need to be examined? Which methods can be used to investigate this?

Cryptographic voting procedures and algorithmic voting (counting) procedures are examined from different perspectives (cryptographic methods, formal correctness, human factors).

This course can also be credited for the KASTEL certificate. Further information about obtaining the certificate can be found on the SECUSO website ([https://secuso.aifb.kit.edu/Studium\\_und\\_Lehre.php](https://secuso.aifb.kit.edu/Studium_und_Lehre.php)).

**Organizational issues**

Die Anmeldung für das Seminar ist bis zum 17.04. über <https://portal.wiwi.kit.edu/ys/8037> möglich.

**Security and Privacy Awareness**2400125, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)**Seminar (S)**  
**Blended (On-Site/Online)**

**Content**

Within the framework of this interdisciplinary seminar, the topics security awareness and privacy awareness are to be considered from different perspectives. It deals with legal, information technology, psychological, social as well as philosophical aspects.

**Important notes:**

- Consider that legal-focused topics require you to speak and understand German legal texts
- The seminar is only for MASTER students (or Mastervorzug)
- The link to enrol is for every student, regardless of the study background

**Dates (not final):**

- Kick-Off: Tue, 22.10.2024, 11:30 Uhr, Raum 1C-03, Gebäude 5.20
- First version: 05.01.2025
- Final version: 23.02.2025
- Presentation: CW 12

**Topics:**

The advertised topics can be found in the wiwi portal [<https://portal.wiwi.kit.edu/ys/8308>]. They will be assigned after the kick-off.

**Seminar Advanced Analytics for Road Traffic Noise (Master)**

2513105, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

**Seminar (S)  
On-Site**

**Content**

Road traffic noise (RTN) stands as a significant environmental pollutant encountered in daily life, profoundly impacting human health. Extensive research has empirically validated its detrimental effects on well-being, encompassing cardiovascular and mental health implications (Stansfeld et al., 2021; Lan et al., 2020). Moreover, regulatory bodies have proposed guidelines and regulations (WHO, 2018; EU, 2019) to mitigate environmental noise exposure, prompting stakeholders like vehicle manufacturers to integrate measures addressing road traffic noise into their design frameworks.

In this seminar, we diverge from the regulatory perspective on RTN and instead delve into its comprehension through data analytics and other techniques. Specifically, we present a guideline for understanding this societal concern and discuss existing road traffic noise modeling (RTNM) approaches, in particular, their formulation and considerations.

**Topics:**

1. Introduction to RTN
2. Overview on RTNM
3. Time series analysis
4. Data exploration and visualization
5. Machine learning for RTNM
6. Sound feature extraction and analysis

**Literature**

- Stansfeld, S., Clark, C., Smuk, M., Gallacher, J., & Babisch, W. (2021). Road traffic noise, noise sensitivity, noise annoyance, psychological and physical health and mortality. *Environmental Health*, 20, 1-15.
- Lan, Y., Roberts, H., Kwan, M. P., & Helbich, M. (2020). Transportation noise exposure and anxiety: A systematic review and meta-analysis. *Environmental research*, 191, 110118.
- WHO. (2018) Environmental Noise Guidelines for the European Region.
- EU. (2019) Regulation (EU) No 540/2014 of the European Parliament and of the Council of 16 April 2014 on the Sound Level of Motor Vehicles and of Replacement Silencing Systems, and Amending Directive 2007/46/EC and Repealing Directive 70/157/EEC.

**Seminar Linked Data and the Semantic Web (Master)**

2513313, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

**Seminar (S)  
On-Site**

**Content**

Linked Data is a way of publishing data on the web in a machine-understandable fashion. The aim of this practical seminar is to build applications and devise algorithms that consume, provide, or analyse Linked Data.

The Linked Data principles are a set of practices for data publishing on the web. Linked Data builds on the web architecture and uses HTTP for data access, and RDF for describing data, thus aiming towards web-scale data integration. There is a vast amount of data available published according to those principles: recently, 4.5 billion facts have been counted with information about various domains, including music, movies, geography, natural sciences. Linked Data is also used to make web-pages machine-understandable, corresponding annotations are considered by the big search engine providers. On a smaller scale, devices on the Internet of Things can also be accessed using Linked Data which makes the unified processing of device data and data from the web easy.

In this practical seminar, students will build prototypical applications and devise algorithms that consume, provide, or analyse Linked Data. Those applications and algorithms can also extend existing applications ranging from databases to mobile apps.

For the seminar, programming skills or knowledge about web development tools/technologies are highly recommended. Basic knowledge of RDF and SPARQL are also recommended, but may be acquired during the seminar. Students will work in groups. Seminar meetings will take place as 'Block-Seminar'.

Topics of interest include, but are not limited to:

- Travel Security
- Geo data
- Linked News
- Social Media

The exact dates and information for registration will be announced at the event page.

**Seminar Real-World Challenges in Data Science and Analytics (Bachelor)**

2513314, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

On-Site

**Content**

In the seminar, various Real-World Challenges in Data Science and Analytics will be worked on.

During this seminar, groups of students work on a case challenge with data provided. Here, the typical process of a data science project is depicted: integration of data, analysis of these, modeling of the decisions and visualization of the results.

During the seminar, solution concepts are worked out, implemented as a software solution and presented in an intermediate and final presentation. The seminar "Real-World Challenges in Data Science and Analytics" is aimed at students in master's programs.

The exact dates and information for registration will be announced at the course page.

**Seminar Real-World Challenges in Data Science and Analytics (Master)**

2513315, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

On-Site

**Content**

In the seminar, various Real-World Challenges in Data Science and Analytics will be worked on.

During this seminar, groups of students work on a case challenge with data provided. Here, the typical process of a data science project is depicted: integration of data, analysis of these, modeling of the decisions and visualization of the results.

During the seminar, solution concepts are worked out, implemented as a software solution and presented in an intermediate and final presentation. The seminar "Real-World Challenges in Data Science and Analytics" is aimed at students in master's programs.

The exact dates and information for registration will be announced at the course page.

**Seminar Cognitive Automobiles and Robots (Master)**

2513500, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)

**Content**

The seminar is intended as a theoretical supplement to lectures such as "Machine Learning". The theoretical basics will be deepened in the seminar. The aim of the seminar is that the participants work individually to analyze a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and theoretical evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

**Learning objectives:**

- Students can apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles for theoretical analysis.
- Students can evaluate, document and present their concepts and results.

**Recommendations:**

Attendance of the lecture machine learning

**Workload:**

The workload of 3 credit points consists of the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

**Organizational issues**

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

**Seminar Knowledge Graphs and Large Language Models (Master)**

2513607, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
On-Site

**Content**

Large language models (LLMs) such as GPT-3 have shown remarkable capabilities in transforming various natural language processing (NLP) tasks across different domains. However, LLMs often generate incorrect answers, known as hallucinations, posing significant challenges to their usability and reliability. Additionally, LLMs operate as black boxes, making it difficult to understand how they arrive at specific conclusions, leading to transparency and explainability issues. Combining LLMs with KGs creates a powerful synergy that significantly enhances the capabilities of artificial intelligence across various tasks. This integration leverages the strengths of both technologies, with LLMs excelling at understanding and generating human-like text, and KGs providing structured, reliable information about entities and their relationships. Together, they offer a robust approach to problem-solving across diverse domains.

This seminar will focus on the intersection of LLMs and KGs, covering areas of interest including, but not limited to:

- KG completion using LLMs
- Question answering with KGs and LLMs
- Explainability of LLMs with KG integration
- Reasoning with LLMs and KGs
- Enhanced prompt engineering using KGs

**Contributions of the students:**

Each student will be assigned one paper on the topic, which could be a research paper discussing a novel approach or a resource paper presenting datasets, tools, etc. The student will be responsible for the following tasks:

1. **Report Writing:** Read the assigned paper thoroughly and write a 15-page seminar report explaining the methods and findings in their own words.
2. **Presenting:** Prepare and deliver a seminar presentation to share insights from the paper with other seminar participants.
3. **Conducting Experiments:** If the authors provide code, re-implement it for small-scale experiments using Google Colab or make the implementation available via GitHub.

**4.247 Course: Seminar in Informatics B (Master) [T-WIWI-103480]**

**Responsible:** Professorenschaft des Instituts AIFB  
**Organisation:** KIT Department of Economics and Management  
**Part of:** M-WIWI-102974 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2513103	Seminar Digital Twins (Master)	2 SWS	Seminar	Lazarova-Molnar, Jungmann
ST 2024	2513211	Seminar Business Information Systems (Master)	2 SWS	Seminar / 🚫	Oberweis, Forell, Frister, Fritsch, Rybinski, Schreiber, Schüler, Ullrich
ST 2024	2513309	Seminar Knowledge Discovery and Data Mining (Master)	3 SWS	Seminar / 🚫	Färber, Noullet, Saier, Popovic, Qu, Shao, Käfer, Kinder
ST 2024	2513311	Seminar Data Science & Real-time Big Data Analytics (Master)	2 SWS	Seminar / 🚫	Färber, Käfer, Thoma
ST 2024	2513403	Seminar Emerging Trends in Internet Technologies (Master)	2 SWS	Seminar / 🔄	Sunyaev, Toussaint, Brecker, Danylak
ST 2024	2513405	Seminar Emerging Trends in Digital Health (Master)	2 SWS	Seminar / 🔄	Sunyaev, Toussaint, Brecker, Danylak
ST 2024	2513500	Cognitive Automobiles and Robots	2 SWS	Seminar / 🚫	Schneider, Zöllner, Daaboul
ST 2024	2513553	Seminar E-Voting (Master)	2 SWS	Seminar / 🚫	Beckert, Müller-Quade, Volkamer, Kirsten, Hilt, Dörre
WT 24/25	2400125	Security and Privacy Awareness	2 SWS	Seminar / 🔄	Seidel-Saul, Volkamer, Boehm, Aldag, Veit
WT 24/25	2513105	Seminar Advanced Analytics for Road Traffic Noise (Master)	2 SWS	Seminar / 🚫	Lazarova-Molnar, Demetgül
WT 24/25	2513107	Seminar Modeling and Simulation for Energy Systems (Master)	2 SWS	Seminar	Lazarova-Molnar, Mostafa
WT 24/25	2513313	Seminar Linked Data and the Semantic Web (Master)	3 SWS	Seminar / 🚫	Käfer, Braun
WT 24/25	2513314	Seminar Real-World Challenges in Data Science and Analytics (Bachelor)	3 SWS	/ 🚫	Käfer, Höllig, Thoma
WT 24/25	2513315	Seminar Real-World Challenges in Data Science and Analytics (Master)	3 SWS	/ 🚫	Käfer, Höllig, Thoma
WT 24/25	2513451	Seminar Cooperative Autonomous Vehicles (Master)	2 SWS	Seminar / 🔄	Vinel
WT 24/25	2513457	Seminar Collective Perception in Autonomous Driving (Master)	2 SWS	Seminar / 🔄	Vinel
WT 24/25	2513500	Seminar Cognitive Automobiles and Robots (Master)	2 SWS	Seminar / 🔄	Zöllner, Daaboul
WT 24/25	2513607	Seminar Knowledge Graphs and Large Language Models (Master)	2 SWS	Seminar / 🚫	Sack, Gesese, Vafaie, Norouzi, Tan
Exams					
ST 2024	7900031	Seminar Selected Issues in Critical Information Infrastructures (Master)			Sunyaev
ST 2024	7900088	Seminar Business Information Systems (Master)			Oberweis
ST 2024	7900128	Seminar Emerging Trends in Internet Technologies (Master)			Sunyaev



ST 2024	7900146	Seminar Emerging Trends in Digital Health (Master)	Sunyaev
ST 2024	7900147	Cognitive Automobiles and Robots	Zöllner
ST 2024	7900191	Seminar Human Factors in Autonomous Driving (Master)	Vinel
ST 2024	7900198	Seminar Data Science & Real-Time Big Data Analytics (Master)	Färber
ST 2024	7900202	Seminar Knowledge Discovery and Data Mining (Master)	Käfer
ST 2024	7900203	Seminar Machine Learning in Autonomous Driving (Master)	Vinel
ST 2024	7900301	Seminar Modeling and Simulation	Lazarova-Molnar
ST 2024	7900305	Seminar Digital Twins (Master)	Lazarova-Molnar
WT 24/25	7500220	Seminar Ubiquitous Computing	Beigl
WT 24/25	7900035	Practical Course Digital Twins with Lego: Hands-on Workshop in Data-driven Simulation (Master)	Lazarova-Molnar
WT 24/25	7900102	Advanced Lab Information Service Engineering (Master)	Sack
WT 24/25	7900119	Seminar Cognitive Automobiles and Robots	Zöllner
WT 24/25	7900121	Security and Privacy Awareness	Volkamer
WT 24/25	7900209	Seminar Digital Twins with Lego: Hands-on Workshop in Data-driven Simulation (Master)	Lazarova-Molnar
WT 24/25	7900215	Seminar Knowledge Graphs and Large Language Models (Master)	Käfer
WT 24/25	7900226	Seminar Modeling and Simulation for Energy Systems (Master)	Lazarova-Molnar
WT 24/25	7900236	Seminar Advanced Analytics for Road Traffic Noise (Master)	Lazarova-Molnar
WT 24/25	7900245	Seminar Cooperative Autonomous Vehicles (Master)	Vinel
WT 24/25	7900274	Seminar Real-World Challenges in Data Science and Analytics (Master)	Sure-Vetter, Färber
WT 24/25	7900279	Seminar Collective Perception in Autonomous Driving (Master)	Vinel
WT 24/25	7900304	Seminar Linked Data and the Semantic Web (Master)	Färber
WT 24/25	7900356	Seminar Real-World Challenges in Data Science and Analytics (Master)	Sure-Vetter, Färber
WT 24/25	79AIFB_AIAD_C4	Seminar Artificial Intelligence for Autonomous Driving (Master)	Vinel

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

### Prerequisites

None.

### Recommendation

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

### Annotation

Placeholder for seminars offered by the Institute AIFB.

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

Below you will find excerpts from events related to this course:

	<b>Seminar Digital Twins (Master)</b> 2513103, SS 2024, 2 SWS, Language: English, <a href="#">Open in study portal</a>	<b>Seminar (S)</b>
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**Content****Name:** Digital Twins (Master)**Size:** 10 students (with 10 different topics)**Workload:**

- 2 Lectures
- One presentation delivered + attendance of the other students' presentations
- One report

**Responsible Persons:** Michelle Jungmann, Sanja Lazarova-Molnar**Deliverables for Grade:**

- 1 report per student and topic (7-8 pages, IEEE Template, usage of Reference Manager – Zotero or EndNote)
- 25 min presentation per student plus 20 min discussion (focus on the presentation topic + presentation skills) = 45 minutes for each student

**Credits:** 3 credits**Format/ Structure of the Seminar:**

- 2 lectures on beginning of semester
- Students have 1 week time to provide a priority list of 5 presentation topics, distribution will be decided based on first come – first serve, ensuring that core topics are covered
- 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
- Presentations are done in blocks of 2 students per class, starting mid-June, presentations will be submitted at the day of the scheduled presentation

**Description:**

The seminar focuses on Digital Twins and data-driven modeling, with an additional goal of improving scientific research and presentation skills for Master students. The seminar targets different topics around the structure and function of Digital Twins as well as their use cases in areas like manufacturing, energy systems, healthcare and others. Additional aspects that we consider in this seminar are cognitive Digital Twins, as well as how data and human expertise can be combined in Digital Twins.

The seminar is structured as a literature review seminar so that each student can select a topic out of a predefined set. The student then writes a paper, as well as delivers a presentation on that topic, based on the provided starting literature and additional research.

**Topics:****1. What is a Digital Twin? (core topic)**

References:

- Fuller, Aidan, et al. "Digital twin: Enabling technologies, challenges and open research." *IEEE access* 8 (2020): 108952-108971.
- Tao, Fei, et al. "Digital twin in industry: State-of-the-art." *IEEE Transactions on industrial informatics* 15.4 (2018): 2405-2415.
- Mihai, Stefan, et al. "Digital twins: A survey on enabling technologies, challenges, trends and future prospects." *IEEE Communications Surveys & Tutorials* (2022).

**2. Digital Twins Architectures (core topic)**

References:

- Ashtari Talkhestani, Behrang, et al. "An architecture of an intelligent digital twin in a cyber-physical production system." *at-Automatisierungstechnik* 67.9 (2019): 762-782.
- Harper, K. Eric, Somayeh Malakuti, and Christopher Ganz. "Digital twin architecture and standards." (2019).
- Minerva, Roberto, Gyu Myoung Lee, and Noel Crespi. "Digital twin in the IoT context: A survey on technical features, scenarios, and architectural models." *Proceedings of the IEEE* 108.10 (2020): 1785-1824.

**3. Validation of Digital Twins (core topic)**

References:

- Worden, K., et al. "On digital twins, mirrors, and virtualizations: Frameworks for model verification and validation." *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part B: Mechanical Engineering* 6.3 (2020): 030902.
- Hua, Edward Y., Sanja Lazarova-Molnar, and Deena P. Francis. "Validation of Digital Twins: Challenges and Opportunities." *2022 Winter Simulation Conference (WSC)*. IEEE, 2022.
- Darvishi, Hossein, Domenico Ciuonzo, and Pierluigi Salvo Rossi. "Exploring a modular architecture for sensor validation in digital twins." *2022 IEEE Sensors*. IEEE, 2022.

**4. Modeling Formalisms for Digital Twins (core topic)**

References:

- Magargle, Ryan, et al. "A Simulation-Based Digital Twin for Model-Driven Health Monitoring and Predictive Maintenance of an Automotive Braking System." *Modelica*. 2017.
- Liu, Qing, et al. "A comparative study on digital twin models." *AIP Conference Proceedings*. Vol. 2073. No. 1. AIP Publishing, 2019.
- Li, Haobin, et al. "Three Carriages Driving the Development of Intelligent Digital Twins-Simulation Plus Optimization and Learning." *2021 Winter Simulation Conference (WSC)*. IEEE, 2021.

#### 5. Digital Twins Data Requirements (core topic)

References:

- Durão, Luiz Fernando CS, et al. "Digital twin requirements in the context of industry 4.0." *Product Lifecycle Management to Support Industry 4.0: 15th IFIP WG 5.1 International Conference, PLM 2018, Turin, Italy, July 2-4, 2018, Proceedings 15*. Springer International Publishing, 2018.
- Qi, Qinglin, and Fei Tao. "Digital twin and big data towards smart manufacturing and industry 4.0: 360 degree comparison." *Ieee Access* 6 (2018): 3585-3593.

#### 6. 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.
- Kritzinger, Werner, et al. "Digital Twin in manufacturing: A categorical literature review and classification." *Ifac-PapersOnline* 51.11 (2018): 1016-1022.
- 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.

#### 7. Digital Twins for Energy Systems

References:

- Steindl, Gernot, et al. "Generic digital twin architecture for industrial energy systems." *Applied Sciences* 10.24 (2020): 8903.
- Granacher, Julia, et al. "Overcoming decision paralysis—A digital twin for decision making in energy system design." *Applied Energy* 306 (2022): 117954.
- Palensky, Peter, et al. "Digital twins and their use in future power systems." *Digital Twin* 1 (2022): 4.

#### 8. 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).
- Croatti, Angelo, et al. "On the integration of agents and digital twins in healthcare." *Journal of Medical Systems* 44 (2020): 1-8.
- 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.

#### 9. 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.
- 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.
- Mylonas, Georgios, et al. "Digital twins from smart manufacturing to smart cities: A survey." *Ieee Access* 9 (2021): 143222-143249.

#### 10. 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.
- Agalinos, K., et al. "Discrete event simulation and digital twins: review and challenges for logistics." *Procedia Manufacturing* 51 (2020): 1636-1641.
- 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.

#### 11. 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.

- 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.
- 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.

## 12. 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.
- 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.
- Todorovski, Ljupčo, and Sašo Džeroski. "Integrating knowledge-driven and data-driven approaches to modeling." *ecological modelling* 194.1-3 (2006): 3-13.



### Seminar Knowledge Discovery and Data Mining (Master)

2513309, SS 2024, 3 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](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/>.

Für weitere Fragen bezüglich des Seminar und der behandelten Themen wenden Sie sich bitte an die entsprechenden Verantwortlichen.

#### Literature

Detaillierte Referenzen werden zusammen mit den jeweiligen Themen 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.



### Seminar Data Science & Real-time Big Data Analytics (Master)

2513311, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
On-Site

#### Content

In this seminar, students will design applications in teams that use meaningful and creative Event Processing methods. Thereby, students have access to an existing record.

Event processing and real-time data are everywhere: financial market data, sensors, business intelligence, social media analytics, logistics. Many applications collect large volumes of data in real time and are increasingly faced with the challenge of being able to process them quickly and react promptly. The challenges of this real-time processing are currently also receiving a great deal of attention under the term "Big Data". The complex processing of real-time data requires both knowledge of methods for data analysis (data science) and their processing (real-time analytics). Seminar papers are offered on both of these areas as well as on interface topics, the input of own ideas is explicitly desired.

Further information to the practical seminar is given under the following Link:

<http://seminar-cep.fzi.de>

Questions are answered via the e-mail address [sem-ep@fzi.de](mailto:sem-ep@fzi.de).

#### Organizational issues

Questions are answered via the e-mail address [sem-ep@fzi.de](mailto:sem-ep@fzi.de).

**Cognitive Automobiles and Robots**2513500, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)**Seminar (S)**  
**On-Site****Content**

The seminar is intended as a theoretical supplement to lectures such as "Machine Learning". The theoretical basics will be deepened in the seminar. The aim of the seminar is that the participants work individually to analyze a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and theoretical evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

**Learning objectives:**

- Students can apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles for theoretical analysis.
- Students can evaluate, document and present their concepts and results.

**Recommendations:**

Attendance of the lecture machine learning

**Workload:**

The workload of 3 credit points consists of the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

**Organizational issues**

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

**Seminar E-Voting (Master)**2513553, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)**Seminar (S)**  
**On-Site****Content**

What should a voting procedure fulfill? When is a voting procedure secure? Which components need to be examined? Which methods can be used to investigate this?

Cryptographic voting procedures and algorithmic voting (counting) procedures are examined from different perspectives (cryptographic methods, formal correctness, human factors).

This course can also be credited for the KASTEL certificate. Further information about obtaining the certificate can be found on the SECUSO website ([https://secuso.aifb.kit.edu/Studium\\_und\\_Lehre.php](https://secuso.aifb.kit.edu/Studium_und_Lehre.php)).

**Organizational issues**

Die Anmeldung für das Seminar ist bis zum 17.04. über <https://portal.wiwi.kit.edu/ys/8037> möglich.

**Security and Privacy Awareness**2400125, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)**Seminar (S)**  
**Blended (On-Site/Online)**

**Content**

Within the framework of this interdisciplinary seminar, the topics security awareness and privacy awareness are to be considered from different perspectives. It deals with legal, information technology, psychological, social as well as philosophical aspects.

**Important notes:**

- Consider that legal-focused topics require you to speak and understand German legal texts
- The seminar is only for MASTER students (or Mastervorzug)
- The link to enrol is for every student, regardless of the study background

**Dates (not final):**

- Kick-Off: Tue, 22.10.2024, 11:30 Uhr, Raum 1C-03, Gebäude 5.20
- First version: 05.01.2025
- Final version: 23.02.2025
- Presentation: CW 12

**Topics:**

The advertised topics can be found in the wiwi portal [<https://portal.wiwi.kit.edu/ys/8308>]. They will be assigned after the kick-off.

	<b>Seminar Advanced Analytics for Road Traffic Noise (Master)</b> 2513105, WS 24/25, 2 SWS, Language: English, <a href="#">Open in study portal</a>	<b>Seminar (S)</b> <b>On-Site</b>
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**Content**

Road traffic noise (RTN) stands as a significant environmental pollutant encountered in daily life, profoundly impacting human health. Extensive research has empirically validated its detrimental effects on well-being, encompassing cardiovascular and mental health implications (Stansfeld et al., 2021; Lan et al., 2020). Moreover, regulatory bodies have proposed guidelines and regulations (WHO, 2018; EU, 2019) to mitigate environmental noise exposure, prompting stakeholders like vehicle manufacturers to integrate measures addressing road traffic noise into their design frameworks.

In this seminar, we diverge from the regulatory perspective on RTN and instead delve into its comprehension through data analytics and other techniques. Specifically, we present a guideline for understanding this societal concern and discuss existing road traffic noise modeling (RTNM) approaches, in particular, their formulation and considerations.

**Topics:**

1. Introduction to RTN
2. Overview on RTNM
3. Time series analysis
4. Data exploration and visualization
5. Machine learning for RTNM
6. Sound feature extraction and analysis

**Literature**

- Stansfeld, S., Clark, C., Smuk, M., Gallacher, J., & Babisch, W. (2021). Road traffic noise, noise sensitivity, noise annoyance, psychological and physical health and mortality. *Environmental Health*, 20, 1-15.
- Lan, Y., Roberts, H., Kwan, M. P., & Helbich, M. (2020). Transportation noise exposure and anxiety: A systematic review and meta-analysis. *Environmental research*, 191, 110118.
- WHO. (2018) Environmental Noise Guidelines for the European Region.
- EU. (2019) Regulation (EU) No 540/2014 of the European Parliament and of the Council of 16 April 2014 on the Sound Level of Motor Vehicles and of Replacement Silencing Systems, and Amending Directive 2007/46/EC and Repealing Directive 70/157/EEC.

	<b>Seminar Linked Data and the Semantic Web (Master)</b> 2513313, WS 24/25, 3 SWS, Language: German/English, <a href="#">Open in study portal</a>	<b>Seminar (S)</b> <b>On-Site</b>
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**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.

**Seminar Real-World Challenges in Data Science and Analytics (Bachelor)**

2513314, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

On-Site

**Content**

In the seminar, various Real-World Challenges in Data Science and Analytics will be worked on.

During this seminar, groups of students work on a case challenge with data provided. Here, the typical process of a data science project is depicted: integration of data, analysis of these, modeling of the decisions and visualization of the results.

During the seminar, solution concepts are worked out, implemented as a software solution and presented in an intermediate and final presentation. The seminar "Real-World Challenges in Data Science and Analytics" is aimed at students in master's programs.

The exact dates and information for registration will be announced at the course page.

**Seminar Real-World Challenges in Data Science and Analytics (Master)**

2513315, WS 24/25, 3 SWS, Language: German/English, [Open in study portal](#)

On-Site

**Content**

In the seminar, various Real-World Challenges in Data Science and Analytics will be worked on.

During this seminar, groups of students work on a case challenge with data provided. Here, the typical process of a data science project is depicted: integration of data, analysis of these, modeling of the decisions and visualization of the results.

During the seminar, solution concepts are worked out, implemented as a software solution and presented in an intermediate and final presentation. The seminar "Real-World Challenges in Data Science and Analytics" is aimed at students in master's programs.

The exact dates and information for registration will be announced at the course page.

**Seminar Cognitive Automobiles and Robots (Master)**

2513500, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)

**Content**

The seminar is intended as a theoretical supplement to lectures such as "Machine Learning". The theoretical basics will be deepened in the seminar. The aim of the seminar is that the participants work individually to analyze a subsystem from the field of robotics and cognitive systems using one or more procedures from the field of AI/ML.

The individual projects require the analysis of the task at hand, selection of suitable procedures, specification and theoretical evaluation of the approach taken. Finally, the chosen solution has to be documented and presented in a short presentation.

**Learning objectives:**

- Students can apply knowledge from the Machine Learning lecture in a selected field of current research in robotics or cognitive automobiles for theoretical analysis.
- Students can evaluate, document and present their concepts and results.

**Recommendations:**

Attendance of the lecture machine learning

**Workload:**

The workload of 3 credit points consists of the time spent on literature research and planning/specifying the proposed solution. In addition, a short report and a presentation of the work carried out will be prepared.

**Organizational issues**

Anmeldung und weitere Informationen sind im Wiwi-Portal zu finden.

Registration and further information can be found in the WiWi-portal.

**Seminar Knowledge Graphs and Large Language Models (Master)**

2513607, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Seminar (S)  
On-Site



**Content**

Large language models (LLMs) such as GPT-3 have shown remarkable capabilities in transforming various natural language processing (NLP) tasks across different domains. However, LLMs often generate incorrect answers, known as hallucinations, posing significant challenges to their usability and reliability. Additionally, LLMs operate as black boxes, making it difficult to understand how they arrive at specific conclusions, leading to transparency and explainability issues. Combining LLMs with KGs creates a powerful synergy that significantly enhances the capabilities of artificial intelligence across various tasks. This integration leverages the strengths of both technologies, with LLMs excelling at understanding and generating human-like text, and KGs providing structured, reliable information about entities and their relationships. Together, they offer a robust approach to problem-solving across diverse domains.

This seminar will focus on the intersection of LLMs and KGs, covering areas of interest including, but not limited to:

- KG completion using LLMs
- Question answering with KGs and LLMs
- Explainability of LLMs with KG integration
- Reasoning with LLMs and KGs
- Enhanced prompt engineering using KGs

**Contributions of the students:**

Each student will be assigned one paper on the topic, which could be a research paper discussing a novel approach or a resource paper presenting datasets, tools, etc. The student will be responsible for the following tasks:

1. **Report Writing:** Read the assigned paper thoroughly and write a 15-page seminar report explaining the methods and findings in their own words.
2. **Presenting:** Prepare and deliver a seminar presentation to share insights from the paper with other seminar participants.
3. **Conducting Experiments:** If the authors provide code, re-implement it for small-scale experiments using Google Colab or make the implementation available via GitHub.

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## 4.248 Course: Seminar in Operations Research A (Master) [T-WIWI-103481]

**Responsible:** Prof. Dr. Stefan Nickel  
Prof. Dr. Steffen Rebennack  
Prof. Dr. Oliver Stein

**Organisation:** KIT Department of Economics and Management

**Part of:** M-WIWI-102973 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2500028	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / 	Nickel, Mitarbeiter, Pomes
ST 2024	2550131	Seminar on Methodical Foundations of Operations Research (B)	2 SWS	Seminar / 	Stein, Beck, Schwarze
ST 2024	2550132	Seminar on Mathematical Optimization (MA)	2 SWS	Seminar / 	Stein, Beck, Schwarze
ST 2024	2550462	Seminar: Trending Topics in Machine Learning and Optimization (Master)	2 SWS	Seminar / 	Rebennack, Warwicker
ST 2024	2550473	Seminar: Energy and Power Systems Optimization (Master)	2 SWS	Seminar / 	Rebennack, Warwicker
WT 24/25	2550131	Seminar on Methodical Foundations of Operations Research (B)	2 SWS	Seminar / 	Stein, Beck, Schwarze
WT 24/25	2550132	Seminar zur Mathematischen Optimierung (MA)	2 SWS	Seminar / 	Stein, Beck, Schwarze
WT 24/25	2550462	Seminar on Trending Topics in Optimization and Machine Learning (Master)	2 SWS	Seminar / 	Rebennack, Warwicker
WT 24/25	2550473	Seminar on Energy and Power Systems Optimization (Master)	2 SWS	Seminar / 	Rebennack, Warwicker
WT 24/25	2550491	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / 	Nickel, Mitarbeiter
Exams					
ST 2024	7900026	Seminar Modern OR and Innovative Logistics			Nickel
ST 2024	7900200_SS2024	Seminar in Operations Research A (Master)			Stein
ST 2024	7900201_SS2024	Seminar in Operations Research (Bachelor)			Stein
ST 2024	7900295	Seminar Trending Topics in Machine Learning and Opt. - Operations Research A (Master)			Rebennack
ST 2024	7900317	Digitalization in the Steel Industry			Nickel
ST 2024	7900349	Seminar on Power Systems Optimization (Master)			Rebennack
WT 24/25	7900342	Seminar Modern OR and Innovative Logistics			Nickel

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

### Prerequisites

None.

**Recommendation**

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

**Annotation**

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

Below you will find excerpts from events related to this course:

	<b>Seminar: Modern OR and Innovative Logistics</b> 2500028, SS 2024, 2 SWS, Language: German, <a href="#">Open in study portal</a>	<b>Seminar (S)</b> <b>Blended (On-Site/Online)</b>
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**Content**

The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

**Organizational issues**

Anmeldung erfolgt über das Wiwi-Portal. Nähere Informationen hierzu finden Sie hier zu einem späteren Zeitpunkt.

**Literature**

Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

	<b>Seminar on Methodical Foundations of Operations Research (B)</b> 2550131, SS 2024, 2 SWS, Language: German, <a href="#">Open in study portal</a>	<b>Seminar (S)</b> <b>On-Site</b>
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**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 student 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 scientific 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 Literatur 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 preparatory meeting.



### Seminar on Methodical Foundations of Operations Research (B)

2550131, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)  
On-Site

#### Content

The seminar aims at describing, evaluating, and discussing recent as well as classical topics in continuous optimization. The focus is on the treatment of optimization models and algorithms, also with respect to their practical application.

Bachelor students are introduced to the style of scientific work. By focused 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 scientific reasoning. Also rhetoric 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 Literatur und die relevanten Quellen werden gegen Ende des vorausgehenden Semesters im Wiwi-Portal und in einer Seminarvorbereitung bekannt gegeben.

References and relevant sources are announced at the end of the preceding semester in the Wiwi-Portal and in a preparatory meeting.



### Seminar: Modern OR and Innovative Logistics

2550491, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)

#### Content

The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

#### Organizational issues

Anmeldezeitraum: 11.09.24 bis 30.09.24 im Wiwi Portal

#### Literature

Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

T

## 4.249 Course: Seminar in Operations Research B (Master) [T-WIWI-103482]

**Responsible:** Prof. Dr. Stefan Nickel  
 Prof. Dr. Steffen Rebennack  
 Prof. Dr. Oliver Stein

**Organisation:** KIT Department of Economics and Management

**Part of:** M-WIWI-102974 - Seminar

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2500028	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / 	Nickel, Mitarbeiter, Pomes
ST 2024	2550131	Seminar on Methodical Foundations of Operations Research (B)	2 SWS	Seminar / 	Stein, Beck, Schwarze
ST 2024	2550132	Seminar on Mathematical Optimization (MA)	2 SWS	Seminar / 	Stein, Beck, Schwarze
ST 2024	2550462	Seminar: Trending Topics in Machine Learning and Optimization (Master)	2 SWS	Seminar / 	Rebennack, Warwicker
ST 2024	2550473	Seminar: Energy and Power Systems Optimization (Master)	2 SWS	Seminar / 	Rebennack, Warwicker
WT 24/25	2550131	Seminar on Methodical Foundations of Operations Research (B)	2 SWS	Seminar / 	Stein, Beck, Schwarze
WT 24/25	2550132	Seminar zur Mathematischen Optimierung (MA)	2 SWS	Seminar / 	Stein, Beck, Schwarze
WT 24/25	2550462	Seminar on Trending Topics in Optimization and Machine Learning (Master)	2 SWS	Seminar / 	Rebennack, Warwicker
WT 24/25	2550473	Seminar on Energy and Power Systems Optimization (Master)	2 SWS	Seminar / 	Rebennack, Warwicker
WT 24/25	2550491	Seminar: Modern OR and Innovative Logistics	2 SWS	Seminar / 	Nickel, Mitarbeiter
Exams					
ST 2024	7900026	Seminar Modern OR and Innovative Logistics			Nickel
ST 2024	7900200_SS2024	Seminar in Operations Research A (Master)			Stein
ST 2024	7900201_SS2024	Seminar in Operations Research (Bachelor)			Stein
ST 2024	7900296	Seminar in Operations Research B (Master)			Rebennack
ST 2024	7900317	Digitalization in the Steel Industry			Nickel
WT 24/25	7900342	Seminar Modern OR and Innovative Logistics			Nickel

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

### Prerequisites

None.

**Recommendation**

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

**Annotation**

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

Below you will find excerpts from events related to this course:

	<b>Seminar: Modern OR and Innovative Logistics</b> 2500028, SS 2024, 2 SWS, Language: German, <a href="#">Open in study portal</a>	<b>Seminar (S)</b> <b>Blended (On-Site/Online)</b>
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**Content**

The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

**Organizational issues**

Anmeldung erfolgt über das Wiwi-Portal. Nähere Informationen hierzu finden Sie hier zu einem späteren Zeitpunkt.

**Literature**

Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

	<b>Seminar on Methodical Foundations of Operations Research (B)</b> 2550131, SS 2024, 2 SWS, Language: German, <a href="#">Open in study portal</a>	<b>Seminar (S)</b> <b>On-Site</b>
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**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 student 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 scientific 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 Literatur 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 preparatory meeting.



### Seminar on Methodical Foundations of Operations Research (B)

2550131, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)  
On-Site

#### Content

The seminar aims at describing, evaluating, and discussing recent as well as classical topics in continuous optimization. The focus is on the treatment of optimization models and algorithms, also with respect to their practical application.

Bachelor students are introduced to the style of scientific work. By focused 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 scientific reasoning. Also rhetoric 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 Literatur und die relevanten Quellen werden gegen Ende des vorausgehenden Semesters im Wiwi-Portal und in einer Seminarvorbereitung bekannt gegeben.

References and relevant sources are announced at the end of the preceding semester in the Wiwi-Portal and in a preparatory meeting.



### Seminar: Modern OR and Innovative Logistics

2550491, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)  
Blended (On-Site/Online)

#### Content

The seminar aims at the presentation, critical evaluation and exemplary discussion of recent questions in discrete optimization. The focus lies on optimization models and algorithms, also with regard to their applicability in practical cases (especially in Supply Chain and Health Care Management). The students get in touch with scientific working: The in-depth work with a special scientific topic makes the students familiar with scientific literature research and argumentation methods. As a further aspect of scientific work, especially for Master students the emphasis is put on a critical discussion of the seminar topic. Regarding the seminar presentations, the students will be familiarized with basic presentational and rhetoric skills.

#### Organizational issues

Anmeldezeitraum: 11.09.24 bis 30.09.24 im Wiwi Portal

#### Literature

Die Literatur und die relevanten Quellen werden zu Beginn des Seminars bekannt gegeben.

**4.250 Course: Seminar in Statistics A (Master) [T-WIWI-103483]**

**Responsible:** Prof. Dr. Oliver Grothe  
Prof. Dr. Melanie Schienle

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-102971 - Seminar](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2500004	<a href="#">Predictive Data Analytics - An Introduction to Statistical Machine Learning</a>	2 SWS	Seminar /	Schienle, Lerch
ST 2024	2521310	<a href="#">Advanced Topics in Econometrics</a>	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher
ST 2024	2550561	<a href="#">Fortgeschrittene Themen zu Statistik, Datenanalyse und maschinellem Lernen (Master)</a>	2 SWS	Seminar /	Grothe, Kaplan, Liu
WT 24/25	25000111	<a href="#">Statistics and Epidemics</a>		Seminar /	Bracher
WT 24/25	2500012		2 SWS	Seminar /	Grothe, Kaplan, Liu
WT 24/25	2500047	<a href="#">Advanced Topics in Econometrics, Statistics and Data Science</a>	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher
WT 24/25	2521310	<a href="#">Topics in Econometrics</a>	2 SWS	Seminar	Schienle, Krüger, Rüter
Exams					
ST 2024	7900004	<a href="#">Predictive Data Analytics - An Introduction to Statistical Machine Learning</a>			Lerch
ST 2024	7900150	<a href="#">Advanced Topics in Econometrics, Seminar in Statistics A (Master)</a>			Schienle, Krüger
ST 2024	7900343	<a href="#">Seminar in Statistics A (Master)</a>			Grothe
WT 24/25	7900090	<a href="#">Advanced Topics in Econometrics, Statistics and Data Science</a>			Schienle
WT 24/25	7900144	<a href="#">Topics in Econometrics</a>			Schienle

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

**Prerequisites**

None.

**Recommendation**

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

**Annotation**

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

*Below you will find excerpts from events related to this course:*



**Predictive Data Analytics - An Introduction to Statistical Machine Learning**2500004, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)Seminar (S)  
On-Site**Organizational issues**

Blockveranstaltung, Termine werden bekannt gegeben

**Advanced Topics in Econometrics**2521310, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden bekannt gegeben

**Statistics and Epidemics**25000111, WS 24/25, SWS, Language: English, [Open in study portal](#)Seminar (S)  
On-Site**Content****Motivation**

Infectious disease epidemiology gives rise to a large variety of real-time data streams. During the COVID-19 pandemic, the interpretation and statistical analysis of these data has proven crucial, but also highly challenging. In this seminar, students will get to know central concepts of infectious disease surveillance and modelling from a statistical perspective. Following an overview of various aspects in the form of blocked lectures, students will choose a more specific topic for their seminar thesis.

**Learning Goals**

Students develop an understanding of central modeling tasks and methods, including

- estimation of reproductive numbers
- compartment models of disease spread
- nowcasting and short-term forecasting of disease spread
- detection of outbreaks
- diagnostic testing

Moreover, they get to know various data types commonly used in the analysis of disease spread.

**Logistics**

The project seminar is worth 4.5 credit points (Leistungspunkte). There will be three blocked lectures (approx. 135 minutes each) in the beginning of the lecture period. For the various topics covered, subjects for seminar theses will be proposed (and students are allowed to propose their own topics). Towards the end of the semester, students present their progress on the chosen topics to the group. Grades will be based on this presentation (25%) and the final report (75%).

**Organizational issues****Prerequisites**

Students should have a very good working knowledge of statistics, including proficiency in a programming language for applied data analysis. The lecture VWL3 Introduction to Econometrics is a prerequisite for the project seminar. Most available software in the field is in R, but in principle Python can be used as well. Advanced knowledge of biology, medicine or epidemiology is not required.

**Application Procedure**

Please submit a transcript of records as well as a short letter of motivation (roughly 200 words) via WIWI-Portal: <https://portal.wiwi.kit.edu/ys/8223>

Application time frame: July 20th, 2024 to September, 30th, 2024.

**Advanced Topics in Econometrics, Statistics and Data Science**2500047, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden bekannt gegeben

**Topics in Econometrics**2521310, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden auf Homepage und über Ilias bekannt gegeben

**4.251 Course: Seminar in Statistics B (Master) [T-WIWI-103484]**

**Responsible:** Prof. Dr. Oliver Grothe  
Prof. Dr. Melanie Schienle

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-102972 - Seminar](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Each term	1

Events					
ST 2024	2500004	<a href="#">Predictive Data Analytics - An Introduction to Statistical Machine Learning</a>	2 SWS	Seminar /	Schienle, Lerch
ST 2024	2521310	<a href="#">Advanced Topics in Econometrics</a>	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher
ST 2024	2550561	<a href="#">Fortgeschrittene Themen zu Statistik, Datenanalyse und maschinellem Lernen (Master)</a>	2 SWS	Seminar /	Grothe, Kaplan, Liu
WT 24/25	25000111	<a href="#">Statistics and Epidemics</a>		Seminar /	Bracher
WT 24/25	2500012		2 SWS	Seminar /	Grothe, Kaplan, Liu
WT 24/25	2500047	<a href="#">Advanced Topics in Econometrics, Statistics and Data Science</a>	2 SWS	Seminar	Schienle, Krüger, Buse, Rüter, Bracher
WT 24/25	2521310	<a href="#">Topics in Econometrics</a>	2 SWS	Seminar	Schienle, Krüger, Rüter
Exams					
ST 2024	7900004	<a href="#">Predictive Data Analytics - An Introduction to Statistical Machine Learning</a>			Lerch
ST 2024	7900341	<a href="#">Seminar in Statistics B (Master)</a>			Grothe
WT 24/25	7900089	<a href="#">Seminar in Statistics B (Master)</a>			Schienle
WT 24/25	7900090	<a href="#">Advanced Topics in Econometrics, Statistics and Data Science</a>			Schienle

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Alternative exam assessment (§ 4(2), 3 SPO 2015). The following aspects are included:

- Regular participation in the seminar dates
- Preparation of a seminar paper on a partial aspect of the seminar topic according to scientific methods
- Lecture on the topic of the seminar paper.

The point scheme for the assessment is determined by the lecturer of the respective course. It will be announced at the beginning of the course.

**Prerequisites**

None.

**Recommendation**

See seminar description in the course catalogue of the KIT (<https://campus.kit.edu/>)

**Annotation**

The listed seminar titles are placeholders. Currently offered seminars of each semester will be published on the websites of the institutes and in the course catalogue of the KIT. In general, the current seminar topics of each semester are already announced at the end of the previous semester. Furthermore for some seminars there is an application required.

The available places are listed on the internet: <https://portal.wiwi.kit.edu>.

*Below you will find excerpts from events related to this course:*

**Predictive Data Analytics - An Introduction to Statistical Machine Learning**2500004, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)Seminar (S)  
On-Site**Organizational issues**

Blockveranstaltung, Termine werden bekannt gegeben

**Advanced Topics in Econometrics**2521310, SS 2024, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden bekannt gegeben

**Statistics and Epidemics**25000111, WS 24/25, SWS, Language: English, [Open in study portal](#)Seminar (S)  
On-Site**Content****Motivation**

Infectious disease epidemiology gives rise to a large variety of real-time data streams. During the COVID-19 pandemic, the interpretation and statistical analysis of these data has proven crucial, but also highly challenging. In this seminar, students will get to know central concepts of infectious disease surveillance and modelling from a statistical perspective. Following an overview of various aspects in the form of blocked lectures, students will choose a more specific topic for their seminar thesis.

**Learning Goals**

Students develop an understanding of central modeling tasks and methods, including

- estimation of reproductive numbers
- compartment models of disease spread
- nowcasting and short-term forecasting of disease spread
- detection of outbreaks
- diagnostic testing

Moreover, they get to know various data types commonly used in the analysis of disease spread.

**Logistics**

The project seminar is worth 4.5 credit points (Leistungspunkte). There will be three blocked lectures (approx. 135 minutes each) in the beginning of the lecture period. For the various topics covered, subjects for seminar theses will be proposed (and students are allowed to propose their own topics). Towards the end of the semester, students present their progress on the chosen topics to the group. Grades will be based on this presentation (25%) and the final report (75%).

**Organizational issues****Prerequisites**

Students should have a very good working knowledge of statistics, including proficiency in a programming language for applied data analysis. The lecture VWL3 Introduction to Econometrics is a prerequisite for the project seminar. Most available software in the field is in R, but in principle Python can be used as well. Advanced knowledge of biology, medicine or epidemiology is not required.

**Application Procedure**

Please submit a transcript of records as well as a short letter of motivation (roughly 200 words) via WIWI-Portal: <https://portal.wiwi.kit.edu/ys/8223>

Application time frame: July 20th, 2024 to September, 30th, 2024.

**Advanced Topics in Econometrics, Statistics and Data Science**2500047, WS 24/25, 2 SWS, Language: German/English, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden bekannt gegeben

**Topics in Econometrics**2521310, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)

**Organizational issues**

Blockveranstaltung, Termine werden auf Homepage und über Ilias bekannt gegeben

T

## 4.252 Course: Seminar Mathematics [T-MATH-105686]

**Responsible:** PD Dr. Stefan Kühnlein  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102730 - Seminar](#)

Type	Credits	Grading scale	Version
Completed coursework	3	pass/fail	1

Exams			
ST 2024	7700025	<a href="#">Seminar Mathematics</a>	Kühnlein

T

## 4.253 Course: Simulation Game in Energy Economics [T-WIWI-108016]

**Responsible:** Dr. Massimo Genoese

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-101451 - Energy Economics and Energy Markets](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3,5	Grade to a third	Each summer term	2

Events					
ST 2024	2581025	<a href="#">Simulation Game in Energy Economics</a>	3 SWS	Lecture / Practice (/)	Genoese, Zimmermann
Exams					
ST 2024	7981025	<a href="#">Simulation Game in Energy Economics</a>			Fichtner

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

### Competence Certificate

Examination as written assignment and oral presentation (§4 (2), 1 SPO).

### Prerequisites

None

### Recommendation

Visiting the course "Introduction to Energy Economics"

### Annotation

The number of participants is limited.

There is a registration procedure via CAS followed by a selection of the participants.

Below you will find excerpts from events related to this course:

V

### Simulation Game in Energy Economics

2581025, SS 2024, 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

## 4.254 Course: Smart Energy Infrastructure [T-WIWI-107464]

**Responsible:** Dr. Armin Ardone  
Dr. Dr. Andrej Marko Pustisek

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-101452 - Energy Economics and Technology](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	5,5	Grade to a third	Each winter term	2

Events					
WT 24/25	2581023	<a href="#">(Smart) Energy Infrastructure</a>	4 SWS	Lecture / 🗣️	Ardone, Pustisek
Exams					
ST 2024	7900228	<a href="#">Smart Energy Infrastructure NEW</a>			Fichtner
ST 2024	7981023	<a href="#">Smart Energy Infrastructure</a>			Fichtner

Legend: 📺 Online, 🔄 Blended (On-Site/Online), 🗣️ On-Site, ✖ Cancelled

### Competence Certificate

The assessment consists of a written exam (60 minutes). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Below you will find excerpts from events related to this course:

V

### (Smart) Energy Infrastructure

2581023, WS 24/25, 4 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site

### Content

The lecture provides a techno-economic overview of different infrastructures of the energy system and their importance regarding the future energy system ("Energiewende") – in particular

- for electricity:
  - the supply side (e.g. power plants)
  - the demand side (e.g. load structures of appliances, flexibilities) as well as
  - transport infrastructures (electricity grids)
- for fuel transportation:
  - pipeline infrastructures (focus on natural gas)
  - shipping of LNG
  - crude oil and oil product transportation
  - hydrogen transportation
  - comparison of potential energy carriers for global trade of renewable energy (e.g., hydrogen and its derivatives, e-fuels, reactive metals)
- storage systems (e.g. batteries)

Additionally, the lecture provides a toolbox for energy system analysis such as an overview and classification of energy systems modelling approaches as well as the usage of scenario techniques for energy systems analysis.

The lecture also provides practical examples for the relevant methods presented.

### Organizational issues

Blockveranstaltung am 14.11., 15.11., 28.11., 29.11., 05.12., 06.12., 12.12., 13.12.24



T

**4.255 Course: Smart Grid Applications [T-WIWI-107504]**

**Responsible:** Prof. Dr. Christof Weinhardt  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-103720 - eEnergy: Markets, Services and Systems](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	see Annotations	2

Exams			
ST 2024	7900308	<a href="#">Smart Grid Applications</a>	Weinhardt

**Competence Certificate**

The assessment consists of a written exam (60 min) (according to §4(2), 1 of the examination regulations). By successful completion of the exercises (§4 (2), 3 SPO 2007 respectively §4 (3) SPO 2015) a bonus can be obtained. If the grade of the written exam is at least 4.0 and at most 1.3, the bonus will improve it by one grade level (i.e. by 0.3 or 0.4).

**Prerequisites**

None

**Recommendation**

None

**Annotation**

The lecture will no longer be offered from the coming winter semester 2023/24. It is only possible to take part in the main exam (first-time writer) and follow-up exam (repeater).

T

**4.256 Course: Sobolev Spaces [T-MATH-105896]**

**Responsible:** Prof. Dr. Roland Schnaubelt  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102926 - Sobolev Spaces](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	2

**Recommendation**

Some basic knowledge of (elementary) linear functional analysis is strongly recommended.

**4.257 Course: Social Choice Theory [T-WIWI-102859]**

**Responsible:** Prof. Dr. Clemens Puppe  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101500 - Microeconomic Theory](#)  
[M-WIWI-101504 - Collective Decision Making](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2024	2520537	<a href="#">Social Choice Theory</a>	2 SWS	Lecture /	Puppe
ST 2024	2520539	<a href="#">Übung zu Social Choice Theory</a>	1 SWS	Practice /	Puppe, Kretz
Exams					
ST 2024	7900039	<a href="#">Social Choice Theory (main date)</a>			Puppe
ST 2024	7900045	<a href="#">Social Choice Theory (make-up date)</a>			Puppe

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written exam (60 min.). The examination is offered every summer semester.

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Social Choice Theory**

2520537, SS 2024, 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 proving 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.

**4.258 Course: Sociotechnical Information Systems Development [T-WIWI-109249]**

**Responsible:** Prof. Dr. Ali Sunyaev  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	2

Events					
ST 2024	2512400	<a href="#">Advanced Lab Development of Sociotechnical Information Systems (Bachelor)</a>	3 SWS	Practical course /	Sunyaev, Leiser
ST 2024	2512401	<a href="#">Advanced Lab Development of Sociotechnical Information Systems (Master)</a>	3 SWS	Practical course /	Sunyaev, Leiser
Exams					
ST 2024	7900173	<a href="#">Advanced Lab Development of Sociotechnical Information Systems (Master)</a>			Sunyaev
WT 24/25	7900080	<a href="#">Advanced Lab Development of Sociotechnical Information Systems (Bachelor)</a>			Sunyaev
WT 24/25	7900143	<a href="#">Advanced Lab Development of Sociotechnical Information Systems (Master)</a>			Sunyaev

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The alternative exam assessment consists of an implementation and a final thesis documenting the development and use of the application.

**Prerequisites**

None.

Below you will find excerpts from events related to this course:

**Advanced Lab Development of Sociotechnical Information Systems (Bachelor)**

2512400, SS 2024, 3 SWS, Language: German/English, [Open in study portal](#)

Practical course (P)  
Blended (On-Site/Online)

**Content**

The aim of the lab is to get to know the development of socio-technical information systems in different application areas. In the event framework, you should develop a suitable solution strategy for your problem alone or in group work, collect requirements, and implement a software artifact based on it (for example, web platform, mobile apps, desktop application). Another focus of the lab is on the subsequent quality assurance and documentation of the implemented software artifact.

Registration information will be announced on the course page.

**Advanced Lab Development of Sociotechnical Information Systems (Master)**

2512401, SS 2024, 3 SWS, Language: German/English, [Open in study portal](#)

Practical course (P)  
Blended (On-Site/Online)

**Content**

The aim of the lab is to get to know the development of socio-technical information systems in different application areas. In the event framework, you should develop a suitable solution strategy for your problem alone or in group work, collect requirements, and implement a software artifact based on it (for example, web platform, mobile apps, desktop application). Another focus of the lab is on the subsequent quality assurance and documentation of the implemented software artifact.

Registration information will be announced on the course page.

**4.259 Course: Software Quality Management [T-WIWI-102895]**

**Responsible:** Prof. Dr. Andreas Oberweis  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	2

Events					
ST 2024	2511208	<a href="#">Software Quality Management</a>	2 SWS	Lecture /	Alpers
ST 2024	2511209	<a href="#">Übungen zu Software-Qualitätsmanagement</a>	1 SWS	Practice /	Frister, Forell
Exams					
ST 2024	79AIFB_STQM_A5	<a href="#">Software Quality Management (Registration until 15 July 2024)</a>			Oberweis
WT 24/25	79AIFB_STQM_C1	<a href="#">Software Quality Management</a>			Oberweis

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation in the first week after lecture period.

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Software Quality Management**

2511208, SS 2024, 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 main models of software 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

**4.260 Course: Space and Time Discretization of Nonlinear Wave Equations [T-MATH-112120]****Responsible:** Prof. Dr. Marlis Hochbruck**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-105966 - Space and Time Discretization of Nonlinear Wave Equations](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	6	Grade to a third	Irregular	1 terms	1

**Prerequisites**

none

T

## 4.261 Course: Spatial Economics [T-WIWI-103107]

**Responsible:** Prof. Dr. Ingrid Ott  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101496 - Growth and Agglomeration](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2561260	<a href="#">Spatial Economics</a>	2 SWS	Lecture /	Ott
WT 24/25	2561261	<a href="#">Exercise for Spatial Economics</a>	1 SWS	Practice /	Ott, Mirzoyan
Exams					
WT 24/25	7900075	<a href="#">Spatial Economics</a>			Ott
WT 24/25	7900276	<a href="#">Spatial Economics</a>			Ott

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Depending on further pandemic developments, the examination will be offered either as an open-book examination, or as a 60-minute written examination.

**Prerequisites**

None

**Recommendation**

Basic micro- and macroeconomic knowledge is required, such as that taught in the courses "Economics I" [2600012] and "Economics II" [2600014], attendance of which is strongly recommended (but not mandatory). An interest in quantitative-mathematical modeling is also a prerequisite. Attendance of the course "Introduction to Economic Policy" [2560280] is recommended.

Below you will find excerpts from events related to this course:

V

**Spatial Economics**

2561260, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)  
On-Site



**Content**

The course covers the following topics:

- Geography, trade and development
- Geography and economic theory
- Core models of economic geography and empirical evidence
- Agglomeration, home market effect, and spatial wages
- Applications and extensions

**Learning objectives:**

The student

- analyses how spatial distribution of economic activity is determined.
- uses quantitative methods within the context of economic models.
- has basic knowledge of formal-analytic methods.
- understands the link between economic theory and its empirical applications.
- understands to what extent concentration processes result from agglomeration and dispersion forces.
- is able to determine theory based policy recommendations.

**Recommendations:**

Basic knowledge of micro- and macroeconomics is assumed, as taught in the courses Economics I [2600012], and Economics II [2600014]. An interest in mathematical modeling is advantageous.

**Workload:**

The total workload for this course is approximately 135 hours.

- Classes: ca. 30 h
- Self-study: ca. 45 h
- Exam and exam preparation: ca. 60 h

**Assessment:**

The assessment consists of a written exam (60 minutes) (following §4(2), 1 of the examination regulation).

**Literature**

Steven Brakman, Harry Garretsen, Charles van Marrewijk (2009): The New Introduction to Geographical Economics, 2nd ed, Cambridge University Press.

Weitere Literatur wird in der Vorlesung bekanntgegeben.  
(Further literature will be announced in the lecture.)

T

**4.262 Course: Spatial Stochastics [T-MATH-105867]**

**Responsible:** Prof. Dr. Daniel Hug  
Prof. Dr. Günter Last  
PD Dr. Steffen Winter

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102903 - Spatial Stochastics](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
WT 24/25	0105600	<a href="#">Spatial Stochastics</a>	4 SWS	Lecture	Hug
WT 24/25	0105610	<a href="#">Tutorial for 0105600 (Spatial Stochastics)</a>	2 SWS	Practice	Hug

**Prerequisites**  
none

*Below you will find excerpts from events related to this course:*

V

**Spatial Stochastics**

0105600, WS 24/25, 4 SWS, Language: English, [Open in study portal](#)

**Lecture (V)****Content**

Competence Goal:

The students are familiar with some basic spatial stochastic processes. They do not only understand how to deal with general properties of distributions, but also know how to describe and apply specific models (Poisson process, Gaussian random fields). They know how to work self-organised and self-reflexive.

Content:

Random sets  
Point processes  
Random measures  
Palm distributions  
Random fields  
Gaussian fields  
Spectral theory of random fields  
Spatial ergodic theorem

**Literature**

Skriptum/Lectures Notes



## 4.263 Course: Special Topics in Information Systems [T-WIWI-113726]

**Responsible:** Prof. Dr. Christof Weinhardt  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-103720 - eEnergy: Markets, Services and Systems](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each term	1

### Competence Certificate

The assessment of this course is in form of a written documentation, a presentation of the outcome of the conducted practical components and an active participation in class.

Please take into account that, beside the written documentation, also a practical component (such as a survey or an implementation of an application) is part of the course. Please examine the course description for the particular tasks.

The overall grade is composed as follows:

A total of 60 points can be achieved, of which

- A maximum of 30 points for the written documentation
- A maximum of 30 points for the practical component

In order to pass the success control, at least 15 points (written documentation / practical component) must be achieved.

### Prerequisites

see below

### Recommendation

None

### Annotation

All the practical seminars offered at the chair of Prof. Dr. Weinhardt can be chosen in the Special Topics in Information Systems course. The current topics of the practical seminars are available at the following homepage: [www.iism.kit.edu/im/lehre](http://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

## 4.264 Course: Special Topics of Numerical Linear Algebra [T-MATH-105891]

**Responsible:** PD Dr. Volker Grimm  
 Prof. Dr. Marlis Hochbruck  
 PD Dr. Markus Neher

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102920 - Special Topics of Numerical Linear Algebra](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
ST 2024	0100083	<a href="#">Special Topics of Numerical Linear Algebra</a>	Grimm

**Prerequisites**

none

**4.265 Course: Spectral Theory - Exam [T-MATH-103414]**

**Responsible:** Prof. Dr. Dorothee Frey  
 PD Dr. Gerd Herzog  
 apl. Prof. Dr. Peer Kunstmann  
 Prof. Dr. Roland Schnaubelt  
 Dr. rer. nat. Patrick Tolksdorf

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-101768 - Spectral Theory](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2024	0163700	<a href="#">Spectral Theory</a>	4 SWS	Lecture	Frey
ST 2024	0163710	<a href="#">Tutorial for 0163700 (Spectral Theory)</a>	2 SWS	Practice	Frey
Exams					
ST 2024	0100035	<a href="#">Spectral Theory - Exam</a>			Kunstmann, Frey, Hundertmark, Schnaubelt

**Competence Certificate**

Oral examination of approx. 30 minutes.

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Spectral Theory**

0163700, SS 2024, 4 SWS, [Open in study portal](#)

Lecture (V)

**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

**4.266 Course: Splitting Methods for Evolution Equations [T-MATH-110805]****Responsible:** Prof. Dr. Tobias Jahnke**Organisation:** KIT Department of Mathematics**Part of:** [M-MATH-105325 - Splitting Methods for Evolution Equations](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

**Prerequisites**

none

T

**4.267 Course: Statistical Learning [T-MATH-111726]**

**Responsible:** Prof. Dr. Mathias Trabs  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105840 - Statistical Learning](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
ST 2024	7700122	<a href="#">Statistical Learning</a>	Ebner

**Competence Certificate**

The module will be completed with an oral exam (approx. 30 min).

**Prerequisites**

none

**Recommendation**

The module "Introduction to Stochastics" is recommended. The module "Probability theory" is preferable.

T

## 4.268 Course: Statistical Modeling of Generalized Regression Models [T-WIWI-103065]

**Responsible:** apl. Prof. Dr. Wolf-Dieter Heller  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101638 - Econometrics and Statistics I](#)  
[M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2521350	<a href="#">Statistical Modeling of Generalized Regression Models</a>	2 SWS	Lecture	Heller
Exams					
WT 24/25	7900146 (WS23/24)	<a href="#">Statistical Modeling of generalized regression models</a>			Heller

### Competence Certificate

The assessment of this course is a written examination (60 min) according to §4(2), 1 of the examination regulation.

### Prerequisites

The course T-MATH-105870 "Generalized Regression Models" must not have been selected.

### Recommendation

Knowledge of the contents covered by the course "Economics III: Introduction in Econometrics" [2520016]

Below you will find excerpts from events related to this course:

V

### Statistical Modeling of Generalized Regression Models

2521350, WS 24/25, 2 SWS, [Open in study portal](#)

Lecture (V)

### Content

#### Learning objectives:

The student has profound knowledge of generalized regression models.

#### Requirements:

Knowledge of the contents covered by the course *Economics III: Introduction in Econometrics* [2520016].

#### Workload:

Total workload for 4.5 CP: approx. 135 hours

Attendance: 30 hours

Preparation and follow-up: 65 hours



T

**4.269 Course: Steins Method with Applications in Statistics [T-MATH-111187]**

**Responsible:** Dr. rer. nat. Bruno Ebner  
Prof. Dr. Daniel Hug

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-105579 - Steins Method with Applications in Statistics](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

**Prerequisites**

none

**4.270 Course: Stochastic Calculus and Finance [T-WIWI-103129]**

**Responsible:** Dr. Mher Safarian  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101639 - Econometrics and Statistics II](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2521331	<a href="#">Stochastic Calculus and Finance</a>	2 SWS	Lecture	Safarian
WT 24/25	2521332	<a href="#">Übungen zu Stochastic Calculus and Finance</a>	2 SWS	Practice	Safarian

**Competence Certificate**

The assessment of this course consists of a written examination (§4(2), 1 SPOs, 180 min.).

**Prerequisites**

None

**Annotation**

For more information see <http://statistik.econ.kit.edu/>

Below you will find excerpts from events related to this course:

**Stochastic Calculus and Finance**

2521331, WS 24/25, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)

**Content****Learning objectives:**

After successful completion of the course students will be familiar with many common methods of pricing and portfolio models in finance. Emphasis will 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

**4.271 Course: Stochastic Control [T-MATH-105871]**

**Responsible:** Prof. Dr. Nicole Bäuerle  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102908 - Stochastic Control](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

**Prerequisites**  
none

T

**4.272 Course: Stochastic Differential Equations [T-MATH-105852]**

**Responsible:** Prof. Dr. Dorothee Frey  
Prof. Dr. Roland Schnaubelt

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102881 - Stochastic Differential Equations](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

T

**4.273 Course: Stochastic Geometry [T-MATH-105840]**

**Responsible:** Prof. Dr. Daniel Hug  
 Prof. Dr. Günter Last  
 PD Dr. Steffen Winter

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102865 - Stochastic Geometry](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Events					
ST 2024	0152600	<a href="#">Stochastic Geometry</a>	4 SWS	Lecture	Winter
ST 2024	0152610	<a href="#">Tutorial for 0152600 (Stochastic Geometry)</a>	2 SWS	Practice	Winter
Exams					
ST 2024	7700035	<a href="#">Stochastic Geometry</a>			Winter

Below you will find excerpts from events related to this course:

V

**Stochastic Geometry**

0152600, SS 2024, 4 SWS, [Open in study portal](#)

Lecture (V)

**Content**

For some idea what this course is about see

<https://www.math.kit.edu/stoch/seite/raeumstoch-lehre/en>

T

**4.274 Course: Stochastic Simulation [T-MATH-112242]**

**Responsible:** TT-Prof. Dr. Sebastian Krumscheid  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106053 - Stochastic Simulation](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	5	Grade to a third	Each winter term	1

Events					
WT 24/25	0100027	<a href="#">Stochastic Simulation</a>	2 SWS	Lecture	Krumscheid

**Competence Certificate**

oral exam of ca. 30 min

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

V

**Stochastic Simulation**0100027, WS 24/25, 2 SWS, [Open in study portal](#)

Lecture (V)

**Content**

The course covers mathematical concepts and computational tools used to analyze systems with uncertainty arising across various application domains. First, we will address stochastic modelling strategies to represent uncertainty in such systems. Then we will discuss sampling-based methods to assess uncertain system outputs via stochastic simulation techniques. The focus of this course will be on the theoretical foundations of the discussed techniques, as well as their methodological realization as efficient computational tools.

Topics covered include:

- Random variable generation
- Simulation of random processes
- Simulation of Gaussian random fields
- Monte Carlo method; output analysis
- Variance reduction techniques
- Quasi Monte Carlo methods
- Markov Chain Monte Carlo methods (Metropolis-Hasting, Gibbs sampler)

Other topics that may be addressed if time allows, such as rare event simulations, and stochastic optimization using stochastic approximation or simulated annealing.

T

## 4.275 Course: Strategy and Management Theory: Developments and "Classics" [T-WIWI-106190]

**Responsible:** Prof. Dr. Hagen Lindstädt

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-103119 - Advanced Topics in Strategy and Management](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Irregular	1

Events					
ST 2024	2577921	<a href="#">Strategy and Management Theory: Developments and "Classics" (Master)</a>	2 SWS	Seminar / 	Lindstädt
WT 24/25	2577921	<a href="#">Strategy and Management Theory: Developments and "Classics" (Master)</a>	2 SWS	Seminar / 	Lindstädt
Exams					
ST 2024	7900278	<a href="#">Strategy and Management Theory: Developments and "Classics"</a>			Lindstädt
WT 24/25	7900120	<a href="#">Strategy and Management Theory: Developments and "Classics"</a>			Lindstädt

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

The control of success according to § 4(2), 3 SPO takes place by writing a scientific work and a presentation of the results of the work in the context of a conclusion meeting. Details on the design of the performance review will be announced during the lecture.

### Prerequisites

None

### Recommendation

Basic knowledge as conveyed in the bachelor module „Strategy and Organization“ is recommended.

### Annotation

This course is admission restricted. If you were already admitted to another course in the module “Advanced Topics in Strategy and Management” the participation at this course will be guaranteed.

The course is planned to be held for the first time in the winter term 2017/18.

Below you will find excerpts from events related to this course:

V

### Strategy and Management Theory: Developments and "Classics" (Master)

2577921, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)  
On-Site



**Content**

This course covers highly topical issues of great relevance to the management of organizations. Students will be enabled to take strategic management positions. By applying appropriate models from the fields of strategy and management - or models developed in-house - participants will learn to evaluate the strategic starting position of an organization and derive precise and well-founded recommendations for action based on this.

This course offers students the opportunity to explore current management issues and sharpen their skills in strategic analysis and evaluation. Through intensive collaboration and practical application of the knowledge learned, students are optimally prepared for the demands and challenges of modern business management.

**Structure**

The course begins with an overarching theme, based on which students are divided into groups of two. The core of the course consists of the preparation of a written paper as well as the presentation and discussion of the results.

**Learning Objectives**

Upon completion of the course, students will be able to,

- analyze complex business situations, think strategically and derive sound management decisions.
- compose clear and convincing written papers that accurately present the analyses and recommendations developed.
- present results in an engaging manner and actively participate in substantive discussions.

**Recommendations:**

Prior attendance of the Bachelor's module "Strategy and Organization" or another module with comparable content at another university is recommended.

**Workload:**

Total effort approx. 90 hours

Attendance time: 15 hours

Preparation and follow-up: 75 hours

Examination and preparation: not applicable

**Verification:**

The success control according to § 4(2), 3 SPO is done by writing a scientific paper and a presentation of the results of the paper in the context of a final event. Details on the design of the performance review will be announced during the lecture.

**Annotation:**

The course is admission restricted. In case of prior admission to another course in the module "Strategy and Management: Advanced Topics" [M-WIWI-103119], participation in this course is guaranteed. For more information on the application process, see the IBU website.

Exams are offered at least every other semester, so the entire module can be completed in two semesters.

**Organizational issues**

siehe Homepage

**Strategy and Management Theory: Developments and "Classics" (Master)**

2577921, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)  
On-Site

**Content**

This course covers highly topical issues of great relevance to the management of organizations. Students will be enabled to take strategic management positions. By applying appropriate models from the fields of strategy and management - or models developed in-house - participants will learn to evaluate the strategic starting position of an organization and derive precise and well-founded recommendations for action based on this.

This course offers students the opportunity to explore current management issues and sharpen their skills in strategic analysis and evaluation. Through intensive collaboration and practical application of the knowledge learned, students are optimally prepared for the demands and challenges of modern business management.

**Structure**

The course begins with an overarching theme, based on which students are divided into groups of two. The core of the course consists of the preparation of a written paper as well as the presentation and discussion of the results.

**Learning Objectives**

Upon completion of the course, students will be able to,

- analyze complex business situations, think strategically and derive sound management decisions.
- compose clear and convincing written papers that accurately present the analyses and recommendations developed.
- present results in an engaging manner and actively participate in substantive discussions.

**Recommendations:**

Prior attendance of the Bachelor's module "Strategy and Organization" or another module with comparable content at another university is recommended.

**Workload:**

Total effort approx. 90 hours

Attendance time: 15 hours

Preparation and follow-up: 75 hours

Examination and preparation: not applicable

**Verification:**

The success control according to § 4(2), 3 SPO is done by writing a scientific paper and a presentation of the results of the paper in the context of a final event. Details on the design of the performance review will be announced during the lecture.

**Annotation:**

The course is admission restricted. In case of prior admission to another course in the module "Strategy and Management: Advanced Topics" [M-WIWI-103119], participation in this course is guaranteed. For more information on the application process, see the IBU website.

Exams are offered at least every other semester, so the entire module can be completed in two semesters.

**Organizational issues**

siehe Homepage

T

**4.276 Course: Structural Graph Theory [T-MATH-111004]**

**Responsible:** Prof. Dr. Maria Aksenovich  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105463 - Structural Graph Theory](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

**Prerequisites**  
none

T

**4.277 Course: Supplement Enterprise Information Systems [T-WIWI-110346]**

**Responsible:** Prof. Dr. Andreas Oberweis  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each term	1

**Competence Certificate**

The assessment of this course is a written or (if necessary) oral examination.

**Prerequisites**

None

**Annotation**

This course can be used in particular for the acceptance of external courses whose content is in the broader area of applied informatics, but is not equivalent to another course of this topic.

T

**4.278 Course: Supplement Software- and Systemsengineering [T-WIWI-110372]**

**Responsible:** Prof. Dr. Andreas Oberweis  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each term	1

**Competence Certificate**

The assessment of this course is a written or (if necessary) oral examination.

**Prerequisites**

None

**Annotation**

This course can be used in particular for the acceptance of external courses whose content is in the broader area of software and systems engineering, but cannot assigned to another course of this topic.

**T 4.279 Course: Tactical and Operational Supply Chain Management [T-WIWI-102714]**

**Responsible:** Prof. Dr. Stefan Nickel  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101413 - Applications of Operations Research](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each summer term	3

Events					
ST 2024	2550486	<a href="#">Tactical and operational SCM</a>	3 SWS	Lecture /	Nickel
ST 2024	2550487	<a href="#">Übungen zu Taktisches und operatives SCM</a>	1.5 SWS	Practice /	Pomes, Linner, Hoffmann
Exams					
ST 2024	7900239	<a href="#">Tactical and Operational Supply Chain Management</a>			Nickel
WT 24/25	7900104	<a href="#">Tactical and Operational Supply Chain Management</a>			Nickel

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

Depending on further pandemic developments, the exam will be offered either as an open-book exam, or as a written exam (60 min).

The exam takes place in every semester.

Prerequisite for admission to examination is the successful completion of the online assessments.

**Prerequisites**

Prerequisite for admission to examination is the succesful completion of the online assessments.

**Recommendation**

None

**Annotation**

The lecture is held in every summer term. The planned lectures and courses for the next three years are announced online.

*Below you will find excerpts from events related to this course:*

	<p><b>Tactical and operational SCM</b>                  2550486, SS 2024, 3 SWS, Language: German, <a href="#">Open in study portal</a></p>	<p><b>Lecture (V)</b>  <b>On-Site</b></p>
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**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

## 4.280 Course: Time Series Analysis [T-MATH-105874]

**Responsible:** Dr. rer. nat. Bruno Ebner  
 Prof. Dr. Vicky Fasen-Hartmann  
 Prof. Dr. Tilmann Gneiting  
 PD Dr. Bernhard Klar  
 Prof. Dr. Mathias Trabs

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102911 - Time Series Analysis](#)

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	3

Events					
ST 2024	0161100	<a href="#">Time Series Analysis</a>	2 SWS	Lecture	Gneiting
ST 2024	0161110	<a href="#">Tutorial for 0161100 (Time Series Analysis)</a>	1 SWS	Practice	Gneiting
Exams					
ST 2024	7700094	<a href="#">Time Series Analysis</a>			Gneiting

Below you will find excerpts from events related to this course:

## V

## Time Series Analysis

0161100, SS 2024, 2 SWS, Language: English, [Open in study portal](#)

Lecture (V)

### Content

A time series is a sequence of data sequentially observed in time. The course provides an introduction to the theory and practice of statistical time series analysis. Topics covered include stationary and non-stationary stochastic processes, autoregressive and moving average (ARMA) models, model selection and estimation, state-space models and the Kalman filter, forecasting and forecast evaluation, and an outline of spectral techniques.



**4.281 Course: Topics in Experimental Economics [T-WIWI-102863]**

**Responsible:** Prof. Dr. Johannes Philipp Reiß  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101505 - Experimental Economics](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Irregular	1

Events					
ST 2024	2560232	<a href="#">Topics in Experimental Economics</a>	2 SWS	Lecture /	Reiß, Peters
ST 2024	25602333	<a href="#">Übungen zu Topics in Experimental Economics</a>	1 SWS	Practice /	Reiß, Peters
Exams					
ST 2024	7910007	<a href="#">Topics in Experimental Economics</a>			Reiß

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

The assessment consists of a written exam (following §4(2), 1 of the examination regulation).

**Prerequisites**

None

**Recommendation**

Basic knowledge of Experimental Economics is assumed. Therefore, it is strongly recommended to attend the course Experimental Economics beforehand.

**Annotation**

The course is offered in summer 2020 for the next time, not in summer 2018.

T

## 4.282 Course: Topics in Stochastic Optimization [T-WIWI-112109]

**Responsible:** Prof. Dr. Steffen Rebennack  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101473 - Mathematical Programming](#)  
[M-WIWI-101637 - Analytics and Statistics](#)  
[M-WIWI-102832 - Operations Research in Supply Chain Management](#)  
[M-WIWI-103289 - Stochastic Optimization](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each winter term	1

### Competence Certificate

Students will be given problem sets on which they work in groups. The problem sets will involve the implementation of the models presented in the course, and exploring features of these models. The groups will present their findings in front of the class. The grading will be based on the presentation.

### Recommendation

A solid understanding of Stochastic Optimization and/or Optimization under Uncertainty as well as optimization in general is highly recommended, since we will heavily build upon basics of these areas.

### Annotation

Teaching and learning format: Lecture and exercise

T

**4.283 Course: Topological Data Analysis [T-MATH-111031]**

**Responsible:** Prof. Dr. Tobias Hartnick  
Prof. Dr. Roman Sauer

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-105487 - Topological Data Analysis](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	6	Grade to a third	Irregular	1

**Prerequisites**

none

T

**4.284 Course: Topological Genomics [T-MATH-112281]**

**Responsible:** Dr. Andreas Ott  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-106064 - Topological Genomics](#)

Type	Credits	Grading scale	Recurrence	Expansion	Version
Oral examination	3	Grade to a third	Irregular	1 terms	1

**Competence Certificate**

oral exam of ca. 20 min

**Prerequisites**

none

T

**4.285 Course: Translation Surfaces [T-MATH-112128]**

**Responsible:** Prof. Dr. Frank Herrlich  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105973 - Translation Surfaces](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

**Prerequisites**  
none

T

**4.286 Course: Traveling Waves [T-MATH-105897]**

**Responsible:** Dr. Björn de Rijk  
Prof. Dr. Wolfgang Reichel

**Organisation:** KIT Department of Mathematics

**Part of:** [M-MATH-102927 - Traveling Waves](#)

Type	Credits	Grading scale	Version
Oral examination	6	Grade to a third	2

**Competence Certificate**

The module examination takes place in form of an oral exam of about 30 minutes. Please see under "Modulnote" for more information about the bonus regulation.

**Prerequisites**

none

**Recommendation**

The following background is strongly recommended: Analysis 1-4.

T

## 4.287 Course: Trustworthy Emerging Technologies [T-WIWI-113026]

**Responsible:** Prof. Dr. Ali Sunyaev**Organisation:** KIT Department of Economics and Management**Part of:** [M-WIWI-101472 - Informatics](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	4,5	Grade to a third	Each summer term	1

Events					
ST 2024	2511404	<a href="#">Trustworthy Emerging Technologies</a>		Lecture / 	Sunyaev, Lins
Exams					
ST 2024	7900185	<a href="#">Trustworthy Emerging Technologies</a>			Sunyaev

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled**Competence Certificate**

Alternative exam assessment (§ 4(2), 3 SPO). Details will be announced in the respective course.

**4.288 Course: Uncertainty Quantification [T-MATH-108399]**

**Responsible:** Prof. Dr. Martin Frank  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-104054 - Uncertainty Quantification](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	4	Grade to a third	Irregular	1

Events					
ST 2024	0164400	<a href="#">Uncertainty Quantification</a>	2 SWS	Lecture	Frank
ST 2024	0164410	<a href="#">Tutorial for 0164400 (Uncertainty quantification)</a>	1 SWS	Practice	Frank
Exams					
ST 2024	7700045	<a href="#">Uncertainty Quantification</a>			Frank

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Uncertainty Quantification**

0164400, SS 2024, 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 Uncertainty 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 uncertain 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. Furthermore, 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

## 4.289 Course: Valuation [T-WIWI-102621]

**Responsible:** Prof. Dr. Martin Ruckes  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)  
[M-WIWI-101482 - Finance 1](#)  
[M-WIWI-101483 - Finance 2](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Each winter term	1

Events					
WT 24/25	2530212	<a href="#">Valuation</a>	2 SWS	Lecture /	Ruckes
WT 24/25	2530213	<a href="#">Übungen zu Valuation</a>	1 SWS	Practice /	Ruckes, Luedecke
Exams					
ST 2024	7900072	<a href="#">Valuation</a>			Ruckes
WT 24/25	7900057	<a href="#">Valuation</a>			Ruckes

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

**Competence Certificate**

See German version.

**Prerequisites**

None

**Recommendation**

None

Below you will find excerpts from events related to this course:

V

**Valuation**

2530212, WS 24/25, 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

## 4.290 Course: Variational Methods [T-MATH-110302]

**Responsible:** Prof. Dr. Wolfgang Reichel  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-105093 - Variational Methods](#)

Type	Credits	Grading scale	Version
Oral examination	8	Grade to a third	1

Exams			
ST 2024	7700141	<a href="#">Variational Methods</a>	Lamm

T

**4.291 Course: Wavelets [T-MATH-105838]**

**Responsible:** Prof. Dr. Andreas Rieder  
**Organisation:** KIT Department of Mathematics  
**Part of:** [M-MATH-102895 - Wavelets](#)

Type	Credits	Grading scale	Recurrence	Version
Oral examination	8	Grade to a third	Irregular	1

**Competence Certificate**

Mündliche Prüfung im Umfang von ca. 30 Minuten.

**Prerequisites**

none

T

**4.292 Course: Web App Programming for Finance [T-WIWI-110933]**

**Responsible:** TT-Prof. Dr. Julian Thimme  
**Organisation:** KIT Department of Economics and Management  
**Part of:** [M-WIWI-101480 - Finance 3](#)

Type	Credits	Grading scale	Recurrence	Version
Written examination	4,5	Grade to a third	Once	1

**Competence Certificate**

Non exam assessment according to § 4 paragraph 3 of the examination regulation. (Anmerkung: gilt nur für SPO 2015). The grade is made up as follows: 50% result of the project (R-code), 50% presentation of the project.

**Prerequisites**

None

**Recommendation**

The content of the bachelor course Investments is assumed to be known and necessary to follow the course.

T

## 4.293 Course: Workshop Business Wargaming – Analyzing Strategic Interactions [T-WIWI-106189]

**Responsible:** Prof. Dr. Hagen Lindstädt

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-103119 - Advanced Topics in Strategy and Management](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Irregular	1

Events					
WT 24/25	2577922	<a href="#">Workshop Business Wargaming - Analyse strategischer Interaktionen (Master)</a>	2 SWS	Seminar / 	Lindstädt
Exams					
WT 24/25	7900172	<a href="#">Workshop Business Wargaming – Analyzing Strategic Interactions</a>			Lindstädt

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

In this course, real conflict situations are simulated and analyzed using various methods from business wargaming. Details on the design of the performance review will be announced during the lecture.

### Prerequisites

None

### Recommendation

Basic knowledge as conveyed in the bachelor module „Strategy and Organization“ is recommended.

### Annotation

This course is admission restricted. If you were already admitted to another course in the module “Advanced Topics in Strategy and Management” the participation at this course will be guaranteed.

The course is planned to be held for the first time in the summer term 2018.

Below you will find excerpts from events related to this course:

V

### Workshop Business Wargaming - Analyse strategischer Interaktionen (Master)

2577922, WS 24/25, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)  
On-Site

**Content**

This course enables the simulation of strategic conflicts in which the participants assume the roles of selected actors. With the help of specially programmed wargaming software, strategic conflicts are simulated interactively and then reflected upon and discussed.

The course focuses on the simulation and analysis of real conflict situations with strategic interaction. Students gain a better understanding of the structural characteristics of strategic conflicts in the fields of economics and politics as well as the ability to derive their own strategies for action.

Through a combination of group work, simulation, and reflection, the seminar provides a learning experience that both strengthens team skills and develops analytical skills in strategic conflict. Join this seminar to gain sound insights into conflict dynamics and develop effective action strategies for complex situations.

**Learning Objectives**

Upon completion of the course, students will be able to,

- learn the basic methodologies, features and benefits of business wargaming
- improve their understanding of conflict dynamics by reflecting on strategic conflicts
- Strengthen analytical skills by processing a variety of courses of action and deriving strategies for action

**Recommendations:**

Prior attendance of the Bachelor's module "Strategy and Organization" or another module with comparable content at another university is recommended.

**Workload:**

- Total workload: approx. 90 hours
- Attendance time: 15 hours
- Preparation and follow-up: 75 hours
- Examination and preparation: not applicable

**Evidence:**

In this course, real conflict situations are simulated and analyzed with the help of various methods from business wargaming. Details on the design of the performance review will be announced during the lecture.

**Annotation:**

The course is admission restricted. In case of prior admission to another course in the module "Strategy and Management: Advanced Topics" [M-WIWI-103119], participation in this course is guaranteed. For more information on the application process, see the IBU website.

Exams are offered at least every other semester, so the entire module can be completed in two semesters.

**Organizational issues**

IBU-Seminarraum, Geb. 05.20, Raum 2A-12.1

T

## 4.294 Course: Workshop Current Topics in Strategy and Management [T-WIWI-106188]

**Responsible:** Prof. Dr. Hagen Lindstädt

**Organisation:** KIT Department of Economics and Management

**Part of:** [M-WIWI-103119 - Advanced Topics in Strategy and Management](#)

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	3	Grade to a third	Irregular	1

Events					
ST 2024	2577923	<a href="#">Workshop aktuelle Themen Strategie und Management (Master)</a>	2 SWS	Seminar / 	Lindstädt
Exams					
ST 2024	7900122	<a href="#">Workshop Current Topics in Strategy and Management</a>			Lindstädt

Legend:  Online,  Blended (On-Site/Online),  On-Site,  Cancelled

### Competence Certificate

The evaluation of the performance takes place through the active participation in the discussion rounds; an appropriate preparation is expressed here and a clear understanding of the topic and framework becomes recognizable. Further details on the design of the performance review will be announced during the lecture.

### Prerequisites

None

### Recommendation

Basic knowledge as conveyed in the bachelor module „Strategy and Organization“ is recommended.

### Annotation

This course is admission restricted. If you were already admitted to another course in the module “Advanced Topics in Strategy and Management” the participation at this course will be guaranteed.

The course is planned to be held for the first time in the winter term 2017/18.

Below you will find excerpts from events related to this course:

V

### Workshop aktuelle Themen Strategie und Management (Master)

2577923, SS 2024, 2 SWS, Language: German, [Open in study portal](#)

Seminar (S)  
On-Site



**Content**

Aspects of strategic management can be found in a variety of daily events. In this course, current strategic and industrial policy issues are discussed and the exchange of ideas on current management topics is promoted.

For this purpose, practice-relevant case studies and dedicated questions are communicated to the students in advance so that they can prepare themselves individually for the discussion. The chair team actively moderates the discussion and creates typical discussion situations such as pro/con discussions and conflicting interests of different groups in order to bring opposing opinions into an exchange and to promote the power of argumentation. In this way, the discussion not only imparts knowledge about the content, but also strengthens the participants' skills by simulating real discussion situations in a management team.

In addition, company representatives and managers participate in individual case studies to strengthen the context of the content and experience the daily dynamics of discussion in strategic business areas.

**Learning Objectives:**

Students will

- are able to evaluate strategic decisions using appropriate models of strategic business management,
- are able to present and critically evaluate theoretical approaches and models in the field of strategic business management and illustrate them using practical examples, and
- have the ability to present their position convincingly through a reasoned argumentation in structured discussions.

**Recommendations:**

Previous attendance of the Bachelor's module "Strategy and Organization" or another module with comparable content at another university is recommended.

**Workload:**

Total effort approx. 90 hours

Attendance time: 15 hours

Preparation and follow-up: 75 hours

Examination and preparation: not applicable

**Evidence:**

Performance will be assessed through active discussion participation in the discussion rounds; here, adequate preparation will be expressed and a clear understanding of the topic and framework will be evident. Further details on the design of the performance assessment will be announced during the lecture.

**Annotation:**

This course is admission restricted. In case of prior admission to another course in the module "Strategy and Management: Advanced Topics"[M-WIWI-103119], participation in this course is guaranteed. For more information on the application process, see the IBU website.

Exams are offered at least every other semester so that the entire module can be completed in two semesters.