Technology
Arts Sciences
TH Köln

Course
HIM - Advanced Mathematics

Version: 3 | Last Change: 28.09.2019 11:58 | Draft: 0 | Status: vom verantwortlichen Dozent freigegeben

General information

Long name	Advanced Mathematics
Approving CModule	HIM_MaCSN, HIM_MaET, HIM_MaTIN
Responsible	Prof. Dr. Heiko Knospe Professor Fakultät IME
Level	Master
Semester in the year	summer semester
Duration	Semester
Hours in self-study	78
ECTS	5
Professors	Prof. Dr. Heiko Knospe Professor Fakultät IME Prof. Dr. Hubert Randerath Professor Fakultät IME Prof. Dr. Beate Rhein Professor Fakultät IME
Requirements	Differential and integral calculus and linear algebra (Bachelor-level mathematics)
Language	German and English
Separate final exam	Yes

Final exam

Details

Written Exam

Minimum standard

Passing the exam

Exam Type

Written Exam

Lecture / Exercises

Learning goals

Knowledge

A combination of:
- Vector Analysis
- Probability Theory, Statistics and Multivariate Statistics
- Stochastic processes
- Optimization

Vector Analysis
- Vector Spaces
- Scalar and Vector Functions
- Differential Operators
- Line Integrals
- Double Integrals
- Triple Integrals
- Change of Variables
- Surface Integrals
- Divergence Theorem
- Theorem of Stokes
- Maxwell Equations

Probability and Statistics
- Descriptive Statistics
- Two-dimensional Data
- Simple Linear Regression
- Probability Spaces
- Random Variables
- Expectation, Variance, Moments
- Jointly Distributed Random Variables
- Independent Random Variables
- Covariance
- Binomial Random Variable
- Poisson Random Variable
- Uniform Random Variable
- Normal Random Variable
- Chi-Square Distribution
- t-Distribution
- Central Limit Theorem
- Distributions of Sampling Statistics
- Confidence Intervals
- Hypothesis Testing

- t-Test, f-Test, Chi-Square Test
- Overview of various Tests

Multivariate Statistics
- Analysis of multidimensional data
- Multivariate Random Variables
- Matrix decompositions, Singular Value Decomposition (SVD)
- Factor analysis, Principal Component Analysis (PCA)
- Multiple Linear Regression

Stochastic Processes
- Discrete and continuous time processes
- Random walk
- Markov chain
- Poisson process
- Queuing theory

Optimization
- Linear Programming
- Unconstrained Optimization: Gradient method, Newton's method, Trust Region method
- Constrained Optimization: Karush–Kuhn–Tucker (KKT) conditions, Lagrange multipliers, Penalty and Barrier functions
- Special optimization problems: Mixed Integer Nonlinear Programming, Nonlinear Stochastic Optimization

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Skills

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Expenditure classroom teaching

Type	Attendance (h/Wk.)
Lecture	3
Exercises (whole course)	1
Exercises (shared course)	0
Tutorial (voluntary)	0

Separate exam

none