Appendix B: Module catalogue

for the study programme Digital Technologies (part-time) M.Eng.

Modules

Big Data Technologies					**BDT**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5032	150 h	6	3rd semester	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students understand the architectural concepts of information systems and analysis methods for large, complex and volatile data sets. They can apply the established concepts for data mining in parallel and distributed systems.
- They are confident in using the Apache Hadoop ecosystem for managing, processing and distributing data in data science applications and know its essential components. They analyse the characteristics of concrete projects and can thus assess which components should be selected and applied in each case.
- They know the principles of NoSQL databases, assess when which type of NoSQL database should be used and apply them in practice.
- Students will be able to define the information technology requirements that must be taken as a basis for handling large data science projects in the cloud.
- By applying and evaluating the technologies, they have increased their practical IT competence, i.e. gained procedural knowledge and trained their teamwork skills through group work (metacognitive level).

3 Contents:

- Big Data Architectures
  - Horizontal vs. vertical scaling
  - Data at rest vs. data in motion
  - Lambda architecture (batch, serving and speed layers)
- The Apache Hadoop ecosystem and its core components
  - Hadoop Distributed File System (HDFS)
  - Map Reduce
- Important extensions of the Hadoop ecosystem
  - YARN
  - Storm
  - Hive
  - Pig
- In-memory processing
  - Spark
- Distributed databases
  - Horizontal vs. vertical fragmentation
  - Fragmentation transparency

	- o Transaction control - o CAP Theorem - NoSQL databases - o Document-oriented (MongoDB) - o Key-Value (Redis) - o Graph-based (Neo4J) - o Column-oriented (HBase) - Cloud-based Big Data systems - o Serverless computing	
4	Forms of teaching:	
	Self-study units, classroom sessions in the form of exercises and laboratory practicals	
5	Participation requirements:	
	Formal:	-
	Content:	Modules: 5025 Programming Languages for Data Analysis; 5026 Statistics for Data Analysis; 5029 Methods of Data Mining; 5030 Machine Learning Methods;
6	Forms of assessment:	
	Written examination or oral examination	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Digital Technologies (part-time) M.Eng.	
9	Importance of the grade for the final grade:	
	according to MRPO	
10	Module Officer:	
	Prof. Dr. rer. nat. Stefan Berlik	
11	Other information:	
	-	
12	Language:	
	German	

Data Science Process and Tools					**DSPW**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5033	150 h	6	3rd semester	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	59	h
	Practical or seminar	15 students	1	SCH	8	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students are able to implement a data science process in terms of organisation and content.
- They apply their knowledge acquired in the module Methods of Data Mining in the context of real, comprehensive data science projects in the data science process.
- They sharpen their planning skills by independently designing the entire data science process, selecting and evaluating algorithms and tools, specifying goals to be achieved and monitoring the progress of the project. By applying the algorithms and tools in a real-world environment, they have consolidated their practical skills and trained their ability to work in a team through group work.

3 Contents:

- The Data Science Process
  - Business Understanding
  - Data Ingest & Understanding (Data Preparation, Cleaning and Integration)
  - Modelling (Feature Engineering, Model Training & Evaluation)
  - Deployment (scoring, performance)
- Project organisation: Management of artefacts, automation
- Local tools: KNIME
- Tools for Big Data architectures: Mahout, Weka, Sparkling Water, etc.
- Realistic practice tasks, for example from KDnuggets or Kaggle

4 Forms of teaching:

Learning units for self-study, attendance events in the form of exercises and seminar

5 Participation requirements:

Formal:	-
Content:	Modules: 5025 Programming Languages for Data Analysis; 5026 Statistics for Data Analysis; 5029 Methods of Data Mining; 5030 Machine Learning Methods;

6 Forms of assessment:

Written examination, combination examination or oral examination

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

	Digital Technologies (part-time) M.Eng.
9	Importance of the grade for the final grade: according to MRPO
10	Module Officer: N. N.
11	Other information: -
12	Language: German

Digital Signal Processing and Controls					**DSR**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5006	150 h	6	1st/2nd/3rd semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

After successful completion of the module, the students can reproduce basic mathematical knowledge and apply functional transformations for the various forms of representation of discrete signals and systems. They are able to handle and evaluate the basic procedures of digital signal processing (windowing, filters, correlation, ...).
The students can apply the knowledge from digital signal processing to design and optimise digital control loops and describe them in the time or image domain.

3 Contents:

1. Digital signal processing
   - Discrete signals, signal sampling, discrete Fourier transform and Fourier analysis, window functions, fast Fourier transform, discrete convolution.
   - Discrete random signals, power density, correlation, short time spectra, power of discrete signals, random signals in linear systems, white and coloured noise.
   - Sampling, discrete Fourier transform and filtering of two-dimensional signals.
   - Discrete systems difference equation, z-transform and z-transfer function, stability of discrete systems, digital filters.
   - Bilinear transformation, transfer functions and recursion of digital filters (IIR), cascading for the realisation of higher order digital filters. Properties and design of non-recursive digital filters (FIR).
   - Selected applications, runtime measurement, system identification. Principle of pattern recognition, signal pre-processing, feature extraction, pattern vectors, non-parametric and parametric classifiers.
2. Digital control
   - Basic structure of digital control loops. Sampling process: technical realisation and mathematical description by sample-and-hold element. Difference equation
   - z-transform, z-transfer function, discrete convolution. The relationships between the Laplace and z-transforms. Pole zeros and stability. Shannon's sampling theorem.

	• Digital filters, too: Reference to analogue filters and frequency response • Procedure for determining the z-transfer function, analytically (exact and approximate), experimentally. • Digital control design: digital PID controller, quasi-continuous and discrete design. dead-beat controller. Principle of predictive relation. Tool-supported design and commissioning of digital control systems for an application example (e.g. loading bridge, three-tank system).
4	Forms of teaching: Learning units for self-study, attendance events in the form of exercises and practicals
5	Participation requirements: Formal: - Content: -
6	Forms of assessment: Written exam or combination exam
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Applied Automation Technology (part-time) M.Eng. and Digital Technologies (part-time) M.Eng.
9	Importance of the grade for the final grade: according to MRPO
10	Module Officer: Prof. Dr. Werner Schwerdtfeger
11	Other information: Required literature (in addition to the basic literature) will be announced each semester.
12	Language: German

Introduction to Artificial Intelligence					**EKI**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5027	150 h	6	1st or 2nd semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- The students name methods and concepts of artificial intelligence and are able to apply them in practical exercises.
- They illustrate knowledge-based inference systems in predicate logic (Prolog).
- They assess the advantages and disadvantages of different search and problem solving strategies and are able to independently select and apply suitable algorithms.
- They are able to explain reinforcement learning and discuss its basic concepts such as discounting, temporal difference learning, policies and value functions.
- The students have gained an impression of the complexity of artificially intelligent systems, are sensitised to the risks and possible technological consequences of the development of systems with strong AI and have derived an attitude to the topic from their value system.
  They have practised the scientific way of working (recognising, formulating and solving problems), improved their ability to abstract and train their social communication skills through free speech in the group.

3 Contents:

- Classical logics
- Inference
- Knowledge & knowledge representation
- Prologue
- Limits of logic
- Agents
- Search and plan
- Uncertainty
- Probability-based reasoning
- Reinforcement learning

4 Forms of teaching:

Learning units for self-study, attendance events in the form of exercises.

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

	Written examination, combination examination or oral examination
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Digital Technologies (part-time) M.Eng.
9	Importance of the grade for the final grade: according to MRPO
10	Module Officer: Prof. Dr. rer. nat. Stefan Berlik
11	Other information: -
12	Language: German

Industrial Internet of Things and Industry 4.0	**IIOT**

Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5034	150 h	6	1st or 2nd semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students explain how the Industrial Internet of Things (IIoT) and Industry 4.0 (I4.0) are revolutionising industry.
- They analyse the paradigm shift that has taken place in the way IT and OT (Operational Technology) systems are designed and work together.
- They contrast edge computing with the cloud computing concept.
- The students have basic knowledge in the area of the OPC-UA standard. They describe the standardisation and specifications and can implement OPC clients and OPC servers.
- They analyse how old and new technologies can be interwoven to produce a holistic system that combines benefits and increases efficiency.

3 Contents:

- Introduction Industrial IoT and Industry 4.0
- IT, OT and IIoT
- Edge computing
- The OPC-UA standard
- M2M communication with MQTT
- Architecture and design concepts for IIoT and I4.0
- The I4.0 Reference Architecture Model
- Communication technologies for component integration
- Sensor networks
- Solutions and components for IIoT & I4.0
- Industrial IoT platforms

4 Forms of teaching:

Learning units for self-study, attendance events in the form of exercises

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Combination exam

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

Digital Technologies (part-time) M.Eng.

9 Importance of the grade for the final grade:

	according to MRPO
10	Module Officer: Prof. Dr. rer. nat. Stefan Berlik
11	Other information: -
12	Language: German

Colloquium					**KLQ**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5024	100 h	4	4th semester	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	100	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	In the colloquium, the student demonstrates that they are able to orally present and independently justify the results of the master thesis, its subject-specific foundations, its interdisciplinary connections and its extra-subject references. The students will be able to critically question the results of their work and assess their significance for practice.	
3	Contents:	
	The colloquium complements the master thesis and is to be assessed independently. Content of the thesis according to the topic. Disputation on the procedure in the preparation of the thesis and the issues that arose in the context of the thesis.	
4	Forms of teaching:	
	Oral examination	
5	Participation requirements:	
	Formal:	All modules of the study programme must be successfully completed. The master thesis must be successfully completed.
	Content:	Treatment of the master thesis
6	Forms of assessment:	
	Oral examination	
7	Prerequisite for the award of credit points:	
8	Application of the module (in the following study programmes)	
	Applied Automation Technology (part-time) M.Eng., Digital Technologies (part-time) M.Eng. and Industrial Engineering and Management (part-time) M.Eng.	
9	Importance of the grade for the final grade:	
	according to MRPO	
10	Module Officer:	
	N. N.	
11	Other information:	
12	Language:	
	German	

Leadership Management					**LSM**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5016	150 h	6	1st or 2nd semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences: After successful completion of the course, students have theoretical and practical basic knowledge for a professional communication and leadership basis and can reproduce it. They are able to comprehend the significance of corporate goals and different leadership cultures. They have learned to evaluate entrepreneurial decisions and measures from an economic, labour law and social perspective and to derive and represent alternative courses of action. In addition, the students have a basic understanding of how to lead, motivate and coach employees in a qualified manner and can transfer this to their everyday work. They show when which leadership styles and methods can be applied in a goal-oriented manner. They are able to successfully motivate themselves and their teams.
3	Contents: Self and time management, communication, giving and receiving feedback, goal pursuit and controlling, leadership techniques and instruments, values in management, intercultural management, change management, crisis management, risks and opportunities
4	Forms of teaching: Learning units for self-study, attendance events in the form of exercises
5	Participation requirements: Formal: - Content: -
6	Forms of assessment: Term paper, project work or oral examination
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Digital Technologies (part-time) M.Eng. and Industrial Engineering and Management (part-time) M.Eng.
9	Importance of the grade for the final grade: according to MRPO
10	Module Officer: Prof. Dr.-Ing. Michael Fahrig
11	Other information: Literature recommendations will be announced at the beginning of the course.
12	Language: German

Master Thesis					**MAR**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5023	500 h	20	4th semester	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	SCH	0	h	500	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	0	SCH	0	h	0	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences:	
	After successful completion of the master thesis, the candidate is able to independently complete a practice-oriented task from his/her special subject area within a specified period of time, both in the subject-specific details and in the interdisciplinary contexts, using scientific methods.	
3	Contents:	
	The master thesis is an independent scientific work from the subject area of the respective study programme with a description and explanation of its solution. It can also be determined by an empirical investigation or by conceptual or design tasks or by an evaluation of existing sources. A combination of these forms is possible.	
4	Forms of teaching:	
	Written composition with faculty tutoring	
5	Participation requirements:	
	Formal:	-
	Content:	Coordinated topic from the student's special subject area
6	Forms of assessment:	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Applied Automation Technology (part-time) M.Eng., Digital Technologies (part-time) M.Eng. and Industrial Engineering and Management (part-time) M.Eng.	
9	Importance of the grade for the final grade:	
	according to MRPO	
10	Module Officer:	
	N. N.	
11	Other information:	
	Literature will be announced at the beginning of the course.	
12	Language:	
	German	

Methods of Data Mining					**MDM**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5029	150 h	6	1st or 2nd semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	16	h	51	h
	Practical or seminar	15 students	1	SCH	8	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- The students discuss the techniques, possibilities and applicability of data mining. They evaluate potential fields of application of data mining methods in the company and select suitable procedures for use.
- They experiment with the methods in practical exercises on larger data sets and analyse their characteristic properties.
- They critically evaluate the theoretical background of the procedures and are able to configure and design them individually for the respective application context.
- Through the application and evaluation of the technologies, the students increase their procedural knowledge.

3 Contents:

- Aims and principles of data mining
- Dimension reduction
  - Principal component analysis
- Clustering
  - Partitioning: k-Means Clustering
- Hierarchical: BIRCH
- Density-based: DBSCAN
- Classification
  - k-Nearest-Neighbors
  - Naïve Bayes
  - Decision Trees
  - Boosting
  - The overfitting problem
- Association analysis
  - Frequent Itemset Generation
- Linear regression

4 Forms of teaching:

Course units for self-study, attendance events in the form of exercises and laboratory practicals.

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Written examination or oral examination

7 Prerequisite for the award of credit points:

	Module examination pass
8	Application of the module (in the following study programmes) Digital Technologies (part-time) M.Eng.
9	Importance of the grade for the final grade: according to MRPO
10	Module Officer: Prof. Dr.-Ing. Christian Schwede
11	Other information: -
12	Language: German

Machine Learning Methods	**MML**

Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5030	150 h	6	1st or 2nd semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students discuss the techniques, possibilities and applicability of machine learning. They evaluate potential fields of application of machine learning methods in the company and select suitable procedures for use.
- They experiment with the methods in practical exercises on larger data sets and analyse their characteristic properties.
- They critically evaluate the theoretical background of the procedures and are able to configure and design them individually for the respective application context.
- They have a comprehensive overview of the methods of machine learning and can name and compare several of these methods; they deduce which methods should be used in which application scenarios.
- Through the application and evaluation of the technologies, the students increase their procedural knowledge.

3 Contents:

- Goals and principles of machine learning
- Feature Subset Selection
- Artificial neural networks, supervised and unsupervised learning:
  - Multi-layer perceptron
  - Self-Organizing Maps
  - Convolutional Neural Networks & Deep Learning
- Application and implementation of selected methods using
  - Python, Pandas, Numpy, Scikit-learn
  - TensorFlow

4 Forms of teaching:

Self-study units, classroom sessions in the form of exercises and laboratory practicals

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Written examination or oral examination

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

	Digital Technologies (part-time) M.Eng.
9	Importance of the grade for the final grade: according to MRPO
10	Module Officer: Prof. Dr.-Ing. Christian Schwede
11	Other information: -
12	Language: German

Philosophical, Ethical and Legal Considerations					**PEJB**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5028	150 h	6	3rd semester	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2	Learning outcomes/competences: • Students discuss the basic features of epistemology and explain in particular the process of the creation of knowledge. • The students are aware of the possible implications of the use of artificially intelligent systems and direct their actions accordingly. • They discuss current ethical and legal requirements in the field of data protection and take them into account in their daily work. • They describe and implement technical and organisational measures to implement these requirements.
3	Contents: • Fundamentals of epistemology and science theory • Knowledge pyramid, emergence of knowledge • Ethical implications of artificial intelligence • Weak vs. strong AI • Superintelligence • Machines with moral status • Overview of technical-organisational measures for the implementation of data protection / data security / information security • The General Data Protection Regulation and informational self-determination
4	Forms of teaching: Learning units for self-study, attendance events in the form of exercises
5	Participation requirements: Formal: - Content: -
6	Forms of assessment: Term paper or oral examination
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Digital Technologies (part-time) M.Eng.
9	Importance of the grade for the final grade: according to MRPO
10	Module Officer: N. N.
11	Other information: -
12	Language: German

Programming Languages for Data Analysis					**PSDA**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5025	150 h	6	1st or 2nd semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	1	SCH	8	h	51	h
	Practical or seminar	15 students	1	SCH	16	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students master the languages Python and R. They can apply them effectively in the following module on Big Data technologies and the module Data Science Process and Tools.
- They will be able to name the relevant packages of the Python programming language, explain their respective components, filter out the components required in a project and apply them.
  Through the application and evaluation of the languages in real-world tasks, they have increased their practical IT skills and trained their teamwork skills through group work.

3 Contents:

This module provides students with the programming skills needed to analyse data. For those who have already acquired this knowledge in their bachelor's degree, it serves as a refresher and consolidation, for others as a brief introduction.

- Python basics
  - Data structures: Lists, tuples, sets, dictionaries
  - Control structures: Case distinctions, loops
- Functional Programming with Python
  - Lambda expressions, map, reduce, filter, list comprehensions
- Editing tabular data with Pandas
- Efficient numerics with Numpy
- Scientific computing with SciPy
- Visualisation with Matplotlib
- Basics R
  - Data structures: Vectors, Matrices, Lists, Data Frames
- Programming in R: Functions, vector-valued functions
- Visualisation with ggplot

4 Forms of teaching:

Self-study units, classroom sessions in the form of exercises and laboratory practicals

5 Participation requirements:

Formal:	
Content:	

6 Forms of assessment:

Written examination or oral examination

7 Prerequisite for the award of credit points:

Module examination pass

8 Application of the module (in the following study programmes)

	Digital Technologies (part-time) M.Eng.
9	Importance of the grade for the final grade: according to MRPO
10	Module Officer: N. N.
11	Other information: -
12	Language: German

Statistics for Data Analysis					**SDA**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
5026	150 h	6	1st or 2nd semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	SCH	0	h	75	h
	Tuition in seminars	30 students	0	SCH	0	h	0	h
	Exercise	20 students	2	SCH	16	h	59	h
	Practical or seminar	15 students	0	SCH	0	h	0	h
	Supervised self-study	60 students	0	SCH	0	h	0	h

2 Learning outcomes/competences:

- Students understand the concepts of descriptive statistics.
- They apply the tests for independence of random variables to unknown distributions, analyse the results and evaluate them.
- They understand hypothesis testing and are able to formulate and test new hypotheses.
- The students apply the factual and conceptual knowledge gained in the first part of the course to develop the methods of the second part. This enables them, for example, to analyse Bayesian networks and to assess the significance of the probabilities encoded in them for the underlying processes.
  They can confidently apply the advanced methods of the second part within the data mining process.

3 Contents:

The first part of the module deals with the basics of statistics. It serves as a refresher and consolidation for students who have already taken a statistics module in the bachelor's programme and as a brief introduction for students who have not.

Descriptive statistics:

- Population, characteristic
- Feature types, scales
- Diagrams: Histograms, scatter plots
- Measures: Position parameters, scattering parameters, concentration parameters

Inductive statistics:

- Chance and probability
  - Basic concepts of probability theory
  - Random sampling and combinatorics (urn problem etc.)
  - Conditional probabilities
  - Probability distributions
- Random variables
- Bivariate distributions
  - Independence of random variables
  - Covariance and correlation
  - Parameter estimation
- Statistical test methods
- Regression

	• Analysis of variance The second part of the module deals with advanced methods of statistics specifically relevant for data analysis. • Multivariate distributions • Gaussian mixed models • Expectation Maximisation Algorithm • Bayesian statistics • Bayesian networks • Markov Chains • Markov Chain Monte Carlo Sampler
4	Forms of teaching: Learning materials for self-study, classroom sessions in the form of exercises.
5	Participation requirements:
	Formal: -
	Content: -
6	Forms of assessment: Written examination or oral examination
7	Prerequisite for the award of credit points: Module examination pass
8	Application of the module (in the following study programmes) Digital Technologies (part-time) M.Eng.
9	Importance of the grade for the final grade: according to MRPO
10	Module Officer: N. N.
11	Other information: -
12	Language: German