Module catalogue

for the study programme Digital Technologies (work-integrated) B.Sc.

Algorithms and Data Structures					**AUDS**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3343	150 h	5	2nd and 4th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	54	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

- Students apply the language constructs of the Python programming language to implement small programmes.
- The students know ways of formally describing algorithms and discuss interface agreements as a basis for the reusability of implemented functions.
- Students name basic search and sorting algorithms as well as fast sorting algorithms and describe them in pseudo code.
- Students programme basic algorithms as functions in a scripting language (preferably Python) and apply the implemented algorithms to given problems.
- The students write programme scripts for the numerical evaluation of the algorithm runtime and test their self-implemented algorithms with regard to their runtime as a function of the problem size.
- The learners compare the runtime complexity (efficiency) of different algorithms by analysing the algorithm structure and can thus classify the previously numerically determined runtime behaviour into runtime classes.
- Students implement backtracking algorithms and fast sorting methods in a scripting language (preferably Python).
- The students implement their own data structures and data types and test them in the context of given problems.

3 Contents:

- Programming in Python
- Basics and terms for the formal description of algorithms
- Formalisation of interface agreements (pre- and postconditions, agreement of data formats, default behaviour, exceptions)
- Hardware-independent evaluation of the complexity of algorithms (in particular runtime complexity, memory complexity, the concept of the Random Access Machine, Big O notation)
- Simple search and sorting algorithms
- Divide-and-conquer strategies, backtracking problems
- Comparison of iterative and recursive programming methods

	for algorithm implementation • Fast sorting algorithms • Abstract and concrete data types • Graphs and trees • Hashing	
4	Forms of teaching: Learning units for self-study, classroom events in the form of exercises and practicals	
5	Participation requirements:	
	Formal:	
	Content:	Knowledge of procedural programming (module “Foundations of Computer Science”)
6	Forms of assessment: Written examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. nat. Alexander Maier	
11	Other information:	
12	Language: German	

Assistance Systems					**ASY**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3349	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

- The students understand the basics of human-machine systems and explain the design rules of ergonomic human-machine interfaces.
- They know the basics of robotics both in the field of robot manipulators and in the field of mobile robotics and compare robotics applications from the fields of industry, service and care, especially from the point of view of interaction between assistive robots and human operators/users.
- The students know the basics of computer vision and pose estimation and implement these methods and simple algorithms for three-dimensional object recognition in their assistance systems.
- They explain the basics of augmented and virtual reality. They implement the representation of 3D objects in a virtual reality environment and the representation of 2D and 3D objects in an augmented reality setup.
- They explain the basics of the voice control of technical systems and use existing APIs.
- They apply large language models and use them for personal assistance in intelligent assistance systems.

3 Contents:

- Human-machine systems
- Design rules of human-machine interfaces
- Robot manipulators
- Robotics applications

	• Methods of pose and gesture recognition • Three-dimensional object recognition • Augmented and Virtual Reality • Voice control of technical systems • Basics of human-AI cooperation • Use of up-to-date methods of Artificial Intelligence in assistance systems	
4	Forms of teaching: Learning units for self-study, classroom events in the form of exercises and practicals	
5	Participation requirements:	
	Formal:	
	Content:	• In-depth computer science knowledge • Knowledge of machine learning incl. speech and image recognition • Module “HMI and User Interfaces”
6	Forms of assessment: Term paper, combination examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. nat. Alexander Maier	
11	Other information:	
12	Language: German	

Bachelor Thesis					**BA**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3133	360 h	12	7th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	weekly hours	0	h	360	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	0	weekly hours	0	h	0	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	0	weekly hours	0	h	0	h

2	Learning outcomes/competences:	
	After successfully completing the bachelor thesis, students are able to independently work on and appropriately present a practice-oriented task from their special subject area, both in the subject-specific details and in the interdisciplinary contexts, using scientific methods within a specified period of time.	
3	Contents:	
	The bachelor 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 be derived from current research projects at the university or from operational problems with an engineering character. It can also be determined by an empirical investigation or by conceptual or design tasks or by an evaluation of existing sources. The different forms can be combined.	
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:	
8	Application of the module (in the following study programmes)	
	Digital Technologies (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	Prof. Dr.-Ing. Andrea Kaimann	
11	Other information:	
	-	
12	Language:	
	German	

Big Data					**BDT**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3345	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

On successful completion of the module, students are able to

- Explain the basic principles of NoSQL databases and categorise databases based on the CAP theorem and the underlying data model.
- Discuss the characteristics of key-value databases, column-oriented databases, document-oriented databases, graph databases and object databases.
- Use an application scenario to assess when which type of NoSQL database should be deployed.
- Design data models for the NoSQL databases mentioned and apply them in practice.
- Explain the concept of the data warehouse in theory and practice and design a data warehouse for the integration of different data sources as a preparatory step for data mining.
- Explain the importance of data management in the company and derive central requirements and measures for a functioning data management system.

3 Contents:

- History and basic concepts of Big Data
- Introduction to NoSQL databases
- Differentiation of NoSQL databases according to CAP theorem and data model
- Concrete NoSQL database types: key-value databases, column-oriented databases, document-oriented databases, graph databases, object databases
- Benchmarking of database systems
- Data warehouses
- Federated information systems
- Basics of data management

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5	Participation requirements:	
	Formal:	
	Content:	Knowledge from the modules “Databases”, “Foundations of Computer Science” and “Object-Oriented Programming”
6	Forms of assessment: Written examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc. and Software Engineering (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. nat. Stefan Berlik	
11	Other information:	
12	Language: German	

Change Management					**CHM**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3338	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

The students get to know aspects of change management in the context of business development and understand how strategic changes in orientation of organizations can be implemented.

The students are able to analyse change situations in companies and/or organizations and can define change strategies. They have knowledge regarding leadership for the respective change situations and understand the importance of gender and diversity aspects.

The students know and understand the change management phase model and are able to structure and implement changes in companies/organisations. Furthermore, they understand typical behavioural models regarding corporate change.

The students can apply systemic analysis and diagnostics in order to evaluate the specific need for action and know how to prepare and implement communicative and change coalition measures.

The students are familiar with the methods and instruments, can deal with resistance, conflicts and power games in change situations and know how to initiate new structures and processes. They also take into consideration equal rights regarding gender and diversity aspects when dealing with the change process.

They acquire the ability to determine quality criteria for successful change projects and to derive appropriate matching change measures.

3 Contents:

- Constitution of organisational change
  - Phase models of business development
  - Fields of action in Change Management
  - Conceptual approaches in Change Management
- Change processes
  - Differentiation revolutionary vs. evolutionary
  - Techniques to planning, management and control
  - Process evaluation
- Business development processes
  - Stakeholder analysis
  - Change Management and ethics
  - Opposition and leadership

4	Forms of teaching: Self-study learning units (literature), face-to-face sessions with exercises and discussions	
5	Participation requirements:	
	Formal:	
	Content:	
6	Forms of assessment: Term paper, written examination or combination examination	
7	Prerequisite for the award of credit points: Module examination pass	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. pol. Mariam Dopslaf	
11	Other information:	
12	Language: English	

Cluster Computing									**CLC**
Identification number:	Workload:	Credits:	Study semester:			Frequency of the offer			Duration:
3344	150 h	5	7th sem.			Annual (Winter)			1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	54	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Upon successful completion of the module, students are able to

- Explain the fundamentals of cluster computing.
- Apply visualisation techniques, in particular construct their own images via Docker and execute them as containers.
- Explain the theoretical foundations of parallel computing (parallel computer architectures, Amdahl's law, race conditions, design patterns for parallel computing, etc.)
- Design and implement distributed applications using MPI and OpenMP.
- Explain the concept of Hadoop and implement simple data analyses on a Hadoop cluster.
- Design data analysis workflows in the cloud.

3 Contents:

- Overview cluster computing
  - Definition
  - Motivation and goals (e.g., scalability, fault tolerance)
  - Challenges (communication overhead)
- Visualisation as a basis of cloud computing
  - Virtual machines
  - Container virtualisation
- Cluster-software stack
  - Middleware for clusters (MPI – Message Passing Interface, OpenMP)
  - Hadoop ecosystem
- Cluster management
  - Resource management and job scheduling in clusters
  - Introduction to cluster-management tools (e.g., OpenStack, Kubernetes)
- Infrastructure as a Service (e.g., EC2 and S3)
- Parallel computing and programming for clusters
  - Introduction to parallel programming (Amdahl's law, race conditions, design patterns for parallel computing, etc.)
  - Parallel computing architectures: shared vs. distributed memory
  - Parallel computing on individual shared-memory systems (e.g. with OpenMP)
  - Distributed computing with MPI
  - Parallel computing on Hadoop clusters (Map-Reduce, etc.)
  - Optimisation of algorithms for clusters
- Applications of cloud computing
  - Scientific applications (e.g., simulations, scientific computing)
  - Data processing and big data analytics
  - Cloud-based cluster computing

4	Forms of teaching: Learning units for self-study, classroom events in the form of exercises and practicals	
5	Participation requirements:	
	Formal:	
	Content:	• Knowledge from the modules “Foundations of Computer Science” and “Object-Oriented Programming” • Basic knowledge of databases
6	Forms of assessment: Written examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. nat. Stefan Berlik	
11	Other information:	
12	Language: German	

Data Mining					**DM**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3341	150 h	5	2nd and 6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	54	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Upon successful completion of the module, students are able to

- Sketch out the history and basics of data mining and establish the relationship to its practical application possibilities.
- Explain and apply methods of data preprocessing.
- Use correlation analysis and regression to detect relationships between data series in multidimensional data sets.
- Critically assess the dimensionality of data and apply common dimensional reduction and feature selection techniques.
- Apply suitable methods to visualise both small and large data sets and the interrelationships within them in an instructive way.
- Name the differences between supervised and unsupervised learning.
- Determine clusters of related data points in multi-dimensional data sets and assess their quality.
- Detect common patterns in data sets and use graph-based methods.
- Describe basic concepts of time series analysis and apply simple procedures from this area in a targeted manner.
- Assess which methods should be used in which application scenarios thanks to their comprehensive overview of data mining methods.
- Design data mining workflows.

3 Contents:

- Basics and history of data mining
- Data preprocessing (standardisation, outlier analysis, recognition of duplicates/missing values)
- Correlation analysis and regression
- Dimension reduction and feature selection
- Visualisation of data (especially also for the visualisation of very large amounts of data; “visual analytics”)
- Supervised vs. unsupervised learning
- Clustering methods
- Association analysis (frequent pattern mining)
- Graph-based methods
- Basics of time series analysis
- Data mining workflows

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	
Content:	• Content of the “Mathematics” and “Statistics” modules • Advanced programming skills in Python

6	Forms of assessment: Written examination or oral examination
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc. and Software Engineering (work-integrated) B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr. rer. nat. Stefan Berlik
11	Other information:
12	Language: German

Databases					**DUD**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3019	150 h	5	2nd sem. or 5th sem.	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Upon successful completion of the module, students:

- Acquire basic knowledge about the architecture, functioning and use of database systems and know the principles of the organisation of a database system.
- Acquire knowledge about data modelling including the meaning of normalisation rules.
- Are able to perform a complete relational database design, starting from a requirements specification.
- Are able to implement a relational database schema using SQL.
- Are proficient in standard SQL to perform simple and complex queries, as well as change operations.
- Are able to manage access rights and users and to implement triggers and procedures.
- Are able to plan and implement database projects.

3 Contents:

- Basics of databases
- Database design (entity relationship model (ERM))
- Relational model (RM) (transformation ERM to RM, fuctional dependencies, normalisation, relational algebra)
- Database language SQL (structured query language): creating/changing/deleting databases, tables and layers, entering/changing/erasing data (Data Manipulation Language (DML), Data Definition Language (DDL)) and creating complex queries (Data Query Language (DQL))
- Access rights and user management (Data Control Language (DCL)) Procedures and triggers

4 Forms of teaching:

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

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, combination examination, 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 (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Dr. rer. nat. Sabrina Proß
11	Other information: -
12	Language: German

Diagnosis and Predictive Maintenance					**DPM**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3252	150 h	5	5th semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

The students apply different procedure models for systematic data analyses in industrial applications and transfer them to their own applications. They use methods of data preprocessing on real, faulty and noisy datasets. They differentiate types of anomalies and explore the applicability of suitable algorithms for anomaly recognition. They assess and implement algorithms to identify behaviour models taking into account the type of anomaly and the available data. They develop their own approaches to model identification by applying state-of-the-art algorithms and enhancing them with explicit characteristics. The students develop algorithms for predictive data analysis and the determination of remaining useful life (RUL). They describe their solutions in technical discussions and justify their approach. They know the challenges of root cause analysis and apply methods of knowledge representation to integrate expert knowledge and transfer these approaches to the root cause analysis in technical systems. They implement holistic applications for example datasets and concrete problems in a selected programming language (e.g., Python).

3 Contents:

Introduction and procedure models
- Procedure models for systematic data analysis in industrial applications

Data preprocessing
- Required steps for data preprocessing and data cleaning

Anomaly recognition
- Different types of anomalies
- Algorithms for model identification in technical systems
- Algorithms for anomaly recognition

Predictive maintenance
- Different maintenance strategies, in particular predictive maintenance
- Predictive data analysis
- Remaining useful lifetime estimation

Diagnosis
- Challenges and methods of error diagnosis
- Integration of expert knowledge
- Root cause analysis

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, 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 (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr. rer. nat. Alexander Maier
11	Other information: -
12	Language: German

Digital Business Models and Value Chains									**DGW**
Identification number:	Workload:	Credits:	Study semester:			Frequency of the offer			Duration:
3339	150 h	5	6th sem.			Annual (Summer)			1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Students can evaluate the specifics of classic business models and digital business models, break them down into their essential components, and also combine mixed models themselves.

Students can analyse and evaluate operational business processes and optimise them, especially with regard to the interfaces between organisations.

Students explore successful examples of digital business models and can assess success factors.

The students can evaluate value chains with regard to their most important performance parameters and derive optimisation proposals, especially on the basis of digital technologies.

3 Contents:

- Fundamentals of value creation – generating customer benefits
- Globalisation and digitalisation as drivers of change processes
- Diversification of value creation processes and specialisation in core competencies
- Integration of a wide variety of partners in a value chain to satisfy consumer needs
- Digital transformation of classic products and services or creation of new virtual services
- Success stories of digital business models – Google, Amazon, Facebook, Uber...
- Communication concepts between partners in the value chain (from telephone to EDI)
- E-business – mapping existing processes and products into electronic form to benefit time, quality and costs.
- Finding partners (sourcing concepts)
- Establishing long-term cooperation (contract design and confidence building)
- Loose business cooperations (marketplace concepts for dynamic collaboration)
- Risk management of more complex value creation networks (agility and resilience)
- Flexible, decentralised and efficient control of inter- and intra-organisational core processes

4	Forms of teaching: Self-study units, exercises and practicals in the form of face-to-face events	
5	Participation requirements:	
	Formal:	
	Content:	Module "Fundamentals of Business Administration"
6	Forms of assessment: Term paper or written examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. oec. Pascal Reusch	
11	Other information:	
12	Language: German	

Business Process Modelling and IT Systems					**GPM**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3210	150 h	5	3rd and 5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	64	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Students:

- structure and evaluate the specific mode of operation of integrated standard software (ERP software).
- design and model processes in the company with the help of modern software architectures (e.g., SOA and BPMS).
- analyse processes and requirements of companies for the use, operation and maintenance of integrated software systems (adaptation options, interfaces to other IT systems, etc.)

3 Contents:

- Process modelling and data modelling using modelling tools (e.g., ARIS)
- Evaluation of concepts of integrated data processing
- Drafting reference models for designing the data, process and function models (e.g., Aachen PPS model)
- Analysis of ERP systems (architecture, structuring, database models, HANA)
- Overview of the core modules and applications of ERP systems in the process: e.g., order to cash process)

Application-oriented use cases are used to demonstrate how business processes can be implemented consistently and across software modules.

4 Forms of teaching:

Learning units for self-study, classroom events in the form of exercises and practicals

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, written examination, project work or oral examination

7 Prerequisite for the award of credit points:

Module examination pass and course assessment

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

Digital Technologies (work-integrated) B.Sc., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.

9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr.-Ing. Jörg Nottmeyer
11	Other information: -
12	Language: German

Fundamentals of Business Administration					**GBW**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3132	150 h	5	1st, 3rd or 7th semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

The students know the basic organisational structures and the optimisation tasks of companies as well as the basic principles and success criteria of economic action. This enables them to classify their own engineering activities in the operational and business context and to assess and control the economic consequences/effects of their activities. In this sense, the module provides the basic business knowledge and the basic structures for interdisciplinary thinking and action.

3 Contents:

- Classification, development and basic concepts of business administration
- Basic principles of economic action
- Overview of the most important business functional areas (procurement, production, logistics, HR, marketing)
- Corporate goals and corporate key figures/key performance indicator systems
- Forms of corporate law and corporate affiliations

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, 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 (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng. and Software Engineering (work-integrated) B.Sc.

9 Importance of the grade for the final grade:

according to BRPO

10 Module coordinator:

Dipl. Volkswirtin Ulrike Franke

11	Other information: -
12	Language: German

Foundations of Computer Science					**GDI**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3353	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

After successful completion of the module, students are able to explain important concepts of computer science and their connections. They are able to render the basic functioning of computer systems and computer architectures. The students know selected methods for the description and evaluation of algorithms and can apply them to new problems. They can structure simple information technology problems and develop suitable solutions, as well as justify and defend them. Students have basic knowledge and initial experience in the implementation of algorithms in the programming language C.

3 Contents:

Introduction to Computer Science:

- Terms and definitions
- Number systems (in particular, decimal, binary and hexadecimal system)
- Representation of numbers and characters in the computer
- Methods for describing algorithms with flow charts and pseudo code
- Methods for evaluating the complexity of algorithms

Basics of computer architecture:

- Basic structure of processors
- Memory hierarchy
- Bus systems

Programming in C:

- Data types and variables
- Conditional instructions
- Loops
- Functions
- Arrays
- Pointers and pointer arithmetic
- Structs and enumerated data types
- Working with files
- Dynamic memory allocation

Selected algorithms:

- Sorting algorithms (e.g., bubble sort and quick sort)
- Search algorithms (e.g., binary search)

4	Forms of teaching: Learning materials for self-study, classroom sessions of exercises and practicals	
5	Participation requirements:	
	Formal:	
	Content:	
6	Forms of assessment: Written examination or project work	
7	Prerequisite for the award of credit points: Module examination pass	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng. and Software Engineering (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr.-Ing. Christian Stöcker	
11	Other information:	
12	Language: German	

Foundations of Data Science and Information Privacy					**GDS**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3342	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	54	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

Upon successful completion of the module, students are able to

- Explain common data analysis workflows and select algorithms that correspond to the requirements.
- Develop programmes in Python and work in a Linux environment.
- Name the goals of sustainable data science and explain the influence of companies and employees on reaching these goals.
- Assess ethical aspects of data science projects and legal requirements in the field of data protection.
- Write and present short papers that meet the formal requirements of academic writing.
- Name the required technical and social competences of engineers in data science.

3 Contents:

- Foundations of data science, data mining, machine learning and data analysis workflows
- Historical development of data science and current problems
- Job profiles in the field of data science
- Introduction to programming in Python
- Basics of the Linux operating system
- Introduction to information privacy: the General Data Protection Regulation
- Aspects of sustainability of data science applications
- Ethical implications of data science applications
- Introduction to academic work (literature research, citing, writing, presenting)

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	
Content:	None

6 Forms of assessment:

Term paper, 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 (work-integrated) B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr. rer. nat. Stefan Berlik
11	Other information:
12	Language: German

HMI and User Interfaces					**HMI**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3254	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

The students know the principles of human information processing. They can explain and apply methods, guidelines and standards for the design of user interfaces. They are able to implement design principles with the corresponding methods and thus develop user interfaces. They design and model user interfaces and can test them with respect to applicability. They are familiar with the software development process and use it to develop interfaces for operating and interacting with machines.

3 Contents:

- Human information processing (models, physiological and psychological foundations, human sensing, action processes)
- Design basics and design methods
- Basics of input and output for computers, embedded systems and mobile devices
- Principles, guidelines and standards for the design of user interfaces
- Basics for the design of user interfaces (text dialogues and forms, menu systems, graphical interfaces, interfaces in the WWW, audio dialogue systems, haptic interaction, gestures)
- Methods for modelling user interfaces (abstract description of interaction, as part of requirements analysis and the software design process)
- Development of user interfaces in an object-oriented programming language

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	Modules “Foundations of Computer Science” and “Object-Oriented Programming”

6 Forms of assessment:

Term paper, written examination or project work

7 Prerequisite for the award of credit points:

Module examination pass

8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc., Software Engineering (work-integrated) B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr. rer. pol. Hans Peter Rauer
11	Other information: -
12	Language: German

Industrial Control Technology					**IST**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3117	150 h	5	4th or 6th semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

After successful completion of the course, the students are able to name the essential components of an automation system and explain their basic functioning. They are able to describe how conventional and PC-based programmable controls work and name their differences. The students know selected programming languages of IEC 61131 and are able to use them to implement simple programmes. The students know simple methods for designing sequence controllers and can apply them to new problems and realise the design in a suitable programming language. They know the basics of bus systems and can name different bus systems and their areas of application.

3 Contents:

Introduction to control technology

- Terms and definitions
- Overview of the mode of operation of a controller (incl. sensors and actuators)

Bus technology

- Basics of industrial communication (incl. Ethernet-based bus systems, e.g., EtherCAT)
- Comparison of different bus systems and their application

Construction and structures of industrial controllers

- PLC and PC-based control
- Information processing

Structured programming according to IEC 61131

- Graphic and text-based programming languages
- Basics of object-oriented PLC programming

Sequence controls

- Model-based design with UML state diagrams
- Practical implementation (in a programming language according to IEC 61131)

4	Forms of teaching: Learning units for self-study, classroom events in the form of exercises and practicals	
5	Participation requirements:	
	Formal:	
	Content:	Knowledge from the following modules: 3267 Object-Oriented Programming
6	Forms of assessment: Project work or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr.-Ing. Christian Stöcker	
11	Other information:	
12	Language: German	

Innovation and Project Management					**IPM**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3211	150 h	5	3rd/4th/5th or 7th sem.	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Students:

- are prepared to lead product development and innovation projects and teams to success in terms of holistic and strategically oriented project management (also including agile methods).
- understand the basics of project management and can use the elementary technical vocabulary.
- can explain the most important instruments of project management.
- are able to lead/manage a project in a given process-organisational project organisation.
- are able to develop and specifically use control options for different project phases (controlling of the degree of completion, cost controlling).
- can explain the specifics of team building and project management.
- can carry out the moderation of team meetings projects.
- know instruments of IT-supported project management.
- can explain the importance of corporate objectives and are able to distinguish between different management cultures.
- can name essential aspects of industrial property protection.

3 Contents:

- Basics of project management (terms/methods/instruments)
- Project phase models and planning systems (project preparation, project planning, project implementation, project completion)
- Agile project management
- Forms of project organisation
- Innovation and change management, self-management
- Project planning (project structure plan/cost plan/resource plan/schedule)
- Project documentation/ project controlling
- Risk management

  Special features of use of methods in innovation projects (strategic preparation / initiation, planning, monitoring and control of innovation projects)

	• Leading project and innovation teams (social structures, special communication situations in projects, real and virtual project work, problem analysis and concepts for action) • Stakeholder management (factors influencing the successful management of projects) • Methods of idea generation (creativity techniques etc.) • Trainings and workshops on selected technical examples • Basic aspects of industrial property protection	
4	Forms of teaching: Learning units for self-study, classroom sessions in the form of exercises	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, written examination, 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 (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr.-Ing. Michael Fahrig	
11	Other information: -	
12	Language: German	

Colloquium					**KOL**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3134	90 h	3	7th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	weekly hours	0	h	90	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	0	weekly hours	0	h	0	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	0	weekly hours	0	h	0	h

2	Learning outcomes/competences:	
	In the colloquium, students demonstrate that they are able to present the results of the bachelor thesis, its subject-specific foundations, its interdisciplinary connections and its extra-curricular references orally and justify them independently. Students can critically question the results of their work and are able to assess their significance for practice.	
3	Contents:	
	The colloquium complements the bachelor thesis and is to be assessed independently. Content of the thesis according to topic. Disputation on topics such as: 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 bachelor thesis must be successfully completed.
	Content:	Treatment of the bachelor thesis
6	Forms of assessment:	
	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 (work-integrated) B.Sc., Mechatronics /Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	Prof. Dr.-Ing. Andrea Kaimann	
11	Other information:	
	-	
12	Language:	
	German	

Marketing and Technical Sales					**MUV**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3355	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Upon successful completion of the module, students can:

- Explain the specifics of marketing and the differences between B2B and B2C marketing;
- Compare the different methods of market research for the analysis of B2C and B2B markets;
- Name the success factors and goals of technical sales and review the determinants of sales channel decisions;
- Describe tools of the marketing mix (4P, product, price, promotion and place) and evaluate them with a focus on sustainability aspects;
- Categorise current market trends against the background of increasing digitalisation, internationalisation and sustainability aspects;
- Interpret the key terms of sustainable marketing and basic models to explain sustainable consumer behaviour;
- Apply the options of the marketing mix to selected practical examples and case studies;
- Discuss questions of structures and concepts in the sale of technical products, develop their own solutions and present the results.

3 Contents:

- Digitalisation and sustainability as marketing trends
- Innovations and influence of behavioural economics
- Customer satisfaction and loyalty as targets in marketing
- Buyer behaviour on B2C and B2B markets
- Market research and segmentation
- Product policy in the individual product life cycle phases
- Strategies of pricing and conditions
- Sales channels and sales channel decision
- Basic instruments/key figures of sales controlling
- Elements of online and offline communication

4 Forms of teaching:

Lecture notes, seminar-based teaching, exercises, case studies

5 Participation requirements:

Formal:	None
Content:	None

6 Forms of assessment:

Written examination, 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 (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10	Module coordinator: Prof. Dr. Adam-Alexander Manowicz
11	Other information: Literature will be announced before the start of the course.
12	Language: German

Machine Learning					**ML**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3340	150 h	5	4th semester	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	54	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Upon successful completion of the module, students are able to

- Explain the history and basics of machine learning and establish the relationship to its practical applications.
- Differentiate between classification and regression and discuss the differences.
- Classify data using classification methods from statistical learning theory, kernel methods and from the field of artificial neural networks. They also use decision trees or discriminant analysis for this purpose.
- Explain the functioning of artificial neural networks in detail.
- Design artificial neural networks to learn mappings between arbitrary input and output data (also for time series).
- Present different methods for parameter determination in artificial neural networks and use them in a targeted manner.
- Explain evolutionary algorithms and apply them.
- Assess which methods should be used in which application scenarios thanks to their comprehensive overview of machine learning methods.
- Develop workflows for machine learning.

3 Contents:

- Foundations of machine learning
- Classification and regression
- Decision trees
- Statistical learning theory: Bayes classifier and discriminant analysis
- Kernel methods: support vector machines
- Artificial neural networks: multi-layer perceptron, self-organising maps, recurrent topologies, extreme learning machines, reservoir computing, etc.
- Method for parameter determination in artificial neural networks
- Evolutionary algorithms: evolution strategies and genetic algorithms
- Workflows in machine learning

4 Forms of teaching:

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

5	Participation requirements:	
	Formal:	
	Content:	• Content of the “Mathematics” and “Statistics” modules • Advanced programming skills in Python
6	Forms of assessment: Written examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. nat. Stefan Berlik	
11	Other information:	
12	Language: German	

Mathematics I					**MATH1**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3218	150 h	5	1st sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2	Learning outcomes/competences: Upon successful participation in the course, students • Are familiar with the mathematical working method • Understand and can apply the introduced mathematical notation • Mastered the basic terms and methods from the areas of analysis and linear algebra • Can apply the methods they have learned to practice-oriented problems from technology, science, computer science and business.
3	Contents: • General basics (set theory, inequalities, propositional logic, methods of proof) • Complex numbers (definition and representation, complex calculus) • Functions of one variable (limit and continuity, polynomial functions, rational functions, trigonometric functions, exponential function, logarithm function) • Differential calculus for functions of one variable (differentiability, derivation rules, applications) • Integral calculus for functions of one variable (fundamental theorem of differential and integral calculus, integration rules, integration methods, improper integrals, applications)
4	Forms of teaching: Learning units for self-study, classroom sessions 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 (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Dr. rer. nat. Sabrina Proß
11	Other information: -

12	Language: German

Please note: The German version of this document is the legally binding version. The English translation provided here is for information purposes only.

Mathematics II					**MATH2**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3257	150 h	5	2nd sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

After successful participation in the course, students

- Master the basic concepts and methods from the mentioned areas of linear algebra.
- Have expanded their knowledge in the field of analysis and master the essential principles of differential calculus for functions of several variables.
- Are familiar with the most important numerical algorithms and their possible uses, and are able to handle numerical problems and estimate errors in numerical calculations.
- Can implement simple algorithms in a high-level programming language on a computer.
- Can develop functions into their Taylor series.
- Can apply the methods they have learned to practice-oriented questions in the fields of technology, sciences, computer science and business.

3 Contents:

- Linear algebra (vectors, matrices, determinants, systems of linear equations, eigenvalues and eigenvectors)
- Differential calculus for functions of several variables (functions of several variables, partial differentiation)
- Numerics (numerical determination of zeros, numerical differentiation, numerical integration)
- Taylor series
- Fourier series
- Use of software such as MATLAB C++, Python

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	- Knowledge from the following modules: 3218 Mathematics I;

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 (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module coordinator:

Dr. rer. nat. Sabrina Proß

11	Other information: -
12	Language: German

Mathematics III					**MATH3**
Identification number	Workload	Credits	Study semester	Frequency of the offer:	Duration
3258	150	5	3rd sem.	Annual (Winter)	1 semesters

1	Course:	Planned group sizes:	Scope:		Actual contact time/ classroom teaching		Self-study:	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Sem. lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

On successful completion of the course, students

- Have an overview of the methods for the analytical solution of ordinary differential equations and systems of differential equations and can apply these to practice-oriented problems.
- Know the most important numerical methods for solving differential equations and their possible applications and are able to handle numerical problems and estimate errors of numerical calculations.
- Can implement simple algorithms in a higher programming language on a computer.
- Can develop functions into their Fourier series.
- Students are familiar with the fundamentals and properties of Fourier and Laplace transforms and can apply them to practice-oriented questions.

3 Contents:

- Ordinary differential equations (differential equations of the 1st order, linear differential equations of the 2nd or nth order with constant coefficients, systems of linear differential equations)
- Numerical solution of differential equations
- Fourier transform
- Laplace transform
- Use of software such as MATLAB C++, Python

4 Forms of teaching:

Study units for self-study, face-to-face teaching in the form of exercises

5 Participation requirements:

Formal:	-
Content:	Knowledge from the following modules: 3218 Mathematics I; 3257 Mathematics II;

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 (work-integrated) B.Sc. and Mechatronics/Automation (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10	Module coordinator: Dr. rer. nat. Sabrina Proß
11	Other information: -
12	Language: German

Object-Oriented Programming									**OOP**
Identification number:	Workload:	Credits:	Study semester:			Frequency of the offer			Duration:
3267	150 h	5	2nd sem.			Annual (Summer)			1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

After successful completion of the module, the students have an understanding of object-oriented programming and its distinction from structured programming. They can analyse concrete problems from IT and design and implement suitable solutions in the programming language C++. The students have gained knowledge about selected models of the UML (in particular, UML class diagrams) and can apply it to new problems.

3 Contents:

Introduction to object-oriented programming:

- Fundamental concepts (abstraction, data encapsulation, inheritance, polymorphy)
- Differences between procedural and object-oriented programming

Programming in C++:

- Classes (incl. attributes and methods), access modifiers
- Objects and class elements
- Operators and operator overloading
- Inheritance and polymorphy
- Class templates
- Error handling

Software development:

- UML (e.g., class diagram and sequence diagram)
- Unit tests

4 Forms of teaching:

Learning letters for self-study, classroom events in the form of exercises and practicals.

5 Participation requirements:

Formal:	
Content:	Structured programming (ideally with C), general informatics basics Modules: 3353 Foundations of Computer Science

6 Forms of assessment:

Written examination and project work

7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng. and Software Engineering (work-integrated) B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr.-Ing. Christian Stöcker
11	Other information:
12	Language: German

Operations Research					**MOR**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3219	150 h	5	2nd or 4th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	1	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	3	weekly hours	24	h	46	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

The students ...

- Know and understand the basic principles and theoretical concepts of operations research, including key mathematical model types and associated solution procedures.
- Can apply the various operations research models and procedures in a situational and effective manner to analyse complex problems and develop solutions.
- Are able to identify, analyse and find solutions to relevant real-world problems from the field of economics and in particular logistics with the help of suitable models and methods of operations research or to provide decision support.
- Can critically assess the suitability and effectiveness of operations research models and methodologies and understand their limitations and capabilities in the context of real-world applications.
- Recognise the relevance and possible applications of operations research in various interdisciplinary contexts and can use their knowledge in collaboration with experts from other areas.
- Are familiar with modern software tools and technologies used in operations research and can effectively use them to model, analyse and solve problems.
- Can present the results of their analysis and solution proposals clearly and convincingly, and are able to work and communicate effectively in multidisciplinary teams.

3 Contents:

- Introduction to Operations Research
- Research Models in Operations Research
- Subfields of Operations Research
- Linear Optimisation
- Fundamentals of Graph Theory
- Transport Problems
- Integer optimisation problems (pure-integer linear optimisation problems, knapsack problems)
- Combinatorial optimisation problems (assignment problems, round trip problems, postman problems, route planning problems, machine allocation problems, location problems)
- Dynamic optimisation (batch size planning)

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Term paper, 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 (work-integrated) B.Sc., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr. rer. oec. Pascal Reusch
11	Other information: -
12	Language: German

Work-Related Module I					PX1
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3112	150 h	5	3rd sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	weekly hours	0	h	150	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	0	weekly hours	0	h	0	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	0	weekly hours	0	h	0	h

2	Learning outcomes/competences:	
	Upon successful completion of the module, students • Can apply and deepen knowledge and skills specific to the study programme. • Work on individual problems holistically and under practical conditions during the work term at the company and develop solution options independently. • Apply academic work skills and successively develop them further. • Document the individual problems and solution options worked on in the company in an academic paper.	
3	Contents:	
	• The topics to be dealt with represent current questions the company is working on. • If relevant to the question, technical trends such as future technologies and social trends such as sustainability are also addressed. • The topics to be dealt with must be related to engineering science and must be oriented towards the module content of the curriculum. • The topic is agreed between the student, the supervisor in the company and the examiner in the university.	
4	Forms of teaching:	
	Work-related module	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment:	
	Term paper	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Digital Technologies (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	Prof. Dr.-Ing. Andrea Kaimann	
11	Other information:	
	-	
12	Language:	
	German	

Work-Related Module II					PX2
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3122	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	weekly hours	0	h	150	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	0	weekly hours	0	h	0	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	0	weekly hours	0	h	0	h

2	Learning outcomes/competences:	
	Upon successful completion of the module, students • Can apply and deepen knowledge and skills specific to the study programme. • Work on individual problems holistically and under practical conditions during the work term at the company and develop solution options independently. • Apply academic work skills and successively develop them further. • Document the individual problems and solution options worked on in the company in an academic paper.	
3	Contents:	
	• The topics to be dealt with represent current questions the company is working on. • If relevant to the question, technical trends such as future technologies and social trends such as sustainability are also addressed. • The topics to be dealt with must be related to engineering science and must be oriented towards the module content of the curriculum. • The topic is agreed between the student, the supervisor in the company and the examiner in the university.	
4	Forms of teaching:	
	Work-related module	
5	Participation requirements:	
	Formal:	Module examination pass in Work-Related Module I
	Content:	-
6	Forms of assessment:	
	Term paper	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Digital Technologies (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	Prof. Dr.-Ing. Andrea Kaimann	
11	Other information:	
	-	
12	Language:	
	German	

Work-Related Module III					PX3
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3129	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	0	weekly hours	0	h	150	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	0	weekly hours	0	h	0	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	0	weekly hours	0	h	0	h

2	Learning outcomes/competences:	
	Upon successful completion of the module, students • Can apply and deepen knowledge and skills specific to the study programme. • Work on individual problems holistically and under practical conditions during the work term at the company and develop solution options independently. • Apply academic work skills and successively develop them further. • Document the individual problems and solution options worked on in the company in an academic paper.	
3	Contents:	
	• The topics to be dealt with represent current questions the company is working on. • If relevant to the question, technical trends such as future technologies and social trends such as sustainability are also addressed. • The topics to be dealt with must be related to engineering science and must be oriented towards the module content of the curriculum. • The topic is agreed between the student, the supervisor in the company and the examiner in the university.	
4	Forms of teaching:	
	Work-related module	
5	Participation requirements:	
	Formal:	Module examination pass in Work-Related Module II
	Content:	-
6	Forms of assessment:	
	Term paper	
7	Prerequisite for the award of credit points:	
	Module examination pass	
8	Application of the module (in the following study programmes)	
	Digital Technologies (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.	
9	Importance of the grade for the final grade:	
	according to BRPO	
10	Module coordinator:	
	Prof. Dr.-Ing. Andrea Kaimann	
11	Other information:	
	-	
12	Language:	
	German	

Quality Assurance for AI Systems					**QKI**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3348	150 h	5	7th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

- The students know the tasks and objectives of quality management systems in the company and compare the tools and procedures of quality planning, control, inspection and improvement.
- They explain the industry standards and certification measures for the functional safety of technical systems and analyse technical and organisational measures for achieving functional safety.
- They apply strategies and frameworks for systematic testing to validate machine-learned models so that they meet the criteria for functional safety in technical systems or general quality criteria.
- They compare interpretable models in machine learning and use them where it is necessary for reasons of functional safety or general validation. In addition, they apply methods of Explainable AI to explain decision of a blackbox AI.
- They develop a catalogue to certify an AI taking into account aspects of safety, social policy and ethics.

3 Contents:

Foundations of quality assurance and management:

- Tasks and objectives of quality management systems in companies
- Tools and procedures for quality planning, control, inspection and improvement

Fundamentals of functional safety in technical systems:

- Industry standards, certification of functional safety in technical systems
- Technical-organisational measures to ensure functional safety

Validation of machine-learned models:

- Challenges in testing an AI
- Strategies and frameworks for systematic testing of machine-learned models

Interpretable models in machine learning (Explainable AI)

- Informed Machine Learning and interpretable models in machine learning
- Strategies and methods for Explainable AI

Certification of an AI

- Requirements and criteria for certification of an AI
- Impact of aspects of safety, social policy and ethics on the development of an AI

4	Forms of teaching: Learning units for self-study, classroom events in the form of exercises and practicals	
5	Participation requirements:	
	Formal:	
	Content:	Knowledge from the following modules: all modules on data mining and machine learning in the DTG study programme
6	Forms of assessment: Term paper, combination examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. nat. Alexander Maier	
11	Other information:	
12	Language: German	

Safety and Security					**SAS**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3259	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

Students:

- Know the Machinery Directive as well as the most important standards (e.g., IEC 61508) in the field of functional safety and understand how to apply them to real processes and technical systems.
- Are able to carry out a risk assessment and develop a technical safety concept.
- Are familiar with the most important aspects of IT security, and can create vulnerability, threat, and risk analysis, and security plans.
- Analyse IT systems with regard to the integrated protection mechanisms. They derive measures and mechanisms to increase safety and reliability.
- Know the most important legal laws and framework conditions with regard to IT security and data protection (in particular the GDPR)

They have comprehensive basic knowledge of legal and data protection and the necessary technical and organisational measures to ensure legally required data protection.

3 Contents:

Functional safety:

- Standards and directives, in particular IEC 61508, ISO 13849
- Machinery Directive and Declaration of Conformity
- Risk assessment, risk analysis, safety integrity levels (e.g., SIL), performance levels
- Technical safety concept
- Validation concept and traceability

IT security:

- Reliability and security objectives (confidentiality, integrity, availability, maintainability)
- Vulnerability, threat and risk analyses and security plan
- Measures and mechanisms to increase reliability and security of IT systems
- Basic concepts of cryptology
- Cryptography, authentication, access control, protocols, firewalls
- Symmetrical and asymmetrical crypto systems

	Legal and data protection: • Legal basis • Technical-organisational measures to ensure the legally required data protection	
4	Forms of teaching: Self-study units, exercises and practicals in the form of face-to-face events	
5	Participation requirements:	
	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, written examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr.-Ing. habil. Thorsten Jungeblut	
11	Other information: -	
12	Language: German	

Sensors and Actuators					**SUA**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3350	150 h	5	5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

The students

- Explain the basics of measurement technology and error calculation,
- Know the transducer principles, properties, structure and design forms of sensors in the field of sensor technology,
- Master description means and methods for sensor systems as an important step for the overall system design of resource-efficient systems,
- Acquire basic knowledge of signal processing and its application in the field of sensor technology,
- Gain insights into current fields of application of modern sensor technology.

In the field of actuators, students

- Explain the basic technical and physical principles of mechanical, thermal and optical actuators,
- Know the areas of application of the different types of actuators,
- Assess in a comparative manner which actuators in which application scenario should be used.

3 Contents:

Sensor technology:

- Fundamentals of measurement technology and error calculation
- Fundamentals of the digital signal processing chain (e.g., sampling, AD/DA conversion, discretisation, quantisation, coding, time/value (dis)continuity, sampling theorem)
- Sensors: concept definition, categorisation according to transducer technologies, sensor characterisation, transfer function (e.g., accuracy, resolution, sensitivity, linearity), calibration, hysteresis

Examples of selected sensor principles (e.g., position/distance sensors, time of flight, gyroscope. Triangulation)

Actuator technology:

- Mechanical actuators: e.g., (electric) motors, hydraulics, pneumatics, valves, pumps, fans
- Thermal actuators: e.g., heating, cooling
- Optical actuators: e.g., luminaires, dimming, shading
- Unconventional actuators: e.g., based on electrostrictive or magnetostrictive effects

Construction of technical sensor/actuator systems: aspects of embedded systems/connectivity, network connection

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:

	Content:	• Mathematical and engineering basics
6	Forms of assessment: Written examination, combination examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr.-Ing. habil. Thorsten Jungeblut	
11	Other information:	
12	Language: German	

Smart Services and Devices					**SMSD**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3262	150 h	5	5th semester	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Tuition in seminars	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Students are able to identify the potential for smart services by using maturity level analysis and assessing their own processes. They have an overview of the state of digitalisation in the various business areas and know the risks of disruption in the field of digitalisation. Students design smart services on the basis of specifications and can operate and qualitatively evaluate them. The students examine innovative business model patterns and conceive their own business models to market their smart services. They can explain the principles of the different technologies for smart services and are familiar with the conventional integration platforms. Students know the technological equipment of smart devices and can use this technology for smart services. They design smart services on platforms as well as smart devices and can explain how these smart services work. The students apply the knowledge of the communication and networking of smart devices, can establish a connection to the Internet of Things and are able to define the interfaces.

3 Contents:

Digitalisation

- Digitalisation and disruption
- Identifying potential for smart services

Assistance systems

- Historical development of assistance systems
- Technological enablers for smart services

Smart services

- Development and specification of smart services
- Technologies for smart services
- Research and assessment of best practices
- Operation of smart services

Smart devices

- Service architectures
- Integration platforms
- Technological equipment
- Communication and networking
- Smart Devices in the Internet of Things

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

	Formal:	-
	Content:	-
6	Forms of assessment: Term paper, combination examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. nat. Alexander Maier	
11	Other information: -	
12	Language: German	

Social Media and Natural Language Processing					**SMNLP**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3351	150 h	5	6th sem.	Annual (Summer)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

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

- Explain the principles of social media, key manifestations, basic technologies and the business model behind them.
- Develop a systematic management concept for the social media presence of companies according to the social media cycle.
- Retrieve data from social media sources via API and where this is not possible to create web scraping scripts.
- Describe the areas of application of Natural Language Processing, explain the methods used there and classify them in the field of machine learning and data mining.
- NLP methods for the syntactic and semantic analysis of text data can be selected and applied in practice.

3 Contents:

Introduction to social media: History, principles, manifestations, business model, technologies

- Social media strategy from a business perspective
- Retrieving data from social media channels via API and web scraping
- Introduction to Natural Language Processing (NLP): history, motivation, application areas, relationship to other data mining techniques and machine learning
- Basic concepts and procedures: corpora, text normalisation, editing distance, N-grammes, language models
- Vector semantics and embeddings: TF-IDF, Word2Vec
- Artificial neural networks in NLP: recurrent networks, LSTMs, Large Language Models (Transformers)

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	
Content:	• Mathematical basics • Basics of machine learning and data mining • Advanced programming skills

6 Forms of assessment:

	Written examination, project work or oral examination
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr. rer. nat. Stefan Berlik
11	Other information:
12	Language: German

Software Engineering					**SEN**
Identification number	Workload	Credits	Study semester	Frequency of the offer:	Duration
3369	150	5	5th sem.	Annual (Winter)	1 semesters

1	Course:	Planned group sizes:	Scope:		Actual contact time/classroom teaching		Self-study:	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Upon completion of the module, students are able to ...

- Apply the design patterns of software development
- Explain the most important processes of software development
- Use module tests, integration tests and system tests in their own software projects.
- Evaluate common forms of software architectures with regard to their situational suitability.

3 Contents:

Contents:

- In-depth/principles of object-oriented design: SOLID principles, data encapsulation, Demeter law, separation of responsibilities, etc.
- Common system architectures for systems of different sizes: Multi-layer architecture models, distributed and microservice architectures.
- Architecture and design patterns: Singleton, factory, observer, facade, strategy, anti-patterns, etc.
- Software development processes: Agile process models such as Scrum, Test-Driven Development, Extreme Programming (XP), Kanban, Continuous Integration, GIT.
- Validation and verification: Module tests, integration tests, system tests and (acceptance tests)
- Programming the above-mentioned patterns and architectures in an object-oriented language

4 Forms of teaching:

Seminar lessons, exercises, case studies

5 Participation requirements:

Formal:	
Content:	

6 Forms of assessment:

Written examination, 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 (work-integrated) B.Sc. and Software Engineering (work-integrated) B.Sc.

9 Importance of the grade for the final grade:

according to BRPO

10 Module coordinator:

Prof. Dr. rer. pol. Hans Peter Rauer

11	Other information:
12	Language: German

Speech and Image Recognition					**SUB**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3346	150 h	5	5th sem.	Annual (Winter)	1 semester

	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
1	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	54	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Successful completion of the module will enable students to:

- Explain the Fourier transformation in the context of speech and image processing and apply it using finished software.
- Explain the fundamentals of Deep Learning (DL) and Convolutional Neural Networks (CNN) and identify possible application areas of DL and CNN.
- Select appropriate DL network topologies and training approaches for the respective learning problem, implement and train the networks using common toolboxes.
- Formulate the basics of machine vision and apply simple machine vision operations to image data.
- Train DL networks for object classification in images and other image transformation tasks.
- Present the basics of machine speech processing and explain speech recognition methods.
- Assess the performance of trained DL networks compared to other speech and image recognition methods.

3 Contents:

- Fourier transform
- Introduction to machine vision
- Deep Learning (DL) and Convolutional Neural Networks (CNN)
  - Basics
  - Optimisation process
  - Network topologies,
  - Training and application
- Object classification in images using DL techniques
- Introduction to machine language processing
- Voice recognition in audio data

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

5 Participation requirements:

Formal:	
Content:	• Mathematical basics and statistics • Advanced programming skills in Python

6 Forms of assessment:

Written examination, project work or oral examination

7 Prerequisite for the award of credit points:

Module examination pass and course assessment

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

	Digital Technologies (work-integrated) B.Sc.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Prof. Dr. rer. nat. Stefan Berlik
11	Other information:
12	Language: German

Statistics					**STAT**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3224	150 h	5	2nd, 3rd or 4th semester	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	2	weekly hours	16	h	62	h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Upon successful completion of the module, students:

- can explain basic concepts of statistics.
- can apply the basic methods and procedures of descriptive statistics and probability theory.
- are able to analyse economic questions and problems with statistical methods and to show correlations.
- are able to solve tasks with the help of suitable software (SPSS, Excel,...).

3 Contents:

- Basic terms of statistics
- Descriptive statistics (one-dimensional frequency distributions, measures for one-dimensional distributions, - bivariable distributions, regression analysis)
- Basics of probability theory
- Probability distributions
- Assessing statistics (hypothesis tests, point and interval estimators)
- Use of software e.g., Excel, SPSS, MATLAB

4 Forms of teaching:

Learning units for self-study, classroom sessions in the form of exercises

5 Participation requirements:

Formal:	-
Content:	-

6 Forms of assessment:

Written examination, combination examination, 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 (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.

9 Importance of the grade for the final grade:

according to BRPO

10 Module coordinator:

Dr. rer. nat. Sabrina Proß

11 Other information:

-

12	Language: German

Please note: The German version of this document is the legally binding version. The English translation provided here is for information purposes only.

Technical English					**TCE**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
3121	150 h	5	1st, 3rd or 5th sem.	Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	0	weekly hours	0	h	0	h
	Practical or seminar	15 students	2	weekly hours	32	h	46	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

- Expertise: The students acquire an extended active language competence at the upper B2 level. They have a sound specialist vocabulary of Technical English and can combine it with Business English terminology relevant to their profession.
- Social competence: they develop sensitivity to differences in intercultural communication, especially in English-speaking business environment.
- Methodological competence: They are able to skim specialist texts for essential information and present them shortly and concisely both in speaking and in writing. They establish wider contexts and make a critical assessment.
- Personal competence: They show English fluency and a pro-active approach to managing authentic English sources.

3 Contents:

- Students can actively participate in international conferences.
- They master engineering-relevant terminology (e.g., manufacturing processes; mathematical operations; dimensions and shapes; forces and mechanisms; properties of materials; automated systems and Industry 4.0).
- They possess interdisciplinary skills (e.g., discussing readings and trends; pitching a technical product; managing projects; designing conference posters; academic writing).

4 Forms of teaching:

Seminar-based teaching / individual and group work, etc. / semester project (Assignment)

5 Participation requirements:

Formal:	
Content:	English language competence: B1.2 (according to the European Reference Framework for Languages)

6 Forms of assessment:

	Combination examination
7	Prerequisite for the award of credit points: Module examination pass and course assessment
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc., Mechatronics/Automation (work-integrated) B.Eng., Software Engineering (work-integrated) B.Sc. and Industrial Engineering and Management (work-integrated) B.Eng.
9	Importance of the grade for the final grade: according to BRPO
10	Module coordinator: Dr. phil. Beate Tarrach
11	Other information:
12	Language: English

Networking and IoT Solutions									**IOT**
Identification number:		Workload:		Credits:		Study semester:		Frequency of the offer	Duration:
3264		150 h		5		3rd sem.		Annual (Winter)	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	56	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1.5	weekly hours	24	h	0	h

2 Learning outcomes/competences:

Students

- Learn about the basics and areas of application of the Internet of Things (IoT).
- Can name and explain the different layers of the ISO-OSI communication model.
- Know the intersections between the individual layers and can apply them.
- Understand the essential processes between the individual communication layers and can name the data abstraction.
- Have an overview of industrial fieldbuses, they know the common protocols and can categorise them within the ISO-OSI communication model.
- Gain basic knowledge of common IoT communication standards (e.g., OPC-UA, MQTT, CoAP).
- Can evaluate different bus technologies and categorise them for different applications.
- Understand the essential principles of wireless communication and can describe their standards.
- Are able to transfer their knowledge in the field of industrial communication and wireless data transmission to resource-efficient IoT solutions.

3 Contents:

Introduction to IoT

Basics of computer networking (basic concepts, network services, roles, transmission media, protocols, Parallel/serial transmission, synchronous/asynchronous transmission, direction dependency, topologies)

ISO-OSI communication model

- Physical layer (media, collisions, performance codes)
- Data link layer (media access method, addressing, fault detection, data link layer circuits, Spanning Tree Protocol, collision domains)
- Network layer (routing, broadcasting, network classes, fragmentation)
- Transport layer (connection-oriented/connectionless transport protocols, flow control)
- Session layer (session build-up, break-up, synchronisation)
- Presentation layer (presentation and formatting of messages)
- Application layer (example protocols (e.g., DNS, DHCP, NTP, SSH, HTTP, SMPT, POP3, FTP))

Basics of common IoT communication standards and industrial fieldbuses

Wireless communication (radio spectrum, basic radio technology, ISM band, signal propagation, frequency spread, media access)

4	Forms of teaching: Self-study units, exercises and practicals in the form of face-to-face events	
5	Participation requirements:	
	Formal:	-
	Content:	Module "Foundations of Computer Science"
6	Forms of assessment: Term paper, written examination or oral examination	
7	Prerequisite for the award of credit points: Module examination pass and course assessment	
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc. and Software Engineering (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr.-Ing. habil. Thorsten Jungeblut	
11	Other information: -	
12	Language: German	

Elective Module: Digital Technologies					**WM**
Identification number:	Workload:	Credits:	Study semester:	Frequency of the offer	Duration:
9006	150 h	5	5th or 6th semester	each semester	1 semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students		weekly hours		h		h
	Seminar lessons	30 students		weekly hours		h		h
	Exercise	20 students		weekly hours		h		h
	Practical or seminar	15 students	0	weekly hours	0	h	0	h
	Supervised self-study	60 students		weekly hours		h		h
2	Learning outcomes/competences:							
3	Contents:							
4	Forms of teaching:							
5	Participation requirements:							
	Formal:							
	Content:							
6	Forms of assessment:							
7	Prerequisite for the award of credit points:							
8	Application of the module (in the following study programmes) Digital Technologies (work-integrated) B.Sc.							
9	Importance of the grade for the final grade:							
10	Module coordinator: Prof. Dr. rer. nat. Stefan Berlik							
11	Other information:							
12	Language: German							

Web Technologies									**WEB**
Identification number:	Workload:	Credits:	Study semester:			Frequency of the offer			Duration:
3207	150	5	4th sem.			Annual (Summer)			1 Semester

1	Course:	Planned group sizes	Scope		Actual contact time / classroom teaching		Self-study	
	Lecture	60 students	2	weekly hours	0	h	64	h
	Seminar lessons	30 students	0	weekly hours	0	h	0	h
	Exercise	20 students	1	weekly hours	8	h	46	h
	Practical or seminar	15 students	1	weekly hours	16	h	0	h
	Supervised self-study	60 students	1	weekly hours	16	h	0	h

2 Learning outcomes/competences:

Students:

- implement simple web pages using appropriate tools; apply mark-up languages and common data exchange formats for web programming and data exchange;
- link databases to web interfaces;
- explain the basic concepts of the semantic web and place it in the canon of web technologies;
- explain the various technical, logical and legal influencing factors that play a role in e-business;
- discuss current and upcoming developments in the various areas and evaluate the effects on existing or planned E-business systems in the overall operational framework; explain the structure and the administration of E-business tools and comprehensive platform solutions.

3 Contents:

Internet technologies and architectures:

- Foundations of web programming
- Markup languages (e.g., XML) and data exchange formats (e.g., JSON)
- Integration of databases with web interfaces
- Fundamental concepts of the Semantic Web

E-business standards (data formats and rules for the exchange of information):

- Identification standards, e.g., GTIN (Global Trade Item Number)
- Classification standards, e.g., eCl@ss
- Catalogue exchange formats, e.g., BMEcat
- Transaction standards, e.g., EDIFACT, EDIFOR
- Process standards, e.g., ECR (efficient consumer response)

Platform solutions:

- Cross-Channel Commerce Management Solutions
- E-commerce logistics fulfilment networks that enable national and international storage, handling and delivery of products (via an interface to online shop or ERP systems)

4 Forms of teaching:

Self-study units, exercises and practicals in the form of face-to-face events

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 (work-integrated) B.Sc. and Software Engineering (work-integrated) B.Sc.	
9	Importance of the grade for the final grade: according to BRPO	
10	Module coordinator: Prof. Dr. rer. pol. Hans Peter Rauer	
11	Other information: -	
12	Language: German	