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Faculty of Computer Science and
Business Information Systems
Technical University of
Applied Sciences
Würzburg-Schweinfurt

Module Handbook
Bachelor Computer Science (B. Eng.)

Winter semester 2026
Summer semester 2026

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1. semester

Module: 5100350
Algebra

Module profile

Exam number
5100350

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Andreas Keller

Lecturer(s)
Prof. Dr. Andreas Keller

Applicability	BIN
Semester according to SPO	1. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
School maths

Content
General Foundations:
- The field of real numbers
- The principle of complete induction
- Introduction to the field of complex numbers

Linear Algebra:
- Vector spaces (linear independence, basis and dimension)
- Matrices (matrix operations, trace and determinant, rank of a matrix)
- Systems of linear equations
- Gauss's algorithm
- Linear transformations
- Eigenvalues and eigenvectors
- Diagonalisation
- Spectral theorem

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
1. Students recall fundamental mathematical concepts and methods relevant to computer science.
2. Students understand the principles of algebraic and geometric mathematics and their application in computer science contexts.
3. Students apply mathematical techniques to solve problems in computer science and to develop solution strategies.
4. Students analyse mathematical problems and identify suitable approaches to solving them, taking into account various mathematical theories.
5. Students evaluate different solution strategies in terms of their efficiency and suitability in computer science.
6. Students create mathematical models to abstract and solve complex problems in computer science.

Literature
Bartholomé, Andreas; Rung, Josef; Kern, Hans: Number Theory for Beginners. Vieweg+Teubner, Wiesbaden, 2013.
Beutelspacher, Albrecht; Zschiegner, Marc-Alexander: Discrete Mathematics for Beginners. Vieweg+Teubner, Wiesbaden, 2014.
Gramlich, Günter: Linear Algebra – An Introduction. Fachbuchverlag Leipzig, published by Carl Hanser Verlag, 2021.
Hartmann, Peter: Mathematics for Computer Scientists. Vieweg +Teubner, Wiesbaden, 2020.
Papula, Lothar: Mathematics for Engineers and Natural Scientists, Volumes 1 and 2. Vieweg+Teubner, Wiesbaden, 2018.
Pommersheim, James E.; Marks, Tim K.; Flapan, Erica L.: Number Theory: A Lively Introduction with Proofs, Applications, and Stories. John Wiley & Sons, 2010.
Schubert, Matthias: Mathematics for Computer Scientists. Vieweg +Teubner, Wiesbaden, 2012.
Strang, Gilbert: Linear Algebra. Springer-Verlag, Berlin/Heidelberg/ New York, 2003.

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Module: 9999999
General Compulsory Elective

Module profile

Exam number
9999999

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr. Jochen Seufert

Lecturer(s)
Beate Wassermann

Applicability	BIN, BWI
Semester according to SPO	1. semester
Type of module	AWPM

Required prerequisites for the participation in the module according to the SPO
As a rule, none; any exceptions are determined and announced by the Faculty of Applied Natural Sciences and Humanities.

Recommended prerequisites for the participation in the module
none

Content
A choice of two compulsory elective general science modules (AWPF) (2 x 2 SWS) or one AWPF (1 x 4 SWS) from the range of modules offered by the Faculty of Applied Natural Sciences and Humanities (FANG).

Subjects offered by FANG in the following areas:
- Languages
- Cultural Studies
- Natural Sciences and Technology
- Politics, Law and Economics
- Education, Psychology and Social Sciences
- Soft Skills
- Creativity and Art.

Courses whose content is already part of, or directly related to, other modules within the degree programme are excluded from the FANG course catalogue. The relevant courses are marked as ‘restricted’ in the FANG course catalogue.
The content of the individual AWPFs is published on FANG’s faculty website.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
none

Learning outcomes
The subject-specific learning objectives depend on the AWPFs selected in each case. Students

- also acquire knowledge and skills that are not subject-specific but may be relevant to their intended career path, such as specialised knowledge of foreign languages or in the natural or social sciences
- analyse a wide variety of issues
- place subject-specific knowledge within an interdisciplinary context
- apply what they have learnt to their current training
- have expanded their key competences and, where applicable, their foreign language skills, thereby supporting their personal development, including from an intercultural perspective
- are aware of their responsibilities in personal, social and ethical terms.

Literature
depending on the selected AWPFs

Module: 5101620,6810030 Databases

Module profile

Exam number
5101620,6810030

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Frank-Michael Schleif

Lecturer(s)
Michael Rott

Applicability	BIN, BISD
Semester according to SPO	1. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
bZv

Recommended prerequisites for the participation in the module
none

Content
This module covers the fundamental concepts and techniques of database development. The relational data model and relational algebra are presented as the theoretical foundations. A key focus is on database modelling, in particular the creation of entity-relationship models (ER models) and their conversion into relational schemas, taking normal forms into account. An introduction to the SQL language is provided, including data manipulation, data retrieval, schema definition and transaction management. Database development and administration are practised through practical exercises and projects carried out throughout the semester.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes

- Students can explain the fundamental concepts of data persistence and the differences between persistent and non-persistent data.
- Students can define the key terms of relational databases, such as relation, primary key, foreign key and normalisation.
- Students understand relational algebra and can apply simple operations to it.
- Students can explain the relationship between conceptual, logical and physical data modelling and justify their significance for database development.
- Students are able to create entity-relationship models (ERM) for given use cases and convert these into relational schemas.
- Students can formulate and execute SQL queries for data manipulation (DML) and schema definition (DDL).
- Students can analyse existing database schemas and evaluate them in terms of redundancy, consistency and normal forms.
- Students are able to analyse business information requirements and derive suitable data structures and queries from them.

Literature

- Michael Kofler (2024). Database Systems – The Comprehensive Textbook (2nd edition). Bonn: Rheinwerk Verlag GmbH
- Kemper, A., & Eickler, A. (2015). Database Systems – An Introduction (10th edition). Munich: De Gruyter Oldenbourg Verlag
- Elmasri, R., & Navathe, S. B. (2015). Fundamentals of Database Systems (7th edition). Munich: Pearson Studium
- Garcia-Molina, H., Ullman, J. D., & Widom, J. (2013). Database Systems: The Complete Book (2nd ed.). Upper Saddle River, NJ: Pearson
- Saake, G., Sattler, K.-U., & Heuer, A. (2011). Databases – Concepts and Languages (3rd edition). Munich: Pearson Studium

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Module: 5111010,6810010 Basics of Algorithms and Data Structures

Module profile

Exam number
5111010,6810010

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Frank Deinzer

Lecturer(s)
Prof. Dr. Frank Deinzer,
Prof. Dr. Dominik Seuß

Applicability	BIN, BISD
Semester according to SPO	1. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
Theoretical topics
- Recursion: terminal/non-terminal, linear recursion/tree recursion
- Complexity: O-notation, time complexity, space complexity
- Higher-order functions
- (Anonymous) lambda functions
- Abstraction mechanisms: procedural abstraction, abstraction with data
- Representation of complex data structures
- Sorting and searching

Practical topics
- Numerical algorithms
- Algorithms on lists
- Algorithms on trees
- Algorithms on arrays
- Algorithms on symbolic data
- Algorithms on strings
- Algorithms on sets
- Algorithms on queues

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
At the start of their course, students develop an understanding of the style and aesthetics of programming.
Students understand the fundamental techniques of algorithmic problem-solving.
Students generalise the appropriate application of key techniques for mastering complex systems.
Students apply concepts in the areas of recursion and abstraction.
Students apply standard solution techniques to algorithmic problems.

Literature
Abelson, Sussman: Structure and Interpretation of Computer Programmes. Springer Verlag, 4th edition, 2014
Wagenknecht: Programming Paradigms: An Introduction Based on Scheme. Vieweg+Teubner, 2013

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Module: 5100720
Basics of Computer Engineering

Module profile

Exam number
5100720

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Arndt Balzer

Lecturer(s)
Prof. Dr. Arndt Balzer, John Zhong Wang

Applicability	BIN
Semester according to SPO	1. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
- Technological fundamentals (passive and active components)
- Boolean algebra (axioms and laws) and circuit algebra
- Number representation in digital systems
- Basic circuit networks (symbols and representation)
- Minimisation of Boolean functions (Karnaugh-Veitch diagram, Quine and McCluskey methods)
- Combinational circuits: encoders, decoders, multiplexers, demultiplexers
- Circuit design and analysis
- Timing effects (hazards)
- Programmable logic devices (PLDs: PROM, PAL, PLA and FPGA)
- Memory elements (types of flip-flops)
- Sequential circuits: counters, storage units, shift registers
- Finite-state machines (FSMs) and implementation using logic circuits (Mealy, Moore)
- Logic circuit synthesis and analysis
- Control circuit design
- Circuits for implementing arithmetic and logical functions
- Introduction to circuit design using VHDL

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
Students will gain an understanding of the structure and organisation of digital computing systems in modern computers, as well as the key milestones in the development of IT systems.
Students will be able to

- explain technical implementations of circuits,
- implement a formal and programming-language-based circuit description,
- analyse unknown circuits based on an understanding of the structure and function of all key basic circuits and arithmetic units,
- evaluate circuits using cost functions,
- develop their own simple circuits.

Literature
Schiffmann, Werner; Schmitz, Rolf: Computer Engineering 1. Springer, 2004.
Hoffmann, Dieter: Fundamentals of Computer Engineering. Hanser, 2023.
Fricke, Karl: Digital Technology. Vieweg+Teubner, 2023.
Hennessy, John L.; Patterson, David A.: Computer Organisation and Design. Morgan Kaufmann, 2011.
Becker, Bernd; Drechsler, Rolf; Molitor, Peter: Computer Engineering. Pearson Studium, 2005.
Borucki, Leonhard: Digital Technology. Teubner, 2000.
Woitowitz, Reiner; Urbanski, Klaus: Digital Technology. Springer, 2011.
Beuth, Bernd: Digital Technology. Vogel, 2019.
Tietze, Ulrich; Schenk, Christoph: Semiconductor Circuit Technology. Springer, 2013.
Möller, Detlef: Computer Architectures – Fundamentals of Computer Engineering. Springer, 2013.

Module: 5100130
Programming I

Module profile

Exam number
5100130

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr.-Ing. Tobias Fertig

Lecturer(s)
Prof. Dr.-Ing. Tobias Fertig, Christine Zilker

Applicability	BIN
Semester according to SPO	1. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
The Programming I module focuses on learning procedural programming as well as the basics of object-oriented programming in the Java programming language. The ability to programme and thereby independently solve minor problems in various fields is one of the fundamental skills expected of a (business) IT specialist.

The course consists of 13 lessons, comprising instructional videos, accompanying exercises, PowerPoint slides relating to the videos, and quizzes covering the material.

The instructional videos are structured so that students gradually become familiar with the various language constructs and fundamental concepts of programming. The accompanying seminar sessions are designed to allow students to ask questions and deepen their understanding of the material.

The exercises are by far the most important component of the course. Students learn to programme by solving problems independently. The exercise sessions are helpful in that the lecturer provides food for thought when a student gets stuck on a task, and the quality of solutions is discussed and improved. The exercises generally relate to the preceding tutorial videos and build on their content.

Each lesson includes a quiz which, through simple questions, gives students the opportunity to check whether they know or understand the material covered.

Contents:
- Introduction/First programme (Hello World)
- Basic language constructs (expressions, primitive variables, assignments)
- Essential (control) statements (conditional statements, branches, head- and tail-controlled loops)
- Methods, recursion, arrays, complex data types
- Object-oriented programming (introduction), classes, objects, (instance) methods, visibility
- Multidimensional arrays, behaviour of reference types, string methods, garbage collector

- Data structures (singly and doubly linked lists, binary trees, traversing trees)
- Packages, implicit inheritance, relations using the `equals` method as an example
- DRY principle, ‘Tell, don’t ask’ principle
- optional: bitwise operators

- IDEs used: IntelliJ IDEA, Eclipse, VSCode, ...

This module forms the basis for Programming 2 and the programming project.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix

bZv – currently suspended

Examination - type

Written exam (sP) according to § 23 APO

Examination - length/format

90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination

German

Condition for the award of credit points

none

Learning outcomes

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

- apply procedural programming and, at an introductory level, the fundamentals of object-oriented programming
- independently implement a solution strategy for writing small procedural and object-oriented Java programmes based on a given design concept
- understand simple mathematical and technical problems and implement a solution
- generalise sub-problems using appropriate methods

Literature

Heinisch, Cornelia; Müller-Hofmann, Frank; Goll, Joachim: Java as a First Programming Language; From Beginner to Professional; Springer Vieweg, 2023
Christian Ullenboom: Java is also an Island, 17th, updated and revised edition, Rheinwerk Computing, 2023
Reinhard Schiedermeier: Programming with Java, Pearson Studium – IT, 2010

2. semester

Module: 5100360
Analysis

Module profile

Exam number
5100360

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Andreas Keller

Lecturer(s)
Prof. Dr. Andreas Keller

Applicability	BIN
Semester according to SPO	2. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
School maths, algebra

Content
This module covers fundamental aspects of single-variable calculus:

Properties of functions
Sequences and series
Limits of functions and continuity
Differential calculus
Integral calculus
Taylor series

Analysis (single- and, in particular, multi-dimensional) serves, amongst other things, as the basis for many real-world applications in the natural sciences and engineering, which can be solved on a computer with the aid of computer science. It is also indispensable for a thorough understanding of probability theory and statistics, as well as numerical mathematics, which in turn form the basis for many specialist areas of computer science such as artificial intelligence (e.g. neural networks, machine learning), data science, Big Data, computer vision and image recognition, and many more.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
Students are able to explain and determine basic concepts (e.g. domain, range, domain of definition) and properties (injectivity, surjectivity, bijectivity, invertibility, periodicity, monotonicity, etc.) in connection with various standard types of functions (polynomials, power functions (roots), rational functions, exponential and logarithmic functions, trigonometric functions). They are confident in handling the concept of limits and can calculate fundamental limits of sequences and functions; they are also familiar with the concept of convergence of series and power series and can test these for convergence using standard methods. Optionally, students are introduced to complexity classes of sequences and functions (linking to computer science and numerical analysis), which can often be classified using limit analyses.
Using the concept of limits, they are also able to examine functions for continuity and differentiability and, by way of examples, understand the geometric properties of continuous or differentiable functions and the useful consequences (including the Intermediate Value Theorem, the zero-point theorem, L'Hospital's rule, etc.) can be derived from these properties.
They are able to differentiate standard types of functions using the rules of differentiation, as well as calculate local and global extrema. As a practical numerical method, they apply the Newton method as an example.
Students are familiar with the concept of the definite (Riemann) integral and the elementary rules for computing it. In addition, they are familiar with the concept of the indefinite integral (primitive function), as well as the integral function and its connection to differential calculus, in particular the fundamental theorem of calculus. They know that, for example, integral calculus can be used in a classical sense to determine areas under graphs, but that this is only one aspect of integration and that integration can also be interpreted, for example, as a generalised form of averaging (as a preliminary step, for instance, to Fourier analysis, which plays a major role in many applications in computer science and engineering). Specifically, they are able to calculate elementary indefinite and definite integrals. Optionally, they can also determine more challenging integrals using partial integration or the method of substitution, or calculate improper integrals.
Students can determine the Taylor polynomial and Lagrange's remainder for a function, and are familiar with the most important power series representations of elementary functions. In addition, they can use Taylor polynomials/series, for example, to determine limits and to approximate functions and integrals, and can provide elementary error estimates.

In general, students assess the suitability of mathematical methods for specific problems, check results for plausibility and interpret them within a subject-specific context.

Through the continuous solving of problems and the analysis of mathematical texts, students strengthen their capacity for logical,

analytical and conceptual thinking and develop strategies for structured problem-solving.

Literature

Brill, Manfred: Mathematics for Computer Scientists. Hanser Verlag, Munich/Vienna, 2004.
Hartmann, Peter: Mathematics for Computer Scientists. Vieweg +Teubner, Wiesbaden, 2020.
Oberguggenberger, Michael; Ostermann, Alexander: Analysis for Computer Scientists. Springer-Verlag, Berlin/Heidelberg, 2009.
Papula, Lothar: Mathematics for Engineers and Natural Scientists, Volumes 1 and 2. Vieweg+Teubner, Wiesbaden, 2024.
Schubert, Matthias: Mathematics for Computer Scientists. Vieweg +Teubner, Wiesbaden, 2012.

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Module: 5103220
IT Project Management

Module profile

Exam number
5103220

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Anne Heß

Lecturer(s)
Prof. Dr. Eva Wedlich,
Prof. Dr.-Ing. Anne Heß

Applicability	BIN
Semester according to SPO	2. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
- Introduction to projects and project management
- Project organisation * Project planning process
- Project costing * Project control and monitoring
- Project closure * Human resources management and project marketing
- IT product management
- Core activities in IT projects (analysis, design, implementation, integration and stabilisation)
- Quality management and quality assurance
- Configuration management (basic)
- Process models (phase-based models vs. iterative / incremental / agile process models)
- Agile project management / Scrum

In the non-dual degree programme, the lecturer determines the topics for the practical examples used in seminar-based teaching and examinations. In the dual degree programme, students can work on practical examples from the company in seminar-based teaching and examinations.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
None

Learning outcomes

- Students acquire project management skills, in particular the knowledge required of project managers. To this end, the course covers project management methods, processes and tools.
- Students are familiar with the relevant core activities of software development and their objectives
- Students can identify and describe sub-activities, prerequisites and output types relevant to the core activities
- Students can describe various process models (waterfall model, V-model, Scrum), including their respective advantages and disadvantages, and can describe and map activities within these process models
- Students understand the characteristic features and differences between phase-based process models and iterative/incremental process models, and can select suitable process models for a given project context and justify their choice
- Students are familiar with the fundamental principles, roles, artefacts, ceremonies and practices of agile projects (using Scrum as an example) and can find their way as a team member in an agile project
- Students understand the importance and relevance of software quality
- Students are familiar with key concepts of quality management and quality assurance and can describe the relevant tasks and skills (soft skills) of quality officers
- Students are familiar with the key objectives, concepts and activities of configuration management, including the basic functionalities of tools used to support configuration management

Literature

- Johannsen, A. and Kramer, A.: Essential Knowledge for Software Project Managers, dpunkt.verlag, 2017.
- Olfert, K.: Project Management, NWB Verlag, 11th edition, 2019.
- Sterrer, C. and Winkler, G.: Setting Milestones: Project Management (Methods, Processes, Tools), Goldegg Verlag, 2010.
- Sterrer, C.: pm k.i.s.s.: Keep it Short and Simple, Goldegg Verlag, 2011.
- Tiemeyer, E.: Handbook of IT Project Management, Hanser, 2018
- Ziegler, Michael: Agile Project Management with Scrum for Beginners, ISBN-13: 979-8751100346, 2021
- Gundlach, Marco: Agile Project Management – Navigating Successfully with Scrum and Kanban: A Comprehensive Guide for Beginners and Experts, ISBN-13: 979-8392911936, 2023

Module: 5111120,6810070
Internet Communication

Module profile

Exam number
5111120,6810070

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Christian Bachmeir

Lecturer(s)
Prof. Dr. Christian Bachmeir

Applicability	BIN, BISD
Semester according to SPO	2. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
Outline:
1) Introduction to communication networks
2) Theoretical principles of communication technology
3) Practical principles of internet communication
4) Introduction to IT security
5) Fundamentals of cryptography

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
1. Students recall fundamental concepts of Internet communication systems and their technical principles.
2. Students understand how wireless communication technology works and its implications for data transmission.
3. Students apply modern cryptographic methods to ensure the security of internet communications.
4. Students analyse the performance, capabilities and limitations of internet communication systems in order to make informed decisions when developing distributed systems.
5. Students understand and evaluate the necessity of cryptographic methods in various real-world application scenarios.
6. Students develop concepts for implementing security mechanisms in internet communication systems based on the cryptographic techniques they have learnt.

Literature
Patrick Schnabel, A Primer on Communications Technology, Kindle eBooks
Kurose, Ross: Computer Networks: The Top-Down Approach, Publisher: Pearson Studium; Edition: 6th, updated edition, 2019
Tanenbaum, Wetherall: Computer Networks, Publisher: Pearson Studium; Edition: 5th, updated edition, 2013
Schmeh: Cryptography: Methods – Protocols – Infrastructures (iX Edition), Publisher: dpunkt.verlag GmbH; Edition: 5th, updated edition, 2013

Module: 5100220
Programming II

Module profile

Exam number
5100220

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr.-Ing. Tobias Fertig

Lecturer(s)
Prof. Dr.-Ing. Tobias Fertig, Christine Zilker

Applicability	BIN
Semester according to SPO	2. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Programming I

Content
The Programming II module focuses on learning object-oriented programming (in the Java programming language). In order to structure larger information systems, it is important to learn how they can be built, designed and tested.

This course consists of 13 lessons, comprising tutorial videos, accompanying exercises, PowerPoint slides relating to the videos, and quizzes covering the material.

The instructional videos are structured so that students are first presented with tests and then gradually learn about object-oriented programming and its application. The accompanying seminar sessions are designed to encourage questions and deepen understanding of the material.

The exercises are by far the most important part of the course. By solving problems independently, students learn object-oriented programming. The tutorial sessions are helpful in that the lecturer provides students with food for thought when a student gets stuck on a task, and the quality of solutions is discussed and improved. The exercises generally relate to the preceding educational videos and build on their content.

Each lesson includes a quiz which, through simple questions, gives students the opportunity to check whether they know or understand the material covered.

Contents:
Unit tests (JUnit 5)
Dependency management (Maven)
Inheritance (specialisation, generalisation)
Enumerations
Abstract classes, interfaces, composition
Exceptions
Streams
Generics
Collections, associative arrays (maps)
Nested classes (static nested, inner, local, anonymous classes)

Lambda expressions
Threads
Design patterns: Builder, Decorator, Visitor
Fluent interfaces
Functional programming using the Stream API

IDE: Eclipse or IntelliJ

The content and skills acquired in this module will make the programming project considerably easier.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix

bZv – currently suspended

Examination - type

Written exam (sP) according to § 23 APO

Examination - length/format

90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination

German

Condition for the award of credit points

none

Learning outcomes

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

- apply concepts of object-oriented programming
- independently develop a solution strategy for writing object-oriented Java programmes
- implement partial solutions to larger programmes or problems
- to structure problems into several sub-problems
- to implement tests for software systems
- to understand and use polymorphism in methods and types
- to use class libraries to extend programmes
- to understand basic design patterns

Literature

Schiedermeier, Reinhard: Programming with Java. Pearson, 2nd edition, 2010.
Schiedermeier, Reinhard: Programming with Java II. Pearson, 2013.
Bloch, Joshua: Effective Java. 3rd edition, Addison-Wesley, 2017.
Ullenboom, Christian: Java is Also an Island. 16th edition, Rheinwerk Computing, 2021.

Module: 5101820,6810220
Computer Architecture

Module profile

Exam number
5101820,6810220

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Christian Bachmeir

Lecturer(s)
Prof. Dr. Christian Bachmeir

Applicability	BIN, BISD
Semester according to SPO	2. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Fundamentals of Computer Engineering

Content
- Historical development
- Computer classifications (Flynn, Händler, Giloi)
- Computer arithmetic (representation of characters and numbers, IEEE 745, basic arithmetic operations, Booth's algorithm)
- Microprocessor core with control and arithmetic units (pipeline concept, dependencies and their resolution, dynamic scheduling: Scoreboard, Tomasulo)
- Machine instructions (ISA, addressing modes, assembler programming)
- x86 assembler (nasm, Linux/Ubuntu)
- RISC/CISC concepts (resource conflicts, microprogramming)
- Memory (structure of DRAM, SRAM, caches, coherence protocols)
- I/O and peripherals (external storage, buses)
- Parallel computing and multithreading
- Performance evaluation (basic concepts, benchmarks)

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
Students gain an understanding of the structure and operation of computing systems,
and of how different computer architectures work.
In addition, they acquire a basic knowledge of embedded systems.
.
Students will be able to

- illustrate the basic components of simple computers,
- explain various implementation methods for complex circuits,
- describe relevant memory technologies,
- analyse the structure and programming of processors,
- implement simple assembler programmes whilst taking into account the specific characteristics of a computer during programming,
- evaluate the performance of computers,
- design sub-components of a simple computer.

Literature
Hennessy, John L.; Patterson, David A.: Computer Architecture: A Quantitative Approach. Edition: 2025 (7th edition).
Hennessy, John L.; Patterson, David A.: Computer Organisation and Design. - Edition: 2020 (6th edition).
Brinkschulte, Uwe; Ungerer, Theo: Microcontrollers and Microprocessors – 2nd edition: 2010.
Tanenbaum, Andrew S.: Structured Computer Organisation. – Edition: 2012 (6th edition).
Coy, Wolfgang: The Structure and Operation of Computing Systems, 2013.
Hermann, Peter: Computer Architecture, 2013.
Bähring, Heinz: Microcomputer Systems, 2013.
Märtin, C.: An Introduction to Computer Architectures, 2003.
Malz, H.: Computer Architecture, 2004.
Oberschelp, W.; Vossen, G.: Computer Design and Computer Structures, 2006.
Bundschuh, B.; Sokolowsky, P.: Computer Structures and Architectures, 1988.
Austin, Todd; Tanenbaum, Andrew S.: Computer Architecture: From Digital Logic to Parallel Computing. Pearson, 2014.
Hennessy, John L.; Patterson, David A.: Computer Organisation and Design: The Hardware/Software Interface. Morgan Kaufmann Publishers, 2021 (6th edition). Homeister, Matthias: Understanding Quantum Computing: Fundamentals, Applications, Perspectives. Springer-Verlag, 2022.
Vossen, Gerhard; Oberschelp, Werner: Computer Architecture. Oldenbourg-Verlag, 2006.
Slomka, Frank; Glaß, Michael: Fundamentals of Computer Architecture. Springer, 2023.
Ernst, Norbert; Schmidt, Inge; Beneken, Johann: Introductory Course in Computer Science. Springer, 2023.

Module: 5101510
Software Engineering I

Module profile

Exam number
5101510

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr. Isabel John

Lecturer(s)
Prof. Dr. Isabel John,
Prof. Dr.-Ing. Anne Heß

Applicability	BIN
Semester according to SPO	2. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Basic Knowledge of Object-Oriented Programming

Content
The module will be taught in English this semester

The discipline of software engineering forms part of practical computer science and covers all aspects of software development, from the user's initial ideas to the tested, delivered system

Basic concepts
- Objectives and principles of software engineering
- Overview of the types of deliverables in software development phases, with associated methods
- Fundamentals of object-oriented function and data modelling using UML
- Object-oriented analysis based on UML (use case modelling, creation of static models, creation of dynamic models)

In addition to these core activities, the following related topics are covered:

- Modelling
- Costs and benefits
- Software quality, quality assurance and testing (overview)
- Inspections and reviews
- Configuration management (basic)
- Fundamentals of data protection, privacy and ethics

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
None

Learning outcomes
1. Students understand the principles of software engineering and their applications in software development.
2. Students apply structured methods to collect, model and specify requirements during discussions with clients.
3. Students analyse requirements using UML diagrams and use cases to facilitate effective communication and design.
4. Students evaluate the role of testing in software development processes and identify the relevant skills required for quality assurance.
5. Students develop effective testing strategies by running and evaluating tests throughout all phases of the software life cycle.
6. Students conceptualise design solutions using simple UML diagrams to represent software architecture and functionality.
7. Students address ethical dilemmas, sustainability aspects and system security requirements in software projects, integrating these considerations into their practice.

Literature
Sommerville, Ian: Software Engineering. 10th edition, Pearson, 2018.
Oestereich, Bernd: Analysis and Design with UML 2.5 / UML 2.5.1. 7th edition, Oldenbourg, Munich, 2020.
Rupp, Chris; SOPHISTen: UML Made Crystal Clear. 6th edition, Hanser, Munich, 2011.
McLaughlin, Brett D.: Object-Oriented Analysis and Design from Head to Toe. O'Reilly, 2007.

3. semester

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5101110 Algorithms and Data Structures II

Module profile

Exam number
5101110

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr.-Ing. Tobias Fertig

Lecturer(s)
Prof. Dr.-Ing. Tobias Fertig,
Prof. Dr. Isabel John,

Applicability	BIN
Semester according to SPO	3. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Fundamentals of Algorithms and Data Structures, Programming I, Programming II, Algebra, Calculus
Practical programming skills acquired in Programming I

Content
This course covers various more complex algorithms and data structures in computer science, both in theory and in practical application.
Java is used to implement the solutions.

The following key topics are covered, both in theory and in practice, by way of example:

- The concept of algorithms, data structures
- Stacks, queues, lists (with optimisations)
- Graphs and various algorithms on graphs
- Various types of trees, with their respective advantages and disadvantages
- Hash maps and search strategies
- Monte Carlo and Las Vegas algorithms
- Evolutionary algorithms
- Encryption algorithms and data protection
- Decentralised software and blockchain data structures

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
1. Students are familiar with fundamental data structures and their performance characteristics.
2. Students understand the functioning and areas of application of specific graph- and tree-based algorithms.
3. Students apply suitable data structures and algorithms to specified use cases and are able to evaluate their performance and applicability.
4. Students analyse technical problems in order to select suitable data structures and algorithms and to evaluate their performance.
5. Students develop their own algorithms to solve practical problems and implement them using Java.
6. Students devise algorithmic solutions for specific challenges and select the appropriate algorithms for implementation.
7. Students evaluate the application scenarios of various algorithms using practical examples and recognise their relevance in real-world applications.

Literature
Saake, Gunter; Sattler, Kai-Uwe: Algorithms and Data Structures: An Introduction using Java. 5th, revised edition, dpunkt.verlag, Heidelberg, 2013.
Cormen, Thomas H.; Leiserson, Charles E.; Rivest, Ronald L.; Stein, Clifford: Algorithms: An Introduction. 5th edition, Oldenbourg Wissenschaftsverlag, 2022.

Module: 5111160,6810140
Backend Systems

Module profile

Exam number
5111160,6810140

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 30 hrs

Self-study: 120 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Prof. Dr. Peter Braun

Applicability	BIN, BISD
Semester according to SPO	3. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
None

Recommended prerequisites for the participation in the module
Programming 1 and Programming 2

Content

- Introduction to distributed systems, client-server and peer-to-peer systems.
- Software architectures for backend systems (3-tier, hexagonal, monolithic vs. microservices, event-driven)
- Frameworks for implementing backend systems (e.g. Spring)
- Advanced database techniques, scalability, replication, sharding, ORM tools, query caching, the CAP theorem
- Protocols for remote procedure calls, for example, GraphQL and Google RPC.
- Fundamentals of the HTTP protocol and its application in the form of Web APIs.
- Comprehensive introduction to the REST architectural principle: resources, URLs, CRUD, hypermedia, caching, security.
- Configuration of web servers (Apache), load balancers and public caches (nginx)
- Testing of backend systems, performance testing using JMeter, monitoring and logging
- Security aspects of network protocols and backend systems

In the traditional degree programme, the lecturer provides or agrees on the topics for the practical examples to be used in the examination. In the BIN dual study programme, the lecturer consults with the company regarding a task, ensuring practical relevance and feedback from the company.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes

- Students understand the fundamental concepts and differences between distributed systems, including their architecture and communication models.
- Students analyse various software architectures for backend systems and evaluate their suitability for different use cases.
- Students apply advanced database techniques, such as replication and sharding, to improve data availability and performance.
- Students implement a backend system using a framework such as Spring, following best practices for configuration, deployment and security.
- Students compare different protocols for remote procedure calls, such as GraphQL and Google RPC, assessing their strengths and limitations.
- Students design RESTful APIs by applying the principles of the REST architecture, focusing on resources, URLs, CRUD operations and security strategies.
- Students evaluate the security aspects of network protocols and backend systems, proposing improvements based on best practices.

Literature

- Coulouris, J. Dollimore, and T. Kindberg, *Distributed Systems: Concepts and Design* (4th edition) (International Computer Science). Boston, MA, USA: Addison-Wesley Longman Publishing Co., Inc., 2005.
- N. Biswas, Practical GraphQL: Learning Full-Stack GraphQL Development with Projects. Berkeley, CA: Apress, 2023.
- J. Webber, S. Parastatidis, and I. Robinson, REST in practice: hypermedia and systems architecture, 1st ed. in Theory in practice. Beijing, Cologne: O'Reilly, 2010.
- L. Richardson and M. Amundsen, *RESTful Web APIs*, First edition, Second release. Beijing, Cambridge, Farnham, Cologne, Sebastopol, Tokyo: O'Reilly, 2015.
- I. Dominte, *Web API Development for the Absolute Beginner: A Step-by-step Approach to Learning the Fundamentals of Web API Development with .NET 7*. Berkeley, CA: Apress, 2023.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5101730
Data Science

Module profile

Exam number
5101730

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr. Frank-Michael Schleif

Lecturer(s)
Prof. Dr. Frank-Michael Schleif

Applicability	BWI, BIN
Semester according to SPO	3. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
None

Recommended prerequisites for the participation in the module
Database systems, courses on programming and software engineering

Content
Most of the work in data science, and most of the risk, lies before a model is
fitted. This module focuses on that part: how data is generated, what is wrong
with it, what can legitimately be concluded from it, and how to express this in a way
that stands up to scrutiny. No models are trained; the module ends where a
machine learning course begins. The subject matter is explored using a real
production database rather than a prepared teaching example, so the defects
encountered are the defects that actually occur.

Core Topics:

- Data and its origin: data, information, knowledge, decision; levels of scale and
the operations each permits; provenance and what it implies for quality.
- Tabular data: the ‘tidy data’ principle and its violations; reshaping; join
types and cardinality; referential integrity on write and on read.
- From query to pipeline: operative versus dispositive data; database
interfaces; parameterised queries; repeatable extraction with provenance.
- Formats, metadata and protection: CSV, XML, JSON, YAML, Parquet and HDF5;
encoding and quoting defects; schema-on-write versus schema-on-read;
querying hierarchical data; data dictionary, FAIR, personal data and the distance to anonymity.
- Data quality: systematic profiling; missing values such as MCAR, MAR and MNAR; defect
classes based on the effort required for detection and correction; outliers; selection,
survivorship and labelling bias; cleaning decisions recorded along with their associated risk.

- Data beyond the table: time series as a distinct data class (resampling,

aggregation windows, gaps, smoothing); graph models (neighbourhood,

centrality, components, querying a property graph).

- Features, similarity and distance: encoding and scaling; Euclidean, cosine,

Jaccard, dynamic time warping and edit distance; metric axioms; feature

engineering as the choice of an embedding.

- Reduction and structure: PCA, explained variance and loadings; what t-SNE

optimises and what may never be discerned from its output; k-means and spectral

clustering.

- Exploratory analysis and visualisation: location and spread suited to the

distribution; Pearson versus Spearman, correlation versus causation; chart

type selected based on the question; misleading axes and scales; validated colour.

- Communication and readiness: dashboard versus analysis tool; what a model

expects; splits and data leakage; readiness criteria and justifying a decision.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
None

Learning outcomes
Upon successful completion, students will be able to:

Knowledge and Understanding:
- Explain the implications of a scale level for the operations it permits
- Explain the tidy data principle, and how join cardinality affects rows
- Distinguish between MCAR, MAR and MNAR, and identify selection, survivorship and

labelling bias
- Explain what a model observes, and what data leakage is and how it arises

Skills and Competences:
- Convert a query into a repeatable, parameterised extraction with a provenance

record
- Profile a dataset for types, completeness, cardinality, duplicates and

plausibility
- Work with time series and graph data using the operations each requires
- Choose and apply an encoding, a scaling and a distance measure suited to the

features
- Determine which statements a projection, a clustering or a dashboard supports and

which it does not
- Produce a documented analysis dataset with a stated unit of observation and a

cleaning log, and justify a ‘go’ or ‘no go’ verdict on its readiness

Literature
- Skiena (2017), *The Data Science Design Manual*, Springer (available via the

university library)
- VanderPlas (2023), *Python Data Science Handbook*, 2nd edition, O’Reilly
- McKinney (2022), *Python for Data Analysis*, 3rd edition, O’Reilly
- Wickham (2014), ‘Tidy Data’, *Journal of Statistical Software* 59(10)
- Wilkinson et al. (2016), The FAIR Guiding Principles for Scientific Data

Management and Stewardship, Scientific Data 3
- Robinson, Webber and Eifrem (2015), Graph Databases, 2nd edition, O’Reilly
- Munzner (2014), Visualisation Analysis and Design, CRC Press
- Kaufman, Rosset and Perlich (2012), Leakage in Data Mining, ACM Transactions

on Knowledge Discovery from Data 6(4)
- Tukey (1977), Exploratory Data Analysis, Addison-Wesley

Module: 5111180
Professional Skills

Module profile

Exam number
5111180

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Isabel John

Lecturer(s)
Prof. Dr. Peter Braun,
Prof. Dr. Isabel John,
Prof. Dr. Gabriele Saueressig,
Prof. Dr.-Ing. Anne Heß

Applicability	BIN
Semester according to SPO	3. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
In this module, students are taught theoretical and practical knowledge and skills that can be applied in a professional working environment across a wide range of fields.
In doing so, students learn and practise a range of methods, techniques and tools, which are categorised under various key topics. These include

- learning and working techniques
- academic work
- subject-specific communication tailored to specific audiences, and
- working in (international) teams

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes

- Students apply methods for effectively planning and structuring their work processes
- Students identify the fundamental principles of academic work in computer science
- Students carry out a literature review and organise the results
- Students describe in detail the fundamentals of effective academic communication in the form of texts, presentations, posters and videos
- Students produce academically oriented texts, presentations, posters and videos in accordance with academic standards
- Students are able to use AI tools as aids in academic research and academic writing, and to critically evaluate them
- Students learn relevant objectives, skills and best practices for planning, conducting and following up on various survey techniques (such as interviews and questionnaires)
- Students apply methods for effective communication and for facilitating discussions within teams

Literature
To be announced in class

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003031
Software industry, education and economy in India

Module profile

Exam number
5003031

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Frank Deinzer

Lecturer(s)
Prof. Dr. Arndt Balzer,
Prof. Dr. Frank Deinzer

Applicability	BDGD, BEC, BIN, BISD, BWI
Semester according to SPO	3. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
A good command of English

Recommended prerequisites for the participation in the module
none

Content
FWPM is organising a field trip to Bangalore, India, in the second half of February 2027; participants must cover their own flight costs. Further details will be provided in the course.

Introduction to India and our partner university, Christ University in Bangalore
Selection of topics for the intercultural presentations (e.g. politics, religion, the IT industry) in preparation for the excursion.
Presentation of methods for developing presentations with regard to topic selection, structure and slide design.
Introduction to the topic for the joint projects with students from Christ University, which will be carried out in small groups from October onwards.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
none

Learning outcomes
Students recall key facts about India and its significance in the field of information technology.
Students analyse and evaluate differences between Germany and India.
Students use a visually-oriented, free-flowing presentation style.
Students apply basic intercultural communication techniques, using India as an example.
Students demonstrate successful collaboration with students from the partner university as part of a technical project.

Literature
This will be announced during the seminar, depending on the topics covered.

Module: 5111170
Stochastics

Module profile

Exam number
5111170

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Patrik Stilgenbauer

Lecturer(s)
Prof. Dr. Patrik Stilgenbauer

Applicability	BIN
Semester according to SPO	3. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Algebra and Calculus: Basic knowledge of linear algebra (in particular systems of linear equations, matrix algebra, vector spaces, scalar product), propositional and set algebra, combinatorics, differential and integral calculus.
Programming I: Programming logic, design of simple algorithms

Content
- Descriptive statistics: basic concepts, frequency distributions, measures of central tendency, measures of dispersion, linear correlation and regression analysis.
- Probability theory: Sample space, events, Kolmogorov's definition of probability, conditional probability and independence, discrete and continuous random variables, expected value and variance, the law of large numbers, binomial distribution, hypergeometric distribution, Poisson distribution, exponential distribution, normal distribution, sums of random variables, central limit theorem.
- Inferential statistics: point and interval estimates, significance tests.
- Application and visualisation of stochastic methods through programming examples in Python or R.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

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

- apply basic concepts and terminology of probability and statistics with confidence,
- to calculate and interpret statistical measures and probabilities, and to use them to describe data,
- to select typical probability distributions and apply them to suitable, practical problems,
- analyse stochastic and statistical problems using logical, structured thinking and approach them in a solution-oriented manner,
- use these methods as a basis for further applications in computer science, data science and machine learning.

Literature
Bamberg, G., Baur, F. and Krapp, M.: Statistics, De Gruyter Oldenbourg, 2022.
Bourier, G.: Descriptive Statistics, Springer Gabler, 2025.
Bourier, G.: Probability Theory and Inferential Statistics, Springer Gabler, 2018.
Dreiseitl, S.: Mathematics for Software Engineering, Springer Vieweg, 2018.
Henze, N.: Stochastics for Beginners, Vieweg + Teubner, 2011.
Kurt, N.: Stochastics for Computer Scientists, Springer Vieweg, 2020.
Teschl, G. and Teschl, S.: Mathematics for Computer Scientists – Volume 2 (Analysis and Probability), Springer Vieweg, 2014.

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5111140 System-oriented Programming

Module profile

Exam number
5111140

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 30 hrs

Self-study: 120 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Prof. Dr. Peter Braun

Applicability	BIN, BISD
Semester according to SPO	3. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
None

Recommended prerequisites for the participation in the module
Programming I and Programming II

Content
- Definition and meaning of system-oriented programming
- Using the command line of an operating system
- Shell programming using Bash as an example
- Data processing on the command line using sed, awk, sort and jq
- Using AI assistance systems (e.g. GitHub Copilot, ChatGPT)
- Editing text documents with vim
- The Git version control system
- Introduction to the C programming language (syntax, data types, pointers, memory management)
- System programming on Linux (system calls, handling files and processes)
- Security aspects of system-related programming and protection mechanisms
- Structure of the Linux operating system
- Processes, process management, scheduling
- Inter-process communication, race conditions, deadlocks, semaphores, Petri nets and deadlock detection, the philosopher's problem, the producer-consumer problem
- Memory management, memory abstraction, partitioning, fragmentation, free memory management, virtual memory, page replacement algorithms
- Input and output, direct memory access, interrupts, hard disks, file systems for hard disks
- Network communication and implementation of network protocols
- Hypervisor technologies, Docker containers, resource management

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes

- The students understand the definition and principles of system-oriented programming, including its role in software development.
- The students demonstrate proficiency in using the command line of an operating system, applying advanced tools such as sed, awk, sort and jq for data processing tasks.
- The students develop shell scripts in Bash to automate system tasks and streamline operations effectively.
- Students utilise AI assistance systems, such as GitHub Copilot and ChatGPT, to improve coding efficiency and solve programming challenges.
- Students manage text documents using the vim text editor, employing advanced editing and configuration techniques.
- Students implement version control practices with Git to support collaborative software development workflows.
- Students programme in C, focusing on syntax, data types, pointers and memory management, and use debugging and profiling tools such as gdb, strace, ltrace and gprof to analyse code performance.
- Students evaluate the security aspects of system-related programming and apply protection mechanisms to ensure code security.

Literature

- D. J. Barrett, *Efficient Linux at the Command Line: Boost Your Command-Line Skills*, 1st ed. Sebastopol, CA: O'Reilly, 2022.
- A. S. Tanenbaum and H. Bos, *Modern Operating Systems*, 4th ed. Boston: Prentice Hall, 2015.
- K. Hitchcock, *Linux System Administration for the 2020s: The Modern Sysadmin Leaving Behind the Culture of Build and Maintain*. Berkeley, CA: Apress, 2022. doi: 10.1007/978-1-4842-7984-7.
- M. Kalin, *Modern C Up and Running: A Programmer's Guide to Finding Fluency and Bypassing the Quirks*. Berkeley, CA: Apress, 2022. doi: 10.1007/978-1-4842-8676-0.
- K. Hitchcock, *The Enterprise Linux Administrator: Journey to a New Linux Career*. Berkeley, CA: Apress, 2023. doi: 10.1007/978-1-4842-8801-6.
- J. Varma, Pro Bash: Learn to Script and Program the GNU/Linux Shell. Berkeley, CA: Apress, 2023. doi: 10.1007/978-1-4842-9588-5.
- S. M. Palakollu, Practical System Programming with C: Pragmatic Example Applications in Linux and Unix-Based Operating Systems. Berkeley, CA: Apress, 2021. doi: 10.1007/978-1-4842-6321-1.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5111279,6812790
Transfer colloquium

Module profile

Exam number
5111279,6812790

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Erik Schaffernicht

Lecturer(s)
Prof. Dr.-Ing. Erik Schaffernicht

Applicability	BIN, BISD
Semester according to SPO	3. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
For dual-study students on the BWI degree programme only

Recommended prerequisites for the participation in the module
none

Content
The Transfer Colloquium is designed to facilitate discussion amongst students on the dual study programme and replaces one of the FWPM sessions. Students on the standard version of the degree programme do not take part in this event. The event takes place across the third to seventh semesters, with the exception of the work placement semester. Under the guidance of a lecturer, dual-study students discuss the following topics:

- Introduction and overview: Presentation of the Transfer Colloquium and its objectives; explanation of the importance of exchanging experiences between the university and the company for dual-study students.
- Reflection on practical experience: In-depth reflection on the knowledge and skills acquired during the degree programme and in practical work, as well as their application in day-to-day business operations.
- Exchange of experiences: Moderated discussions on challenges and solutions relating to balancing university studies with practical work within the company.
- Best-practice examples: Presentation and discussion of successful projects and practices from the company that have been implemented by students during their studies and in practical work.
- Problem-solving strategies: Development and presentation of solutions for typical problems that may arise in dual study programmes, including time management and prioritisation.
- Application of theoretical knowledge: Deepening students' understanding of how theoretical knowledge from university modules can be applied in practice within the company.
- IT security in the company: An introduction to the importance and practical implementation of IT security measures, based on theoretical principles and practical applications.
- Project documentation and presentation: Training in the preparation and presentation of project documentation to present the work carried out within the company in a structured manner.
- Feedback and continuous improvement: Systematic collection and analysis of feedback from companies and the university to ensure the continuous improvement of the dual study programme.

- Professional development and career planning: Discussion of career paths and development opportunities for dual-study students, based on the skills acquired during their studies and in practical work.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
none

Learning outcomes

- Students systematically reflect on their practical experiences in order to draw conclusions for their professional development.
- Students develop strategies for resolving problems that arise when balancing their studies with professional practice.
- Students apply the theoretical knowledge they have acquired in a practical context within a company in order to optimise the transfer of knowledge between higher education and professional practice.
- Students communicate their practical experiences clearly and in a structured manner and present their findings effectively.
- Students assess the importance of IT security in a business context and implement appropriate measures in their day-to-day work.
- Students produce professional project documentation to ensure their work is transparent and traceable.
- Students use feedback constructively to continuously improve their working methods and the collaboration between the university and the company.

Literature
To be announced during the seminar.

4. semester

Module: 5100430
Applied Numerics

Module profile

Exam number
5100430

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Patrik Stilgenbauer

Lecturer(s)
Prof. Dr. Patrik Stilgenbauer

Applicability	BIN
Semester according to SPO	4. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
Practical mathematical knowledge acquired in previous semesters

Recommended prerequisites for the participation in the module
Algorithms, Programming I and II (imperative or object-oriented), Mathematics (Algebra, Calculus and Probability)

Content
This course covers various mathematical and numerical problem-solving methods, both in theory and in practice. Either Python or MATLAB is used to implement the solutions.

The following key mathematical topics are covered, both in theory and in practice, by way of example:

- Numerical fundamentals (floating-point arithmetic, algorithmic complexity)
- Numerical solution of systems of linear equations (in particular, matrix decomposition methods)
- Eigenvalue problems and their applications
- Interpolation algorithms
- Numerical differentiation and integration
- Optimisation problems and algorithms (e.g. Newton's method, gradient descent)
- Stochastic simulation and Monte Carlo methods

This is accompanied by an introduction to numerical Python libraries (NumPy, SciPy, Matplotlib, and, where appropriate, SymPy) or, alternatively, an introduction to the MATLAB tool environment (MATLAB as a programming language and development environment, vectors, matrices, data types, operators, mathematical functions, plots, etc.).

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
1. Students are familiar with fundamental mathematical concepts and their implementation in Python or MATLAB.
2. Students understand various mathematical methods relevant to solving practical problems that can be modelled mathematically.
3. Students apply specific mathematical methods to solve computer science problems effectively.
4. Students analyse mathematical problems and develop logical solution strategies for these problems.
5. Students evaluate the suitability of various mathematical methods and their implementation in software development.
6. Students create mathematical and algorithmic models to translate development problems into consistent mathematical questions.
7. Students are able to use appropriate mathematical software tools to support their problem-solving skills.
8. Students develop their ability to work independently with specialist academic literature in order to broaden their methodological competence.

Literature
Bayen, A., Kong, Q. and Siauw, T.: Python Programming and Numerical Methods. Academic Press, 2020.
Huckle, T. and Schneider, S.: Numerical Methods, Springer, 2006.
Johansson, R.: Numerical Python, Apress, 2024.
Knorrenschild, M.: Numerical Mathematics, Carl Hanser Verlag, 2024.
Moler, C. B.: Numerical Computing with MATLAB, SIAM, 2008.
Plato, R.: Fundamentals of Numerical Methods, Springer-Spektrum, 2023.
Strang, G.: Linear Algebra and Learning from Data. Cambridge Press, 2020.

Further reading will be announced during the course.

Module: 5111230,6810200
Frontend Systems

Module profile

Exam number
5111230,6810200

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Prof. Dr. Peter Braun

Applicability	BIN, BISD
Semester according to SPO	4. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Back-end Systems

Content

- Introduction to Web Technologies: The basic building blocks of web development, including HTML for structuring web content, CSS for styling and layout, and JavaScript for adding interactivity and dynamic behaviour to web pages.
- Advanced JavaScript and Modern ES6+ Features: A more in-depth look at JavaScript, exploring modern ES6+ features such as `let`, `const`, arrow functions, template literals, modules, promises and `async/await`, and learning how to apply these in real-world scenarios.
- Fundamentals of React: Core concepts of React, including its component-based architecture, JSX syntax, and the use of state and props to manage data within components, enabling the creation of dynamic and interactive user interfaces.
- Advanced React Techniques: Advanced topics in React, such as the Context API for managing state across the application, React hooks for managing state and side effects in functional components, and performance optimisation strategies.
- IT Security in Frontend Development: Principles of IT security as they relate to frontend development, including securing user input, preventing cross-site scripting (XSS) and cross-site request forgery (CSRF), and ensuring secure communication between frontend and backend systems. Introduction to the Open Web Application Security Project’s Top Ten list.
- Project Development and Deployment: Setting up development environments, following best practices in code organisation and documentation, and deploying and maintaining front-end applications in a production environment.

In the traditional degree programme, the lecturer provides or agrees on the topics for the practical examples to be used in the examination. In the BIN dual study programme, the lecturer consults with the company regarding a task, ensuring practical relevance and feedback from the company.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes

- The students understand the fundamental principles of HTML, CSS and JavaScript to build and style basic web pages effectively.
- Students apply modern web frameworks such as React and Svelte to develop dynamic and responsive user interfaces.
- Students analyse different state management techniques, such as React hooks and the Context API, to manage complexity in web applications.
- Students design cross-platform mobile user interfaces using Flutter, focusing on user experience and performance.
- Students implement best practices in front-end development, including version control, testing and secure deployment processes.
- Students create a comprehensive front-end project from scratch, integrating all the concepts they have learnt into a fully functional application.
- Students evaluate different frameworks and tools for front-end development to make informed decisions based on specific project requirements.

Literature

Marijn Haverbeke: Eloquent JavaScript: A Modern Introduction to Programming. 4th edition, 2024.
Alex Banks, Eve Porcello: Learning React: Modern Patterns for Developing React Apps. O'Reilly, 2020.
Thomas Bailey, Alessandro Biessek: Flutter for Beginners: Cross-platform mobile development from 'Hello, World!' to app release with Flutter 3.10+ and Dart 3.x. Packt, 2023.
Andrew Hoffman: Web Application Security: Exploitation and Countermeasures for Modern Web Applications. O'Reilly, 2024.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5100620
Basics of Business Administration

Module profile

Exam number
5100620

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Eva Wedlich

Lecturer(s)
Prof. Dr. Eva Wedlich

Applicability	BIN
Semester according to SPO	4. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
Basic concepts of business administration:
- The business
- The factors of production in business
- Business objectives
- Key business indicators

Fundamental decisions for a business:
Choice of location:
- The location problem
- Location factors
- Germany as a business location

Legal forms:
- Partnerships
- Companies
- Hybrid forms

Business functions:
Procurement/purchasing
Warehousing
Production
Sales and marketing
Cost accounting
Financial accounting

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
Students become familiar with the basic concepts of business administration and are able to recall them.
In the field of business administration, students are particularly able to understand the fundamental decisions of a company and analyse its business functions.
Students are able to understand and construct economic relationships.
Students are able to understand and correctly interpret economic texts (including those from business newspapers).

Literature
Balderjahn, I.; Specht, G.: Introduction to Business Administration, 8th edition, Schäffer-Poeschel, Stuttgart, 2020
Vahs, D.; Schäfer-Kunz, J.: Introduction to Business Administration; 16th edition; Schäffer-Poeschel, Stuttgart, 2021
Wöhe, G.: Introduction to General Business Administration; 28th edition; Vahlen; Munich, 2024

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5101010
Basics of Theoretical Computer Science

Module profile

Exam number
5101010

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Frank Deinzer

Lecturer(s)
Prof. Dr. Frank Deinzer,
Prof. Dr.-Ing. Pascal Meißner

Applicability	BIN
Semester according to SPO	4. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Algebra, Calculus, Algorithms

Content
Automata Theory and Formal Languages
- Automata
- Regular languages
- Context-free languages
- Context-sensitive languages
- General Chomsky grammar

Computability
- Turing machines, non-deterministic Turing machines
- Programming-language computation models: GOTO programmes, WHILE programmes, LOOP programmes
- Mathematical computational models: primitive recursion, -recursion
- Halting problem, undecidability, reducibility

Complexity theory
- Complexity classes: P and NP
- NP-completeness

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
Students understand the fundamental concepts in the field of theoretical computer science.
Students understand the concepts of formal languages, automata theory, computability and complexity theory.
Students apply the skills they have acquired in abstract and theoretical thinking. The topics covered are highly abstract and thus promote the ability to think abstractly and theoretically.
Students apply theoretical concepts to practical solutions.

Literature
Uwe Schöning: Theoretical Computer Science – A Concise Introduction. 5th edition, Spektrum Akademischer Verlag, 2008.
John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman: An Introduction to Automata Theory, Formal Languages and Complexity. 2nd edition, Addison-Wesley Longman, 2011.
Ingo Wegener: Theoretical Computer Science – An Algorithm-Oriented Introduction. 3rd edition, Teubner, 2005.

Module: 5100240,6810210
Programming Project

Module profile

Exam number
5100240,6810210

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 12 hrs

Self-study: 138 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Prof. Dr. Peter Braun

Applicability	BISD, BIN
Semester according to SPO	4. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
BIN: Programming I and Programming II
BISD: Programming I

Recommended prerequisites for the participation in the module
Programming I + II
Databases I
Software Engineering I

Content
Students are to work in groups to develop their own application.
An application could, for example, be a game, a three-tier web application or a similar application. Possible components of the application could include a graphical user interface (including a web interface), a database connection including schema design, network communication, AI, etc.
Furthermore, the students will produce documentation (an overview, various use cases, the most important activity and sequence diagrams, etc.).

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Practical study achievement

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

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

- develop their first major application as part of a team of 4–6 people
- plan and implement a project
- allocate and implement tasks
- apply their knowledge of software design
- apply the programming concepts they have learnt
- look up the necessary information themselves using relevant literature
- break down a task into sub-problems.

Literature
None

Module: 5102810
Software Engineering II

Module profile

Exam number
5102810

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Anne Heß

Lecturer(s)
Prof. Dr.-Ing. Tobias Fertig,
Prof. Dr.-Ing. Anne Heß

Applicability	BIN
Semester according to SPO	4. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Software Engineering I
Programming 1 to 3

Content
This module builds on the Software Engineering I module and explores many of the topics covered there in greater depth. This includes advanced and quality-focused activities in software development, together with the associated specific techniques and tools:

- Principles and activities of the Human-Centred Design (HCD) process
- User experience and emotions
- Creativity processes and techniques
- Context-of-use analysis, requirements specification, interaction design, evaluation
- In-depth study and application of quality assurance principles and measures using HCD as an example
- Architecture: architectural principles, design patterns, architecture using UML
- Build systems, continuous integration, continuous deployment
- Design documentation and reviews

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
None

Learning outcomes

- Students will learn about the relevant basic concepts and terminology of HCI (usability, user experience)
- Students will gain an overview of various lifecycle models of the human-centred design process
- Students will learn why ensuring a positive user experience is important for product success and how this can be effectively achieved within a software development project
- Students will learn about the principles, methods and techniques of the early phases of the user-centred design process and will be able to apply individual methods and techniques in practice (in particular, context of use analysis and user research, as well as requirements gathering and documentation)
- Students will become familiar with the principles, methods and techniques for creative ideation and the design of interactive products
- Students will become familiar with the principles, heuristics, methods and techniques for evaluating interactive products in terms of usability and user experience
- Students will be able to conduct tests on user interfaces
- Students understand the principle of continuous integration
- Students are familiar with the concept of design patterns and can select suitable design patterns for a given problem and implement them where appropriate
- Students are familiar with common architectural principles and can apply design rules at a basic level

Literature

- Balzert, H.: Textbook of Software Engineering: Design, Implementation, Installation and Operation. 3rd edition, Spektrum, 2011.
- Gamma, Erich; Helm, Richard; Johnson, Ralph; Vlissides, John: Design Patterns: Elements of Reusable Object-Oriented Software. mitp, 2014.
- Oestereich, Bernd: Analysis and Design with UML 2.5: Object-Oriented Software Development. Oldenbourg, 2012.
- Sommerville, Ian: Software Engineering. Pearson Studium, 2018.

5. semester

Module: 5111250
Supervised Internship

Module profile

Exam number
5111250

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
1

ECTS-Credits (CP)
30.0

Workload
Guided study time:
Presence time: 15 hrs

Self-study: 885 hrs

Total: 900 hrs

Teaching format
Practice

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Erik Schaffernicht

Lecturer(s)
Prof. Dr.-Ing. Erik Schaffernicht

Applicability	BIN
Semester according to SPO	5. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
SPO 2019: >90 ECTS credits, course 510002X
SPO 2023: >90 ECTS credits, of which 55 ECTS credits must be from the first year of study, as well as the Professional Skills module

Recommended prerequisites for the participation in the module
Databases
Programming I
Programming II
Data Management and Data Science
Fundamentals of Business Administration
Programming Project
Back-end Systems
Front-end Systems
Low-level Programming
Software Engineering II
Project Management
Internet Communication

Content
- As part of a larger IT project, the intern must work independently in as many project phases as possible (system analysis, system planning, implementation, system roll-out and testing). This project should last for at least 12 weeks.
- Ideally, the intern should familiarise themselves with various departments and areas of the company prior to the project in order to gain a general understanding of other departments and the company as a whole.

The contact person/supervisor at THWS is the representative responsible for the supervised practical phase, Prof. Dr.-Ing. Erik Schaffernicht

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Documentation, Presentation

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
none

Learning outcomes
The intern should

- acquire relevant, practical knowledge of business processes
- learn (through guidance) to work independently and on their own initiative on IT projects.
- link the skills acquired during their degree with practical experience
- learn to understand problems and requirements (e.g. customer requirements)
- learn to design and implement solutions (e.g. for business processes and/or IT projects)
- Gain first-hand experience of working in a team.
- Learn about and experience how the company's processes and organisational workflows are integrated into the business.
- Learn about and experience the professional field of computer science.
- Learn to approach the right contact persons when problems arise.
- See the unwavering commitment to the successful and professional implementation of projects demonstrated in practice.
- Experience excellence and professionalism.
- See how staff are inspired and engaged.
- Recognise and feel the purpose of their work.

Literature
It is not possible to provide a general recommendation for reading material

6. semester

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003859
Agentic AI: Enabling Autonomous and Goal-Driven Intelligence

Module profile

Exam number
5003859

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Frank-Michael Schleif

Lecturer(s)
Dr. Manikandakumar Muthusamy

Applicability	BIN, BWI, BEC, BISD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Python programming, Fundamentals of AI/ML.

Content
This course is designed to introduce students to next-generation AI systems capable of autonomous decision-making, planning, reasoning and self-improvement. Unlike traditional reactive AI models, agentic AI systems can initiate actions, perform multi-step tasks, collaborate with other agents and adapt to dynamic environments. This course equips learners with both theoretical foundations and hands-on experience in building autonomous AI agents.
Learners will explore agent architectures, cognitive models, memory systems, tool-use capabilities, multi-agent collaboration frameworks, and practical agent deployment workflows. Through laboratory exercises using modern frameworks such as Flowise, LangChain, AutoGen Studio, CrewAI and AgentOps, students will build goal-driven agents, evaluators, planners and multi-agent systems. Real-world applications from business automation, sustainability, smart systems and software engineering will be emphasised throughout.
The course concludes with a practical assessment in which participants design, implement and demonstrate a functional autonomous agent. By integrating theory, hands-on experimentation and evaluation, this course provides a strong foundation for applying Agentic AI in academic, industrial and research environments aligned with the green digital transformation.

1. Foundations of Agentic AI
Agentic AI – Autonomous AI vs Traditional AI – Agent lifecycle and capabilities – Types of autonomy in AI systems – Rule-based agents vs LLM-driven agents – Real-world examples of agents – Maturity levels of autonomous systems – Application domains aligned with sustainability and the green digital transition.
Interactive brainstorming: Where can agents be used in business?
2. Agent Architectures, Memory, and Planning
Cognitive architecture: perception, reasoning, memory, action – Memory systems in agents: short-term memory, episodic memory, vector-store memory, long-term memory - Planning systems: task decomposition, tree of thought, planner-executor architecture – Tool invocation & API integration – Evaluator-planner loops – Safety layers & guardrails.
3. Building Autonomous Agents and Tool-using Systems

Agent capabilities: tool use, retrieval augmentation, action loops – Safety, guardrails and constraints; Using frameworks: LangChain Agents, AutoGen Studio, CrewAI worker-manager roles – Hands-on use cases: research automation agents – business workflow agents.

4. Multi-agent Systems, Collaborations, and Workflows

Multi-agent systems: roles & communication, manager-worker architecture, planner-agent-reviewer loops, collaboration strategies: parallel, sequential, cooperative, real-world MAS applications (smart grids, supply chain, robotics)

5. Deployment, Monitoring, Ethics

Deployment workflows (local, cloud) – Logging, monitoring, and evaluation of agents – Safety, ethical issues & governance of autonomous systems – Responsible AI principles for autonomous systems – Real-world challenges: hallucination, error handling, misuse.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Practical study achievement

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
1. Understand and explain the principles, architecture and lifecycle of agentic AI systems, and compare them with traditional AI models.
2. Design and implement autonomous agents using modern frameworks with capabilities such as planning, memory, tool use and reasoning.
3. Evaluate and deploy single-agent and multi-agent systems for real-world applications related to sustainability, automation and intelligent digital ecosystems.

Literature
Textbooks:
Martin Ford, *Architects of Intelligence: The Truth About AI from the People Building It*, 2018.
Stuart J. Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Prentice Hall Series in Artificial Intelligence, 2009
Reference Books:
Kence Anderson, “Designing Autonomous AI: A Guide for Machine Teaching”, O’Reilly Media, Inc., 2022

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 6322190
Augmented Reality

Module profile

Exam number
6322190

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Stefan Sauer

Lecturer(s)
Stefan Sauer

Applicability	BEC, BIN, BWI, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
This event is organised by the Faculty of Plastics Technology and Surveying (FKV):
(https://geo.thws.de/studium/bachelor-geovisualisierung/studienablauf/modulhandbuch-bgv-ab-ws-202223/)

For the schedule, see: https://geo.thws.de/studium/aktuelle-lehrveranstaltungsplaene/

Augmented and Mixed Reality and their applications
- Implementation of marker-based applications
- Implementation of image-based applications
- Implementation of LBS applications

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
1. Students are familiar with the fundamental concepts of augmented reality (AR) and mixed reality (MR), as well as their areas of application.
2. Students understand the differences between marker-based, image-based and location-based (LBS) applications in AR technology.
3. Students apply relevant services to plan and implement AR applications.
4. Students analyse requirements and potential uses for AR applications in relation to various content-based approaches.
5. Students evaluate the effectiveness of various techniques for visualising content in relation to spatial objects and markers.
6. Students independently create AR applications that are both marker-based and image-based, and are able to publish them successfully.
7. Students understand concepts for integrating AR applications into existing systems and services.

Literature
Dörner, R.; Broll, W.; Grimm, P.; Jung, B.: Virtual and Augmented Reality (VR/AR): Fundamentals and Methods of Virtual and Augmented Reality. 2nd edition, Springer-Verlag Berlin, Heidelberg, 2019. ISBN 978-3-662-58860-4.
Vetter, M. & Olberding, H.: E-learning material on geovisualisation, [online] smart.vhb.org, 2019/2020.

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003836
BSI BCM Practitioner and BSI Incident Practitioner

Module profile

Exam number
5003836

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Alexander Schinner

Lecturer(s)
Liane Kiesewalter,
Tobias Kasch

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
BCM Practitioners
- Introduction to BCM
- BCM process and phased model
- Standards and regulatory framework
- Initiation, planning and implementation
- Establishing and empowering the BAO
- BIA pre-screening and BIA
- Risk analysis
- Contingency planning (BC strategies, GFPs and WAPs)
- Exercises and testing
- Performance review and key performance indicators

Incident Responders
- Introduction to the cyber security network, including the framework for digital first responders, incident responders and incident experts
- Summary of the content of the basic course
- Conduct on the telephone, including non-technical measures
- Threats and types of attack, and an overview of the current threat landscape
- Standard operating procedures
- Handling IT security incidents
- Remote support
- Incident handling for IT systems ‘outside the usual office environment’
- ‘After the incident is before the incident’ – preventive measures

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes

- Teaching the BCMS process in accordance with BSI Standard 200-4, with a practical focus
- Effective detection, analysis and management of security incidents in accordance with BSI standards
- Preparation for the relevant BSI audits within the framework of the Cybersecurity Network (CSN)

Literature
https://www.bsi.bund.de/DE/Topics/Companies-and-Organisations/Standards-and-Certification/IT-Basic-Security/Certified-Information-Security/BCM-Practitioner-Training-Courses/BCM-Practitioner-Training-Courses_node.html
https://www.bsi.bund.de/DE/Themen/Unternehmen-und-Organisationen/Informationen-und-Empfehlungen/Cyber-Sicherheitsnetzwerk/Qualifizierung/Vorfall_Praktiker/Vorfall_Praktiker.html

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003843
Business Data Visualization with Power BI and AI

Module profile

Exam number
5003843

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Isabel John

Lecturer(s)
Dr. Soundarabai Beaulah Paulsingh

Applicability	BIN, BWI
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
A basic understanding of problem-solving skills, including simple Excel calculations, creating graphs and charts, and a basic understanding of database concepts.

Content
This course teaches students how to transform raw business data into actionable insights using Microsoft Power BI through interactive dashboards and AI-driven analytics. Participants gain hands-on experience in data cleaning, transformation, modelling and visualisation, whilst applying AI features – including anomaly detection – to uncover trends and patterns. Students will develop practical expertise in the following areas:

- Foundations of Business Visualisation: Understanding the role of data visualisation in business, an overview of the Power BI environment, data connectivity, and navigating the Power Query Editor.
- Data Preparation and Modelling: Transforming, cleaning and structuring data using Power Query, and building analytical data models with effective relationship management.
- Interactive Dashboard Development: Creating business-focused visuals, applying filters, slicers and drill-throughs, and designing interactive dashboards for exploring insights.
- AI-Enabled Business Insights: Applying Power BI's built-in AI capabilities – such as Key Influencers, Decomposition Tree, Q&A, Smart Narratives and anomaly detection – to explain trends and identify key drivers.
- Case Study: Conducting an end-to-end analysis and developing an interactive Power BI dashboard using a real-world business dataset to generate actionable insights.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix

None

Examination - type

Other exam (soP) according to §§ 26, 27 APO

Examination - length/format

Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination

English

Condition for the award of credit points

None

Learning outcomes

By the end of this course, students will be able to

- Demonstrate an understanding of the principles of business data visualisation and the importance of analytics in decision-making.
- Clean, transform and structure business data using Power Query to ensure reliable and analysis-ready datasets.
- Use Power BI's built-in AI features, including anomaly detection, to explain trends, patterns and key drivers in business data.
- Design and build interactive Power BI dashboards that effectively communicate insights to business stakeholders.

Literature

A reading list will be provided during the course

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003823
Computer Networks and Cyber Security

Module profile

Exam number
5003823

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Sebastian Biedermann

Lecturer(s)
Siavosh Haghighi Movahed

Applicability	BIN, BWI, BISD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
This module is designed to provide students with the knowledge and skills required to design, implement and manage secure computer networks.
In this module, students will gain a solid foundation in establishing and maintaining robust network infrastructures. At the same time, the module addresses the critical aspect of securing these networks against potential threats, ranging from cyberattacks to data breaches. Through a combination of theoretical concepts and practical exercises, students will develop the expertise needed to identify vulnerabilities, implement security measures and formulate strategies to safeguard information assets in the interconnected world of computer networks. In addition to providing a broad range of fundamental computer networking and security knowledge relevant to all IT careers, this module will also offer students the opportunity to pursue further self-study and acquire the conceptual knowledge and practical skills required for the Cisco® Certified Network Associate (CCNA®) 200-301 exam.

Indicative content:
- Fundamentals of enterprise campus network design
- Network protocols and models
- Fundamentals of IP routing and switching
- IP addressing (IPv4/IPv6)
- Network security concepts and principles
- Configuring and verifying secure inter-switch connectivity
- Implementing, optimising and securing switched networks
- Implementing secure device access and access control systems
- Defining key security concepts (threats, vulnerabilities, exploits and mitigation techniques)
- Firewall technologies

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
Upon successful completion of this module, students will be able to:
1. Explain the fundamentals of computer networks and cyber security.
2. Design, implement, configure and troubleshoot highly available, secure and scalable network infrastructures.
3. Implement network security and access control solutions using routers, switches and firewalls.
4. Explain how vulnerabilities, threats and exploits can be mitigated to enhance network security.

Literature
1. Students are familiar with the fundamentals of computer networks and the principles of cyber security.
2. Students understand the importance of securing network infrastructures against potential threats and vulnerabilities.
3. Students apply best practices in designing, implementing, configuring and troubleshooting high-availability, secure and scalable network infrastructures.
4. Students understand how threats and exploits can undermine network security and identify measures to mitigate these risks.
5. Students evaluate network security solutions, including access control measures implemented via routers, switches and firewalls.
6. Students develop comprehensive strategies to secure information assets and maintain robust network infrastructures, drawing on theoretical knowledge and practical exercises.
7. Students develop the practical skills required to prepare for the 200-301 Cisco® Certified Network Associate (CCNA®) exam, applying what they have learnt to real-world scenarios.

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003861
Computer Networks for Practical Engineers

Module profile

Exam number
5003861

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Rolf Schillinger

Lecturer(s)
Prof. Bishnu Prasad Gautam

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
This course provides students with practical knowledge and skills in computer networks, focusing on how networks are built, configured and operated by computer network engineers. The course begins at the physical layer with hands-on construction of LAN (Ethernet) cables, and then introduces fundamental concepts such as classful and classless IP addressing, switching and routing.
Students will learn static routing as a foundation, followed by dynamic routing protocols including RIP, OSPF and BGP through practical laboratory exercises. The course also introduces essential network security concepts, with particular attention to firewalls and basic network protection mechanisms required in real-world network environments.
In the final part of the course, students are introduced to next-generation networking paradigms, such as the Internet of Things (IoT), Software-Defined Networking (SDN) and quantum networks, providing insight into the future evolution of networks. As well as providing a broad foundation in computer networking for careers in IT and engineering, this course also supports self-study for the 200-301 Cisco Certified Network Associate (CCNA) exam by developing the relevant conceptual understanding and practical skills.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes

- Students understand the fundamentals of computer networking, including LAN construction, network components, and basic communication principles used in modern information systems.
- Students apply IP addressing, VLAN configuration and routing concepts to design and configure small- to medium-scale networks using both static and dynamic routing methods.
- Students analyse and compare dynamic routing protocols such as RIP, OSPF and BGP, and explain their operational principles, use cases and performance characteristics.
- Students design and implement practical network topologies by integrating routers, switches and end devices, and verify connectivity through hands-on configuration and testing.
- Students gain an understanding of emerging and future network systems, including the Internet of Things (IoT), Software-Defined Networking (SDN) and quantum networks, and evaluate their potential impact on security, scalability and next-generation communication infrastructures.

Literature
Will be provided at the start of the module.

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003817
Computer Vision: Artificial Intelligence Applied

Module profile

Exam number
5003817

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Pascal Meißner

Lecturer(s)
Prof. Dr.-Ing. Pascal Meißner

Applicability	BIN, BWI, BISD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
None

Recommended prerequisites for the participation in the module
None

Content
Have you ever wondered how self-service checkouts scan items, how self-driving cars recognise pedestrians, how computers detect skin cancer, and how 3D models of iconic places such as the Colosseum are scanned?

This module aims to answer these questions and many more by

- Providing an overview of the problems and approaches in computer vision, for applications as diverse as automation, robotics, medical imaging and photogrammetry.
- Introducing the fundamentals of neural networks, which are required for building artificial systems with human-level perception capabilities.

The module covers everything from selecting the appropriate equipment for visual inspection tasks to image classification using convolutional neural networks and image retrieval using bag-of-visual-words models. The topics covered are:

01. Introduction – Terminology, history, state of the art, module logistics
02. Image Acquisition & Digitisation – Image sensors & representations, A/D conversion, Fourier transform
03. Image Enhancement – Point operations, contrast adjustment, smoothing filters
04. Feature Extraction – Edge detection, detection and description of local features
05. Segmentation and Morphology – Region growing, Hough transform, morphological operators
06. Camera Modelling – 3-D transformations, pinhole camera model, camera calibration
07. Stereo Vision – Epipolar geometry, correlation methods, triangulation
08. Classification – Classifier evaluation, generalisation, nearest-neighbour, decision trees
09. Ensemble Methods – Boosting and bagging, random forests, AdaBoost
10. Neural Networks – Multi-layer perceptron, gradient descent, backpropagation

11. Convolutional Neural Networks – Convolution and pooling layers, example architectures
12. Bag-of-Visual Words – K-means clustering, TF-IDF, histogram comparison

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Colloquium

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
By the end of the module, students should be able to:

- Select appropriate camera systems and convert image representations, as well as discuss the causes of aliasing and how to avoid it
- Implement and apply smoothing and morphological operators, edge detectors and segmentation techniques
- Distinguish between contrast adjustment methods and compare the various approaches to detecting and describing local features
- Determine and compute rigid-body transformations. Specify camera models and project image and scene points.
- Determine epipolar geometries and lines. Calculate and discuss different correlation methods
- Assess and implement the various techniques for visualising and cleaning data for training classifiers
- Apply feature engineering and selection to classification tasks
- Distinguish between the quantities in the bias-variance problem and apply this to classifiers
- Assess, implement and train neural networks, and discuss their application to vision tasks

This module will be taught in English and delivered online and on campus. All sessions will be recorded. Colloquia may be conducted in English or German.

Literature

- Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, 4th ed. Pearson, 978-0133356724, 2017
- Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library, Adrian Kaehler and Gary Bradski, O'Reilly Media, 978-1491937990, 2017
- Introduction to Machine Learning, Ethem Alpaydin, 4th ed. MIT Press, 978-0262043793, 2020

Module: 5003862
Data Analytics

Module profile

Exam number
5003862

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Tobias Aubele

Lecturer(s)
Dr. Jaani Väisänen

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
No coding is required. Please install Altair AI Studio before the course; a student licence is available via https://web.altair.com/altair-student-edition.

Content
This course provides business students with a practical, no-coding introduction to data analytics using Altair AI Studio. You'll learn to build an end-to-end analytics workflow—from importing and preparing data to selecting variables, building models, evaluating performance, and interpreting results to inform business decisions.

- Course introduction, AI Studio workflow basics, and practical data preparation for modelling
- Regression

o Concept: what regression explains
o Hands-on workflow: build a regression model in AI Studio
o Validation and model quality: simple train/validation/test set incorporating key fit metrics

- Clustering

o Concept: grouping similar cases
o Hands-on workflow: preparing data and creating clusters in AI Studio
o Validation and model quality: choosing a useful number of clusters for the business question

- Tree models

o Concept: classification and interpretable drivers
o Hands-on workflow: building and interpreting a decision tree in AI Studio
o Validation and model performance: cross-validation and practical classification metrics

- Association analysis:

o Concept: co-occurrence and recommendations
o Hands-on workflow: create association rulesets in AI Studio
o Validation and model performance: support, confidence and lift

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
Upon successful completion of this course, students will be able to:
1. Construct end-to-end analytics workflows (Apply/Create): Independently design and execute complete data mining processes within Altair AI Studio—from data import and cleansing to model generation—without relying on programming code.
2. Analyse and select appropriate methodologies (Analyse): Diagnose specific business problems to determine the most suitable analytical technique (regression, clustering, decision trees or association analysis) based on the structure of the data and the desired business outcome.
3. Evaluate model performance and robustness (Evaluate): Critically assess the quality of analytical models by interpreting quantitative validation metrics (such as R^2, lift, confidence and cross-validation scores) to distinguish between statistical noise and reliable patterns.
4. Synthesise Data into Business Strategy (Create): Translate technical model outputs into actionable business insights and formulate data-driven strategic recommendations for management.

Literature
will be specified in the lecture.

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003135
Design Thinking & Innovation

Module profile

Exam number
5003135

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Michael Müßig

Lecturer(s)
Lisa Straub

Applicability	BEC, BIN, BWI, BDGD, BISD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
- An interest in creative yet challenging problem-solving approaches
- Entrepreneurial thinking
- A willingness to rigorously scrutinise one's own ideas

Content
This course explains the fundamentals and background of innovation management, and design thinking in particular, illustrating these with clear examples. Above all, it is important to convey to participants that today's innovation processes place people at the centre and seek to reconcile customer needs with technical feasibility and economic viability. Students are provided with initial tools to enable them to organise and carry out simple design thinking innovation processes independently.
They must understand the fundamental elements underpinning an innovation or design thinking process and how these can be skilfully navigated through exercises. This provides a practical illustration of the differences between this approach and the traditional development process, as well as the advantages offered by a customer-centred approach and the disadvantages associated with the Design Thinking (DT) approach.
The course is divided into two main modules:
1. A brief introduction to innovation management
Participants gain an insight into common innovation models and processes, as well as the background and basic concepts of innovation research.
2. Learning and applying Design Thinking
Design Thinking is based on an iterative, customer-centred and playful problem-solving process, which enables participants to think beyond familiar solutions in order to realise or strive for ideas that have previously been overlooked, seem impossible, or may appear illogical or unattainable. During this course, participants will go through a Design Thinking process and, in the process, develop their own ideas into a project. The course is therefore designed to be interactive, which is why a high level of proactive participation is expected. In return, participants can look forward to a course full of creativity, interesting discussions and crazy ideas.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio, Presentation

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
1. Students are familiar with the fundamental components of the Design Thinking process and can identify them.
2. Students understand the role of Design Thinking in the context of other innovation models and processes and can contextualise it.
3. Students apply methods for effective problem definition to identify relevant challenges in the innovation process.
4. Students analyse the fundamentals of user research within the Design Thinking process and can explain its significance for solution development.
5. Students evaluate assumptions and hypotheses relevant to innovation in order to (de)construct them effectively.
6. Students organise and conduct brainstorming sessions to generate creative ideas.
7. Students develop prototyping processes, describe them conceptually and can explain their practical application.

Literature
Wobser, Gunther (2022): Agile Innovation Management: Overcoming Dilemmas, Mastering Ambidexterity and Achieving Long-Term Success through Innovation. Springer Gabler. 978-3662645147
Hasso Plattner Institute (A): What is Design Thinking? https://hpi-academy.de/en/design- thin- thinking/what-is-design-thinking.html.
Hasso Plattner Institute (B): The six steps in the Design Thinking innovation process. https://hpi.de/school-of-design-thinking/design-thinking/hintergrund/design-thinking-prozess.html.
IDEO: Design Thinking. https://designthinking.ideo.com/?page_id=1542.
d.School: An Introduction to Design Thinking. PROCESS GUIDE. Institute of Design at Stanford. https://dschool-old.stanford.edu/sandbox/groups/designresources/wiki/36873/attachments/74b3d/ModeGuideBOOTCAMP2010L.pdf.
Brown, Tim (2009): Change by Design. How Design Thinking Transforms Organisations and Inspires Motivation. 1st edition. Harper Business. 978-006176608-4.
Lewrick, Michael; Link, Patrick; Leifer, Larry (2017): The Design Thinking Playbook. Featuring traditional, current and future success factors. Franz Vahlen GmbH. 978-3039097050.
Uebernickel, Falk; Brenner, Walter; Pukall, Britta; Naef, Therese; Schindholzer, Bernhard (2015): Design Thinking. The Handbook. 1st edition. Frankfurter Allgemeine Buch. 978-3956010651.
Wobser, Gunther: Reinventing: What Small and Medium-Sized Enterprises Can Learn from Silicon Valley. BESHU BOOKS. 978-3982195025

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003852
Digital Sovereignty - Operational Concepts and Technologies

Module profile

Exam number
5003852

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr.-Ing. Tobias Fertig

Lecturer(s)
Prof. Dr. Michael Müßig,
Prof. Dr.-Ing. Tobias Fertig,
Andreas Schütz

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
None

Recommended prerequisites for the participation in the module
None

Content
This module covers the fundamental concepts of digital sovereignty, with a focus on operational and technical implementation.
Following an introduction to key terms (e.g. dependence on platform providers, data sovereignty, vendor lock-in, open source, open standards), specific technical alternatives and tools are examined.

Topics covered include:
- Open-source software vs. proprietary solutions
- Full-stack open source (OS): in e-commerce, IT security, knowledge management, ERPs, etc.
- Digital sovereignty at all levels: from hardware to payment flows (PayPal, Apple Pay, Google Pay vs. the digital euro, GNU Taler, Wero, etc.)
- Cloud alternatives (self-hosting, European cloud providers)
- Open standards and interoperability
- Data protection, encryption and data storage
- Practical examples from public administration, education and business

In the project-based component, students work in teams on specific application scenarios (e.g. the digital infrastructure of a university, an SME or a local authority).
The aim is to devise realistic technical concepts for improving digital sovereignty.
At the end of the semester, the results are presented and discussed at a transfer conference attended by the public and a jury.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Practical study achievement

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes

- Students can identify key concepts, stakeholders and motivations relating to digital sovereignty.
- Students can explain how technical dependencies arise through software, cloud services and platforms.
- Students can select suitable open-source and open alternative solutions for specific application scenarios.
- Students can analyse existing digital infrastructures in terms of dependencies, risks and sovereignty deficits.
- Students can compare technical solutions in terms of cost, maintainability, security and sustainability.
- Students can design and present an operational concept for improving digital sovereignty for a defined scenario.

Literature

- https://link.springer.com/book/10.1007/978-3-031-69994-8
- https://direct.mit.edu/books/monograph/3504/The-StackOn-Software-and-Sovereignty
- https://link.springer.com/article/10.1007/s44206-024-00146-7

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003840
Introduction to Project Management and Software Development based on SAP

Module profile

Exam number
5003840

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Frank Hennermann

Lecturer(s)
Daniel Rösch

Applicability	BIN, BWI
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Business Software, Programming 1

Content
In this FWPM, students learn – using a mobile order approval process as an example – how modern SAP technologies relating to FIORI 3 and SAP UI5 are interconnected, structured and put to use. An application based on FIORI 3 is developed using existing components, and the associated OData backend services are integrated. The course covers everything from planning and design through to the backend data model and user interface design. All tasks are carried out in small groups, which is intended to ensure that what is learnt is retained in the long term.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Colloquium

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
This module provides students with fundamental knowledge and skills in the field of project management, particularly in the context of consultancy and the development of SAP FIORI applications.

- Students learn to plan, execute and manage SAP FIORI projects efficiently in order to meet the needs of businesses in the digital age.
- Students will review fundamental concepts, terminology and architectures of relational database systems.
- Students will understand the structure and functioning of SAP FIORI applications.
- Students will apply modelling techniques to create conceptual data models.
- Students analyse the technical and functional requirements of a specific task in order to select suitable technical solutions.
- Students independently create fully functional SAP FIORI applications using appropriate modelling and implementation tools.

Literature
Engelbrecht, M.: SAP FIORI – Implementation and Development, SAP PRESS Verlag, 2017

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003845
Emotional and Persuasive Design in E-Commerce

Module profile

Exam number
5003845

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Tobias Aubele

Lecturer(s)
Petteri Markkanen

Applicability	BIN, BWI, BEC
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
This module focuses on the design and development of an e-commerce website over the course of one intensive week, with a primary emphasis on emotional and persuasive design. The module combines theoretical foundations with hands-on, iterative practice, enabling students to apply design principles directly to real-world e-commerce contexts. The work is grounded in user experience design and extends to ethical design in relation to dark patterns, as well as growth hacking as a means of improving and optimising digital commerce solutions.
Throughout the week, students work in teams to design, build and iteratively refine an e-commerce website. All student teams are provided with access to a shared web hosting environment supplied by the course tutor, which is used throughout the week for building and testing the e-commerce sites. Theoretical concepts are continuously applied through practical implementation, user testing and reflection. Applying theoretical concepts in practice, combined with iterative testing and refinement of the students' e-commerce websites, provides valuable insights. This process helps students recognise and understand different user groups, learn how to engage them emotionally, and ethically apply emotional and persuasive strategies in an e-commerce context.

- Introduction to basic operations and UX principles.

Students set up the e-commerce website using WordPress and WooCommerce on the provided web hosting environment, define target groups, and create user personas.

- Emotional Design.

Students design and implement emotional design strategies tailored to their selected target groups and personas.

- Persuasive Design and Ethical Design.

Students carry out user testing, apply persuasive design strategies, and develop the next iteration of the website whilst identifying and avoiding dark patterns.

- Growth Hacking for e-commerce.

Students carry out further user testing, finalise the website, and develop a plan for growth and optimisation.

- Presentation and Reflection.

Students present their completed websites and key findings, followed by a reflection on the design and development process.
Mornings are devoted to theoretical sessions, whilst afternoons focus primarily on hands-on activities, such as building e-commerce sites, user testing and interviews.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

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

- apply emotional and persuasive design principles to the design of e-commerce websites
- design and evaluate user experiences for different target groups
- recognise ethical challenges in persuasive design in relation to dark patterns
- iteratively improve an e-commerce website based on user testing and feedback
- reflect on the role of emotional and persuasive strategies in digital commerce

Literature
Norman, D. A. (2004) Emotional Design: Why We Love (or Hate) Everyday Things. New York, NY: Basic Books.
Yocco, V. S. (2016) Design for the Mind: Seven Psychological Principles of Persuasive Design. Brooklyn, NY: Manning Publications.
Ellis, S. and Brown, M. (2017) Hacking Growth: How Today's Fastest-Growing Companies Drive Breakout Success. New York: Currency.

Module: 5003846
Ethical AI Hacking

Module profile

Exam number
5003846

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Benjamin Weggenmann

Lecturer(s)
Paulius Baltrušaitis

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
None

Recommended prerequisites for the participation in the module
Python, ML/AI basics

Content
This course provides a comprehensive understanding of Artificial Intelligence (AI) security,
with a focus on ethical hacking principles, attacks on machine learning (ML) models and data, and defence strategies and techniques.

Students will gain theoretical and practical knowledge of key threats such as evasion, model extraction, model inversion, data extraction, data poisoning and backdoor attacks. They will learn how to simulate attacks for testing purposes, which detection and protection techniques to employ, and how to apply them.

Machine learning models such as Linear Regression, Support Vector Regression, K-Nearest Neighbours, Logistic Regression, Support Vector Machines (SVM) and Decision Trees will be used.

Red and blue team scenarios will be used for practical exercises. Each student will take on a role on both sides. The course will utilise several different scenarios for various attacks and machine learning models.

Here is an example of a scenario for a red and blue team exercise focused on data poisoning and detection:
The company is developing a machine learning model to predict customer churn. The red team aims to reduce the accuracy of the logistic regression model by poisoning the data through label flipping. The blue team's objective is to detect and mitigate the attack.
Red team tasks: Analyse the dataset, develop the poisoning strategy, execute the attack, document the attack. The red team's success is measured by the extent to which they degrade the model's performance.
Blue team tasks: Establish a baseline (train a baseline model and evaluate the model's performance); implement detection mechanisms – using techniques such as outlier detection (e.g. Isolation Forest); mitigate the attack; document the defence. The Blue Team's success is measured by their ability to detect and mitigate the attack and restore the model's performance.
Both teams will be assessed on the clarity and thoroughness of their documentation and the presentation of their findings to the whole

group of students, demonstrating and commenting on their Python code and explaining their strategies.
Tools for coding: Jupyter Notebook environment for Python (scikit-learn, pandas, numpy, matplotlib, seaborn), e.g. Google Colab.

By the end of the course, students will work in teams to formulate responsible AI security testing methodologies that meet ethical and legal standards. They will discuss and evaluate the ethical implications of AI vulnerabilities and develop a set of ethical guidelines for AI security and ethical hacking.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
1. Understand basic AI security concepts, ethical hacking principles, and key machine learning threats.
2. Identify and classify AI-specific attacks, including evasion, model extraction, and data poisoning.
3. Simulate red team (attacker) and blue team (defender) AI security scenarios.
4. Apply ethical hacking techniques to assess and exploit vulnerabilities in AI models.
5. Evaluate AI attack detection and protection strategies to improve security.
6. Investigate AI security breaches and analyse countermeasures.
7. Develop ethical guidelines for responsible AI security testing and vulnerability disclosure.

Literature
To be clarified during lessons

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003863 International Digital Marketing

Module profile

Exam number
5003863

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Christina Völkl-Wolf

Lecturer(s)
Sami Lanu

Applicability	BIN, BWI, BDGD, BISD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
None

Content
- Digital marketing strategies
- Digital marketing channels (owned, earned, paid)
- Search engine optimisation
- Segmentation of digital marketing target audiences
- Social media marketing (including TikTok)
- Digital marketing objectives, analytics and metrics

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
Upon completion of the module/course, students will:
1. Remember & Understand:
- explain the role of marketing in e-commerce and in the digital society.
- describe the fundamental concepts of search engine optimisation (SEO).
- outline key digital marketing metrics and analytical tools.

2. Apply
- plan and implement digital marketing campaigns at an international level.
- carry out target group segmentation using Meta and Google Ads tools.
- manage social media marketing activities.
- use digital analytics and tracking tools to monitor campaign performance.

3. Analyse
- analyse and select appropriate digital marketing channels (owned, earned and paid media) for different business objectives.
- evaluate campaign results based on relevant performance indicators.

4. Evaluate
- assess the effectiveness and efficiency of digital marketing strategies.
- compare and critically evaluate different digital marketing approaches and channels.

5. Create
- develop integrated digital marketing strategies for international markets.
- design data-driven optimisation plans for digital marketing campaigns.

Literature
Marketing 4.0 by Philip Kotler et al. (The lecturer will provide PDFs of the relevant sections of the book)
Digital Marketing Trends 2026 by Brandwatch (the lecturer will provide PDFs of the relevant sections of the book)
Latest best practices for Meta and Google Ads (the lecturer will provide PDFs)

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003837
Introduction to Artificial Intelligence

Module profile

Exam number
5003837

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Andreas Lehrmann

Lecturer(s)
Prof. Dr. Andreas Lehrmann

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Basic knowledge of programming (Python) and mathematics (linear algebra, analysis).

Content
Over the last few years, artificial intelligence (AI) has profoundly changed the way we process information and make decisions, both in our personal and professional lives. A thorough understanding of the principles underlying AI is therefore a critical skill in many industries.

This course serves as a broad introduction to AI and its subfields. We will discuss — starting from scratch — the design, training and operation of an AI system. Drawing on intuitive concepts and visual insights, we will introduce a technical framework that enables us to describe the fundamental building blocks of an intelligently operating system (e.g. an autonomous robot). Such a system needs to:

- Organise task-dependent data and use this data to make predictions.
- Understand its environment by linking sensory information to physical location.
- Interact with its environment by planning routes and manipulating objects.

The course will be accompanied by small coding projects in Python that demonstrate the application of these concepts in a series of practical scenarios.

In particular, the course covers the following topics:

[The State of AI] Historical developments, emerging trends and open questions
[Tools & Techniques] AI-assisted productivity and creativity
[The AI Pipeline] From hard-coded rules to learned decisions
[Data] Collection, representation and analysis of data
[Hello World] Algebraic, analytical and statistical foundations of AI
[Supervised Learning I] Data-driven models of reality: classification and regression
[Supervised Learning II] Data-driven models of reality: model complexity and regularisation

[Unsupervised Learning] Identifying patterns without annotations
[From Perception to Action I] Visual AI: understanding information in images
[From Perception to Action II] Visual AI: localising information in images
[From Perception to Action III] Embodied AI: manipulating environments
[From Perception to Action IV] Embodied AI: navigating environments
[Guest Lecture] Industrial applications of AI in the automotive industry
[AI & U] Working with and contributing to the future of AI

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes

- The students understand the structure of the AI landscape, including its various sub-fields and how they are interconnected.
- They can formulate industry tasks as learning problems (supervised, unsupervised, reinforcement) and select an appropriate AI framework for the type of data in question.
- They are familiar with the individual components of the selected AI framework — (1) data acquisition and representation; (2) model specification and optimisation; and (3) performance evaluation and analysis — and can set up and execute this pipeline.
- The students understand the role of embodied AI and the challenges and solutions associated with it, such as perception, kinematics and navigation.

Literature
W. Ertel: Introduction to Artificial Intelligence, Springer, 2024.
C. Bishop: Pattern Recognition and Machine Learning, Springer, 2016.

Module: 5003069
Mobile Applications

Module profile

Exam number
5003069

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 50 hrs

Self-study: 100 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Prof. Dr. Peter Braun

Applicability	BEC, BIN, BWI, BISD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
Good programming skills (e.g. from Programming 1 and 2, Web Programming 1 to 3) or equivalent.

Recommended prerequisites for the participation in the module
none

Content
This module introduces software development for mobile devices. The course will utilise the Android operating system and/or iOS. The development environment will be Flutter running on Android Studio or VS Code. Dart will be used as the programming language. No prior knowledge of Dart programming is required, but a good understanding of other languages (e.g. Java, Python or JavaScript) is essential.

Introduction to Dart Programming
- Brief overview of Flutter: history, advantages and architecture.
- Introduction to the Dart programming language.
- Setting up the development environment.

Introduction to Flutter – Flutter GUI development
- Understanding widgets and basic UI elements.
- Understanding stateful and stateless widgets.
- Layout widgets: Row, Column, Stack, etc.
- Basic interaction elements: buttons, sliders and switches.

Navigation and State Management
- Navigation patterns: push/pop navigation, named routes.
- Basics of state management: setState, Provider.
- Implementing forms and handling user input.

Working with External Data
- Fetching data from the internet (APIs).
- JSON serialisation and deserialisation.
- Firebase

Integrating Device APIs such as Location and Camera
- Introduction to Device APIs in Flutter.
- Implementing location services: obtaining and using GPS data.
- Accessing and using the camera: taking photographs and recording video.
- Handling permissions for location and the camera.

Testing Advanced Features and Best Practices
- Animations and transitions.

- Using custom fonts and assets.
- Best practices in Flutter development.
- Testing Flutter apps

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes

- Students gain an understanding of the fundamentals of mobile application development using Flutter for Android and iOS, with a focus on professional programming practices.
- Students apply concepts of asynchronous programming and thread management to handle complex tasks in mobile applications efficiently.
- Students analyse architectural concepts for mobile solutions, including the division of responsibilities between client and server and communication protocols for mobile devices.
- Students design mobile user interfaces based on reusable software components, ensuring an intuitive and consistent user experience.
- Students implement mobile applications that integrate sensor data analysis and server communication, following best practice in mobile development.
- Students evaluate different mobile architecture approaches and technologies to select the most suitable solutions for specific application requirements.
- Students create a fully functional mobile application for Android or iOS, including publication and deployment.

Literature
Dieter Meiller: Modern App Development with Dart and Flutter 2: A comprehensive introduction to Flutter. De Gruyter Oldenbourg, 2021.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003864
Next-Generation Ethical Hacking and Cyber Forensics

Module profile

Exam number
5003864

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Sebastian Biedermann

Lecturer(s)
Prof. Dr. Minal Moharir

Applicability	BIN, BWI
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Basic knowledge of computer networks and operating systems.
Installation of Kali Linux on Oracle VirtualBox.

Content
1. Introduction to Ethical Hacking and Vulnerability Analysis
Fundamentals of key issues in the world of information security, including the basics of ethical hacking, the ethical hacking life cycle, various vulnerability assessment and penetration testing tools, and an overview of AI in offensive and defensive security
Hands-on: Shodan, Nmap, Nexpose, Netcraft, PrivateEye, Google advanced search operators, Harvester, Burp Suite, SIEM tools
2. Social Engineering and Session Hijacking
Social engineering concepts and techniques, including how to identify attempts at identity theft, and the use of generative AI for phishing content and deepfakes
Web server attacks, including a comprehensive attack methodology used to audit vulnerabilities in web servers and web applications. Web application hacking methodology.
Hands-on:: Case study: Phishing attack; MiM attack: Kali Linux, BettrCap, SetTool Kit, GoFish; Hacking web servers and web applications: SQL injection attack, CSS attack, Splunk ML Toolkit
3. IoT and Cloud Hacking
IoT and cloud attacks, hacking methodology, hacking tools, IoT and cloud security techniques and tools
Hands-On:: IoT SCADA hacking using MODBUS. Automotive hacking, the role of AI in large-scale log analysis and anomaly detection in cloud/IoT telemetry, case study using Suricata
4. Introduction to Cyber Forensics: Principles of cyber forensics, chain of custody and evidence handling, introduction to types of digital evidence, importance of forensic image creation, introduction to machine-learning-supported triage of logs, files and network traces
Hands-On:: Create a forensic image using FTK Imager, validate image integrity with hash functions, Splunk SOAR
5. File System and Disk Forensics: Analysing File Systems: FAT, NTFS, EXT, data recovery techniques and deleted file recovery. Identifying hidden files and metadata
Network Forensics: Basics of network traffic analysis, identifying suspicious network activity, packet analysis and monitoring logs
Hands-On:: Create a forensic image using FTK Imager, validate image integrity with hash functions, analyse network packets using Wireshark, capture and analyse suspicious traffic for anomalies

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Practical study achievement

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
Develop a solid understanding of ethical hacking and cyber forensics concepts, techniques and tools.
Identify, exploit and analyse vulnerabilities in systems, networks, IoT and cloud environments using both traditional and AI-assisted tools.
Apply forensic techniques and selected machine learning-based methods to investigate and document cyber incidents.
Execute different attack scenarios within an ethical framework.
Gain hands-on experience with industry-standard and AI-enhanced tools (e.g. Nmap, Wireshark, Metasploit, Autopsy and anomaly-

Literature
CEH with AI v13: Certified Ethical Hacker Study Guide" by Ric Messier
"Digital Forensics with Open Source Tools" by Cory Altheide and Harlan Carvey
Securing Agentic AI: A Comprehensive Threat Model and Mitigation Framework for Generative AI Agents, https://arxiv.org/pdf/2504.19956

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003809
Principles of Autonomous Drones

Module profile

Exam number
5003809

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Frank Deinzer

Lecturer(s)
Marcel Kyas

Applicability	BIN, BWI, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
You will learn the fundamental methods for equipping autonomous aerial drones with perception, planning and decision-making capabilities. You will learn algorithmic approaches to robot perception, localisation and simultaneous localisation and mapping, as well as the control of non-linear systems, learning-based control and aerial drone motion planning. You will learn methodologies for reasoning under uncertainty.

On day one, you will learn to describe the basic control loop of an autonomous robot. You will explain the basics of drone locomotion and kinematics (how drones move). On day two, you will learn to list the purposes of sensors on a drone. You will explain the structure and applications of Bayesian filters. On day three, you will learn to implement a simple localisation system. On day four, you will learn to explain behaviour trees as a formalism for describing drone behaviour. You will learn to define the principles of planning algorithms (Dijkstra's Algorithm, A* Search, D* Search). You will apply reinforcement learning to solve drone planning problems.

You will design a simulation in Robot Operating System 2 (ROS2) for demonstrations and hands-on activities.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Colloquium

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
1. Students are familiar with the fundamental principles of motion control as applied to autonomous aerial drones.
2. Students understand the basic concepts of perception, distinguishing between traditional approaches and deep learning methods for robot perception.
3. Students can explain the principles of localisation and Simultaneous Localisation and Mapping (SLAM), including their importance for autonomous navigation.
4. Students analyse navigation algorithms, focusing on the planning and decision-making processes necessary for effective drone operation.
5. Students apply algorithmic approaches to robot perception, localisation and planning in practical scenarios.
6. Students implement learning-based control techniques for aerial drones to enhance their motion planning capabilities.
7. Students utilise the Robot Operating System (ROS) in demonstrations and hands-on activities, reinforcing the theoretical concepts covered in the course.

Literature
Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza. *Introduction to Autonomous Mobile Robots*, second edition. 2011, The MIT Press
Sebastian Thrun, Wolfram Burgard, and Dieter Fox. *Probabilistic Robotics*. 2005, The MIT Press

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5102910
Project Work

Module profile

Exam number
5102910

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
4

ECTS-Credits (CP)
10.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 240 hrs

Total: 300 hrs

Teaching format
Project

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Prof. Dr. Arndt Balzer,
Prof. Dr. Peter Braun,
Prof. Dr. Frank Deinzer,
Prof. Dr. Isabel John,
Prof. Dr. Frank-Michael Schleif,
Prof. Dr. Christian Bachmeir,
Prof. Dr.-Ing. Sebastian Biedermann,
Prof. Dr.-Ing. Anne Heß,
Prof. Dr. Benjamin Weggenmann

Applicability	BIN
Semester according to SPO	6. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
100 ECTS credits

Recommended prerequisites for the participation in the module
none

Content
Project work is usually carried out as a team (at least three students). It involves either a comprehensive software development project in accordance with the principles of software engineering or another task from the field of IT (e.g. software comparison, software selection, software implementation). Each project is supervised by a professor from the Faculty of Computer Science and Business Informatics.
As part of the project work, students practise the techniques and methods of computer science they have learnt in a professional context (teamwork; project organisation; practical tasks).
In the standard degree programme, the topics for the practical examples forming part of the assessment are provided by the lecturer or agreed with them. In the BIN dual study programme, a task from a real-world business context is undertaken in consultation with the lecturer. This ensures a practical focus and provides feedback from the company.
Students are guided to independently produce a software development project and accompanying documentation comprising the following parts:

- For a software development project
- Specification document setting out the requirements for the project (including milestones and a timetable)
- Technical design using appropriate methods
- IT design
- Programme listing
- User manual
- Appendix (bibliography; list of abbreviations, glossary, etc.)
- For other types of assignment:
- Project description setting out the requirements for the project work (including milestones/timetable)
- Further content to be specified by the supervising professor, arising from the individual nature of the respective assignment
- Appendix (bibliography; list of abbreviations, glossary, etc.)

In the standard degree programme, the topics for the practical examples forming part of the examination are provided by the lecturer or agreed with them. In the dual study programme, a task from a real-world business context is undertaken in consultation with the lecturer.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
error

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
none

Learning outcomes
Students are able to approach and solve complex problems using appropriate methodologies.
Students are able to develop and implement suitable solution strategies as part of a team.
They understand how team processes work and how they can contribute their own personality to these processes.
Students can independently set up, carry out, oversee and present a small IT project as part of a team. They can identify and use appropriate development technologies, and test and document their code.

Literature
depending on the specific project work

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003865
Quantum Computing

Module profile

Exam number
5003865

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Frank-Michael Schleif

Lecturer(s)
Dr. Divyarani Mandya Shivakumar

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Basic Linear Algebra and Python Programming

Content
This course provides a comprehensive introduction to the principles, mathematical foundations, hardware concepts and programming tools of quantum computing. Students will explore qubits, superposition, entanglement, quantum gates, algorithms, noise models, error correction and real-world applications. Hands-on sessions using Qiskit enable learners to construct and simulate quantum circuits and run programmes on IBM Quantum devices.

1. Foundations of Quantum Computing
Classical versus quantum computation, qubits and quantum states, superposition and entanglement, Dirac notation (bras and kets), Bloch sphere representation, quantum measurement and collapse, physical implementations of qubits: superconducting, ion traps, photonic systems.
2. Quantum Gates and Quantum Circuits
Single-qubit gates: Pauli-X, Y, Z, Hadamard (H), Phase, S, T; multi-qubit gates: CNOT, Swap, Controlled phase; building quantum circuits; principles of reversible computing; quantum circuit simulation tools; IBM Qiskit basics; circuit construction and visualisation; noise, error sources and decoherence.
3. Quantum Algorithms
Quantum parallelism, Deutsch–Jozsa algorithm, Grover's search algorithm, Shor's factoring algorithm, Quantum Fourier Transform (QFT), Phase estimation, Variational Quantum Algorithms (VQA): VQE, QAOA
4. Quantum Hardware, Noise & Error Correction
NISQ (Noisy Intermediate-Scale Quantum) era systems, Quantum noise models: Bit flip, phase flip, depolarising noise, basics of quantum error correction: Shor code, Steane code, surface code (overview), fault-tolerant quantum computation, claims of quantum supremacy (Google, IBM).
5. Applications, Future Trends & Quantum Programming
Quantum cryptography (BB84, QKD), Post-Quantum Cryptography (PQC), basics of Quantum Machine Learning (QML), Quantum optimisation (QAOA use cases), Quantum simulation in chemistry & physics Hands-on Qiskit programming: Creating circuits, running them on simulators, running them on IBM Quantum systems.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
Upon successful completion of the course, students will be able to
1. Explain the fundamental concepts of qubits, superposition, entanglement and quantum measurement.
2. Construct and simulate quantum circuits using quantum gates and operators.
3. Analyse how major quantum algorithms work and identify their computational advantages.
4. Understand hardware constraints, quantum noise and basic quantum error correction techniques.
5. Implement quantum programmes using Qiskit and evaluate applications of quantum computing across various fields.

Literature
Textbooks:
1. Nielsen, M., & Chuang, I. *Quantum Computation and Quantum Information*, Cambridge University Press, 2010.
2. Yanofsky, N., & Mannucci, M. *Quantum Computing for Computer Scientists*, Cambridge University Press, 2008.
References:
1. IBM Quantum Documentation – https://quantum-computing.ibm.com
2. Qiskit Textbook – https://qiskit.org/learn
3. Preskill, J. Quantum Computing in the NISQ Era.
4. Arun P. Quantum Computing: An Applied Approach, Springer
Online Resources (e-books, notes, PowerPoint presentations, video lectures, etc.):
1. Qiskit Tutorials: https://qiskit.org/tutorials
2. Quantum Algorithms Zoo: https://quantumalgorithmzoo.org
3. MIT OCW – Quantum Computation
4. IBM Quantum Lab (free cloud access).

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003067
Requirements Engineering

Module profile

Exam number
5003067

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Isabel John

Lecturer(s)
Prof. Dr. Isabel John,
Dr. Anne Heß,
Dr.-Ing. Benedikt Kämpgen

Applicability	BEC, BIN, BWI, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Software Engineering / Software Development

Content
This module focuses on the crucial initial phase of the software development lifecycle, during which the system's requirements and constraints are gathered, analysed and documented. Similarly, machine learning (ML) system development projects benefit from RE. This module therefore covers requirements engineering techniques for both traditional systems and ML systems.

Basics of Requirements Engineering
Task-Oriented and Goal-Oriented RE
Elicitation Techniques
Analysis Techniques
Specification and Modelling Techniques
Validation Techniques
RE in User Experience Engineering
RE Skills
Case Studies and Applications of Requirements Engineering
Requirements Engineering for Machine Learning Systems
Requirements Engineering in the Age of ChatGPT and Generative Artificial Intelligence

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes
Students are familiar with fundamental RE models and methods, and their relevance to the software development process.
Students understand the importance of requirements engineering, including stakeholder analysis, in a variety of project contexts, including international and AI-driven projects.
Students apply requirements elicitation techniques and modelling methods, such as UML, use cases, user stories and non-functional requirements, to real-world scenarios.
Students analyse requirements through negotiation, prioritisation and validation against quality criteria to ensure completeness and clarity.
Students evaluate different RE approaches and adapt techniques suited to specific domains such as machine learning and generative AI systems.
Students create comprehensive requirements specifications and models that address the needs of complex, modern software systems, including AI applications.
Students are able to adapt requirements engineering techniques for generative artificial intelligence-based systems.

Literature
Cockburn, Writing Effective Use Cases, Addison Wesley, 2016
Hull, Requirements Engineering, Springer Verlag, 2019
Berenbach, Software & Systems Requirements Engineering: In Practice, McGraw Hill, 2017
Chris Rupp & the SOPHISTs, Requirements Engineering (in German), Hanser, 2022
Huyen, Chip. *Designing machine learning systems*. O'Reilly Media, Inc., 2022.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003857
Seminar Smart Systems

Module profile

Exam number
5003857

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Arndt Balzer

Lecturer(s)
Prof. Dr. Arndt Balzer

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Courses in the field of Computer Engineering

Content
Content: In this specialisation module, students work independently on topics relating to smart systems. They develop and present solutions (involving both hardware and software).
Topics from previous years (selection): AI-based checkout, Braille reader, inverse pendulum, Kalman filtering, pathfinding with Turtlebot, quadcopter, radar + lidar, ROS (Robot Operating System), SDR (Software-Defined Radio), SLAM (mapping, localisation, navigation), supervised learning, reinforcement learning, Rock-Paper-Scissors on Pepper, Wi-Fi indoor localisation, …
The seminar operates under a regularly updated overarching theme, within which individual topics are assigned. The topics are determined at the start of the seminar and are based on current developments. Areas of interest always include actuators and sensors, low-performance systems right through to smartphones, their programming and the evaluation of prototypical implementations.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Multimedia presentation, Colloquium

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
Learning objectives: By exploring a selected topic, students will develop their ability to engage with challenging subjects.

- Students will acquire fundamental mathematical and technical knowledge
- They will use this to derive the specialist knowledge required for their specific topic or field of application
- They apply this knowledge using the methods they have learnt and gain further confidence in their application

The findings are documented and the results are presented at the end of the seminar

- Students acquire the skills to document and present results clearly.
- Students apply methods of scientific work, including (literature) research.
- Students generalise their ability to independently expand their existing knowledge and to quickly familiarise themselves with topics covered by other students

Literature

- To be announced in each case.

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003854
Smart Agriculture

Module profile

Exam number
5003854

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Prof. Dr. Peter Braun,
Prof. Dr. Isabel John

Applicability	BIN, BWI, BEC
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
None

Recommended prerequisites for the participation in the module
None

Content
The module addresses typical challenges in smart agriculture using a specific example: the systematic collection of data in the field using drones, the structured processing and analysis of image data, and the derivation of transparent key performance indicators and maps as a basis for an initial assessment. Building on this, methods for image-based detection and quantification of anomalies are developed and integrated into a simple data management system with visualisation. A further focus is on the validation of image-based findings using independent measurements, as well as on the statistical testing and interpretation of relationships through correlations. Implementation takes the form of prototypes, comprising software artefacts and presentations of results.

The module is run in cooperation with our partner institution, Suwa University of Technology in Japan, and is supported by teaching contributions from professors at the partner university. An important part of the module is an excursion to Suwa University, during which the prototype results are further developed, validated and jointly presented together with Japanese students. Intercultural content covers etiquette, communication styles in emails and video conferences, joint laboratory work, projects and presentations, as well as behaviour and everyday customs whilst in Japan.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes

- Students describe key data sources and outputs (drone images/ logs, AI results, measurement values) and organise them into a consistent data flow.
- Students implement a transparent data pipeline in Python, including simple quality controls and reproducible exports (e.g. GeoTIFF/PNG, reports).
- A group of students calculates ExG/VARI/NDVI and critically interprets index maps under field conditions (changes in light, shade, missing bands).
- A group of students explains fundamental AI tasks (classification, detection, segmentation) and assesses their limitations due to domain shift and uncertainty in the field.
- A group of students correlates physiological measurements (Fv/Fm, chlorophyll index) with image/AI metrics (Pearson/Spearman) and derives an evidence-based assessment from this.
- Students explain basic etiquette and courtesies in the Japanese higher education environment and use this to determine appropriate behaviour in meetings and on site.
- Students draft professional emails and prepare for video conferences with Japanese contacts in a structured manner.
- Students carry out their project using appropriate project management methods and take into account intercultural project management aspects during the field trip and when interacting with Japanese students.

Literature
This will be announced later in the seminar.

Module: 5003810
Software Testing

Module profile

Exam number
5003810

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Pascal Moll

Applicability	BEC, BIN, BWI, BISD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
None

Recommended prerequisites for the participation in the module
Programming I, Back-end Programming, Programming in Python, or Fundamentals of Programming; Object-Oriented Programming in Java
Participants will be provided with a virtual machine, the functionality of which should be tested before the course begins.

Content
This module covers various types of testing and their application in software development. It teaches the SOLID principles and the 4-layer concept for test architectures. It also covers automated testing of user interfaces and APIs, as well as the use of mocking. Another key focus is Behaviour-Driven Development with Cucumber. The module also covers exploratory testing and the integration of automated tests into a DevOps life cycle. The module includes practical content, for which a virtual machine is provided. This requires the installation of VirtualBox.

- Fundamentals of testing (test coverage, test paths, black-box, white-box and grey-box testing, functional and non-functional tests, test pyramid)
- Test automation (objectives, success factors, differences between various types, the JUnit test framework, annotations, assertions, exception testing, parameterisation, test types, record-replay, scripted testing, keyword-driven testing)
- Test architecture (SOLID principles, 4-layer concept, test modelling layer, test definition, test execution, test adaptation, interfaces, design and development, key design patterns for testing)
- Testing graphical user interfaces (introduction to Selenium, drivers, PageObject pattern, identifiers, waits, cookies)
- Mocking (Wiremock)
- Behaviour-Driven Development (Feature Files & Step Files, Cucumber & Gherkin, Parameters, Data Tables, Scenario Outlines and Background, Runner Classes)
- Exploratory Testing (methods and techniques)
- Build servers (Jenkins basics & DevOps basics, gPipelines, the DevOps process from a testing perspective)

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
None

Learning outcomes

- Students define test objectives for a piece of software.
- Students analyse test objectives and define appropriate test types.
- Students translate test types into automated tests.
- Students decide on the use of design patterns in testing and apply them.
- Students explain Behaviour-Driven Development.
- Students set up and configure a build server for testing.

Literature

- Essentials of Software Testing* by Ralf Bierig, Stephen Brown, Edgar Galván and Joe Timoney, 2021, Cambridge University Press

Module: 5003858
Smart Systems

Module profile

Exam number
5003858

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Arndt Balzer

Lecturer(s)
Prof. Dr. Arndt Balzer

Applicability	BIN, BWI, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Programming I + II, Fundamentals of Computer Engineering, Computer Architecture, Operating Systems, Algorithms & Data Structures

Content
- Introduction to C for programmers
- Specifics of microcontroller programming (ESP32, 32-bit microcontroller family from Espressif)
- Memory model, interrupt concept, ...
- Hardware architecture and programming of common interfaces for communication and control of peripherals such as U(S)ART, SPI (four-wire), I²C (two-wire), OneWire, CAN
- Programming of peripheral devices such as digital sensors: IMU (10-axis), digital thermometers, ultrasonic sensors and actuators: displays, servos, loudspeakers, etc.
- Programming of wireless interfaces (RF) such as Bluetooth and Wi-Fi to control applications such as servos, etc., using smartphones
- Implementation of small AI models (image recognition using a USB camera)
- Introduction to a modern, application-based development environment: ESP-IDF (Espressif IoT Development Framework)

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Colloquium, Practical study achievement

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
Students will be able to

- explain the specific programming of controllers and their interfaces,
- to evaluate interfaces that have evolved over time,
- to use a software development environment that makes efficient use of innovative and application-optimised peripheral functions,
- to develop low-level software in the C programming language for various use cases.

Literature

- Kernighan, Ritchie: The C Programming Language, 2nd Edition (ANSI)
- Udo Brandes: The ESP32 Microcontroller – The Comprehensive Handbook
- Dausmann, et al.: C as a First Programming Language, Vieweg, 2011, e-book
- Wolf: C from A to Z, Galileo Computing, openbook

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Module: 100002
Usability for Engineers and Computer Scientists

Module profile

Exam number
100002

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 0 hrs

Self-study: 150 hrs

Total: 150 hrs

Teaching format
Lecture

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Isabel John

Lecturer(s)

Applicability	BIN, BWI, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
This is a programme offered by the Virtual University of Bavaria.
Further information:
https://kurse.vhb.org/VHBPORTAL/kursprogramm/kursprogramm.jsp?kDetail=true&COURSEID=19832,83,816,1

Recommended prerequisites for the participation in the module
none

Content
This is a programme offered by the Virtual University of Bavaria.
Further information:
https://kurse.vhb.org/VHBPORTAL/kursprogramm/kursprogramm.jsp?kDetail=true&COURSEID=19832,83,816,1
In our highly technologised and interconnected world, the usability of products, services and interactive systems is becoming an increasingly important factor for users on the one hand, and a competitive advantage for manufacturers on the other. With comparable functionalities, many products are being offered at ever lower prices in the global marketplace. Users have a choice and will opt for the benefits of a product that has been tested and optimised for usability and user experience. By employing usability engineering methods, manufacturers can meet these requirements and develop unique selling points for their products. Usability and user experience objectives should therefore be taken into account as early as possible in the development process and implemented using appropriate methods, amongst other things to avoid costly development failures and to increase the benefits for customers. Prospective engineers and computer scientists must be able to recognise this issue and know in which phases of product development suitable methods are applied.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
This is a course offered by the Virtual University of Bavaria. Further information:
https://kurse.vhb.org/VHBPORTAL/kursprogramm/kursprogramm.jsp?kDetail=true&COURSEID=19832,83,816,1
Identifying the content of the analysis phase in usability engineering.

- Independently applying analysis methods and techniques of usability engineering
- Identifying, on an application-specific basis, relevant sections of the DIN/ISO 9241 series of standards
- Describing and applying terminology (usability) and principles (dialogue design)
- Describing and applying a process for designing usable interactive systems
- Describing the key aspects of cognitive psychology and occupational psychology
- Identifying and naming criteria for evaluating colour schemes in order to identify and name associated usability problems
- Describing fundamental aspects of contrast and its use in design
- Recognising in which development phases Gestalt principles must be taken into account and how these simple principles help to identify usability problems
- Targeted application of Gestalt principles within the context of usability evaluations
- Describing the typical approach in interface and interaction design.
- Identify different types of prototypes and describe their function in usability engineering
- Describe and apply usability metrics from the areas of ‘usability performance metrics’ and ‘usability issue-based metrics’.

Literature
see course

Module: 6322200
Virtual Reality

Module profile

Exam number
6322200

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction, Exercise

Language of instruction
German

Organisation

Responsible lecturer
Stefan Sauer

Lecturer(s)
Stefan Sauer

Applicability	BEC, BIN, BWI, BISD, BDGD
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
This event is organised by the Faculty of Plastics Technology and Surveying (FKV):
(https://geo.thws.de/studium/bachelor-geovisualisierung/studienablauf/modulhandbuch-bgv-ab-ws-202223/)

For scheduling: https://geo.thws.de/studium/aktuelle-lehrveranstaltungsplaene/

- Creating 3D models for integration into game engines
- Working with game engines
- Rendering pipeline
- Integration of VR functionality into game engines
- Creation of fully functional 3D models in game engines
- Development of virtual tours

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
None

Learning outcomes
Upon completion of the module, students will be able to independently plan, develop and set up VR applications, or publish them using appropriate services.

Game engines are used to create VR environments. Students therefore learn the basics of importing and handling geodata in game engines, as well as the settings for rendering and preparing the data for VR applications, including the programming of controllers and the interface to VR headsets.

Literature
Akenine-Möller, T.; Haines, E.; Hoffman, N.; Pesce, A.; Iwanicki, M.; Hillaire, S.: Real-Time Rendering, 2018, 4th edition, Milton: Chapman and Hall/CRC, London, ISBN: 9781138627000 Edler, D.; Husar, A.; Keil, J.; Vetter, M. & Dickmann, F.: Virtual Reality (VR) and Open Source Software: A Workflow for Constructing an Interactive Cartographic VR Environment to Explore Urban Landscapes, 2018. In: Kartographische Nachrichten, Journal of Cartography and Geographic Information, 68(1), pp. 5–13, ISSN: 2524-4965
Edler, D.; Kühne, O.; Jenal, C.; Vetter, M.; Dickmann, F.: The Potential of Spatial Visualisation in Virtual Reality (VR) for Social Constructivist Landscape Research, 2018. In: Kartographische Nachrichten, Journal of Cartography and Geographic Information, 68(5), pp. 245–254, ISSN: 2524-4965
Vetter, M.: Technical Potentials for Visualisation in Virtual Reality, 2020. In D. Edler, C. Jenal, & O. Kühne (Eds.), Modern Approaches to the Visualisation of Landscapes, 2020, Wiesbaden: Springer VS, ISBN: 978-3-658-30956-5

Module: 5003855
Web Exploitation

Module profile

Exam number
5003855

Duration
1 semester

Frequency
Every summer semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Sebastian Biedermann

Lecturer(s)
Prof. Dr.-Ing. Sebastian Biedermann

Applicability	BIN, BWI, BEC
Semester according to SPO	6. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
None

Content
Students learn about the professional role and methodological workflow of web penetration testers, including legal and ethical frameworks. Techniques for identifying and exploiting common web vulnerabilities (e.g., the OWASP Top Ten) in front-ends, back-ends and APIs are taught. Web post-exploitation scenarios (e.g. web shells, session hijacking, API abuse) and related containment considerations are practised in isolated labs. Finally, students practise structured reporting and the presentation of findings in a manner appropriate to the target audience.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
None

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

- describe the professional role of web penetration testers and their responsibilities within IT security.
- outline the typical workflow of a web penetration test (reconnaissance → enumeration → exploitation → post-exploitation → reporting).
- identify legal constraints, scope boundaries and ethical considerations and incorporate them into test planning.
- identify common web vulnerabilities (e.g., injection, XSS, CSRF, authentication issues) in test applications and produce reproducible proofs of concept.
- perform web post-exploitation techniques (e.g., session takeover, web shells, API abuse) in a laboratory setting and analyse their effects.
- Assess discovered vulnerabilities in terms of exploitability and business impact (e.g., using CVSS criteria) and set priorities for remediation.
- Document the results of a web penetration test in a structured report and present key findings in a manner appropriate to the target audience.

Literature
The Web Application Hackers' Handbook (Dafydd Stuttart et al.), 2023
Penetration Testing – a Hands-On Introduction to Hacking (Georgia Weidman), 2014
Hacking, The Next Generation (Nitesh Dhanjani et al.), 2021

7. semester

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Module: 5003028
ABAP/4 Development Workbench

Module profile

Exam number
5003028

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Frank Hennermann

Lecturer(s)
Martin Espenschied

Applicability	BIN, BWI
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
Fundamentals of Programming with ABAP
- Overview of the ABAP programming language
- Creating and testing an ABAP report
- Output statements
- Program data – types and variables
- Multilingual support – text elements
- Reading database tables
- Control statements
- Program data – field strings and internal tables
- Modularisation using function modules and classes

Dialogue programming
- Dialogue programmes from the developer's perspective
- Developing a simple dialogue programme
- The graphical elements of a screen
- Importing definitions from the Data Dictionary
- The Menu Painter
- Dynamic screen sequence
- Field input checks/messages
- Dynamic screen modifications
- Database changes and locks

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
Students are familiar with the architecture and use of the ABAP/4 Development Workbench.
They can create simple programmes, applying SAP-specific instructions. They can analyse and rectify errors. They can create function modules and classes, and design user interfaces.

Literature
ABAP Development for SAP S/4HANA by Constantin-Catalin Chiuaru, Sebastian Freilinger-Huber, Timo Stark and Tobias Trapp, Rheinwerk-Verlag, 2nd edition, Bonn 2021.
ABAP – The Comprehensive Handbook by Felix Roth, Rheinwerk-Verlag, 3rd edition, Bonn 2023.
Agile ABAP Development by Winfried Schwarzmann, Rheinwerk-Verlag, Bonn 2018.
BOPF – Developing Business Objects with ABAP by Felix Roth and Stefan Stöhr, Rheinwerk-Verlag, Bonn 2017.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003180
Advanced Database Techniques

Module profile

Exam number
5003180

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Michael Rott

Applicability	BIN, BWI, BISD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Databases, Databases I, Back-end Systems

Content
As part of this module, students acquire practice-oriented and interdisciplinary skills in the field of modern database management. The course content is designed to combine technological fundamentals with current requirements from industry and research.

In particular, the following aspects are covered:

- An in-depth examination of the CAP theorem, taking real-world distributed database systems into account.
- The systematic selection of suitable database management systems (DBMS) based on specific deployment scenarios. This includes both relational systems (e.g. PostgreSQL, MySQL, SQL Server, Oracle) as well as non-relational systems (e.g. MongoDB, Redis, Riak).
- Use of a data modelling tool (e.g. erwin Data Modeler) to create conceptual and physical data models.
- Use and evaluation of monitoring and performance tools, particularly with regard to load balancing, system monitoring and the analysis of query execution plans.
- Investigation of various fragmentation strategies for the efficient storage and management of large volumes of data in distributed database systems.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes

- Students recall the fundamental concepts, terminology and architectures of relational database systems.
- Students understand the structure and operation of various database management systems (DBMS).
- Students apply relational modelling techniques to create conceptual data models (e.g. ER diagrams).
- Students analyse requirements for database systems in order to select suitable technical solutions.
- Students evaluate simple database designs in terms of freedom from redundancy, normalisation and performance.
- Students create relational database schemas using appropriate modelling and implementation tools.

Literature

Kofler, Michael: Database Systems – The Comprehensive Textbook; 2nd ed.; Rheinwerk Verlag; Bonn, 2024
Heuer, Andreas; Saake, Gunter: Databases – Concepts and Languages; 6th ed.; MITP-Verlag; Bonn, 2018
Rahm, Saale, Sattler: Distributed and Parallel Data Management; Springer Vieweg; Berlin Heidelberg, 2015

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003847
Algorithms for Distributed Systems

Module profile

Exam number
5003847

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Erik Schaffernicht

Lecturer(s)
Prof. Dr.-Ing. Erik Schaffernicht

Applicability	BIN, BWI, BISD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Courses on computer networks and communication (e.g. Internet communication, backend systems), algorithms and data structures, and the basics of operating systems

Content
Introduction/recap on communication models for distributed systems
- Remote procedure calls
- Blackboards and event-based models

Fundamentals of distributed algorithms
- Differences between algorithms in distributed systems, parallel algorithms and single-machine algorithms
- Consensus problems
- Failure models
- Physical clocks and logical clocks

Algorithms for common problems in distributed systems
- Coordination
- Leader election
- Searching
- Fault tolerance / fault handling
- Consistent data replication

The course will be taught in English.
The course is programming language-agnostic; students may choose their preferred languages to implement seminar assignments.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
none

Learning outcomes
Upon completion of the course, students will be able to

- understand the capabilities and limitations of distributed systems,
- explain different failure models,
- utilise remote procedure call frameworks to programme in distributed systems,
- design and implement solutions to common problems in distributed systems,
- select algorithms to handle conflicts and failures in distributed systems,
- discuss the major challenges in distributed systems, both in general and for specific tasks,
- compare different algorithmic solutions to common problems in distributed systems and discuss potential trade-offs

Literature
M. van Steen and A.S. Tanenbaum, *Distributed Systems*, 4th ed., 2023
Further specific reading recommendations will be provided during the course

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003828
Automotive and Industrial Cybersecurity

Module profile

Exam number
5003828

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Sebastian Biedermann

Lecturer(s)
Dr.-Ing. Rodrigo Daniel do Carmo

Applicability	BIN, BWI
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
Part I: Automotive Cybersecurity

Introduction to Automotive Cybersecurity
- Architecture of Modern Vehicles
- Cybersecurity Challenges of Modern Vehicles and E/E Architectures

Legislation and Standardisation for Cybersecurity in the Automotive Industry
- Introduction to Automotive Cybersecurity Regulations and Standards: UN ECE WP.29 and UN Regulations Nos. 155 and 156, Vehicle Type Approval, Overview of Global and European Approaches
- Introduction to the International Standard ISO/SAE 21434
- Related and Upcoming Standards

Automotive Threat Analysis and Risk Assessment (TARA) in accordance with ISO/SAE 21434
- Introduction to Risk Management and TARA
- Scope of a TARA, Attacker Model, Item Definition
- Asset Identification (Typical Assets for Automotive Embedded Systems)
- Cybersecurity Properties (CIA Triad and Other Properties)
- Definition of Damage Scenarios
- Identifying Threats: Overview of Threat Modelling, STRIDE, Brainstorming, MITRE ATT&CK, OWASP
- Definition of Attack Paths: Identification and Description of Attack Paths, Attack Trees, Vulnerabilities
- Attack Feasibility Evaluation
- Risk Evaluation
- Risk Treatment Decision: Cybersecurity Goals
- Cybersecurity Requirements, Typical Controls for Automotive Embedded Systems

Part II: Industrial Cybersecurity

Introduction to Industrial Networks and Control Systems
- Industrial Security, Basic Process Control Systems, Differences Between IT and OT Systems

- Components and Architecture of Industrial Control Systems: Field Devices, Programmable Logic Controllers, Distributed Control Systems, Supervisory Control and Data Acquisition (SCADA) Systems, Network Transmission Media, Field Device Architecture, Industrial Network Protocols, Enterprise Network Protocols, Industrial Safety and Protection Systems, Safety Instrumented Systems (SIS), OT/IT Network Integration, Purdue Reference Model

Industrial Cybersecurity and Secure OT Architectures

- Introduction to Cybersecurity Challenges in Modern Industry (Industry 4.0): Examples of Attacks, MITRE ATT&CK Database, SHODAN
- Overview of Relevant EU Cybersecurity Regulations: NIS2, Cyber Resilience Act (CRA), Machinery Regulation, Radio Equipment Directive (RED)
- Secure OT Architecture: Boundary protection, firewalls, industrial demilitarised zone, proxies, network zoning, data diode, zero-trust architecture (ZTA)

The International Standard IEC 62443

- Overview of the International Standard ISA/IEC 62443
- Basic Terminology
- Security of Industrial Networks: Security Programme, the Automation Solution Security Lifecycle, Security Levels and Maturity Levels, Security Objectives and Foundational Requirements, Defence-in-Depth Principle, Threat-Risk Assessment, Security Zones and Conduits
- Product Security: Risk-based Approach and Relationship to the Cyber Resilience Act, Security Levels and Functional Requirements, Secure Development Lifecycle

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Practical study achievement

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
none

Learning outcomes

- Students understand the architecture and cybersecurity challenges of modern vehicles, including the basics of E/E architectures.
- Students are familiar with the essentials of risk management and threat modelling, including terminology, standards and methods for conducting threat analysis and risk assessment (TARA) in both automotive and industrial contexts.
- Students are familiar with fundamental cybersecurity protection concepts for industrial control systems (ICS), understand the differences between OT and IT, understand the terminology and concepts of the IEC 62443 standard, and are aware of relevant guidelines and new European regulations.
- Students are capable of performing comprehensive threat analysis and risk assessment (TARA) for automotive systems and industrial/operational technology (OT) environments, identifying vulnerabilities and evaluating risks.
- Students are able to manage and develop the deliverables of automotive development projects in accordance with the international standard ISO/SAE 21434.
- Students can design and implement secure network architectures for industrial systems, applying principles such as zoning, Zero Trust and defence-in-depth.
- Develop analytical, structured and logical thinking skills to systematically evaluate and address cybersecurity challenges in both automotive and industrial contexts.
- Enhance abstraction skills to understand and apply complex cybersecurity concepts, standards and risk management techniques.

Literature

- N. Ferguson, B. Schneier, T. Kohno, “Cryptography Engineering – Design Principles and Practical Applications”, Wiley, 2010
- C. Paar, J. Pelzl, “Understanding Cryptography – A Textbook for Students and Practitioners”, Springer, 2010
- M. Rosulek, “The Joy of Cryptography”, 2021. URL: https://joyofcryptography.com
- L. Van Houtven, “Crypto 101”, 2013. URL: https://www.crypto101.io
- C. Smith, “The Car Hacker’s Handbook: A Guide for the Penetration Tester”, 1st edn. No Starch Press, San Francisco, 2016
- M. Wurm, “Automotive Cybersecurity: Security Components for Automotive Embedded Systems”, Springer Berlin Heidelberg, Berlin, Heidelberg, 2022
- A. Shostack, “Threat Modelling: Designing for Security”, 1st ed. Wiley Publishing, 2014
- ISO/SAE 21434:2021, “Road vehicles – Cybersecurity engineering”, International Standard
- R. do Carmo, A. Schlensog, “Automotive Threat Analysis and Risk Assessment in Practice”, Springer, 2024
- IEC 62443 International Series of Standards (Parts 1-1 to 4-2)
- The MITRE Corporation, MITRE ATT&CK®. URL https://attack.mitre.org/
- OWASP Foundation, “OWASP Top Ten”. URL https://owasp.org/www-project-top-ten/

- C. Brooks, P. Craig, “Practical Industrial Cybersecurity – ICS, Industry 4.0, and IIoT”, Wiley, 2022
- P. Kobes, “Guideline Industrial Security: IEC 62443 is easy”, VDE Verlag, 2023
- NIST SP 800-82r3, “Guide to Operational Technology (OT) Security”, 2023
- P. Ackermann, “Industrial Cybersecurity – Second Edition: Efficiently monitor the cybersecurity posture of your ICS environment”, Packt Publishing, 2021

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Module: 5103500
Bachelor Thesis / Bachelor Seminar

Module profile

Exam number
5103500

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
1

ECTS-Credits (CP)
15.0

Workload
Guided study time:
Presence time: 40 hrs

Self-study: 410 hrs

Total: 450 hrs

Teaching format
Seminar

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Prof. Dr. Arndt Balzer,
Prof. Dr. Peter Braun,
Prof. Dr. Frank Deinzer,
Prof. Dr. Isabel John,
Prof. Dr. Frank-Michael Schleif,
Prof. Dr. Christian Bachmeir,
Prof. Dr.-Ing. Sebastian Biedermann,
Prof. Dr.-Ing. Pascal Meißner,
Prof. Dr. Benjamin Weggenmann

Applicability	BIN
Semester according to SPO	7. semester
Type of module	Compulsory module

Required prerequisites for the participation in the module according to the SPO
120 ECTS credits from the first two years of study, practical module, professional skills, project work

Recommended prerequisites for the participation in the module
none

Content
The Bachelor's thesis module comprises the Bachelor's thesis (12 CP) and the Bachelor's seminar (3 CP).

The Bachelor's thesis includes, amongst other things, the student's own studies and research into the state of the art in the relevant subject area. In particular, the thesis must abstract from constraints which, by their very nature, are not technically justified but arise from the specific circumstances of the company or organisation. Where software-based solutions are required as part of the assignment, this generally means that prototypes are to be implemented as part of the Bachelor's thesis; however, this does not include ensuring product specifications (including accompanying manuals, etc.).

In the traditional degree programme, the topics for the practical examples forming part of the assessment are provided by the lecturer or agreed with them. In the dual study programme, a task from a real-world business context is undertaken in consultation with the lecturer.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
None

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Thesis, Presentation

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
None

Learning outcomes
Through their Bachelor's dissertation or seminar, the student demonstrates that they are capable of independently tackling a challenging task in computer science (which may be interdisciplinary), that they have mastered the methodological and academic principles of the subject, and that they can present the results appropriately.

Students on the dual study programme are assigned a topic relating to or arising from their respective partner company. The task is set by the supervising professor at THWS.

Literature
Depending on the topic set; the Bachelor's thesis must be written to an academic standard, i.e. the relevant literature must be thoroughly reviewed, utilised and cited in accordance with the topic.

Module: 5003848
Big Data Analytics

Module profile

Exam number
5003848

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Isabel John

Lecturer(s)
Prof. Dr. Rajesh Ramachandran

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
- Basic programming knowledge (Java/Python)
- Previous experience with databases and Linux is recommended

Content
This comprehensive course provides an in-depth introduction to Big Data technologies, focusing on Hadoop and its ecosystem. Participants will learn core concepts such as the Big Data 4 Vs, types of analytics and Hadoop architecture, followed by hands-on programming skills using MapReduce, Hadoop Streaming, Pig, Hive and Kafka. The modules combine theoretical knowledge with practical projects, including real-world case studies and an integrated data pipeline, preparing learners to handle large-scale data processing and analytics.
The course covers the following content:
- Understanding Big Data concepts, including the 4 Vs and types of analytics
- Overview of the Hadoop ecosystem and architectural components
- Programming with MapReduce using Java, including advanced techniques
- Developing Hadoop Streaming applications with Python/Shell scripts
- Exploring real-world case studies and mini-projects to gain practical experience
- Data analysis using Pig Latin and scripting operators
- Building data warehousing solutions using Hive and HiveQL
- Learning about Kafka's architecture, key topics and data pipeline integration
- Hands-on exercises with HDFS, YARN, Pig, Hive and Kafka
- Final project focusing on designing an end-to-end data processing pipeline

The course combines on-site teaching in Würzburg (one week in October) with online teaching for the remainder of the semester

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
none

Learning outcomes
Upon successful completion of this module, students will be able to:

- LO1: Explain the fundamental characteristics of Big Data systems and analytics.
- LO2: Use Hadoop HDFS and carry out distributed storage and processing.
- LO3: Implement MapReduce programmes using Java, including advanced features such as distributed caches and joins.
- LO4: Use Pig Latin and HiveQL for high-level querying of large datasets.
- LO5: Demonstrate an understanding of real-time streaming using Apache Kafka.
- LO6: Develop integrated solutions using multiple components of the Hadoop ecosystem.

Literature
Tom White, *Hadoop: The Definitive Guide* (2012), O'Reilly
Garry Turkington, Hadoop Beginner's Guide (2013), Packt Publishing
Pethuru Raj et al., High-Performance Big Data Analytics (2015), Springer
Official Apache Docs: Hadoop, Pig, Hive, Kafka (2018)

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Module: 5003188
Blockchain and Smart Contracts

Module profile

Exam number
5003188

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Tobias Fertig

Lecturer(s)
Prof. Dr.-Ing. Tobias Fertig

Applicability	BEC, BIN, BWI, BDGD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
In this module, students gain a deep understanding of blockchain technology and smart contracts. After learning the basics, students are divided into teams to develop prototypes for suitable use cases. By the end of the module, students are able to evaluate use cases and implement them in practice.

The following content is covered:
- Evaluating use cases
- How blockchains work
- How the various consensus models work
- Introduction to contract-oriented programming
- Introduction to Solidity and suitable development environments
- Introduction to programming smart contracts
- Testing and debugging smart contracts
- Common design patterns for smart contracts
- Deployment and management of smart contracts
- Basics of decentralised applications (DApps)
- Frameworks for programming DApps
- Development of DApps
- Deployment of DApps
- Testing of DApps

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
none

Learning outcomes
1. Students recall the basic concepts of blockchain technology and its functionalities.
2. Students understand the principles and functioning of smart contracts and their significance within the blockchain ecosystem.
3. Students apply the Solidity programming language to develop and implement smart contracts.
4. Students develop decentralised applications (DApps) for the Ethereum blockchain and integrate smart contracts.
5. Students analyse security vulnerabilities in smart contracts and are able to formulate and implement strategies to mitigate these risks.

Literature
https://www.rheinwerk-verlag.de/blockchain-the-comprehensive-guide-to-blockchain-development-ethereum-solidity-and-smart-contracts/

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 100000
Business Intelligence and Reporting

Module profile

Exam number
100000

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 0 hrs

Self-study: 150 hrs

Total: 150 hrs

Teaching format
Lecture

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Frank-Michael Schleif

Lecturer(s)

Applicability	BEC, BIN, BWI
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
This is a programme offered by the Virtual University of Bavaria.
Further information:
https://kurse.vhb.org/VHBPORTAL/kursprogramm/kursprogramm.jsp?kDetail=true&COURSEID=20773,84,1508,1

Recommended prerequisites for the participation in the module
This is a programme offered by the Virtual University of Bavaria.
Further information:
https://kurse.vhb.org/VHBPORTAL/kursprogramm/kursprogramm.jsp?kDetail=true&COURSEID=20773,84,1508,1

Content
This module currently replaces the 'Business Intelligence' course in the Business Technologies specialisation.
As such, it can only be selected once, either as a FWPM or (exclusively) for the 'Business Intelligence' course.
If the BT specialisation is chosen, the module is recognised as Specialisation I.

This is a course offered by the Virtual University of Bavaria. Further information:
https://kurse.vhb.org/VHBPORTAL/kursprogramm/kursprogramm.jsp?kDetail=true&COURSEID=20773,84,1508,1

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
This is a programme offered by the Virtual University of Bavaria.
Further information:
https://kurse.vhb.org/VHBPORTAL/kursprogramm/kursprogramm.jsp?kDetail=true&COURSEID=20773,84,1508,1

Literature
This is a programme offered by the Virtual University of Bavaria.
Further information:
https://kurse.vhb.org/VHBPORTAL/kursprogramm/kursprogramm.jsp?kDetail=true&COURSEID=20773,84,1508,1

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003804
Cloud Native Enterprise Java

Module profile

Exam number
5003804

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Rolf Schillinger

Lecturer(s)
Matthias Reining

Applicability	BEC, BIN, BWI
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Programming skills in Java

Content
This course covers the fundamentals of Jakarta EE (https://jakarta.ee/), also known by its former name, Java EE (EE: Enterprise Edition).
The course focuses on the development of modern cloud-native enterprise applications, organised into the following subject areas:

- General requirements for business applications
- Web services (JAX-RS – RESTful Web Services)
- Enterprise software patterns (CDI – Context and Dependency Injection)
- Data persistence (JPA – Java Persistence API)
- Use of microservice architecture patterns (via Microprofile https://microprofile.io/)
- Different runtimes (on-premises and cloud)

The majority of the topics will be demonstrated and discussed directly using source code and live-coding examples.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

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

- Distinguish between terms such as Java, Java EE and Jakarta EE, and contextualise buzzwords from the Java Enterprise world.
- efficiently implement applications in different runtime environments based on the Jakarta EE APIs
- design and implement microservice architectures using Jakarta EE / Quarkus
- use Docker in the Jakarta EE / Quarkus environment
- analyse Docker cloud deployments.

Literature
https://eclipse-ee4j.github.io/jakartaee-tutorial/
https://jakarta.ee/
https://microprofile.io/
https://www.adam-bien.com/roller/abien/

Module: 5003082
Computer Graphics

Module profile

Exam number
5003082

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Frank Deinzer

Lecturer(s)
Prof. Dr. Frank Deinzer

Applicability	BIN, BWI, BISD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Linear Algebra, knowledge of C++

Content
Theoretical topics
- Mathematical foundations of computer graphics
- Fundamentals of physically based lighting
- Ray tracing

Algorithmic topics
- Overview of fundamental computer graphics algorithms
- Lighting
- Texturing
- Shadows
- Volume rendering

Practical topics
- Computer graphics with OpenGL
- Implementation of ray tracing
- Shader programming

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Colloquium

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
Students broaden and deepen their knowledge in the field of 'computer graphics' and acquire the ability to analyse and structure complex problems.
Students understand problems in the field of 'computer graphics', analyse them and develop solutions.
As part of their assignments, students apply their knowledge in practical situations.
Students develop high-performance computer graphics applications.
Students understand the mathematical principles underlying computer graphics.

Literature
Foley, van Dam, Feiner: Fundamentals of Computer Graphics. Introduction, Concepts, Methods. Addison Wesley, 1999
Zeppenfeld, K.: Textbook of Graphics Programming: Fundamentals, Programming, Applications. Spektrum Akademischer Verlag, 2003
Peter Shirley: Fundamentals of Computer Graphics. AK Peters LTD, 3rd edition, 2009
Hearn, Baker, Carithers: Computer Graphics with OpenGL. Prentice Hall, 4th edition, 2010
Matt Pharr, Greg Humphreys: Physically Based Rendering, Second Edition: From Theory to Implementation, Morgan Kaufmann, 2010

Module: 5003814
Digital Accessibility

Module profile

Exam number
5003814

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Tobias Aubele

Lecturer(s)
Joschi Kuphal

Applicability	BEC, BIN, BWI, BDGD, BISD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Experience in the design and/or development of web applications (HTML, CSS, JavaScript)

Content
The event is divided into theoretical and practical sections, each with a specific focus on digital accessibility:

- Fundamentals of digital accessibility, design and development models
- Types of disability, assistive technologies and adaptation strategies
- Types and mechanisms of barriers, and the allocation of responsibilities
- Relevant standards, norms and legislation supporting accessibility in national and international contexts
- Strategies for implementing accessible design and development processes
- Identifying, reducing and avoiding barriers in digital media: the web, documents (e.g. MS Word, MS PowerPoint, PDF, e-books), and audiovisual media (e.g. video, audio)
- Conceptualisation, design, implementation and testing of accessible web applications
- Setting up and using screen readers and other assistive technologies

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
Students are familiar with various conceptual and design approaches associated with accessibility, and understand their similarities and differences.

- They are familiar with the most common types of disability and can characterise the prevailing models of understanding in society and academia.
- They understand demographic trends and are familiar with the key statistics on disability worldwide, in Europe and in Germany.
- They can identify various types of barriers that arise when interacting with digital products. They are familiar with assistive technologies and adaptation strategies for overcoming these barriers.
- You are familiar with the standards, norms and laws relevant to accessibility at various levels (global, European, D-A-CH) and understand how they relate to one another.
- You have internalised the benefits of accessible design at a personal, societal and business level and are familiar with strategies for implementing and embedding accessibility within organisations and development processes.
- You understand the barriers that can arise in various digital media (the web, documents, multimedia systems, e-books, apps, software, terminals, etc.) and are familiar with the principles, techniques and tools for identifying, reducing and preventing barriers.
- You will have in-depth knowledge of the conception, design and implementation of accessible web applications; you will be able to evaluate them for accessibility and be familiar with relevant testing tools and methods.
- You have the skills to check, assess and correct digital documents for accessibility, as well as to create accessible documents independently.
- You are familiar with the use of common screen readers on different platforms and are able to set up a suitable testing environment for assessing web and other applications.

Literature

- Alexander, Kerstin (2019) — Image & Type: Communicating Accessibly through Typography and Images, Frank & Timme
- Aubele, Tobias; Gierke, Detlef (2025) — Accessible Websites, Rheinwerk Verlag
- Kalbag, Laura (2017) — Accessibility for Everyone, A Book Apart
- Matuzović, Manuel (2024) — Web Accessibility Cookbook: Creating Inclusive Experiences, O'Reilly
- Miller, Susi (2021) — Designing Accessible Learning Content, Kogan Page
- Pickering, Heydon (2018) — Inclusive Components: The Book, Smashing
- Silver, Adam (2018) — Form Design Patterns, Smashing

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003830
Introduction to SAP Business Technology Platform

Module profile

Exam number
5003830

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Frank Hennermann

Lecturer(s)
Christian Fink

Applicability	BIN, BWI
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
SAP user skills

Content
- What is the SAP Business Technology Platform (SAP BTP)?
- History of SAP BTP
- SAP's strategy for SAP BTP
- How is the BTP structured?
- What services does SAP BTP include?
- Technical aspects of SAP BTP
- Overview of SAP BTP use cases such as side-by-side extension, clean core, integration, analytics and AI, low-code/no-code
- Reference architectures with and without S/4HANA

SAP BTP Customisation
- Basic customisation
- Roles and authorisations
- Setting up sample applications

o A first app in SAP BTP
o Configuring the Work Zone
o Clean Core with S/4HANA
o Setting up an integration scenario
o Initial integration of generative AI

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
1. Students are familiar with the fundamental concepts and definitions of the SAP Business Technology Platform (SAP BTP) and its historical development.
2. Students understand the strategic significance of SAP BTP and its role in the context of corporate digitalisation strategies.
3. Students explain the structure and architecture of SAP BTP, as well as the services it contains and their functions.
4. Students apply basic customisation techniques to adapt SAP BTP to specific use cases.
5. Students analyse various areas of application for the SAP BTP, such as side-by-side extensions, integration and analytics, as well as low-code/no-code approaches.
6. Students evaluate reference architectures for the SAP BTP, including its integration with S/4HANA and the development of integration scenarios.

Literature
SAP Business Technology Platform – Administration, Martin Koch, Siegfried Ziegler, Rheinwerk-Verlag, Bonn 2024, ISBN 978-3-367-10020-0.
SAP Integration Suite, Jan Arensmeyer, Enrico Hegenbart, Rheinwerk-Verlag, Bonn 2024, ISBN 978-3-8362-9933-6
Enterprise Content Management with SAP, Christian Fink, Rheinwerk-Verlag, Bonn 2019, ISBN 978-3-8362-6524-9

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003851
Ethical Hacking (Blended Intensive Program)

Module profile

Exam number
5003851

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr.-Ing. Tobias Fertig

Lecturer(s)
Prof. Dr.-Ing. Tobias Fertig, Franziska Königer

Applicability	BIN, BWI, BEC, BISD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
n/a

Recommended prerequisites for the participation in the module
Before the course unit, learners/students are expected to have a basic understanding of computer networking, Linux and programming, as well as the fundamentals of machine learning and artificial intelligence.

Content
This intensive ethical hacking training programme focuses on ethical hacking techniques and practices. The 2025 programme is geared towards network and AI security, and typically covers topics such as attacks on AI systems, penetration testing, vulnerability assessment, IDS, packet analysis, various testing and hacking tools, and defensive strategies. Participants can expect hands-on training and real-world simulations to enhance their ethical hacking skills. Team-based learning approaches will be utilised. A competition will take place at the end. By the end of the programme, participants should be equipped with the knowledge and tools needed to carry out ethical hacking assessments, identify security weaknesses, and recommend solutions to strengthen cyber security defences.

This course will be delivered as a Blended Intensive Programme comprising several online sessions and a study trip to Kaunas, Lithuania.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
n/a

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
n/a

Learning outcomes

- The students explain the fundamental ethical and legal principles of ethical hacking and establish effective guidelines for teamwork.
- The students present their technical findings clearly, both orally and in writing, to a variety of audiences.
- Students build a controlled simulation environment (cyber range) to practise and test their skills safely.
- Students analyse full packet captures using Wireshark to extract protocols, traffic flows and indicators.
- Students classify common cybersecurity attacks and select appropriate tools for safe reproduction and analysis.
- Students design basic penetration tests and interpret IDS outputs to assess detection and response.
- Students evaluate vulnerabilities in AI systems and propose defence strategies against adversarial attacks.
- Students plan a continuous-learning roadmap, selecting tools and resources that build knowledge and self-confidence.

Literature
This will be announced during the lesson.

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003827
Governance, Risk, Compliance and Ethics (FWPM)

Module profile

Exam number
5003827

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Kristin Weber

Lecturer(s)
Prof. Dr. Kristin Weber,
Prof. Dr. Markus Oermann

Applicability	BIN, BWI, BEC
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
ISM Standards & Processes

Content
Many individuals and units, both within and outside organisations, are involved in the management of information security. Governance ensures that transparency, accountability and efficiency are guaranteed by establishing structures, responsibilities and framework conditions, whilst at the same time safeguarding the interests of all stakeholders. This module outlines the stakeholders involved in information security management, how responsibilities are defined, decisions are made and optimal conditions are created to ensure maximum information security.

The identification and assessment of IT risks helps organisations to address threats to information security in a targeted and structured manner. The risk-based approach is adopted in many ISMS (Information Security Management System) frameworks. This module covers the fundamentals of IT risk management, including measures for identifying, analysing, assessing and addressing IT risks within a structured risk management process.

The section on ethics explains essential conceptual foundations of moral philosophy. Drawing on established schools of ethics, it examines the normative justification of (information) security as a value and a guiding principle for action. The examination of models for integrating ethical considerations into development and system design processes bridges the gap to the practical application of ethical principles. In this context, issues of compliance with current data protection legislation are also of particular relevance. Following an overview of its basic structures, the focus is on the requirements for technical and organisational data protection, as well as on the enforcement of the law and the consequences of legal breaches. Finally, the fundamentals of the reformed information security legislation are explained.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

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

- identify and specifically design fundamental governance mechanisms (e.g. responsibilities, guidelines, decision-making processes, committees) in the context of information security.
- describe relevant roles and stakeholders in information security management both within and outside organisations, and outline their tasks in detail.
- explain the significance and function of IT risk management for information security and illustrate this using practical examples.
- Identify and describe the organisational framework for effective IT risk management.
- Understand, apply and document a simple, structured IT risk management process.
- Recognise ethical challenges in dealing with digital systems that have security implications and develop approaches to integrating ethical principles into work processes.
- Explain the basic structures of data protection law and answer fundamental questions regarding data protection compliance.
- Describe the key elements of information security law and assess their relevance to business practice.
- Communicate effectively with legal or regulatory experts on issues relating to data protection and information security law.
- reflect on the interrelationships between governance, risk and compliance management, and ethics in security-critical IT environments.

Literature
Green, J.: Information Security Management Principles. 4th ed., BCS, 2024. (esp. ch. 1 to 3)
Harich, T.: IT Security Management – The Comprehensive Practical Handbook, 4th ed., mitp, 2025.
Harkins, M.: Managing Risk and Information Security: Protect to Enable. 2nd ed., Apress, 2016.
Johannsen, A.; Kant, D.: IT Governance, Risk and Compliance Management (IT-GRC) – A Competence-Oriented Approach for SMEs. In: HMD – Praxis der Wirtschaftsinformatik, 57, 2020, pp. 1058–1074. https://doi.org/10.1365/s40702-020-00625-8
Kersten, H. et al.: IT Security Management in accordance with the new ISO 27001 – ISMS, Risks, Key Performance Indicators, Controls. 2nd, updated edition, Springer-Verlag, 2020.
Lang, M.; Löhr, H.: IT Security – Technologies and Best Practices for Implementation in Organisations. 2nd, revised edition, Hanser, 2024.
Lewinski/Rüpke/Eckhardt (2022): Data Protection Law. 2nd edition. Munich, C.H. Beck.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003868
Internet of Things

Module profile

Exam number
5003868

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Christian Bachmeir

Lecturer(s)
Prof. Dr. Christian Bachmeir

Applicability	BIN, BISD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
- Architectures and concepts of IoT systems
- Hardware platforms and sensors
- Communication technology for IoT
- IoT software platforms, cloud integration
- Security and privacy for IoT
- Practical development of an IoT prototype in the laboratory:
- Design, build and evaluation
- Demonstration of the prototype and oral presentation at the end of the course
- Documentation

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
Students will be familiar with the key fundamentals, components and processes of IoT systems. Participants will gain an insight into architectures, hardware platforms, communication technology, protocols, programming (device and cloud) and security concepts.
Students explain how individual components and processes function within IoT systems. They can describe and explain how architectures, protocols and security concepts interrelate.
Students can apply the fundamentals they have learnt to problem situations and put suitable IoT components into practice. As part of the course, they develop an IoT prototype to gain hands-on experience of what they have learnt.
Students are able to make specific statements about systems, identify differences and distinguish between different systems.
Students can make informed decisions regarding the use of various IoT systems. They are able to evaluate the advantages and disadvantages of specific architectures, protocols or platforms.
By developing the IoT prototype, students design their own system that integrates different components and processes.

Literature
- [CLOUD] C. Fehling, F. Leymann, R. Retter, W. Schupeck, P. Arbitter, *Cloud Computing Patterns: Fundamentals to Design, Build, and Manage Cloud Applications*, 2014, Springer, ISBN: 978-3709115671

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Faculty of Computer Science and Business Information Systems
Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 6322290
Project-related geovisualization VI (deep sea VR)

Module profile

Exam number
6322290

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Project

Language of instruction
German

Organisation

Responsible lecturer
Stefan Sauer

Lecturer(s)
Stefan Sauer

Applicability	BIN, BWI, BISD, BDGD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
An interest in games
Experience with Unreal
Creating small VR applications
Basic experience with Blender or 3ds Max

Content
In Project-Based Geovisualisation VI, a deep-sea scenario is being developed using the Unreal game engine, with the aim of exploring the scenario from inside a submersible in the MAVEL multi-projection VR laboratory.
The focus is on independent project work using Unreal, 3ds Max and Blender in the areas of modelling, animation, shaders, scripting, particle systems, rendering and project management.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Presentation

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
By taking part in this module, students will be able to examine and apply selected topics from the field of geovisualisation using practical examples and exercises, thereby broadening and deepening their knowledge. Participants will be able to assess, evaluate and compare the results of their practical work and present them in a manner tailored to specific topics and target audiences.

Literature
varies depending on the project

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003170
Project Management and Strategic Management

Module profile

Exam number
5003170

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Eva Wedlich

Lecturer(s)
Prof. Dr. Eva Wedlich,
Manuela Ziegler

Applicability	BEC, BIN, BWI
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
'IT Project Management' or 'Project Management' and 'Fundamentals of Economics' or 'Fundamentals of Business Administration'

Content
This course consists of a two-day 'Project Management' simulation game (SysTeams by RIVA) and a two-day 'Strategic Management' simulation game (Global Strategy).
Structure:
I. Introduction to FWPM (organisational matters),

II. Part 1: Block course 'Project Management'

Content: Project management simulation game 'SysTeamsProject' by Riva.
The simulation game models a project management process from initial contact with the client through to the successful completion of the project. Working in small teams, participants define, plan and manage the project, and also implement it themselves. Numerous project management tools are available to aid effective planning, e.g.:

- Objectives plan
- Project structure plan
- Milestone plan
- Gantt chart
- Project reports
- Risk analyses

The project is divided into several phases, during which participants must tackle various project management tasks and work packages whilst taking available resources into account.

III. Introduction to 'Strategic Management'

IV. Part 2: Block course 'Strategic Management'

Content: Global Strategy is an intensive general management simulation. Over the course of several rounds, participants develop a success strategy for their company. The importance of strategic management for business success and the interrelationships within business administration are recognised and understood.

Content and programme:

- Profit and loss account, balance sheet

- Business and liquidity planning
- Costing
- Contribution margin analysis
- Cost management
- Break-even analysis
- Financing
- Marketing
- Investment analysis
- Balanced scorecard
- SWOT analysis
- Value-based corporate management
- Investment analysis
- Balanced scorecard
- SWOT analysis
- Value-based corporate management

V. Review

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes

- Students understand the principles and methods required for the effective planning and execution of projects, as well as for the management of a

business.

- Students apply the knowledge they have learnt in realistic, simulated projects in order to gain practical experience.
- Students analyse the results of each phase of the project and each financial year to identify strengths and weaknesses.
- Students evaluate the effectiveness of the strategies implemented in project management and business leadership on the basis of the

simulation results.

- Students develop new strategies for future simulation periods, based on the insights gained from previous phases.
- Students reflect on their experiences in the business simulation games in order to set personal and team-related learning objectives for future challenges.

Literature
The workbook and supplementary reading material will be provided during the course.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003826
Social Engineering and Security Awareness

Module profile

Exam number
5003826

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
English

Organisation

Responsible lecturer
Prof. Dr. Kristin Weber

Lecturer(s)
Prof. Dr. Kristin Weber,
David Henkelmann

Applicability	BEC, BWI, BIN
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
The module 'Social Engineering and Security Awareness' focuses on the human factor in information security. People play a decisive role in information security within organisations through their behaviour – they are a key security factor. Because of this influence, they are increasingly targeted by cybercriminals. The module examines the human factor in information security in general and two aspects in particular – the security factor and the victim.

The Human Factor in Information Security:
- The roles of people in information security
- Insider threats
- Reasons for non-compliant behaviour

Information security awareness refers to raising employees' awareness of information security (security factor):
- Security awareness concepts and models
- Psychological understanding of awareness
- Practical examples of awareness measures
- Promoting and measuring security awareness – turning employees into security factors
- Security awareness maturity models

Social engineering is the targeted manipulation of people in order to persuade them to take unintended actions (victims):
- Forms and tools of social engineering
- Psychological Tactics Used by Social Engineers
- The Social Engineering Attack Cycle, including Information Gathering
- Phishing and Phishing Simulations

The course utilises group work and interactive elements, and provides opportunities for hands-on experience (in both attacking and defending against the human factor).

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
English

Condition for the award of credit points
none

Learning outcomes
Students view people as a solution rather than a problem for information security.
They explain the role of the human factor in information security using examples.
The students are familiar with and can identify the principles of social engineering and can explain them using examples.
They can name different forms of phishing and discuss the advantages and disadvantages of phishing simulations.
They understand what information security awareness means and are familiar with methods to enhance the various aspects of awareness.
Students can develop awareness measures in a targeted and personalised manner.

Literature
Beißel, S.: Security Awareness, De Gruyter, 2019.
Cialdini, R.: Influence – The Psychology of Persuasion, Collins Business, 2007.
Hadnagy, C. (with Schulman, S.): Human Hacking – Win Friends, Influence People, and Leave Them Better off for Having Met You, Harper Business, 2021.
Helisch, M.; Pokoyski, D. (eds.): Security Awareness – New Approaches to Successful Employee Awareness, Vieweg+Teubner, 2010.
Schroeder, J.: Advanced Persistent Training, Apress, 2017.
Verplanken, B. (ed.): The Psychology of Habit – Theory, Mechanisms, Change, and Context, Springer, 2018.
Weber, K.: People and Information Security, Hanser, 2024.
Weber, K.; Schütz, A.; Fertig, T.: Fundamentals and Applications of Information Security Awareness, SpringerVieweg, 2019.
Take Aware Sec&Life Magazine, https://www.take-aware-events.com/news-post/magazinesecandlife

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003109
Data Protection - Technical Aspects

Module profile

Exam number
5003109

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Kristin Weber

Lecturer(s)
Prof. Dr. Alexander Schinner, Christian Wolff

Applicability	BIN, BWI
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
Based on an overview of the current legal framework governing the protection of personal data and the definitions of informational self-determination and privacy, the course discusses in detail the fundamental types of protection concepts, along with the relevant technologies and protective measures applicable in each case.
The following key topics are covered:

- Fundamental protection and assurance objectives in the field of information security and data protection
- Technical and organisational measures for implementing the objectives/requirements
- Measures for access control
- Data protection-related functions on mobile devices
- Security and data protection in cloud computing and big data analytics
- Specific privacy-preserving technologies

The second part addresses technical aspects of data and system protection. The aim of the course is to examine attacks on data from various perspectives. These include, amongst others, the perspective of those who wish to store data securely, those who wish to detect or investigate attacks, but also the perspective of the attacker themselves.
The course covers the following core topics:

- Cyber Kill Chain and MITRA Att&ck Framework
- Cryptography
- Steganography
- Attacks on cryptography
- Quantum key exchange
- Authentication
- Passwords
- Zero-knowledge proofs
- Attacks
- Blockchain
- Fundamentals
- Attacks
- NFTs
- Ordinals
- Forensics

- Fundamentals
- Evidence preservation
- Carving

Practical demonstrations on the topics of incident response and cryptography will complement the event.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
The learning objective of this module is to teach the fundamental requirements of data protection in Germany and the resulting measures in the field of information security and the protection of personal data. The focus is on technical aspects.
Upon successful completion of the module, students will be able to:

- Understand terms such as 'information security', 'data protection', 'informational self-determination', 'privacy' and 'anonymity', and distinguish between them
- Analyse legal and normative requirements with regard to the protection and assurance objectives they entail, and apply them to a given context
- Derive technical and organisational measures from these requirements, assessing their suitability for implementing protection and assurance objectives and evaluating their protective effect
- To be familiar with and understand the functioning of fundamental technologies and procedures in the field of information security and data protection (e.g. procedures relating to anonymisation, encryption, authentication, communication security, incident detection and response, and security testing), including the associated potential vulnerabilities and attack vectors
- To develop a protection concept for a given scenario or application context (e.g. protecting the data of a website or an end device) in which these measures are implemented

Literature
Bibliography:
Eckert, Claudia: IT Security: Concepts – Methods – Protocols, Oldenbourg Wissenschaftsverlag, 10th ed., 2018
Schwenk, Jörg: Security and Cryptography on the Internet: From Secure Email to IP Encryption, Vieweg+Teubner Verlag, 4th ed., 2014
Schneier, Bruce: Secrets & Lies. IT Security in a Networked World, dpunkt.verlag/Wiley, 2001
Blog: http://www.schneier.com

Module: 5003872
Topics of Socioinformatics

Module profile

Exam number
5003872

Duration
1 semester

Frequency
Irregular

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr. Markus Oermann

Lecturer(s)
Prof. Dr. Markus Oermann

Applicability	BISD, BWI, BIN
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Successful completion of the module ‘Introduction to Socioinformatics’

Content
The module ‘Topics in Socio-Informatics’ is designed to provide in-depth practice in the skills required for the analysis of socio-technical digital systems, using current examples and discourses. To this end, the content of this module is adapted each year to reflect the latest societal and academic discourses on the topic of digitalisation. At the start of the semester, participants determine which discourses to examine in consultation with the lecturer. To this end, participants map out the landscape of available sources on current topics in socioinformatics and the digital society, and then analyse these to identify which themes are currently shaping the discourse. Building on this, the participants make a selection in consultation with the lecturer. Working independently in small groups, the participants develop the background knowledge for a discourse of their choice, identifying the key concepts, the issues under discussion and specific examples of application. The results of this group work are presented and discussed in the seminar. They also serve as the basis for the assessment (portfolio).

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
none

Learning outcomes
Students
- gain an overview of the discourse surrounding current topics in socio-informatics and the digital society.
- expand their personal repertoire of sources for reliable information on these topics.
- gain in-depth knowledge, based on the topics they have studied, of the issues, key concepts and societal challenges associated with the digital transformation, whilst at the same time developing their skills in analysing socio-informatics systems.
- assess at least one socio-technical system using a small-group-based methodological approach, thereby deepening key skills for the remainder of their studies, such as for project work in the 6th semester.

Literature
Zweig, Katharina A./Krafft, Tobias D./Klingel, Anita/Park, Enno (2021): Socioinformatics: A New Perspective on Computer Science and Society, (1st ed.). Carl Hanser, Munich.
Nassehi, Armin (2019): Patterns: A Theory of Digital Society (2nd ed.). C.H.Beck, Munich.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003876
General Management

Module profile

Exam number
5003876

Duration
1 semester

Frequency
Every semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr.-Ing. Anne Heß

Lecturer(s)
Patrick Kalisch

Applicability	BIN, BWI, BEC, BDGD, BISD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
The Business Management module covers the following key topics:

1. Understanding the fundamentals of business management
- The concept and functions of business management
- Distinguishing between management, leadership and organisation
- The role of business management within the overall organisational system
- Corporate objective systems: economic, social and environmental objectives
- Business management as a process of decision-making, control and coordination

2. Understanding and applying corporate objectives and objective systems
- Types of objectives: substantive objectives, formal objectives and secondary/sub-objectives
- Goal hierarchies and conflicting goals
- Goal-setting within the organisation
- Operationalisation and measurability of goals
- Key performance indicator-based goal management

3. Understanding and applying strategic corporate management
- The concept of strategy and strategic thinking
- Analysis of the external environment and the organisation
- Competitive strategies
- Growth, differentiation and cost strategies
- Strategy development, implementation and monitoring

4. Understanding and applying business management analytical tools
- SWOT analysis
- PESTEL analysis
- Industry analysis and competitive analysis
- Portfolio approaches
- Use of key performance indicators and management tools to support decision-making

5. Understanding organisational design and organisational structure
- Basic principles of organisation

- Functional, procedural and process organisation
- Forms of organisation: functional, divisional, matrix, project and process organisation
- Advantages and disadvantages of different organisational structures
- The influence of organisational structure on leadership and communication

6. Understanding leadership styles, leadership behaviour and motivation
- The concept of leadership and leadership tasks
- Traditional and modern leadership styles
- Leadership behaviour in different business contexts
- Motivation theories, e.g. Maslow, Herzberg, Vroom
- Leading staff, delegation and feedback

7. Understanding and applying decision-making and problem-solving in management
- Decision-making processes and decision-making logic
- Rational versus intuitive decision-making
- Methods of problem analysis and creativity techniques
- Risks, uncertainty and decision quality

8. Understanding Change Management and Organisational Development
- Causes and triggers of change processes
- Phases of change processes
- Resistance to change
- Methods of organisational development

9. Understanding sustainable business management and corporate governance
- Sustainability as a management principle
- ESG criteria and social responsibility
- Corporate Social Responsibility (CSR)
- Good governance, compliance and ethical leadership
- Engaging with stakeholders and long-term value creation

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
1. Fundamentals of Business Management
Students can explain the fundamental tasks, concepts and objectives of business management and contextualise their significance for the management of organisations.

2. Business Objectives and Objective Systems
Students can analyse different types of objectives and conflicts of interest, as well as develop and evaluate systems of objectives for organisations.

3. Strategic Management
Students can describe and contextualise strategic approaches, competitive strategies and the process of strategy development and implementation.

4. Analytical tools in business management
Students can apply common analytical tools such as SWOT or PESTEL and utilise their findings to inform strategic decisions.

5. Organisational design and organisational structure
Students can compare and evaluate organisational forms and structures, and apply them to practical business situations.

6. Leadership Styles, Leadership Behaviour and Motivation
Students can explain leadership styles and motivation theories, and derive measures for effective staff management.

7. Management Control and Business Management
Students can explain the functions of management control and utilise fundamental tools for planning, monitoring and managing businesses.

8. Change Management and Organisational Development
Students can identify change processes, resistance and success factors in change management and derive appropriate measures.

9. Sustainable Business Management and Corporate Governance
Students can assess sustainable, ethical and governance-related aspects of business management and apply them to operational decisions.

Literature
To be announced during the course.

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Module: 5003873
From Software Craftsmanship to AI-powered software

Module profile

Exam number
5003873

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German/English

Organisation

Responsible lecturer
Prof. Dr. Peter Braun

Lecturer(s)
Prof. Dr. Peter Braun, Prof. Dr. Isabel John, Prof. Dr.-Ing. Tobias Fertig, Christine Zilker

Applicability	BIN, BWI, BEC, BISD, BDGD
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
Modules on Programming and Software Engineering

Content
The module examines professional software development as a progression from traditional craftsmanship principles towards AI-supported development processes. In each thematic block, the historical foundations are first explored, such as software craftsmanship, clean code, *The Pragmatic Programmer*, complexity management, module design, and deep and shallow modules. This is followed by a discussion of the significance these concepts will retain in a future where AI assistants generate, refactor and test code, and prepare design decisions. Students learn to critically evaluate tried-and-tested principles and apply them to modern tools such as prompt engineering, agentic coding and AI-assisted development. Guest contributions from industry highlight current and future application scenarios.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Multimedia presentation

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German/English

Condition for the award of credit points
none

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

- Describe key concepts and principles of software craftsmanship, clean code, pragmatic software development and AI-assisted development.
- Explain the historical evolution of professional software development, from traditional craftsmanship practices to AI-assisted development processes.
- Apply software design principles such as complexity management, modularisation, and deep and shallow modules to specific code and architectural examples.
- Analyse recommendations from *Clean Code*, *The Pragmatic Programmer* and *Software Craftsmanship* in terms of their viability, limitations and context-dependence.
- Evaluate AI-assisted development practices such as prompt engineering, code generation, refactoring support, test generation and agentic coding in terms of their risk-benefit profiles.
- Apply classical development principles to the use of AI assistants to enable better prompts, reviews, tests and design decisions.
- Develop your own approaches to professional AI-assisted software development that take into account quality standards, traceability, accountability and the critical review of generated artefacts.

Literature

- Ousterhout, John. A Philosophy of Software Design. 2nd ed., Yaknyam Press, 2021.
- Hunt, Andrew, and David Thomas. The Pragmatic Programmer: Your Journey to Mastery. 20th Anniversary Edition, Addison-Wesley, 2019.
- Mancuso, Sandro. The Software Craftsman: Professionalism, Pragmatism, Pride. Prentice Hall, 2014.
- Martin, Robert C. Clean Code: A Handbook of Agile Software Craftsmanship. Prentice Hall, 2008.
- Kuhlen, Rainer. The Consequences of Information Assistants: What Does Informational Autonomy Mean, and How Can Trust in Electronic Services Be Ensured in Open Information Markets? Suhrkamp, 1999.
- Taulli, Tom. AI-Assisted Programming: Better Planning, Coding, Testing, and Deployment. O'Reilly Media, 2024.
- Kofler, Michael, Bernd Öggl, and Sebastian Springer. AI-Assisted Coding: The Practical Guide for Software Development. Rheinwerk Computing, 2025.
- Pereira, Sergio. Generative AI for Software Development. O'Reilly Media, 2025.
- Huyen, Chip. AI Engineering: Building Applications with Foundation Models. O'Reilly Media, 2025.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003834
Web-Intelligence

Module profile

Exam number
5003834

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Rolf Schillinger

Lecturer(s)
Dr.-Ing. Benedikt Kämpgen

Applicability	BEC, BIN, BWI
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content

- Methods and technologies for the systematic, and as far as possible automated, collection and analysis of business-relevant information from the Internet, in particular from the World Wide Web
- Web Intelligence as a form of 'data discovery/acquisition via the web',
- to enable better decision-making and
- to develop more useful web applications.
- Practical insights into the following topics:
- Data analytics (e.g. Pivot, OLAP, data warehousing, BigQuery),
- Web applications (e.g. low-code, AppSheet, MediaWiki),
- Data Lake (e.g. Big Data, NoSQL, Cloud, SaaS, MapReduce),
- Graph Data (e.g. Knowledge Graph, Semantic Web, Reasoning),
- Text data (e.g. natural language processing, large language models, ChatGPT),
- Internet of Things (e.g. sensors, actuators, micro:bit),
- Artificial Intelligence (e.g. machine learning, responsible AI).

Each session consists of approximately 50 per cent lecture and 50 per cent practical work.
The course content is delivered through lectures and presentations. Students are encouraged to study the relevant literature and engage critically with the topics.
In addition to the lecturer, up to two external speakers will give talks based on practical experience.
During the practical sessions, students will work in groups to answer specific questions and analyse real-world examples. To complete the practical sessions, students must have their own laptop or one laptop per group.
Course slides, sample solutions to the practical exercises and additional material are made available on the THWS e-learning platform (https://elearning.fhws.de).
A portfolio assessment will be used to award credit points. Students will be set 6–8 portfolio tasks, which they may complete in 1–3-page documents by pre-determined deadlines.

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Other exam (soP) according to §§ 26, 27 APO

Examination - length/format
Portfolio

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

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

- Identify suitable data sources and data on the web, and use analysis tools to compare data.
- Identify systems on the web and apply low-code systems to their own projects.
- Illustrate the challenge of big data and apply possible solutions.
- Identify and compare text and graph data, and demonstrate their benefits.
- To illustrate the Internet of Things.
- To apply artificial intelligence to data on the web. To discuss further use cases for artificial intelligence on the web.

Literature
Jiming Liu, Ning Zhong, Yiyu Yao, and Zbigniew W. Ras. 'The Wisdom Web: New Challenges for Web Intelligence (WI)'. *Journal of Intelligent Information Systems*. 2003.
Tom Heath and Christian Bizer. Linked Data: Evolving the Web into a Global Data Space. Vol. 1. Morgan & Claypool. 2011.
Sergey Melnik, Andrey Gubarev, Jing Jing Long, Geoffrey Romer, Shiva Shivakumar, Matt Tolton, Theo Vassilakis, Hossein Ahmadi, Dan Delorey, Slava Min, Mosha Pasumansky, and Jeff Shute. Dremel: A Decade of Interactive SQL Analysis at Web Scale. PVLDB. 2020.

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Technical University of Applied Sciences Würzburg-Schweinfurt

Module: 5003874
Business and IT Law

Module profile

Exam number
5003874

Duration
1 semester

Frequency
Every winter semester

Credit hours (SWS)
4

ECTS-Credits (CP)
5.0

Workload
Guided study time:
Presence time: 60 hrs

Self-study: 90 hrs

Total: 150 hrs

Teaching format
Seminar-style instruction

Language of instruction
German

Organisation

Responsible lecturer
Prof. Dr. Oliver Ehret

Lecturer(s)
Prof. Dr. Oliver Ehret

Applicability	BIN
Semester according to SPO	7. semester
Type of module	FWPM

Required prerequisites for the participation in the module according to the SPO
none

Recommended prerequisites for the participation in the module
none

Content
General Contract Law
Specific Contract Law relating to IT, specific types of contract; fundamentals of copyright law
Overview of relevant areas of industrial property law; law relating to the internet
Data protection law

Examination

Required prerequisites for the participation in the examination according to the SPO appendix
none

Examination - type
Written exam (sP) according to § 23 APO

Examination - length/format
90 minutes

The concrete length/format of the examination will be determined in the study plan.

Language of examination
German

Condition for the award of credit points
none

Learning outcomes
To provide an understanding of the law, the fundamental legal concepts of our legal system and its basic structures; to give an overview of the role the law plays for computer scientists. Understanding the essential principles of general private and public law; understanding and classifying IT-related legal terms; gaining an overview of the key IT-relevant areas of law and contractual matters; Identifying, assessing and mitigating legal risks; developing practical skills in dealing with IT-related legal issues and becoming familiar with basic types of contracts in the IT sector; acquiring an understanding of the fundamentals of copyright law, particularly in relation to software and databases; understanding the principles of data protection, particularly in the IT sector.
The importance of data protection law, particularly in an international context, is highlighted. In this regard, emphasis is also placed on conveying how closely computer science, the architecture of IT systems, information security and data protection are interlinked.

Literature
Köhler, The German Civil Code, dtv, 89th edition, 2022
Schneider: IT and Computer Law, 15th edition, Beck dtv, Munich, 2022.
Kallwass, Abels: Private Law, Franz Vahlen Publishers, Munich, 24th edition, 2021
Hoeren: IT Contract Law, 2nd edition, Otto Schmidt Publishers, Cologne, 2012.
Marly: Practical Handbook on Software Law, 7th edition, C.H. Beck, Munich 2018.
Härting: Internet Law, 7th edition, Otto Schmidt Publishers, Cologne 2022.
Hoeren: Lecture Notes on Internet Law, University of Münster, as at April 2020
Haug: Fundamentals of Internet Law, W. Kohlhammer, 3rd edition, 2016
Redeker: IT Law, C.H. Beck, 7th edition, 2020
Schneider: Handbook on IT Law, Otto Schmidt, 5th edition, 2017
Kühling, Sack, Hartmann: Data Protection Law, 5th edition, C.F. Müller, 2021