# MODULE HANDBOOK

**Bachelor of Science**

## Bachelor Cloud Computing (FS-OI-EU-BACCO)

**180 CP**

**Distance Learning**

INTERNATIONAL
UNIVERSITY OF
APPLIED SCIENCES

Classification: Undergraduate

www.iu.org

# Contents

5. Semester

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6. Semester

# 1. Semester

# Introduction to Computer Science

**Module Code: DLBCSICS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Carsten Skerra (Introduction to Computer Science)

**Contributing Courses to Module**

- Introduction to Computer Science (DLBCSICS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Information representation
- Algorithms and data structures
- Propositional logic / Boolean algebra
- Hardware
- Networks and the internet
- Software
- Computer science as a discipline

| Learning Outcomes | |
|---|---|
| **Introduction to Computer Science**<br>On successful completion, students will be able to<br>▪ understand basic algorithms and data structures.<br>▪ apply basic constructs of propositional logic in programming.<br>▪ describe the structure of computer hardware systems.<br>▪ specify the structure and the main services of the internet.<br>▪ discuss professional conduct in computer science. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development. | All Bachelor Programs in the IT & Technology field. |

# Introduction to Computer Science

**Course Code: DLBCSICS01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

The goal of this course is to provide an introduction to computer science and its main concepts. It covers basic topics such as information representation and an introduction to algorithms and data structures. Propositional logic and Boolean algebra are also introduced, both of which form an important basis in computer science, e.g., for expressing conditions in programming.Furthermore, the course introduces the three main components of computing infrastructures: hardware, networks, and software. Finally, the course covers the meta level by looking at the role of computer science as a discipline as well as ethics and professional conduct.

**Course Outcomes**

On successful completion, students will be able to

- understand basic algorithms and data structures.
- apply basic constructs of propositional logic in programming.
- describe the structure of computer hardware systems.
- specify the structure and the main services of the internet.
- discuss professional conduct in computer science.

**Contents**

1. Basic concepts of data processing
   - 1.1 Data, information and messages
   - 1.2 Software, firmware and hardware
   - 1.3 Languages, syntax and semantics
   - 1.4 Historical overview
2. Information representation
   - 2.1 Number representation formats
   - 2.2 Representation of non-numerical information
   - 2.3 Data types
   - 2.4 Redundancy and error tolerance
3. Algorithms and data structures
   - 3.1 Algorithms and flow diagrams

3.2 Simple data structures
3.3 Searching and sorting
3.4 Quality of algorithms (correctness, termination, efficiency/complexity)

4. Propositional logic, Boolean algebra and circuit design
   4.1 Propositions and logical conclusions
   4.2 Conjunctive and disjunctive normal form
   4.3 Digital circuit design

5. Hardware and computer architectures
   5.1 Computer types and their architecture
   5.2 Processors and memory
   5.3 Input and output
   5.4 Interfaces and drivers
   5.5 High-performance computing

6. Networks and the internet
   6.1 Wired and wireless networks and their topologies
   6.2 The TCP/IP and the ISO/OSI model
   6.3 Internet structure and services
   6.4 The internet of things

7. Software
   7.1 BIOS and operating systems
   7.2 Application software and information systems
   7.3 Apps
   7.4 Embedded systems
   7.5 Software development

8. Computer Science as a discipline
   8.1 The role and sub-disciplines of computer science
   8.2 Artificial intelligence, data science and computer science
   8.3 Ethical aspects of computer science
   8.4 The ACM Code of Ethics and Professional Conduct

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Dale, N., & Lewis, J. (2020). Computer science illuminated (7th ed.). Jones & Bartlett Learning.<br>▪ Downey, A. B., & Mayfield, C. (2020). Think Java: How to think like a computer scientist. O'Reilly.<br>▪ Filho, W. F. (2018). Computer science distilled: Learn the art of solving computational problems. Code Energy LLC.<br>▪ Petzold, C. (2000). Code: The hidden language of computer hardware and software. Microsoft Press.<br>▪ Whitington, J. (2016). A machine made this book: Ten sketches of computer science. Coherent Press. |

### Study Format myStudies

| Study Format | Course Type |
| --- | --- |
| myStudies | Lecture |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
| --- | --- | --- |
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Online Tests |
| | ☑ Audio | |
| | ☑ Slides | |

### Study Format Distance Learning

| **Study Format**<br>Distance Learning | **Course Type**<br>Online Lecture |
|---|---|

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study**<br>90 h | **Contact Hours**<br>0 h | **Tutorial/Tutorial Support**<br>30 h | **Self Test**<br>30 h | **Independent Study**<br>0 h | **Hours Total**<br>150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

# Cloud Computing

**Module Code: DLBDSCC**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Tianxiang Lu (Cloud Computing)

**Contributing Courses to Module**

- Cloud Computing (DLBDSCC01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Cloud computing fundamentals
- Relevant enabling technologies for cloud computing
- Introduction to serverless computing
- Established cloud platforms
- Cloud offerings for data science and analytics

| Learning Outcomes | |
|---|---|
| **Cloud Computing**<br>On successful completion, students will be able to<br>▪ understand the fundamentals of cloud computing and cloud service models.<br>▪ recognize enabling technologies that underlie current cloud offerings.<br>▪ cite the principles of serverless computing.<br>▪ analyze characteristics of established cloud offerings.<br>▪ describe cloud options for data science and machine learning | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the fields of Data Science & Artificial Intelligence | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# Cloud Computing

**Course Code: DLBDSCC01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

Many of the recent advances in data science, particularly machine learning and artificial intelligence, rely on comprehensive data storage and computing power. Cloud computing is one way of providing that power in a scalable way, without considerable upfront investment in hardware and software resources. This course introduces the area of cloud computing together with its enabling technologies. Moreover, the most cutting-edge advances like serverless computing and storage are illustrated. Finally, a thorough overview on popular cloud offerings, especially in regard to analytics capabilities, is given.

**Course Outcomes**

On successful completion, students will be able to

- understand the fundamentals of cloud computing and cloud service models.
- recognize enabling technologies that underlie current cloud offerings.
- cite the principles of serverless computing.
- analyze characteristics of established cloud offerings.
- describe cloud options for data science and machine learning

**Contents**

1. Introduction to Cloud Computing
   - 1.1 Fundamentals of Cloud computing
   - 1.2 Cloud Service Models
   - 1.3 Benefits and Risks

2. Enabling Technology
   - 2.1 Virtualization and Containerization
   - 2.2 Storage Technology
   - 2.3 Networks and RESTful Services

3. Serverless Computing
   - 3.1 Introduction to Serverless Computing
   - 3.2 Benefits
   - 3.3 Limitations

4. Established Cloud Platforms
   - 4.1 General Overview
   - 4.2 Google Cloud Platform
   - 4.3 Amazon Web Services
   - 4.4 Microsoft Azure
   - 4.5 Platform Comparison

5. Data Science in the Cloud
   - 5.1 Provider-independent services and tools
   - 5.2 Google Data Science and Machine Learning Services
   - 5.3 Amazon Web Services Data Science and Machine Learning Services
   - 5.4 Microsoft Azure Data Science and Machine Learning Services

**Literature**

**Compulsory Reading**

**Further Reading**

- Goessling, S., & Jackson, K. L. (2018). Architecting cloud computing solutions. Birmingham: Packt Publishing.
- Mahmood, Z., Puttini, R., & Erl, T. (2013). Cloud computing: Concepts, technology & architecture. Boston, MA: Prentice Hall.
- Sehgal, N. K., & Bhatt, P. C. P. (2023). Cloud Computing with Security and Scalability: Concepts and Practices.
- Zonooz, P. Farr, E., Arora, K., & Laszewski, T. (2018). Cloud native architectures. Birmingham: Packt Publishing.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Online Tests |
| | ☑ Audio | |
| | ☑ Slides | |

### Study Format Distance Learning

| **Study Format**<br>Distance Learning | **Course Type**<br>Online Lecture |
|---|---|

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study**<br>90 h | **Contact Hours**<br>0 h | **Tutorial/Tutorial Support**<br>30 h | **Self Test**<br>30 h | **Independent Study**<br>0 h | **Hours Total**<br>150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

# Introduction to Academic Work

**Module Code: DLBCSIAW**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Brigitte Huber (Introduction to Academic Work)

**Contributing Courses to Module**

- Introduction to Academic Work (DLBCSIAW01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Basic Workbook (passed / not passed)<br>Study Format: Distance Learning<br>Basic Workbook (passed / not passed) | |

**Weight of Module**

see curriculum

**Module Contents**

- Scientific Theoretical Foundations and Research Paradigms
- Application of Good Scientific Practice
- Methodology
- Librarianship: Structure, Use, and Literature Management
- Forms of Scientific Work at IU

| Learning Outcomes | |
| --- | --- |
| **Introduction to Academic Work**<br>On successful completion, students will be able to<br>▪ understand and apply formal criteria of a scientific work.<br>▪ distinguish basic research methods and identify criteria of good scientific practice.<br>▪ describe central scientific theoretical basics and research paradigms and their effects on scientific research results.<br>▪ use literature databases, literature administration programs, and other library structures properly; avoid plagiarism; and apply citation styles correctly.<br>▪ apply the evidence criteria to scientific texts.<br>▪ define a research topic and derive a structure for scientific texts.<br>▪ compile a list of literature, illustrations, tables, and abbreviations for scientific texts.<br>▪ understand and distinguish between the different forms of scientific work at IU. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Methods | **Links to other Study Programs of the University**<br>All Bachelor Programs in the Business & Management field |

# Introduction to Academic Work

**Course Code: DLBCSIAW01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

The application of good scientific practice is one of the basic academic qualifications that should be acquired while studying. This course deals with the distinction between everyday knowledge and science. This requires a deeper understanding of the theory of science, as well as the knowledge of basic research methods and instruments for writing scientific texts. The students therefore gain initial insight into academic research and are introduced to the basic knowledge that will help them in the future to produce scientific papers. In addition, the students receive an overview of the different IU examination forms and insight into their requirements and implementation.

**Course Outcomes**

On successful completion, students will be able to

- understand and apply formal criteria of a scientific work.
- distinguish basic research methods and identify criteria of good scientific practice.
- describe central scientific theoretical basics and research paradigms and their effects on scientific research results.
- use literature databases, literature administration programs, and other library structures properly; avoid plagiarism; and apply citation styles correctly.
- apply the evidence criteria to scientific texts.
- define a research topic and derive a structure for scientific texts.
- compile a list of literature, illustrations, tables, and abbreviations for scientific texts.
- understand and distinguish between the different forms of scientific work at IU.

**Contents**

1. Theory of Science
   - 1.1 Introduction to Science and Research
   - 1.2 Research Paradigms
   - 1.3 Fundamental Research Decisions
   - 1.4 Effects of Scientific Paradigms on Research Design

2. Application of Good Scientific Practice
   - 2.1 Research Ethics
   - 2.2 Evidence Teaching

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Bell, J., & Waters, S. (2018). Doing your research project: A guide for first-time researchers (7th ed.). Open University Press McGraw-Hill Education.<br>▪ Deb, D., Dey, R., & Balas, V. E. (2019). Engineering research methodology: A practical insight for researchers. Springer.<br>▪ Saunders, M., Lewis, P., & Thornhill, A. (2019). Research Methods for Business Students (8th ed.). Pearson.<br>▪ Veal, A. J. (2018). Research Methods for Leisure and Tourism (5th ed.). Pearson. |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Basic Workbook (passed / not passed) |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests<br>☑ Guideline |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Basic Workbook (passed / not passed) |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Ses-sions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Online Tests<br>☑ Guideline |

# Techniques and methods for agile software development

**Module Code: IWNF1_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Jörn Fahsel (Techniques and methods for agile software development)

**Contributing Courses to Module**

- Techniques and methods for agile software development (IWNF01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

| **Module Contents** | |
|---|---|
| ▪ Characteristics and Principles of Agility<br>▪ Agility in Small Teams with SCRUM<br>▪ Agile Project Management<br>▪ Agile Requirements and Software Architecture Management<br>▪ Agile Testing<br>▪ Agile Delivery and Deployment | |
| **Learning Outcomes**<br>**Techniques and methods for agile software development**<br>On successful completion, students will be able to<br>▪ analyse and evaluate problems and risks of industrial SW development and their consequences for development processes.<br>▪ know and understand the basic principles of No-Frills Software Engineering.<br>▪ analyse practical scenarios and independently apply suitable methods and tools of No-Frills Software Engineering. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science & Software Development | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# Techniques and methods for agile software development

**Course Code: IWNF01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

| |
|---|
| **Course Description** |
| The goal of the course is to give students a deeper insight into the topic of agile software development. First of all, the basic characteristics and principles of agility are presented and discussed. Afterwards, it is shown how small projects and teams can use agile software engineering and how agile principles can be transferred and applied to large projects. Afterwards, agile techniques are taught for selected core activities in software engineering, with a focus on testing, delivery and deployment. |

**Course Outcomes**

On successful completion, students will be able to

- analyse and evaluate problems and risks of industrial SW development and their consequences for development processes.
- know and understand the basic principles of No-Frills Software Engineering.
- analyse practical scenarios and independently apply suitable methods and tools of No-Frills Software Engineering.

**Contents**

1. Characteristics and Principles of Agility
   - 1.1 Features and Challenges of Software Projects
   - 1.2 Classification of Uncertainty
   - 1.3 Comparison of Agile and Classic Software Development
   - 1.4 Principles of Agility

2. Agility in Small Teams with Scrum
   - 2.1 Basics of SCRUM
   - 2.2 Central Management Artifact: Product Backlog
   - 2.3 Other Management Artifacts abd Tools

3. Agile Project Management
   - 3.1 Planning Levels in Agile Project Management

3.2 Agile Portfolio Management
3.3 Organization of Several Teams in One Project
3.4 Product and Release Planning

4. Agile Requirements and Software Architecture Management
   4.1 Requirements Engineering in Agile Projects
   4.2 Architecture Management in Agile Projects

5. Agile Testing
   5.1 Basic Principles and Requirements for the Quality Assurance Organization
   5.2 Test Levels and Agility
   5.3 Test Automation

6. Agile Delivery and Deployment
   6.1 Continuous Delivery Pipeline
   6.2 Continuous Build and Continuous Integration
   6.3 Acceptance Tests, Load Tests and Continuous Deployment

**Literature**

**Compulsory Reading**

**Further Reading**


- Biffl, S. et al. (Hrsg.) (2005): Value-Based Software Engineering. Springer, Berlin/Heidelberg.
- Highsmith, J. (2009): Agile Project Management: Creating Innovative Products. Addison Wesley, Upper Saddle River, NJ.
- Layton, M. C. (2012): Agile project management for dummies. John Wiley & Sons, New York, NY.
- Rubin, K. S. (2012): Essential Scrum: A Practical Guide to the Most Popular Agile Process. Addison Wesley, Upper Saddle River, NJ.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Project: Agile Software Engineering

**Module Code: IWNF2_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| Martin Ejeagwu (Project: Agile Software Engineering) |

| Contributing Courses to Module |
|---|
| ▪ Project: Agile Software Engineering (IWNF02_E) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br><u>Study Format: Distance Learning</u><br>Written Assessment: Project Report | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

| Module Contents |
|---|
| Realization and documentation of projects using agile techniques as well as consolidation of selected topics in the field of agile software development. |

<table>
<tr><td colspan="2">Learning Outcomes<br><br>Project: Agile Software Engineering<br><br>On successful completion, students will be able to<ul><li>address typical problems in various project situations through the targeted use of agile techniques and methods.</li><li>document the design and project-specific use of techniques and tools.</li></ul></td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Computer Science & Software Development</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the IT & Technology field</td></tr>
</table>

# Project: Agile Software Engineering

**Course Code: IWNF02_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | None |

| **Course Description** |
|---|
| Building on their knowledge of agile software development, students in this course independently implement projects in this subject area and document their results in the form of a written paper. |
| **Course Outcomes** |
| On successful completion, students will be able to<br>▪ address typical problems in various project situations through the targeted use of agile techniques and methods.<br>▪ document the design and project-specific use of techniques and tools. |
| **Contents** |
| ▪ Implementation and documentation of a project using agile techniques as well as deepening of knowledge in the field of agile software development. |

| **Literature** |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Beck, K., Beedle, M., Van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001). Principles behind the Agile manifesto.<br>▪ Forsgren, N., Humble, J., & Kim, G. (2018) Accelerate: The Science Behind Devops: Building and Scaling High Performing Technology Organizations.<br>▪ Raps, S. J. (2017). Scrum of Scrums: Scaling up Agile to create efficiencies, reduce redundancies. Defense AT&L, 46(5), 34—37.<br>▪ Schwaber, K., & Sutherland, J. (2020). The Scrum guide. The definitive guide to Scrum: The rules of the game. Kenn Schwaber and Jeff Sutherland.<br>▪ Tanner, M., & Dauane, M. (2017). The use of Kanban to alleviate collaboration and communication challenges of global software development. Issues in Informing Science & Information Technology, 14, 177—197. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Slides | ☑ Guideline |

# 2. Semester

# Mathematics I

**Module Code: DLBCSM1**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Veronica Mas (Mathematics I)

**Contributing Courses to Module**

- Mathematics I (DLBCSM101)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes<br><br>Study Format: myStudies<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Basic definitions and terms of discrete mathematics
- Sets and propositional logic
- Number systems such as decimal and binary systems
- Graphs and mappings
- Selected topics of elementary number theory
- Cryptography

<table>
<tr><td colspan="2">Learning Outcomes<br><br>Mathematics I<br><br>On successful completion, students will be able to<br>▪ understand basic terms of discrete mathematics as well as describe them and distinguish them from each other.<br>▪ understand concepts of number theory and their application in IT and technology and be able to solve tasks independently by applying these concepts.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Methods.</td><td>Links to other Study Programs of the University<br>All Bachelor Programmes in the Business & Management field.</td></tr>
</table>

# Mathematics I

**Course Code: DLBCSM101**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

Many practical concepts in IT and technology are based on the findings of discrete mathematics. For an in-depth understanding of, for example, data structures, the construction of communication networks, or of solutions to algorithmic problems, a basic understanding of their mathematical background is necessary. This course therefore introduces discrete mathematical terms and concepts, with specific areas of number theory also taught.

**Course Outcomes**

On successful completion, students will be able to

- understand basic terms of discrete mathematics as well as describe them and distinguish them from each other.
- understand concepts of number theory and their application in IT and technology and be able to solve tasks independently by applying these concepts.

**Contents**

1. Mathematical Basics
   - 1.1 Basic Concepts
   - 1.2 Proof Techniques
   - 1.3 Finite Sums

2. Sets
   - 2.1 Properties and Calculation Rules for Sets
   - 2.2 Equivalence Relations

3. Propositional Logic
   - 3.1 Statements and Logical Connections
   - 3.2 Truth Tables
   - 3.3 Computational Rules of Propositional Logic
   - 3.4 Simplification of Expressions in Propositional Logic

4. Number Systems
   - 4.1 Decimal System

4.2 Binary System
4.3 Hexadecimal System

5. Mappings
   5.1 Mappings and Graphs
   5.2 Special Properties of Mappings

6. Basic Algebraic Structures
   6.1 Groups
   6.2 Rings
   6.3 Residual Class Rings

7. Prime Numbers
   7.1 Definition and Properties of Prime Numbers
   7.2 Prime Number Test

8. Modular Arithmetic
   8.1 The Euclidean Algorithm
   8.2 Fundamental Theorem of Arithmetic

9. Applications in Cryptography
   9.1 The Shift Cryptosystem
   9.2 Symmetric vs Asymmetric Cryptosystems
   9.3 The RSA Cryptosystem

**Literature**

**Compulsory Reading**

**Further Reading**

- Rosenthal, D., Rosenthal, D., Rosenthal, P. (2018). A Readable Introduction to Real Mathematics (2nd ed.). Springer.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Review Book<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Review Book<br>☑ Online Tests |

# Database Modeling and Database Systems

**Module Code: DLBCSDMDS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Carsten Skerra (Database Modeling and Database Systems)

**Contributing Courses to Module**

- Database Modeling and Database Systems (DLBCSDMDS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Fundamentals of Relational Databases
- Simple Database Queries
- Entity/Relationship (E/R) Diagrams
- Database Development
- Complex Database Queries Across Multiple Tables
- Changing Data in Databases
- NoSQL Database Systems

| Learning Outcomes | |
|---|---|
| **Database Modeling and Database Systems**<br>On successful completion, students will be able to<br>▪ describe the basic concepts of the relational data model and distinguish them from each other.<br>▪ visually model data schemas.<br>▪ know SQL queries, read data from databases, change the data stock, and have experience in their use.<br>▪ design, create, and modify SQL queries and data schemas for SQL databases, and have experience using them.<br>▪ independently design database schemas and create database queries to solve concrete problems.<br>▪ know the most important NoSQL concepts and distinguish them from each other. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Data Science & Artificial Intelligence | All Bachelor Programs in the IT & Technology field. |

# Database Modeling and Database Systems

**Course Code: DLBCSDMDS01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

## Course Description

Stored data form the basis of many value chains of an information and knowledge society. The methodical structuring of data through data schemas therefore forms an important basis for storing information in such a way that it can be retrieved and processed quickly and easily. In addition to the structured storage of data, structured access to large amounts of data must also be possible.This course teaches students how to store data in relational data models and how to access stored data with SQL. In addition to relational database systems, modern DB systems (NoSQL) for storing and accessing data will be presented.

## Course Outcomes

On successful completion, students will be able to

- describe the basic concepts of the relational data model and distinguish them from each other.
- visually model data schemas.
- know SQL queries, read data from databases, change the data stock, and have experience in their use.
- design, create, and modify SQL queries and data schemas for SQL databases, and have experience using them.
- independently design database schemas and create database queries to solve concrete problems.
- know the most important NoSQL concepts and distinguish them from each other.

## Contents

1. Fundamentals of Relational Databases
   - 1.1 Basic Concepts of the Relational Data Model
   - 1.2 Find and Delete Records in the Database
   - 1.3 SQL and Relational Database Systems

2. Querying Data from a Single Table
   - 2.1 Query Data (SELECT)
   - 2.2 Query Data With Condition (WHERE)
   - 2.3 Sort Query Output (ORDER BY)
   - 2.4 Queries With Group Formation (GROUP BY)

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Elmasri, R., & Navathe, S. (2017). Fundamentals of database systems (Seventh edition, global edition). Pearson.<br>▪ Foster, E. C., & Godbole, S. V. (2016). Database systems: a pragmatic approach (2nd ed.). Apress.<br>▪ Esakkirajan, S., & Sumathi, S. (2007). Fundamentals of relational database management systems [electronic resource] : Springer.<br>▪ C. J. Date. (2019). Database Design and Relational Theory : Normal Forms and All That Jazz: Vol. Second edition. Apress.<br>▪ Date, C.J. (2019). Database design and relational theory: Normal forms and all that jazz (2nd ed.). Apress.<br>▪ W3Schools (2020). SQL Tutorial. |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
| --- | --- |
| Distance Learning | Online Lecture |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
| --- | --- | --- |
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Big Data Technologies

**Module Code: DLBDSBDT**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLBCSDMDS01 | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| Prof. Dr. Christian Müller-Kett (Big Data Technologies) |

| Contributing Courses to Module |
|---|
| ▪ Big Data Technologies (DLBDSBDT01) |

| Module Exam Type | |
|---|---|
| **Module Exam** | **Split Exam** |
| <u>Study Format: Distance Learning</u><br>Exam, 90 Minutes<br><u>Study Format: myStudies</u><br>Exam, 90 Minutes | |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Data types and data sources
- Text-based and binary data formats
- Distributed systems
- Streaming frameworks
- NoSQL approach to data storage

| Learning Outcomes |
|---|
| **Big Data Technologies**<br>On successful completion, students will be able to<br>▪ name types and sources of data.<br>▪ understand text-based and binary data formats.<br>▪ analyze the requirements and constraints of distributed analysis systems.<br>▪ evaluate the applications of streaming frameworks.<br>▪ describe the motivation for NoSQL data stores and categorize pertaining established concepts. |

| Links to other Modules within the Study Program | Links to other Study Programs of the University |
|---|---|
| This module is similar to other modules in the field of Data Science & Artificial Intelligence | All Bachelor Programs in the IT & Technology field |

# Big Data Technologies

**Course Code: DLBDSBDT01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | DLBCSDMDS01 |

**Course Description**

Data are often considered the “new oil”, the raw material from which value is created. To harness the power of data, the data need to be stored and processed on a technical level. This course introduces the four “Vs” of data, as well as typical data sources and types. The course discusses the most common data storage formats encountered in modern systems, focusing both on text-based as well as binary data formats.Handling large amounts of data poses significant challenges for the underlying infrastructure. The course discusses the most important distributed and streaming data handling frameworks which are used in leading edge applications.

**Course Outcomes**

On successful completion, students will be able to

- name types and sources of data.
- understand text-based and binary data formats.
- analyze the requirements and constraints of distributed analysis systems.
- evaluate the applications of streaming frameworks.
- describe the motivation for NoSQL data stores and categorize pertaining established concepts.

**Contents**

1. Data Types and Data Sources
   - 1.1 The 4Vs of data: volume, velocity, variety, veracity
   - 1.2 Data sources
   - 1.3 Data types

2. Text-Based and Binary Data Formats
   - 2.1 Simple formats: CSV, YAML
   - 2.2 XML
   - 2.3 JSON
   - 2.4 Hierarchical data format 5 (HDF 5)
   - 2.5 Apache Parquet
   - 2.6 Apache Arrow

3. NoSQL data stores
   3.1 Introduction and motivation
   3.2 Approaches and technical concepts
4. Distributed Systems
   4.1 Hadoop & MapReduce
   4.2 Hadoop file system (HDFS)
   4.3 Spark
   4.4 DASK
5. Streaming Frameworks
   5.1 Spark streaming
   5.2 Kafka

**Literature**

**Compulsory Reading**

**Further Reading**


- Kleppmann, M. (2017). Designing data-intensive applications: the big ideas behind reliable, scalable, and maintainable systems. O'REILLY.
- White, T. (2015) Hadoop: The Definitive Guide. O’REILLY.

## Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Introduction to the Internet of Things

**Module Code: DLBINGEIT_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Marian Benner-Wickner (Introduction to the Internet of Things)

**Contributing Courses to Module**

- Introduction to the Internet of Things (DLBINGEIT01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes<br><br>Study Format: myStudies<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Internet of Things Fundamentals
- Social and Economic Significance
- Communication Standards and Technologies
- Data Storage and Processing
- Design and Development
- Applicability

| **Learning Outcomes** | |
|---|---|
| **Introduction to the Internet of Things**<br>On successful completion, students will be able to<br>▪ grasp the distinctive features of Internet of Things (IoT) and IoT systems.<br>▪ understand the social and economic importance of Internet of Things.<br>▪ identify the most important standards for communication between IoT devices.<br>▪ differentiate between various techniques for storing and processing data in IoT systems.<br>▪ identify different architectures and technologies for structuring IoT systems.<br>▪ recognize challenges of data protection and data security in IoT systems. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science & Software | **Links to other Study Programs of the University**<br>All Bachelor Programmes in the IT & Technology field |

# Introduction to the Internet of Things

**Course Code: DLBINGEIT01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

The aim of this course is to give students an insight into technical and theoretical basics of the Internet of Things (IoT) and its fields of application. In addition to the general structure of IoT systems and the technology standards used in them, students are also taught the importance of Internet of Things for economy and society. Furthermore, this course demonstrates how data is exchanged, stored and processed in IoT.

**Course Outcomes**

On successful completion, students will be able to

- grasp the distinctive features of Internet of Things (IoT) and IoT systems.
- understand the social and economic importance of Internet of Things.
- identify the most important standards for communication between IoT devices.
- differentiate between various techniques for storing and processing data in IoT systems.
- identify different architectures and technologies for structuring IoT systems.
- recognize challenges of data protection and data security in IoT systems.

**Contents**

1. Internet of Things Fundamentals
   - 1.1 The Internet of Things - Basics and Motivation
   - 1.2 Evolution of the Internet - Web 1.0 to Web 4.0

2. Social and Economic Significance
   - 2.1 Innovations for Consumers and Industry
   - 2.2 Implications on People and the World of Work
   - 2.3 Data Protection and Data Security

3. Communication Standards and Technologies
   - 3.1 Network Topologies
   - 3.2 Network Protocols
   - 3.3 Technologies

4. Data Storage and Processing

4.1 Networked Storage with Linked Data and RDF(S)
4.2 Analysis of Networked Data using a Semantic Reasoner
4.3 Processing of Data Streams with Complex Event Processing
4.4 Operation and Analysis of Large Data Clusters using NoSQL and MapReduce

5. Design and Development
5.1 Software Engineering for Distributed and Embedded Systems
5.2 Architectural Patterns and Styles for Distributed Systems
5.3 Platforms: Microcontrollers, Monoboard Computers, One-Chip Systems

6. Applicability
6.1 Smart Home / Smart Living
6.2 Ambient Assisted Living
6.3 Smart Energy / Smart Grid
6.4 Smart Factory
6.5 Smart Logistics

**Literature**

**Compulsory Reading**

**Further Reading**


- Buyya, R. & Vahid Dastjerdi, A. (Hrsg.) (2016). Internet of things. Principles and paradigms. Morgan Kaufmann, Cambridge (MA).
- Dian, F. J., & Vahidnia, R. (2020). IoT use cases and technologies. British Columbia Institute of Technology.
- Firouzi, F., Chakrabarty, K., & Nassif, S. (2020). Intelligent Internet of Things: From device to fog and cloud. Springer.
- Gilchrist, A. (2016). Industry 4.0. The industrial internet of things. Apress.
- Raj, P., & Raman, A. C. (2017). The Internet of things: enabling technologies, platforms, and use cases. CRC Press.

## Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Project: Build a Data Mart in SQL

**Module Code: DLBDSPBDM**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| Prof. Dr. Silke Vaas (Project: Build a Data Mart in SQL) |

| Contributing Courses to Module |
|---|
| ▪ Project: Build a Data Mart in SQL (DLBDSPBDM01) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Portfolio<br><br>Study Format: myStudies<br>Portfolio | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- This course is about the implementation of a practical database use case employing previously-acquired knowledge on pertaining approaches and methods.

<table>
<tr><td colspan="2">

**Learning Outcomes**

**Project: Build a Data Mart in SQL**

On successful completion, students will be able to

- transfer previously-acquired knowledge about database methods and approaches to practical use cases.
- design, architect, and implement a working data-mart solution.
- reason about design choices of and trade-offs between relevant implementation alternatives.
- critically evaluate said choices with respect to the stated design goal.
- describe and explain the resulting solution.

</td></tr>
<tr><td>

**Links to other Modules within the Study Program**

This module is similar to other modules in the field of Data Science & Artificial Intelligence.

</td><td>

**Links to other Study Programs of the University**

All Bachelor Programmes in the It & Technology field.

</td></tr>
</table>

# Project: Build a Data Mart in SQL

**Course Code: DLBDSPBDM01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

### Course Description

This course provides the opportunity to implement a realistic database use case scenario. A list of use case ideas is provided on the online learning platform. In addition, the students can contribute use case ideas of their own in accord with the tutor. The core aim is to apply the hitherto theoretical knowledge of database methods and approaches to solve a real-world application scenario. This entails reasoning about possible design and architectural choices in a rational way, as well as implementing them in a functioning database system.

### Course Outcomes

On successful completion, students will be able to

- transfer previously-acquired knowledge about database methods and approaches to practical use cases.
- design, architect, and implement a working data-mart solution.
- reason about design choices of and trade-offs between relevant implementation alternatives.
- critically evaluate said choices with respect to the stated design goal.
- describe and explain the resulting solution.

### Contents

- In this course, students apply their knowledge of data modeling and databases to implement a project use case of their choosing. All relevant artefacts, like use case evaluation, chosen implementation method, code, and outcomes, are documented in the form of a written project report.

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Date, C. J. (2012). Database design and relational theory. Sebastopol, CA: O'Reilly.<br>▪ DeBarros, A. (2018). Practical SQL: A beginner's guide to storytelling with data. San Francisco, CA: No Starch Press.<br>▪ Harrington, J. L. (2016). Relational database design and implementation (4th ed.). Burlington, MA: Morgan Kaufmann.<br>▪ Hernandez, M. J. (2013). Database design for mere mortals: A hands-on guide to relational database design (3rd ed.). Boston, MA: Addison-Wesley.<br>▪ Viescas, J. (2018). SQL queries for mere mortals: A hands-on guide to data manipulation in SQL (4th ed.). Boston, MA: Addison-Wesley. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Slides | ☑ Guideline |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Slides | ☑ Guideline |

# 3. Semester

# Operating Systems, Computer Networks, and Distributed Systems

**Module Code: DLBIBRVS_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Paul Libbrecht (Operating Systems, Computer Networks, and Distributed Systems)

**Contributing Courses to Module**

- Operating Systems, Computer Networks, and Distributed Systems (DLBIBRVS01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes<br><br>Study Format: myStudies<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Operating systems
- Computer networks
- Distributed systems
- Mobile computing

| **Learning Outcomes** | |
|---|---|
| **Operating Systems, Computer Networks, and Distributed Systems**<br>On successful completion, students will be able to<br>▪ explain the basic functions of operating systems.<br>▪ compare different operating systems.<br>▪ explain and compare the OSI reference model and the TCP/IP protocol stack.<br>▪ explain the most important IP-based protocols and services and their application.<br>▪ explain and compare different architectures for distributed systems.<br>▪ explain and compare the main mobile communication networks.<br>▪ explain basic challenges of the security on the Internet and their solutions. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science & Software Development | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# Operating Systems, Computer Networks, and Distributed Systems

**Course Code: DLBIBRVS01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

| **Course Description** |
|---|
| Operating systems are a central component of computers and provide their basic functions. To an increasing extent, however, computers do not stand alone, but are integrated into networks within which data and functions of other computer systems can be accessed. This enables distributed systems in which data and functions are systematically assigned to different computers in order to perform jointly defined tasks. While in the past, the various computers were stationary, many mobile computers are now also in use, which leads to completely new application scenarios in both private and business contexts. |

**Course Outcomes**

On successful completion, students will be able to

- explain the basic functions of operating systems.
- compare different operating systems.
- explain and compare the OSI reference model and the TCP/IP protocol stack.
- explain the most important IP-based protocols and services and their application.
- explain and compare different architectures for distributed systems.
- explain and compare the main mobile communication networks.
- explain basic challenges of the security on the Internet and their solutions.

**Contents**

1. Foundations of Operating Systems
   - 1.1 Basic Structure of Computer Systems
   - 1.2 File Systems
   - 1.3 Memory Management
   - 1.4 Processes and Threads

2. Common Operating Systems
   - 2.1 Basic Concepts: Windows
   - 2.2 Basic Concepts: Unix and Linux
   - 2.3 Basic Concepts: Apple Operating Systems
   - 2.4 Mobile Operating Systems

3. Computer Networks
   - 3.1 Principles of Data Transmission
   - 3.2 The OSI Reference Model
   - 3.3 Network Topologies

4. TCP/IP And Internet
   - 4.1 Historical background
   - 4.2 TCP/IP Protocol Stack
   - 4.3 Selected IP-Based Protocols and Services
   - 4.4 Online Security

5. Architectures of Distributed Systems
   - 5.1 Client-Server Systems and Distributed Applications
   - 5.2 Basic Concepts of Distributed Systems: Concurrency, Semaphores, Deadlock
   - 5.3 Communication in Distributed Systems
   - 5.4 Service Orientation: SOA, Web Services and Microservices
   - 5.5 Cloud Applications
   - 5.6 Transactions in Distributed Systems
   - 5.7 High-Performance Computing Cluster

6. Mobile Computing
   - 6.1 Basics, Techniques and Protocols for Mobile Computing
   - 6.2 Mobile Internet and its Applications
   - 6.3 Mobile Communication Networks
   - 6.4 Security And Data Protection in Mobile Systems

**Literature**

**Compulsory Reading**

**Further Reading**


- Tanenbaum, A. S., & Bos, H. (2015). Modern operating systems (4th ed.). Pearson.
- Tanenbaum A. S., & Wetherall, D. J. (2014) . Computer networks (5th ed.). Pearson.
- van Steen, M., & Tanenbaum , A. S. (2017). Distributed systems. (3rd ed.). Pearson. Available online.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# IT Infrastructure

**Module Code: DLBSEPITI_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Marian Benner-Wickner (IT Infrastructure)

**Contributing Courses to Module**

- IT Infrastructure (DLBSEPITI01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Fundamentals of Operating Systems
- Processes
- Data-Storage
- Virtualization
- Networks
- Remote Access
- Infrastructure Provisioning

| **Learning Outcomes** | |
|---|---|
| **IT Infrastructure**<br>On successful completion, students will be able to<br>▪ understand main aspects of the operation of computers.<br>▪ manipulate and manage computer operations using shells and more visual user-interfaces.<br>▪ understand, analyze and configure simple IP network structures.<br>▪ manipulate and manage basic orchestrated sets of containers. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science & Software Development | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# IT Infrastructure

**Course Code: DLBSEPITI01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

This course describes the internal basic structure of computers and how they operate: Starting from the basic models of operating systems, the essential manipulation methods (shells and other user-interfaces) are structured and experimented. Networking basics are introduced far enough that they can be practiced. Contemporary network and virtualization structures and practices are explained so that students can experiment them on their own.

**Course Outcomes**

On successful completion, students will be able to

- understand main aspects of the operation of computers.
- manipulate and manage computer operations using shells and more visual user-interfaces.
- understand, analyze and configure simple IP network structures.
- manipulate and manage basic orchestrated sets of containers.

**Contents**

1. Fundamentals of Operating Systems
   - 1.1 The User, the Inventor, the Maker, the Developer and the Support
   - 1.2 Standard Ingredients
   - 1.3 Kernel, APIs, Application Programs
   - 1.4 WIMP
   - 1.5 REPL Shell

2. Processes
   - 2.1 Process-Scheduling, Traps and Threads
   - 2.2 Process-Management
   - 2.3 Process Security

3. Data-Storage
   - 3.1 Hard-Disk, Blocks, Formatting
   - 3.2 Files and their Manipulation
   - 3.3 Permissions of Files
   - 3.4 Data Pipes

3.5 Network Data Storage

4. Virtualization
   - 4.1 Concepts of Virtual Machines and Containers
   - 4.2 Virtual Machines
   - 4.3 Containers
   - 4.4 Sharing Resources

5. Networks
   - 5.1 Transmission Media, Commutation, Packet Switching
   - 5.2 TCP/IP and Related Communication Standards
   - 5.3 Web-Servers
   - 5.4 Public Key Cryptography
   - 5.5 Network Security

6. Remote Access
   - 6.1 Remote Shell
   - 6.2 Remote UI
   - 6.3 Web-Services
   - 6.4 Challenges of Distributed Computing

7. Infrastructure Provisioning
   - 7.1 Specification and Planning of Containers
   - 7.2 Orchestration of Containers
   - 7.3 Horizontal and Vertical Scaling
   - 7.4 Load-Testing and Monitoring

**Literature**

**Compulsory Reading**

**Further Reading**


- Albing, C., & Vossen, J. (2017). Bash cookbook (2nd ed.). O'Reilly.
- Grigorik, I. (2013). High performance browser networking. O'Reilly.
- Miell, I., & Sayers, I. A. (2016). Docker in practice. Manning Publications.
- Tanenbaum, A., & Bos, H. (2014). Modern operating systems (4th ed.). Pearson.
- Tanenbaum, A. (2010). Computer networks. Pearson.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Review Book |
| | ☑ Audio | ☑ Online Tests |
| | ☑ Slides | |

# Introduction to Low-Code Development

**Module Code: DLBDBEILCD**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

N.N. (Introduction to Low-Code Development)

**Contributing Courses to Module**

- Introduction to Low-Code Development (DLBDBEILCD01)

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Written Assessment: Case Study | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Definition of Low-Code, No-Code and Citizen Development
- Areas of Application and Advantages and Disadvantages of Low-Code Development
- Low-Code and No-Code Platforms and Vendor Landscape
- Frameworks and Patterns in Low-Code Programming
- Data Models in Low-Code Development
- User Interface Design in Low-Code Development

<table>
<tr><td colspan="2">

**Learning Outcomes**

**Introduction to Low-Code Development**

On successful completion, students will be able to

- reflect what is considered low-code, no-code and citizen development.
- approach low-code projects methodically and to evaluate the importance of business process modeling in this context.
- classify which environments and platforms exist for low-code development.
- evaluate which data models are relevant in low-code development.
- discuss which patterns are applied in low-code programming and for what purpose.
- configure applications from software modules and made them available on different end devices.

</td></tr>
<tr><td>

**Links to other Modules within the Study Program**

This module is similar to other modules in the field of Computer Science & Software Development

</td><td>

**Links to other Study Programs of the University**

All Bachelor Programs in the IT & Technology field

</td></tr>
</table>

# Introduction to Low-Code Development

**Course Code: DLBDBEILCD01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

### Course Description

Low-code programming offers considerable potential for the digitization and optimization of business processes. Thus, in the context of low-code programming, in contrast to classic software development, it is possible to create software applications without advanced programming knowledge by means of a graphical user interface. Low-code is a type of app development that uses visual, model-based development methods to reduce time to value. In the process, agile development methods enable cross-team collaboration and the rapid creation and deployment of cloud-based applications. In addition, low-code platforms reduce the burden on non-expert programmers by eliminating the need to write code, while supporting professional developers by abstracting tedious installation and infrastructure tasks during application development. Against this background, this course will explain the historical background and the conceptual foundations of low-code, no-code, and citizen development. Furthermore, the significance as well as advantages and disadvantages of the concepts will be clarified. Important platforms and the technological framework conditions are also presented. Finally, the typical phases in the low-code and no-code application lifecycle as well as important areas of application are also discussed in detail.

### Course Outcomes

On successful completion, students will be able to

- reflect what is considered low-code, no-code and citizen development.
- approach low-code projects methodically and to evaluate the importance of business process modeling in this context.
- classify which environments and platforms exist for low-code development.
- evaluate which data models are relevant in low-code development.
- discuss which patterns are applied in low-code programming and for what purpose.
- configure applications from software modules and made them available on different end devices.

### Contents

1. History and Conceptual Basics
   - 1.1 Origin and Emergence of Low-Code and No-Code Concepts
   - 1.2 Definition of the Low-Code and No-Code Concept
   - 1.3 The Major Characteristics of Today’s Low-Code and No-Code Tools

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Di Ruscio, D., Kolovos, D., Lara, J. de, Pierantonio, A., Tisi, M. & Wimmer, M. (2022). Low-Code Development and Model-Driven Engineering: Two Sides of the Same Coin? Software and Systems Modeling, 21(2), 437–446.<br>▪ Leung, T. (2021). Beginning Power Apps: The Non-Developer's Guide to Building Business Applications. Springer eBook Collection. Apress.<br>▪ Sahay, A., Indamutsa, A., Di Ruscio, D. & Pierantonio, A. (2020). Supporting the Understanding and Comparison of Low-Code Development Platforms. In 2020 46th Euromicro Conference on Software Engineering and Advanced Applications (SEAA) (S. 171–178). IEEE.<br>▪ Sanchis, R., García-Perales, Ó., Fraile, F. & Poler, R. (2020). Low-Code as Enabler of Digital Transformation in Manufacturing Industry. Applied Sciences, 10(1), 12. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests |

# Computer Science and Society

**Module Code: DLBCSCSAS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Florian Allwein (Computer Science and Society)

**Contributing Courses to Module**

- Computer Science and Society (DLBCSCSAS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Written Assessment: Written Assignment<br><br>Study Format: myStudies<br>Written Assessment: Written Assignment | |

**Weight of Module**

see curriculum

**Module Contents**

- The role of computer science
- The impact of the information society on the economy and society
- Infrastructure vulnerability
- Informatics and the military
- Responsibility in Information Technology

<table>
<tr><td colspan="2">Learning Outcomes<br><br>Computer Science and Society<br><br>On successful completion, students will be able to<br>▪ name significant stages of development in computer science and the Internet.<br>▪ describe the role of computer science as a science and its relation to other sciences.<br>▪ explain and discuss the main economic and social implications of the information society.<br>▪ explain and discuss the causes and effects of infrastructure vulnerability.<br>▪ discuss and apply relevant ethical principles to issues in computer science.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Computer Science & Software Development.</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the IT & Technology field.</td></tr>
</table>

# Computer Science and Society

**Course Code: DLBCSCSAS01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

## Course Description

Computer science is a science that shapes society in a special way, and thus has a significant impact on society. Depending on its application and prevailing conditions, it can help to improve society and living conditions or cause and exacerbate surveillance, unemployment, and other social problems. In many cases, it is not the results of computer science itself that are "good" or "bad", but the results can be used to serve very different purposes ("dual use"). In this module students acquire the basic tools to understand the effects of computer science in general and its effects on their everyday work as a data scientist.

## Course Outcomes

On successful completion, students will be able to

- name significant stages of development in computer science and the Internet.
- describe the role of computer science as a science and its relation to other sciences.
- explain and discuss the main economic and social implications of the information society.
- explain and discuss the causes and effects of infrastructure vulnerability.
- discuss and apply relevant ethical principles to issues in computer science.

## Contents

1. Introduction
   - 1.1 Computer Science, Society, and the Information Society
   - 1.2 Historical Overview of Computer Science and the Internet
   - 1.3 What is Computer Science?
   - 1.4 Relevant Organizations

2. The Role of Data in the Information Society
   - 2.1 Data as a Commodity
   - 2.2 Data Protection and Data Spying
   - 2.3 Long-Term Archiving

3. Economic Impacts of the Information Society
   - 3.1 Globalization and the Formation of Monopolies in the Economy
   - 3.2 Open Movement

3.3 Change in the Labor Market
3.4 Intellectual Property

4. Social impacts of the Information Society
   4.1 Social Networks
   4.2 Surveillance
   4.3 Digitization of Education
   4.4 Women in Computer Science

5. Infrastructure Vulnerability
   5.1 Attacks and Accidents
   5.2 Technical Infrastructure
   5.3 Political and Social Infrastructure

6. Computer Science and the Military
   6.1 Military as the Driver of Computer Science
   6.2 Cyber War
   6.3 Dual Use

7. Responsibility in Computer Science
   7.1 Ethics of Responsibility According to Jonas
   7.2 Ethical Guidelines for Computer Science in Society
   7.3 Decision-making by Algorithms
   7.4 Mechanisms for Implementing Responsibility in Computer Science

**Literature**

**Compulsory Reading**

**Further Reading**


- Clegg, B. (2017): Big Data. How the Information Revolution is Transforming Our Lives. Icon Books.

### Study Format Distance Learning

| **Study Format**<br>Distance Learning | **Course Type**<br>Online Lecture |
|---|---|

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Written Assignment |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study**<br>110 h | **Contact Hours**<br>0 h | **Tutorial/Tutorial Support**<br>20 h | **Self Test**<br>20 h | **Independent Study**<br>0 h | **Hours Total**<br>150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests<br>☑ Guideline |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Written Assignment |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests<br>☑ Guideline |

# Project: Low-Code Development

**Module Code: DLBDBEPLCD**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| N.N. (Project: Low-Code Development) |

| Contributing Courses to Module |
|---|
| ▪ Project: Low-Code Development (DLBDBEPLCD01) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br><u>Study Format: Distance Learning</u><br>Oral Project Report | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

| Module Contents |
|---|
| In the age of digitization, low-code represents an opportunity to develop software at a manageable cost and time. The use of low-code platforms such as the Microsoft Power Platform provides support for the digital transformation under appropriate project conditions. Objective of this project is to teach students the process of developing a low-code app through a low-code project that they plan and execute themselves. |

| Learning Outcomes | |
|---|---|
| **Project: Low-Code Development**<br>On successful completion, students will be able to<br>▪ identify a relevant problem for the development of a low-code app.<br>▪ carry out a modelling of relevant business processes.<br>▪ plan and implement a low-code project based on the business process.<br>▪ successfully develop and deploy a low-code app. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science & Software Development | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# Project: Low-Code Development

**Course Code: DLBDBEPLCD01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

## Course Description

Digital transformation is a challenging process that places high demands on many companies. In practice, there is often a lack of well thought-out concepts for exploiting the potential of digitization. A lack of IT expertise or IT infrastructure are among the reasons. Low-code is a method for companies to experience support for digital transformation. Simplification, acceleration, and agility are just some of the benefits that low-code offers for digitization in companies. Against this background, students will identify a relevant problem for the development of a low-code app based on a practical project. Starting from the modeling of relevant business processes, a low-code app is to be systematically planned, developed, implemented, and deployed within the Power Platform of Microsoft or Mendix.

## Course Outcomes

On successful completion, students will be able to

- identify a relevant problem for the development of a low-code app.
- carry out a modelling of relevant business processes.
- plan and implement a low-code project based on the business process.
- successfully develop and deploy a low-code app.

## Contents

- Students learn how to use a low-code environment on a practical example project. The result of the low-code programming is a low-code application for a self-selected business process. After identifying a relevant problem, students will first model the affected business process. In practice, these are often processes that can be digitized and automated, where data was previously exchanged verbally, by form, notepad, or e-mail. While users today write information in an e-mail that other users then transfer to or check using standard software, low-code applications offer a decisive advantage: data can be recorded in a structured manner and the checks can be automated by accessing other programs. Low-code is therefore particularly interesting for administrative business processes and secondary processes. Once business process modeling is complete, students develop a comprehensive project plan and implementation strategy. Next step is to develop the low-code application and demonstrate how to deploy it via the Microsoft’s Power Platform or Mendix. In addition, they develop the low-code application considering the previously defined problem and the selected business process. They show how the low-code app can be deployed and used in practical application.

**Literature**

**Compulsory Reading**

**Further Reading**


- Gurcan, F. & Taentzer, G. (2021). Using Microsoft PowerApps, Mendix and OutSystems in Two Development Scenarios: An Experience Report. In 2021 ACM/IEEE International Conference on Model Driven Engineering Languages and Systems Companion (MODELS-C) (S. 67–72). IEEE.
- Leung, T. (2021). Beginning Power Apps: The Non-Developer's Guide to Building Business Applications. Springer eBook Collection. Apress.
- Prakash Pradhan, S. (2022). Power Platform and Dynamics 365 CE for Absolute Beginners. Apress.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Oral Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Slides | ☑ Guideline |

# 4. Semester

# Introduction to Data Protection and Cyber Security

**Module Code: DLBCSIDPITS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Ralf Kneuper (Introduction to Data Protection and Cyber Security)

**Contributing Courses to Module**

- Introduction to Data Protection and Cyber Security (DLBCSIDPITS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes<br><br>Study Format: myStudies<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Fundamentals of IT Security
- Data Protection
- IT Security Management
- Network and Communication Security

<table>
<tr><td colspan="2">Learning Outcomes<br>Introduction to Data Protection and Cyber Security<br>On successful completion, students will be able to<br>▪ explain the terms and concepts of IT security and know the typical procedures and techniques which exist in each area.<br>▪ cite the legal regulations on data protection and explain their implementation.<br>▪ discuss in-depth IT security management and suitable measures for implementation.<br>▪ use their overview knowledge of activities and strategies for IT security in software and system development.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Computer Science & Software Development.</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the IT & Technology field.</td></tr>
</table>

# Introduction to Data Protection and Cyber Security

**Course Code: DLBCSIDPITS01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In this course, the students are familiarized with important concepts from the field of IT security. Basic terms are introduced and discussed, and typical application fields, areas of IT security application, and typical procedures and techniques are introduced and described.

**Course Outcomes**

On successful completion, students will be able to

- explain the terms and concepts of IT security and know the typical procedures and techniques which exist in each area.
- cite the legal regulations on data protection and explain their implementation.
- discuss in-depth IT security management and suitable measures for implementation.
- use their overview knowledge of activities and strategies for IT security in software and system development.

**Contents**

1. Fundamentals of Data Protection and Cyber Security
   - 1.1 Conceptual Bases, Protection Goals
   - 1.2 Attacks and Threats
   - 1.3 Security Strategy
   - 1.4 Legal Regulations
2. Data Protection
   - 2.1 Data Protection as a Personal Right
   - 2.2 Basic Principles of Data Protection
   - 2.3 EU General Data Protection Regulation
   - 2.4 Further International Regulations on Data Protection
   - 2.5 Cross-Border Data Flow
   - 2.6 Data Protection in Everyday Life
3. Basic Functions of Cyber Security and Their Implementation
   - 3.1 Identification and Authentication
   - 3.2 Rights Management

**Literature**

**Compulsory Reading**

**Further Reading**


- Arnold, R. (2017). Cybersecurity: A business solution. An executive perspective on managing cyber risk. Threat Sketch.
- European Parliament and Council of the European Union. (2016). EU General Data Protection Regulation (GDPR): Regulation 2016/679 of the European Parliament and of the council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). Official Journal of the European Union. Chapters 1—3 .
- Mattord, H., & Whitman, M. (2017). Management of information security. Cengage.

## Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Technical and Operational IT Security Concepts

**Module Code: DLBCSEEISC1_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | | WiSe/SoSe | English |

**Module Coordinator**

Dr. Rachel John Robinson (Technical and Operational IT Security Concepts)

**Contributing Courses to Module**

- Technical and Operational IT Security Concepts (DLBCSEEISC01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Network analysis and evaluation
- Protection Profiles
- Intrusion Detection Systems
- Network Monitoring
- Security Information and Event Management (SIEM)
- IT-Security evaluation and assessment

| Learning Outcomes | |
|---|---|
| **Technical and Operational IT Security Concepts**<br>On successful completion, students will be able to<br>▪ analyze and evaluate IT systems and networks and detect vulnerabilities.<br>▪ develop enterprise specific protection profiles.<br>▪ design and implement tools for sensor based network monitoring, intrusion detection and response.<br>▪ use Big Data fusion mechanisms, evaluate and assess the IT-system network security status and decide and initiate incident response measures.<br>▪ evaluate the security status of IT systems and networks and provide guidance for improvement. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Technical and Operational IT Security Concepts

**Course Code: DLBCSEEISC01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

IT-Systems and Networks containing and processing highly sensitive information and data as well as IT-Infrastructure in support of business-critical processes or national critical infrastructure require higher security mechanism regarding confidentiality, integrity and availability. Based on specific “Protection Profiles” high sophisticated tools, mechanisms and procedures need to be designed, implemented, configurated and operated.With this course the student will be able to evaluate given IT-Infrastructure, support the security-design of new IT-Systems and Networks by developing specific Protection Profiles, evaluate which technical and operational security measures and application are required and how these are integrated, configured and operated.

**Course Outcomes**

On successful completion, students will be able to

- analyze and evaluate IT systems and networks and detect vulnerabilities.
- develop enterprise specific protection profiles.
- design and implement tools for sensor based network monitoring, intrusion detection and response.
- use Big Data fusion mechanisms, evaluate and assess the IT-system network security status and decide and initiate incident response measures.
- evaluate the security status of IT systems and networks and provide guidance for improvement.

**Contents**

1. Network Analysis and Evaluation
   - 1.1 Layer Specific Threats and Vulnerabilities
   - 1.2 DATA Flow, Interdependencies and Interrelationships
   - 1.3 Vulnerability Scanning and Detection
   - 1.4 Supporting Tools and Techniques

2. Protection Profiles
   - 2.1 Reference Architecture Technology and Networking
   - 2.2 Risk Assessment, Residual Risk and Risk Management
   - 2.3 Security Requirements and Safeguards
   - 2.4 Security Evaluation of IT-Security Products

|  |
|---|
| 2.5 Accreditation of IT-Systems and Networks<br><br>3. Intrusion Detection Systems<br>3.1 Detection Strategy<br>3.2 Data Sources, Sensors<br>3.3 Analytics<br>3.4 Indicators of Compromise<br><br>4. Network Monitoring<br>4.1 Threat Protection Systems<br>4.2 Wireless Sensor Networks Technology<br>4.3 Threat Information Sharing<br><br>5. Security Information and Event Management (SIEM)<br>5.1 Technical and Operational DATA Sources<br>5.2 DATA Fusion<br>5.3 Network Norm Behavior<br>5.4 Big Data Analysis – Transferring Technical Data for Operational Information<br>5.5 Security Situation Picture, Situational Awareness<br>5.6 Incident Response Strategies and Automated Responses<br><br>6. IT-Security Evaluation and Assessment<br>6.1 IT-Security Metrics<br>6.2 IT-Security Assessment |

| **Literature** |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Federal Office for Information Security (BSI) (2018): IT-Grundschutz Profiles - Structural Description - COMMUNITY DRAFT.<br>▪ Hayden, L. (2010): IT Security Metrics: A Practical Framework for Measuring Security & Protecting Data. McGraw-Hill Education.<br>▪ McNab, C. (2016): Network Security Assessment: Know Your Network. 3. Auflage, O'Reilly UK Ltd.<br>▪ Miller, D. R. et al. (2011): Security Information and Event Management (SIEM) Implementation. McGraw-Hill Education. |

## Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Security Controls in the Cloud

**Module Code: DLBCSEECS1_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLBDSCC01 | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Ahmed Taha (Security Controls in the Cloud)

**Contributing Courses to Module**

- Security Controls in the Cloud (DLBCSEECS01_E)

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Cloud security
- Losing the intranet
- Security by design
- Secure cloud coding
- Confidentiality aspects
- Monitoring and Audit

| Learning Outcomes | |
|---|---|
| **Security Controls in the Cloud**<br>On successful completion, students will be able to<br>▪ design a secure cloud deployment using infrastructure as code methodologies.<br>▪ understand cloud-specific attacks and threat models.<br>▪ define appropriate storage classes in compliance with security requirements.<br>▪ monitor cloud resources to detect misuse and incidents. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science & Software Development | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# Security Controls in the Cloud

**Course Code: DLBCSEECS01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | DLBDSCC01 or DLBDSCC01_D |

## Course Description

Maintaining a datacenter is expensive and inflexible, so it is expected that most corporations will be moving their server-based processes to a private, public or hybrid cloud in the next few years. Doing so will make operations more flexible and elastic but poses challenges to security architectures and operations. The paradigm of Infrastructure as Code (IaC) has been embraced by cloud providers and is a great opportunity to architect security into the design of a system (security by design) utilizing security best practices. However, too often, we see the on-premises mentality being applied to cloud deployments resulting in less secure systems instead of utilizing the security advantages a cloud provides. This course teaches the principles of Cloud Native security and how to avoid common pitfalls.

## Course Outcomes

On successful completion, students will be able to

- design a secure cloud deployment using infrastructure as code methodologies.
- understand cloud-specific attacks and threat models.
- define appropriate storage classes in compliance with security requirements.
- monitor cloud resources to detect misuse and incidents.

## Contents

1. Cloud security is different
   - 1.1 Shared responsibility model
   - 1.2 Infrastructure as code
   - 1.3 The Private, Public and Hybrid Cloud
   - 1.4 Types of virtualization
   - 1.5 Cloud threat models: Mitre Cloud ATT&CK

2. Losing the intranet
   - 2.1 Identify and Access Management
   - 2.2 Principle of least privilege and fine-grained cloud access control
   - 2.3 Using Software Defined Networks, virtual private clouds and subnets
   - 2.4 Moving to a serverless architecture
   - 2.5 Defense in depth

3. Security by design
   - 3.1 Orchestration: Infrastructure as Code
   - 3.2 The Automate-Everything principle, Updating and Repeatability
   - 3.3 Reuse of good design patterns
   - 3.4 Container security
   - 3.5 Identification and Authentication
4. Secure cloud coding
   - 4.1 Software supply chain security
   - 4.2 Continuous Integration and Deployment
   - 4.3 Testing in code integration for security
   - 4.4 Canaries in code deployment
   - 4.5 Policy engines
5. Confidentiality aspects
   - 5.1 Secrets management
   - 5.2 Encryption of data at rest
   - 5.3 Encryption of data in transit
   - 5.4 Data leakage and exfiltration
6. Availability
   - 6.1 Storage tiers and locality
   - 6.2 Backup strategies
   - 6.3 Data and process redundancy
   - 6.4 Data lifecycle configuration
   - 6.5 DDoS mitigation
7. Locality
   - 7.1 Compliance requirements
   - 7.2 Geography of data/processes
   - 7.3 Redundancy of data centers
   - 7.4 Colocation for performance reasons
8. Monitoring and Audit
   - 8.1 Centralized logging
   - 8.2 Auditing orchestration scripts
   - 8.3 Detecting misconfigurations
   - 8.4 Cloud Forensics

9. Summary and Research topics
    9.1 Homomorphic encryption
    9.2 Attestation
    9.3 Proof-carrying data
    9.4 Side-channel attacks
    9.5 Conclusions

**Literature**

**Compulsory Reading**

**Further Reading**


- Mitre Cloud ATT&CK. https://attack.mitre.org/matrices/enterprise/cloud/

### Study Format Distance Learning

| **Study Format**<br>Distance Learning | **Course Type**<br>Online Lecture |
|---|---|

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study**<br>90 h | **Contact Hours**<br>0 h | **Tutorial/Tutorial Support**<br>30 h | **Self Test**<br>30 h | **Independent Study**<br>0 h | **Hours Total**<br>150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

# Seminar: Current Topics in Cloud Computing

**Module Code: DLBCCOSCTICC**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| (Seminar: Current Topics in Cloud Computing) |

| Contributing Courses to Module |
|---|
| ▪ Seminar: Current Topics in Cloud Computing (DLBCCOSCTICC01) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Written Assessment: Research Essay | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

| Module Contents |
|---|
| Students familiarize themselves with the most recent developments in the area of cloud computing and are introduced to contemporary cloud-based platforms and tools. This allows them to understand the increasing significance and uses of cloud technology in today's digital age. |

| Learning Outcomes | |
|---|---|
| **Seminar: Current Topics in Cloud Computing**<br>On successful completion, students will be able to<br>▪ recognise emerging issues, theories, and principles in the field of cloud computing and understand innovative designs, implementations, and best practices for cloud solutions.<br>▪ know contemporary cloud computing topics globally, underlying technologies that enable cloud computing and explain associated concepts and their applications.<br>▪ differentiate between cloud computing and related technologies and critically analyse their interplay, roles, significance and effects within various business and technology contexts.<br>▪ evaluate the most recent advancements and research in the field of cloud computing and appraise their benefits and limitation for enterprise applications.<br>▪ independently choose suitable techniques and methods to investigate crucial topics in the context of cloud computing, upcoming technological trends and present the findings in an appropriate scientific manner. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Seminar: Current Topics in Cloud Computing

**Course Code: DLBCCOSCTICC01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In this course, students will focus on examining current developments and advancements in cloud computing. The course will challenge students to contemplate novel improvements and the latest research findings on distributed storage, cloud architectures, cloud security, big data in the cloud, and serverless computing, among other topics. To this end, students will be expected to reflect, critically evaluate, and demonstrate their understanding and appreciation of contemporary cloud computing issues.

**Course Outcomes**

On successful completion, students will be able to

- recognise emerging issues, theories, and principles in the field of cloud computing and understand innovative designs, implementations, and best practices for cloud solutions.
- know contemporary cloud computing topics globally, underlying technologies that enable cloud computing and explain associated concepts and their applications.
- differentiate between cloud computing and related technologies and critically analyse their interplay, roles, significance and effects within various business and technology contexts.
- evaluate the most recent advancements and research in the field of cloud computing and appraise their benefits and limitation for enterprise applications.
- independently choose suitable techniques and methods to investigate crucial topics in the context of cloud computing, upcoming technological trends and present the findings in an appropriate scientific manner.

**Contents**

- This course will encompass fundamental subject matter within the field, which includes the security of cloud technology, strategies associated with multi-cloud use, environmentally friendly cloud computing, and the implementation of cloud computing within public sector organizations, among others. Cloud security is an essential aspect of modern Information Technology systems, underpinned by a growing need for multi-cloud strategies. Nowadays, many organizations are integrating these strategies with technologies like containerization and microservices, improving scalability and operational efficiency. The management and enhancement of these systems are crucial for their cost-effective usage. Innovations in serverless, distributed computing such as edge and fog provide necessary flexibility. These technologies decentralize data processing, augmenting speed, and reliability. This is particularly critical for areas like artificial intelligence and machine learning that need extensive data management. Also, numerous organizations are concentrating on eco-friendly cloud computing due to the rising consciousness towards environmental sustainability. This ensures that digital transformation does not damage the environment. In the public sector, there's a gradual recognition of the benefits of cloud computing. The adoption of such technologies is increasingly widespread, aiding these sectors in providing efficient and reliable services to their constituents. Furthermore, the advent of quantum computing signifies a major advancement in computational capabilities, which could potentially benefit various technology and computing sectors.

**Literature**

**Compulsory Reading**

**Further Reading**


- Alhaidari, F., Rahman, A., & Zagrouba, R. (2023). Cloud of Things: architecture, applications and challenges. Journal of Ambient Intelligence and Humanized Computing, 14(5), 5957–5975. https://doi.org/10.1007/s12652-020-02448-3
- Dharshika, S., & Cholli, N. G. (2021). Green Cloud Computing: Redefining the future of Cloud Computing. International Research Journal on Advanced Science Hub, 3, 12–19. https://doi.org/10.47392/irjash.2021.203
- Ionescu, L. (2022). Machine Learning-based Decision-Making Systems, Cloud Computing and Blockchain Technologies, and Big Data Analytics Algorithms in Accounting and Auditing. Economics, Management, and Financial Markets, 17(4). https://doi.org/10.22381/emfm17420221
- Kiyan, Z. (2023). The Future of Cloud Computing: Cloud-Based Artificial Intelligence; Cloud Computing: How Cloud Computing is Revolutionizing IT. https://doi.org/10.18130/db20-ym56
- Mills, M. P. (2021). The Cloud Revolution: How the Convergence of New Technologies Will Unleash the Next Economic Boom and A Roaring 2020s. Encounter Books.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Seminar |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Research Essay |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# Project: Security by Design in the Cloud

**Module Code: DLBCSEECS2_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLBDSCC01 or<br>DLBDSCC01_D,<br>DLBCSEECS01_E | BA | 5 | 5 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

N.N. (Project: Security by Design in the Cloud)

**Contributing Courses to Module**

- Project: Security by Design in the Cloud (DLBCSEECS02_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Written Assessment: Project Report | |

**Weight of Module**

see curriculum

**Module Contents**

This module is about the implementation of a practical cloud application employing best security practices to arrive at a system that is practical, auditable, monitored and easily updated.

| Learning Outcomes | |
|---|---|
| **Project: Security by Design in the Cloud**<br>On successful completion, students will be able to<br>▪ transfer previously acquired knowledge about cloud security to practical use cases.<br>▪ design, architect, and implement a working cloud-based system.<br>▪ reason about design choices of and how best cloud security practices are followed.<br>▪ critically evaluate said choices with respect to the stated design goal.<br>▪ describe and explain the resulting solution in a report. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science & Software Development | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# Project: Security by Design in the Cloud

**Course Code: DLBCSEECS02_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | DLBDSCC01 or DLBDSCC01_D, DLBCSEECS01_E |

**Course Description**

This course provides the opportunity to implement a cloud software system using best cloud security practices. A list of ideas is provided on the online learning platform. In addition, the students can contribute use case ideas of their own after consulting with the tutor. The core aim is to apply the theoretical knowledge of cloud security methods and best practices to implement an application that is deployed as an Infrastructure-as-code project, can be monitored and audited, as well as easily and preferably automatically updated without danger. This entails reasoning about possible design and architectural choices in a rational way, as well as implementing them on a cloud platform, such as CNCF, Amazon AWS, Microsoft Azure or Google GCP.

**Course Outcomes**

On successful completion, students will be able to

- transfer previously acquired knowledge about cloud security to practical use cases.
- design, architect, and implement a working cloud-based system.
- reason about design choices of and how best cloud security practices are followed.
- critically evaluate said choices with respect to the stated design goal.
- describe and explain the resulting solution in a report.

**Contents**

- This course is about the implementation of a practical cloud application employing best security practices to arrive at a system that is practical, auditable, monitored and easily updated.

**Literature**

**Compulsory Reading**

**Further Reading**

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# 5. Semester

# IT Architecture Management

**Module Code: IAMG_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Sebastian Lempert (IT Architecture Management)

**Contributing Courses to Module**

- IT Architecture Management (DLBCSEITPAM02)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Basic Terms and Foundations of IT Enterprise Architectures Management
- IT Application Portfolio Management
- Architecture Governance
- Modeling of IT Enterprise Architectures
- Frameworks using TOGAF as an Example
- Reference Models and Sample Catalogues

| Learning Outcomes | |
|---|---|
| **IT Architecture Management**<br>On successful completion, students will be able to<br>▪ describe and explain the basic principles of IT strategy, governance, and architecture management, differentiating between them.<br>▪ explain and differentiate the typical activities of IT architecture management, their interrelationships, and their dependencies.<br>▪ explain suitable models of IT architecture management, distinguish between them, and explain their intended purpose.<br>▪ explain and describe selected IT architectural frameworks as well as reference models and sample catalogues. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science and Software Development | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# IT Architecture Management

**Course Code: DLBCSEITPAM02**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In addition to concrete IT projects, such as the development of a new IT system or the introduction of standard software, a strategic management system for organizational-wide IT infrastructure – that is, for all IT hardware and software systems – must be used.Strategic management is the responsibility of the IT enterprise architect, who operates IT architecture management. Their task is to strategically align IT infrastructure with an organization's business and IT strategy.This course covers the typical concepts, methods, procedures, and IT models of architecture management.

**Course Outcomes**

On successful completion, students will be able to

- describe and explain the basic principles of IT strategy, governance, and architecture management, differentiating between them.
- explain and differentiate the typical activities of IT architecture management, their interrelationships, and their dependencies.
- explain suitable models of IT architecture management, distinguish between them, and explain their intended purpose.
- explain and describe selected IT architectural frameworks as well as reference models and sample catalogues.

**Contents**

1. Basic Terms and Foundation for the Management of IT Enterprise Architectures
   - 1.1 IT Enterprise Architecture
   - 1.2 Goals of Enterprise Architecture Management
   - 1.3 Processes in the Management of IT Enterprise Architectures
2. IT Application Portfolio Management
   - 2.1 IT Application Portfolio Management Overview
   - 2.2 Application Manual
   - 2.3 Portfolio Analysis
   - 2.4 Development Planning
3. Architecture Governance

3.1 Organizational Structure
3.2 Policy Development and Enforcement
3.3 Project Support

4. Modeling of IT Enterprise Architectures
   4.1 Models in the Context of IT Architecture Management
   4.2 Forms of Documentation for Processes and Applications
   4.3 Forms of Documentation for Systems and Technologies

5. Frameworks Using the Example of TOGAF
   5.1 Fundamentals and Use of IT Architecture Frameworks
   5.2 Overview and Categories of EAM Frameworks
   5.3 The Open Group Architecture Framework (TOGAF)

6. Reference Models and Sample Catalogues
   6.1 Architecture Reference Models
   6.2 EAM Design Sample Catalogue

**Literature**

**Compulsory Reading**

**Further Reading**


- Ahlemann, F., Messerschmidt, M., Stettiner, E., & Legner, C. (2012). Strategic enterprise architecture management. Challenges, best practices, and future developments. Springer-Verlag.
- Perroud, T., & Inversini, R. (2013). Enterprise architecture patterns: Practical solutions for recurring IT-architecture problems. Springer.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# IT Service Management

**Module Code: DLBCSITSM-02**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Dr. Rachel John Robinson (IT Service Management)

**Contributing Courses to Module**

- IT Service Management (DLBCSITSM01-02)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- IT Service Management Basics and Terms
- ITIL 4 - Basics and Four Dimensions
- ITIL 4 - Service Value System
- ITIL 4 - Principles
- ITIL 4 - Practices
- Information Security Management

| Learning Outcomes | |
|---|---|
| **IT Service Management**<br>On successful completion, students will be able to<br>▪ identify the fundamentals and challenges of IT service management.<br>▪ describe the motivation and structure of the IT Infrastructure Library (ITIL), distinguish four dimensions, apply the service value system and identify concrete practices.<br>▪ describe and apply fundamentals of IT security management. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# IT Service Management

**Course Code: DLBCSITSM01-02**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

IT service management is an approach to align and understand a company's IT as a service provider and supporter of operational and business processes. This course uses the IT Infrastructure Library (ITIL) to teach concepts, procedures and best practices in the area of IT service management (IT operations). In other words, it looks at the management of activities that take place after an IT system has been developed: IT operations as a continuous run of the productive day-to-day business of a company's IT departments.

**Course Outcomes**

On successful completion, students will be able to

- identify the fundamentals and challenges of IT service management.
- describe the motivation and structure of the IT Infrastructure Library (ITIL), distinguish four dimensions, apply the service value system and identify concrete practices.
- describe and apply fundamentals of IT security management.

**Contents**

1. IT Service Management Basics and Terms
   - 1.1 IT Services
   - 1.2 IT Service Management
   - 1.3 ITSM Frameworks
2. ITIL 4 - Basics and Four Dimensions
   - 2.1 Stakeholders, Services and Service Management
   - 2.2 Value Contribution of IT
3. ITIL 4 - Service Value System
   - 3.1 Basics and Overview
   - 3.2 Inputs, Outcome and Governance
   - 3.3 The Service Value Chain
   - 3.4 Continual Improvement
4. ITIL 4 - Principles

**Literature**

**Compulsory Reading**

**Further Reading**

- Agutter, C. (2019). ITIL® foundation essentials ITIL 4 edition: The ultimate revision guide. ITGovernance Publishing.
- Axelos Limited. (2019). ITIL 4 foundation: ITIL 4 edition. The Stationery Office.

### Study Format myStudies

| Study Format<br>myStudies | Course Type<br>Lecture |
|---|---|

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study**<br>90 h | **Contact Hours**<br>0 h | **Tutorial/Tutorial Support**<br>30 h | **Self Test**<br>30 h | **Independent Study**<br>0 h | **Hours Total**<br>150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Introduction to Programming with Python

**Module Code: DLBDSIPWP**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Dr. Cosmina Croitoru (Introduction to Programming with Python)

**Contributing Courses to Module**

- Introduction to Programming with Python (DLBDSIPWP01)

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes<br><br>Study Format: On Campus<br>Exam, 90 Minutes | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Python as a programming language for data science
- Variables and built-in datatypes
- Statements and functions
- Error and exception handling
- Important Python data science modules

| **Learning Outcomes** | |
|---|---|
| **Introduction to Programming with Python**<br>On successful completion, students will be able to<br>▪ use fundamental Python syntax.<br>▪ recollect common elementary data types.<br>▪ recognize foundational programming concepts and their realization in Python.<br>▪ understand error handling and logging.<br>▪ create working programs.<br>▪ list the most important libraries and packages for data science. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Data Science & Artificial Intelligence | All Bachelor Programs in the IT & Technology field |

# Introduction to Programming with Python

**Course Code: DLBDSIPWP01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

### Course Description

This course provides students with a foundational understanding of the Python programming language. Following an introductory exposition to the importance of Python for data science-related programming tasks, students will be acquainted with fundamental programming concepts like variables, data types, and statements. Building on this basis, the important notion of a function is explained and errors, exception handling, and logging are explicated. The course concludes with an overview of the most widely-used library packages for data science.

### Course Outcomes

On successful completion, students will be able to

- use fundamental Python syntax.
- recollect common elementary data types.
- recognize foundational programming concepts and their realization in Python.
- understand error handling and logging.
- create working programs.
- list the most important libraries and packages for data science.

### Contents

1. Introduction
   - 1.1 Why Python?
   - 1.2 Obtaining and installing Python
   - 1.3 The Python interpreter , IPython, and Jupyter

2. Variables and Data Types
   - 2.1 Variables and value assignment
   - 2.2 Numbers
   - 2.3 Strings
   - 2.4 Collections
   - 2.5 Files

3. Statements
   - 3.1 Assignment, expressions, and print

**Literature**

**Compulsory Reading**

**Further Reading**


- Barry, P. (2016). Head first Python: A brain-friendly guide. Sebastopol, CA: O'Reilly Media, Inc.
- Kapil, S. (2019). Clean Python: Elegant coding in Python. Berkeley, CA: Apress.
- Lubanovic, B. (2019). Introducing Python (2nd ed.). Sebastopol, CA: O’Reilly.
- Lutz, M. (2013). Learning Python (5th ed.). Sebastopol, CA: O’Reilly.
- Matthes, E. (2015). Python crash course: A hands-on, project-based introduction to programming. San Fransisco, CA: No Starch Press.
- Müller, A. C., & Guido, S. (2016). Introduction to machine learning with Python: A guide for data scientists. Sebastopol, CA: O'Reilly Media, Inc.
- Ramalho, L. (2015). Fluent Python: Clear, concise, and effective programming. Sebastopol, CA: O’Reilly.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format On Campus

| Study Format<br>On Campus | Course Type |
|---|---|

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study**<br>90 h | **Contact Hours**<br>0 h | **Tutorial/Tutorial Support**<br>30 h | **Self Test**<br>30 h | **Independent Study**<br>0 h | **Hours Total**<br>150 h |

| Instructional Methods |
|---|
| |

# Object Oriented and Functional Programming with Python

**Module Code: DLBDSOOFPP**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Max Pumperla (Object Oriented and Functional Programming in Python)

**Contributing Courses to Module**

- Object Oriented and Functional Programming in Python (DLBDSOOFPP01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Portfolio<br><br>Study Format: myStudies<br>Portfolio | |

**Weight of Module**

see curriculum

**Module Contents**

This course introduces the students to the advanced programming concepts of object orientation and functional programming and how they are realized in the Python programming language.

| Learning Outcomes | |
|---|---|
| **Object Oriented and Functional Programming in Python**<br>On successful completion, students will be able to<br>▪ explain basic notions in object-oriented programming such as functions and classes.<br>▪ understand object-oriented programming concepts and their relation to software design and engineering.<br>▪ describe advanced function concepts in Python.<br>▪ recognize important ideas from functional programming.<br>▪ recall important libraries for functional programming in Python. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Data Science & Artificial Intelligence | All Bachelor Programs in the IT & Technology field |

# Object Oriented and Functional Programming in Python

**Course Code: DLBDSOOFPP01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

This course builds upon basic knowledge of Python programming (Introduction to Programming with Python, DLBDSIPWP) and is concerned with the exposition of advanced Python programming concepts. To this end, important notions of object-oriented programming like classes and objects and pertaining design principles are outlined. Starting from an in-depth discussion of advanced features of Python functions, functional programming concepts and their implementation in Python are conveyed.

**Course Outcomes**

On successful completion, students will be able to

- explain basic notions in object-oriented programming such as functions and classes.
- understand object-oriented programming concepts and their relation to software design and engineering.
- describe advanced function concepts in Python.
- recognize important ideas from functional programming.
- recall important libraries for functional programming in Python.

**Contents**

- This course provides students with a thorough introduction to important notions and concepts from the domain of object-oriented programming such as classes, objects, abstraction, encapsulation, inheritance, polymorphism, composition, and delegation. Additionally, the functional programming paradigm and pertaining ideas like functions as first class objects, decorators, pure functions, immutability and higher order functions are conveyed. Pursuant to the portfolio course type, the aforementioned concepts and ideas are explored by hands-on programming projects.

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Lott, S. F. (2018): Functional Python programming: Discover the power of functional programming, generator functions, lazy evaluation, the built-in itertools library, and monads. 2nd ed., Packt Publishing, Birmingham.<br>▪ Lutz, M. (2013): Learning Python. 5th ed., O'Reilly.<br>▪ Phillips, D. (2018): Python 3 object-oriented programming: Build robust and maintainable software with object-oriented design patterns in Python 3.8. 3rd ed., Packt Publishing.<br>▪ Ramalho, L. (2015): Fluent Python: Clear, concise, and effective programming. O'Reilly. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

### Study Format myStudies

| Study Format | Course Type |
| --- | --- |
| myStudies | Project |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
| --- | --- |
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# Smart Devices I

**Module Code: DLBINGSD1_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Sheik Radiah Ravim Rivu (Smart Devices I)

**Contributing Courses to Module**

- Smart Devices I (DLBINGSD01_E)

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Overview and introduction
- Smart devices
- Technological features
- Communication and networking
- User interfaces
- Ubiquitous computing

| **Learning Outcomes** | |
|---|---|
| **Smart Devices I**<br>On successful completion, students will be able to<br>▪ recall the historical development of assistance systems towards smart devices.<br>▪ classify and define different types and examples of smart devices with regard to their properties.<br>▪ know typical features of smart devices.<br>▪ identify different communication standards with which smart devices can communicate with their environment.<br>▪ recognize different approaches with which smart devices can be controlled.<br>▪ classify smart devices as elements of ubiquitous computing. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Smart Devices I

**Course Code: DLBINGSD01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In this course, students are familiarized with the properties and applications of smart devices. In doing so, the possible applications in the context of Industry 4.0 are specifically highlighted. For this purpose, current trends in microsystems technology are discussed alongside assistance functions in production, e.g. through data glasses or other wearables. In addition to the typical technological features, this course also teaches the basics of various interfaces with which a smart device interacts with its environment. These include, on the one hand, wireless system ports linked to other devices and, on the other hand, various selections for controlling the devices via a user interface. This course concludes with a classification of smart devices in the field of ubiquitous computing.

**Course Outcomes**

On successful completion, students will be able to

- recall the historical development of assistance systems towards smart devices.
- classify and define different types and examples of smart devices with regard to their properties.
- know typical features of smart devices.
- identify different communication standards with which smart devices can communicate with their environment.
- recognize different approaches with which smart devices can be controlled.
- classify smart devices as elements of ubiquitous computing.

**Contents**

1. Overview and Introduction
   - 1.1 Historical Development of Smart Devices
   - 1.2 Technological Pioneers for Smart Devices
   - 1.3 Smart Devices in the Internet of Things

2. Properties and Applications
   - 2.1 Typical Properties and Classification
   - 2.2 Example Devices
   - 2.3 Smart Devices in Microsystems Technology (MEMS)
   - 2.4 Further Fields of Application

3. Technological Features
    - 3.1 Processors
    - 3.2 Sensors
    - 3.3 Radio Interfaces

4. Communication and Networking
    - 4.1 Personal Area Networks
    - 4.2 Local Area Networks
    - 4.3 Body Area Networks
    - 4.4 Middleware for Smart Devices
    - 4.5 Open Core Interface

5. User Interfaces
    - 5.1 Touch Control
    - 5.2 Gesture Control
    - 5.3 Voice Control
    - 5.4 Multimodal Control

6. Ubiquitous Computing
    - 6.1 Aims and Basic Properties of Ubiquitous Systems
    - 6.2 Examples for Ubiquitous Systems
    - 6.3 Context Sensitivity
    - 6.4 Autonomy
    - 6.5 Smart Device Management

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Fortino, G., & Trunfio, P. (2014). Internet of Things Based on Smart Objects: Technology, Middleware and Applications. Springer International Publishing.<br>▪ López, T. S. et al. (2011). Taxonomy, Technology and Applications of Smart Objects. Information Systems Frontiers, 13(2), 281–300.<br>▪ McTear, M., Callejas, Z., & Griol, D. (2016). The Conversational Interface: Talking to Smart Devices. Springer International Publishing.<br>▪ Nihtianov, S., & Luque, A. (2014). Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications. Woodhead.<br>▪ Poslad, S. (2009). Ubiquitous Computing: Smart Devices, Environments and Interactions (2nd ed.). Wiley. - Sendler, U. (Ed.) (2018). The Internet of Things – Industrie 4.0 Unleashed. Springer.<br>▪ Vinoy, K. J. et al. (Eds.) (2014). Micro and Smart Devices and Systems. Springer India. |

## Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Smart Devices II

**Module Code: DLBINGSD2_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Sheik Radiah Ravim Rivu (Smart Devices II)

**Contributing Courses to Module**

- Smart Devices II (DLBINGSD02_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Written Assessment: Project Report | |

**Weight of Module**

see curriculum

**Module Contents**

- Overview and introduction
- Smart devices
- Technological features
- Communication and networking
- User interfaces
- Ubiquitous computing

<table>
<tr><td colspan="2">Learning Outcomes<br>Smart Devices II<br>On successful completion, students will be able to<br>▪ have an in-depth understanding of the technologies and standards in the context of smart devices.<br>▪ apply technologies in the context of smart devices using a simple practical example.<br>▪ design a hardware or software prototype for a selected task.<br>▪ document design and development activities in the form of a project report.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Computer Science & Software Development</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the IT & Technology field</td></tr>
</table>

# Smart Devices II

**Course Code: DLBINGSD02_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In this course, students select one assignment from the provided topic catalogue in consultation with the tutor. They work on the task with the help of a prototyping environment that fits the subject matter of the assignment. The environments can be hardware (e.g. prototyping boards) or software (e.g. technology-specific development environments). To complete the task, students apply concepts, methods and tools taught in the Smart Devices I course. They document their results in a project report.

**Course Outcomes**

On successful completion, students will be able to

- have an in-depth understanding of the technologies and standards in the context of smart devices.
- apply technologies in the context of smart devices using a simple practical example.
- design a hardware or software prototype for a selected task.
- document design and development activities in the form of a project report.

**Contents**

- A catalogue with currently available assignments is provided on the online learning platform. It provides the content basis of the module and can be supplemented or updated by the tutor.

**Literature**

**Compulsory Reading**

**Further Reading**

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# Theoretical Computer Science and Mathematical Logic

**Module Code: DLBCSTCSML**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Robert Graf (Theoretical Computer Science and Mathematical Logic)

**Contributing Courses to Module**

- Theoretical Computer Science and Mathematical Logic (DLBCSTCSML01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Proposition and predicate logic
- Finite automata
- Formal languages
- Computability and Turing machines
- Complexity theory
- Petri nets

<table>
<tr><td colspan="2">Learning Outcomes<br>Theoretical Computer Science and Mathematical Logic<br>On successful completion, students will be able to<br>▪ formulate and translate predicate logical relationships into programming languages.<br>▪ use finite automatons and regular expressions to describe technical facts.<br>▪ explain the Chomsky hierarchy.<br>▪ identify the limits of provability and predictability.<br>▪ explain the meaning and relevance of the P=NP problem.<br>▪ apply Petri nets for the description of technical facts.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Computer Science & Software Development.</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the IT & Technology field.</td></tr>
</table>

# Theoretical Computer Science and Mathematical Logic

**Course Code: DLBCSTCSML01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

Theoretical computer science and mathematical logic form the theoretical basics of computer science. However, this is not "pure theory", as these fundamentals are applied in many areas of computer science. These include, for example, the formulation of conditions in SQL queries or other programs based on statement and predicate logic, the use of finite state machines to specify systems with state transition diagrams, and the modeling of business and other processes with Petri nets. In addition, theoretical computer science and mathematical logic analyze the limits of computer science and computability, which cannot be exceeded irrespective of the technologies and algorithms used.

**Course Outcomes**

On successful completion, students will be able to

- formulate and translate predicate logical relationships into programming languages.
- use finite automatons and regular expressions to describe technical facts.
- explain the Chomsky hierarchy.
- identify the limits of provability and predictability.
- explain the meaning and relevance of the P=NP problem.
- apply Petri nets for the description of technical facts.

**Contents**

1. Propositional Logic
   - 1.1 Basic Concepts
   - 1.2 Calculation Rules and Normal Forms
   - 1.3 Interpretation and Satisfiability
   - 1.4 Proof by Contradiction and Resolution
   - 1.5 Soundness and Completeness

2. Predicate Logic
   - 2.1 Basic Concepts
   - 2.2 Resolution in Predicate Logic
   - 2.3 Completeness and Incompleteness
   - 2.4 Logic Programming with Prolog

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Sipser, M. (2014). Introduction to the theory of computation (3rd ed.). Cengage Learning.<br>▪ Huth, M., & Ryan, M. (2004). Logic in computer science: Modelling and reasoning about systems (2nd ed.). Cambridge University Press.<br>▪ Reisig, W. (2013). Understanding Petri nets: Modeling techniques, analysis methods, case studies. Springer.<br>▪ Parkes, A. P. (2008). A concise introduction to languages and machines. Springer.<br>▪ Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2022). Introduction to algorithms (4th ed.). MIT Press. |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Review Book |
| | ☑ Audio | ☑ Online Tests |
| | ☑ Slides | |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Review Book<br>☑ Online Tests |

# Requirements Engineering

**Module Code: DLBCSRE**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Andrew Adjah Sai (Requirements Engineering)

**Contributing Courses to Module**

- Requirements Engineering (DLBCSRE01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| <u>Study Format: Distance Learning</u><br>Exam, 90 Minutes<br><br><u>Study Format: myStudies</u><br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Basics of requirements engineering
- Enterprise modeling
- Requirement determination techniques
- Techniques of requirements documentation
- Testing and coordination of requirements
- Managing requirements

| Learning Outcomes | |
|---|---|
| **Requirements Engineering**<br>On successful completion, students will be able to<br>▪ describe models of enterprise modeling relevant to IT support and have experience in modeling.<br>▪ understand techniques and methods for determining requirements of IT systems and be able to distinguish them from each other.<br>▪ understand techniques for the documentation of requirements on IT systems and have experience in their use.<br>▪ describe techniques for testing, coordinating, and managing the requirements of IT systems and be able to distinguish between them.<br>▪ independently select suitable techniques and methods of requirements engineering for given project situations. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Requirements Engineering

**Course Code: DLBCSRE01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

The early phases of software development are largely characterized by the fact that functional and technical requirements for the IT system have to be determined. The determination of these requirements must be carried out extremely carefully because all of the following activities in the SW development process are planned and executed on the basis of documented requirements. In this course, procedures, methods, and models are covered, which make it possible to have a structured and methodical determination and documentation of requirements for operational information systems.

**Course Outcomes**

On successful completion, students will be able to

- describe models of enterprise modeling relevant to IT support and have experience in modeling.
- understand techniques and methods for determining requirements of IT systems and be able to distinguish them from each other.
- understand techniques for the documentation of requirements on IT systems and have experience in their use.
- describe techniques for testing, coordinating, and managing the requirements of IT systems and be able to distinguish between them.
- independently select suitable techniques and methods of requirements engineering for given project situations.

**Contents**

1. Fundamentals and Terms of Requirements Engineering
   - 1.1 Requirements Engineering in the Software Process
   - 1.2 Core Activities in Requirements Engineering
   - 1.3 What is a Requirement?

2. Determination of Requirements
   - 2.1 Determination of the System Context
   - 2.2 Determination of the Sources of Requirements
   - 2.3 Selection of the Appropriate Investigative Techniques
   - 2.4 Determine Requirements Using Techniques

3. Selected Investigative Techniques
   - 3.1 Creativity Techniques
   - 3.2 Interview Techniques
   - 3.3 Observation Techniques
   - 3.4 Prototyping

4. Documentation of Requirements
   - 4.1 Activities for Documenting Requirements
   - 4.2 Typical Elements of Requirements Documentation
   - 4.3 Forms of Documentation

5. Modeling of Processes
   - 5.1 Basics and Terms
   - 5.2 Modeling with the Business Process Model and Notation
   - 5.3 Modeling with Event Driven Process Chains

6. Modeling of Systems
   - 6.1 Fundamentals of Unified Modeling Language
   - 6.2 UML Use Case Diagram
   - 6.3 UML Activity Diagram
   - 6.4 UML Class Diagram
   - 6.5 UML State Diagram

7. Checking and Reconciling Requirements
   - 7.1 Activities for Checking and Reconciling Requirements
   - 7.2 Test Criteria
   - 7.3 Test Principles
   - 7.4 Testing Techniques
   - 7.5 Coordination of Requirements

8. Management of Prioritization Requirements and Techniques
   - 8.1 Managing Requirements
   - 8.2 Techniques for Prioritizing Requirements

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Dick, J., Hull, E., & Jackson, K. (2017). Requirements engineering (4th ed.). Springer.<br>▪ Glinz, M., van Loenhoud, H., Staal, S., & Bühne, S. (2020). Handbook for the CPRE foundation level according to the IREB standard: Education and training for certified professional for requirements engineering (CPRE): Foundation level (Version 1.0.0). InternationalRequirements Engineering Board.<br>▪ Pohl, K., & Rupp, C. (2015). Requirements engineering fundamentals: A study guide for the certified professional for requirements engineering exam: Foundation level—IREB compliant (2nd ed.). Rocky Nook. |

## Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Mathematics: Analysis

**Module Code: DLBDSMFC**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Robert Graf (Mathematics: Analysis)

**Contributing Courses to Module**

- Mathematics: Analysis (DLBDSMFC01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Sequences and series
- Functions & reverse functions
- differential calculus
- integral calculus

<table>
<tr><td colspan="2">Learning Outcomes<br><br>Mathematics: Analysis<br><br>On successful completion, students will be able to<br>▪ summarize the basic concepts of analysis.<br>▪ illustrate the terms "consequences" and "series".<br>▪ explain the concept of function and to understand the concept of the inverse function.<br>▪ explain basic statements of the differential and integral calculus.<br>▪ explain the relationship between differentiation and integration.<br>▪ master the derivation of higher-dimensional functions.</td></tr>
<tr><td>Links to other Modules within the Study Program<br><br>This module is similar to other modules in the field of Methods</td><td>Links to other Study Programs of the University<br><br>All Bachelor Programs in the IT & Technology field</td></tr>
</table>

# Mathematics: Analysis

**Course Code: DLBDSMFC01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

Analysis is one of the essential basic subjects of mathematics. Originally developed to be able to formulate and solve problems of classical mechanics mathematically, in its present rigorous form it has become indispensable in numerous applications in the natural sciences and technology. This module aims to introduce the basic hand tool of differential and integral calculus and to explain their mutual interrelations. In addition, the differential calculus is generalized to multidimensional spaces.

**Course Outcomes**

On successful completion, students will be able to

- summarize the basic concepts of analysis.
- illustrate the terms "consequences" and "series".
- explain the concept of function and to understand the concept of the inverse function.
- explain basic statements of the differential and integral calculus.
- explain the relationship between differentiation and integration.
- master the derivation of higher-dimensional functions.

**Contents**

1. Sequences and series
   - 1.1 Sequences and series
   - 1.2 Convergence of infinite series
   - 1.3 power series

2. Functions and reverse functions
   - 2.1 Continuous functions
   - 2.2 Exponential and logarithm function
   - 2.3 Trigonometric functions and their inverse functions

3. Differential calculus
   - 3.1 Derivatives and higher derivatives
   - 3.2 curve discussion
   - 3.3 Rules (chain rule, product rule, quotient rule ...)

|  |  |  |
|---|---|---|
|  | 3.4 | Taylor Rows |
| 4. | Integral calculus |  |
|  | 4.1 | The Riemann Integral |
|  | 4.2 | Specific and indefinite integrals |
|  | 4.3 | The fundamental theorem of differential and integral calculus |
|  | 4.4 | Volumes and shells of rotary bodies |
|  | 4.5 | Paths and lengths |
| 5. | Differential calculus in the Rn |  |
|  | 5.1 | Partial Derivation |
|  | 5.2 | Total Derivation |
|  | 5.3 | Gradients of vector-valued functions and matrices |

**Literature**

**Compulsory Reading**

**Further Reading**


- Deisenroth, M.P., Faisal, A.A., & Ong, C.S. (2020). Mathematics for Machine Learning. Cambridge University Press.
- Magnus, R. (2020). Fundamental Mathematical Analysis. Springer International Publishing.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Review Book<br>☑ Online Tests |

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Review Book |
| | ☑ Audio | ☑ Online Tests |
| | ☑ Slides | |

# Mathematics: Linear Algebra

**Module Code: DLBDSMFLA**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Robert Graf (Mathematics: Linear Algebra)

**Contributing Courses to Module**

- Mathematics: Linear Algebra (DLBDSMFLA01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Matrix Algebra
- Vector Spaces
- Linear and Affine Transformations
- Analytical Geometry
- Matrix Decomposition

| Learning Outcomes | |
|---|---|
| **Mathematics: Linear Algebra**<br>On successful completion, students will be able to<br>▪ explain fundamental notions in the domain of linear equation systems.<br>▪ exemplify properties of vectors and vector spaces.<br>▪ summarize characteristics of linear and affine mappings.<br>▪ identify important relations in analytical geometry.<br>▪ utilize different methods for matrix decomposition. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Methods | **Links to other Study Programs of the University**<br>All Bachelor Programs in the Business & Management field |

# Mathematics: Linear Algebra

**Course Code: DLBDSMFLA01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

Linear algebra is a fundamental subject in mathematics. Its historical origin lies in the development of solution techniques for systems of linear equations arising from geometric problems. Numerous scientific and engineering applications can be solved using its methods. This course introduces the foundations of linear algebra and its basic notions like vectors and matrices. It then builds upon this foundation by introducing the derivation of solution techniques for problems in analytical geometry.

**Course Outcomes**

On successful completion, students will be able to

- explain fundamental notions in the domain of linear equation systems.
- exemplify properties of vectors and vector spaces.
- summarize characteristics of linear and affine mappings.
- identify important relations in analytical geometry.
- utilize different methods for matrix decomposition.

**Contents**

1. Foundations
   - 1.1 Systems of Linear Equations
   - 1.2 Matrices: Basic Terms
   - 1.3 Matrix algebra
   - 1.4 Matrices as compact representations of linear equations
   - 1.5 Inverse and trace

2. Vector Spaces
   - 2.1 Definition
   - 2.2 Linear Combination and Linear Dependance
   - 2.3 Basis, Linear Envelope, and Rank

3. Linear and Affine Mapping
   - 3.1 Matrix Representation of Linear Mappings
   - 3.2 Image and Kernel

3.3 Affine Spaces and Subspaces
3.4 Affine Mapping

4. Analytical Geometry
4.1 Norm
4.2 Scalar Product
4.3 Orthogonal Projections
4.4 Outlook: Complex Numbers

5. Matrix Decomposition
5.1 Determinant
5.2 Eigenvalues and Eigenvectors
5.3 Cholesky Decomposition
5.4 Eigenvalue Decomposition and Diagonalisation
5.5 Singular Value Decomposition

**Literature**

**Compulsory Reading**

**Further Reading**


- Aggarwal, C.C. (2020). Linear Algebra and Optimization for Machine Learning: A Textbook. Springer.
- Mathai, A. M., & Haubold, H. J. (2017). Linear algebra, a course for physicists and engineers (1st ed.) De Gruyter.
- Neri, F. (2019). Linear algebra for computational sciences and engineering (2nd ed.) Springer.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Review Book<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Review Book<br>☑ Online Tests |

# Mathematics II

**Module Code: DLBCSM2**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| Prof. Dr. Robert Graf (Mathematics II) |

| Contributing Courses to Module |
|---|
| ▪ Mathematics II (DLBCSM201) |

| Module Exam Type | |
|---|---|
| **Module Exam** | **Split Exam** |
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |
| **Weight of Module**<br>see curriculum | |

| Module Contents |
|---|
| ▪ Selected topics of linear algebra<br>▪ Selected chapters on graphs and algorithms |

<table>
<tr><td colspan="2">Learning Outcomes<br><br>Mathematics II<br><br>On successful completion, students will be able to<br>▪ understand basic concepts of linear algebra, their interrelations, and their application in IT and technology and be able solve tasks independently using these concepts.<br>▪ understand and distinguish the basic concepts and important algorithms for graphs and trees from the field of discrete mathematics as well as their application in IT and technology.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Methods</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the Business & Management field</td></tr>
</table>

# Mathematics II

**Course Code: DLBCSM201**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

This course continues the introduction to topics of discrete mathematics which began in the module "Mathematics Fundamentals I". In this course, the concepts of linear algebra are introduced and knowledge about graphs and algorithms for graphs is deepened. Typical questions of applied computer science are selected, and students are shown how they can be solved with graphs.

**Course Outcomes**

On successful completion, students will be able to

- understand basic concepts of linear algebra, their interrelations, and their application in IT and technology and be able solve tasks independently using these concepts.
- understand and distinguish the basic concepts and important algorithms for graphs and trees from the field of discrete mathematics as well as their application in IT and technology.

**Contents**

1. Introduction to Matrices
   - 1.1 Basic Concepts of Matrices
   - 1.2 Addition of Matrices
   - 1.3 Scalar Multiplication and Product

2. Inverting Matrices
   - 2.1 Multiplication of Matrices
   - 2.2 Properties of Matrix Multiplication
   - 2.3 Inverse Matrices

3. Linear Systems of Equations
   - 3.1 Gauss Algorithm
   - 3.2 Example Applications of the Gaussian Algorithm

4. Introduction to Graphs
   - 4.1 Undirected Graphs
   - 4.2 Further Properties of Graphs

4.3 Adjacency Matrix

5. The Problem of the Shortest Routes
   5.1 Directional Graph or Digraph
   5.2 Weighted Graph
   5.3 Dijkstra's Algorithm

6. The Königsberg Bridge Problem
   6.1 Routing in Graphs
   6.2 Eulerian Graph
   6.3 Hierholzer's Algorithm
   6.4 The Postman Problem

7. A City Tour Where Each City is Visited Exactly Once.
   7.1 Special Graphs
   7.2 Hamiltonian Graph
   7.3 The Ore and Dirac Condition
   7.4 The Problem of the Traveling Salesman

8. Trees
   8.1 Properties of Trees
   8.2 Root Tree
   8.3 Spanning Tree
   8.4 Minimal Spanning Tree

**Literature**

**Compulsory Reading**

**Further Reading**


- Benjamin, A., Chartrand, G., and Zhang, P. (2017). The fascinating world of graph theory. Princeton University Press.
- Erciyes, J. (2021). Discrete mathematics and graph theory: A concise study companion and guide. Princeton University Press.
- Lewis, H., & Zax, R. (2019). Essential discrete mathematics for computer science. Princeton University Press.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Managerial Economics

**Module Code: DLBBWME_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Tolga Ülkü (Managerial Economics)

**Contributing Courses to Module**

- Managerial Economics (DLBBWME01_E)

| Module Exam Type | |
|---|---|
| **Module Exam**<br>Study Format: Distance Learning<br>Exam, 90 Minutes<br>Study Format: myStudies<br>Exam, 90 Minutes | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Basics
- The Invisible Hand of the Market
- Consumer Decisions
- Business Decisions I: Full Competition
- Business Decisions II: Partial Competition
- Business Decisions III: Game Theory
- Advanced Microeconomics

| Learning Outcomes | |
|---|---|
| **Managerial Economics**<br>On successful completion, students will be able to<br>▪ understand basic economic interrelationships and apply them to different markets.<br>▪ explain the importance of supply, demand and market balance.<br>▪ assess the determinants of consumers' willingness to pay.<br>▪ discuss the determinants of production decisions and identify peak entrepreneurial strategies.<br>▪ assess the influence of different types of markets on production and price decisions.<br>▪ analyse strategic interactions between companies.<br>▪ critically question traditional economic models on the basis of findings from information and behavioural economics. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Economics | **Links to other Study Programs of the University**<br>All Bachelor Programs in the Business & Management field |

# Managerial Economics

**Course Code: DLBBWME01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

The source for (almost) all economic questions is the issue of scarcity. Building on this insight, this course considers three central elements. First, an analysis of the interplay between supply and demand on markets is made. Secondly, the course will consider the development of insights into the behaviour of consumers in markets. In a third part, the course will focus on entrepreneurial decisions that depend, among other things, on production technology available and competitive conditions in markets. These three core elements are taught from an application-oriented standpoint, in which references to (current) challenges of the management of companies are established. The course includes both the examination of economic theories and their application in business practice.

**Course Outcomes**

On successful completion, students will be able to

- understand basic economic interrelationships and apply them to different markets.
- explain the importance of supply, demand and market balance.
- assess the determinants of consumers' willingness to pay.
- discuss the determinants of production decisions and identify peak entrepreneurial strategies.
- assess the influence of different types of markets on production and price decisions.
- analyse strategic interactions between companies.
- critically question traditional economic models on the basis of findings from information and behavioural economics.

**Contents**

1. Basics
   - 1.1 Definitions & Main Topics of Economics
   - 1.2 Thinking like an Economist

2. The Invisible Hand of the Market
   - 2.1 Supply and Demand
   - 2.2 Market Balance
   - 2.3 Flexibility
   - 2.4 Applications

3. Consumer Decisions
   - 3.1 Utility Theory
   - 3.2 Willingness to Pay
   - 3.3 Demand
   - 3.4 Applications

4. Business Decisions I: Full Competition
   - 4.1 Production
   - 4.2 Costs
   - 4.3 Supply
   - 4.4 Applications

5. Business Decisions II: Partial Competition
   - 5.1 Monopoly
   - 5.2 Monopolistic Competition
   - 5.3 Oligopoly

6. Business Decisions III: Game Theory
   - 6.1 Methodology
   - 6.2 Simultaneous Games
   - 6.3 Sequential Games

7. Advanced Microeconomics
   - 7.1 Information Economics
   - 7.2 Behavioural Economics

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Acemoglu, D., Laibson, & D., List, J. A. (2018). Microeconomics, Global edition (2nd ed.). Pearson.<br>▪ Case, K. E., Osten, S. M., & Fair, R. C. (2019). Principles of economics, Global edition (13th ed.). Harlow.<br>▪ Keat, P. G., & Young, P. K. Y. (2013). Managerial economics, Global Edition (7th ed.). Pearson Education Limited.<br>▪ Leyton-Brown, K., & Shoham, Y. (2008). Essentials of game theory: A concise multidisciplinary introduction. Morgan & Claypool.<br>▪ Parkin, M. (2019). Economics (13th ed.). Harlow.<br>▪ Pindyck, R. S., & Rubinfeld, D. L. (2017). Microeconomics (9th ed.). Pearson. |

## Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
| --- | --- |
| myStudies | Lecture |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
| --- | --- | --- |
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

# Corporate Governance and Strategy

**Module Code: DLBBACGS_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| N.N. (Corporate Governance and Strategy) |

| Contributing Courses to Module |
|---|
| ▪ Corporate Governance and Strategy (DLBBACGS01_E) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Exam or Written Assessment: Case Study, 90 Minutes<br><br>Study Format: myStudies<br>Exam or Written Assessment: Case Study, 90 Minutes | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

| Module Contents | |
|---|---|
| ▪ Introduction to Corporate Governance and Strategy<br>▪ Perspectives of Corporate Governance<br>▪ Monitoring Concepts for Corporate Governance<br>▪ Perspectives of Strategy<br>▪ Tools for Strategy Development<br>▪ Aligning Corporate Governance and Strategy | |
| **Learning Outcomes**<br>**Corporate Governance and Strategy**<br>On successful completion, students will be able to<br>▪ define and explain fundamentals of Corporate Governance.<br>▪ explain different understandings of Corporate Governance.<br>▪ understand the possible compositions of governance mechanisms and governance systems.<br>▪ define and explain strategy.<br>▪ distinguish different approaches to strategy.<br>▪ describe various strategy instruments.<br>▪ comprehend the link between strategy and governance. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Business Administration & Management | **Links to other Study Programs of the University**<br>All Bachelor Programs in the Business & Management field |

# Corporate Governance and Strategy

**Course Code: DLBBACGS01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

This course addresses major frameworks under which companies are established and operated. It explains key elements of Corporate Governance and outlines different patterns of governance. In particular, it refers to different approaches to management and control. Furthermore, it links the concept of management and control to corporate strategy. Students are familiarized with different understandings of strategy and how they relate to corporate governance. This course facilitates tools of strategic market analysis and subsequent strategies to enter markets successfully. This course also explains the implications of corporate governance frameworks on strategy development of a firm.

**Course Outcomes**

On successful completion, students will be able to

- define and explain fundamentals of Corporate Governance.
- explain different understandings of Corporate Governance.
- understand the possible compositions of governance mechanisms and governance systems.
- define and explain strategy.
- distinguish different approaches to strategy.
- describe various strategy instruments.
- comprehend the link between strategy and governance.

**Contents**

1. Introduction to Corporate Governance and Strategy
   - 1.1 Fundamentals of Corporate Governance
   - 1.2 Fundamentals of Strategy
   - 1.3 The link between Strategy and Corporate Governance

2. Perspectives of Corporate Governance
   - 2.1 The Corporate Governance Debate
   - 2.2 Underlying Approaches to Corporate Governance
   - 2.3 The Concept of Control and its Interpretation

3. Monitoring Concepts for Corporate Governance
   - 3.1 Governance Mechanisms

**Literature**

**Compulsory Reading**

**Further Reading**


- Ferris, S. P., John, K., & Makhija, A. K. (2019). International corporate governance and regulation. Emerald Publishing.
- International Corporate Governance Network (2021). Global governance principles.
- Slack, N., Brandon-Jones, A., & Johnston, R. (2019). Operations management (9th ed.). Pearson.

### Study Format Distance Learning

| Study Format | Course Type |
| --- | --- |
| Distance Learning | Online Lecture |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam or Written Assessment: Case Study, 90 Minutes |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 100 h | 0 h | 25 h | 25 h | 0 h | 150 h |

| Instructional Methods | | |
| --- | --- | --- |
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Online Tests |
| | ☑ Audio | |
| | ☑ Slides | |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam or Written Assessment: Case Study, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 100 h | 0 h | 25 h | 25 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Explorative Data Analysis and Visualization

**Module Code: DLBDSEDAV**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLBDSIPWP01 or DLBDSIPWP01_D, DLBDSOOFPP01 | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Visieu Lac (Explorative Data Analysis and Visualization)

**Contributing Courses to Module**

- Explorative Data Analysis and Visualization (DLBDSEDAV01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Written Assessment: Written Assignment<br><br>Study Format: Distance Learning<br>Written Assessment: Written Assignment | |

**Weight of Module**

see curriculum

**Module Contents**

- Exploratory data analysis
- Principles of data visualization
- Established visualization types and apposite use cases
- Commonly-used Python modules for visualization
- Principles of effective visual communication

| Learning Outcomes | |
|---|---|
| **Explorative Data Analysis and Visualization**<br>On successful completion, students will be able to<br>▪ recognize foundational concepts of exploratory data analysis.<br>▪ cite principles of data visualization.<br>▪ identify well-established types of visualizations and their appropriate uses.<br>▪ describe visualization best practices.<br>▪ understand practical data visualization fundamentals in Python.<br>▪ use different approaches for effective visual communication of data science results. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Data Science & Artificial Intelligence | All Bachelor Programs in the IT & Technology field |

# Explorative Data Analysis and Visualization

**Course Code: DLBDSEDAV01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | DLBDSIPWP01 or DLBDSIPWP01_D, DLBDSOOFPP01 |

**Course Description**

Obtaining an overview of the salient characteristics of a data set is one of the core activities at the outset of any data analysis endeavour. The corresponding activities, methods, and techniques are grouped under the term "exploratory data analysis". During exploratory data analysis, gaining insight into a given data set is often aided by the application of suitable visualization techniques. The utility of visualization, however, does not end at this stage; it is also crucial for communicating analytical outcomes. This course first introduces a set of approaches, tools, and techniques that are useful for exploring data sets. It then takes a thorough look at the subject area of visualization, which is presented in detail by an exposition arc that spans from first principles of visualization to practical implementation to insights into the communication of data science results and findings.

**Course Outcomes**

On successful completion, students will be able to

- recognize foundational concepts of exploratory data analysis.
- cite principles of data visualization.
- identify well-established types of visualizations and their appropriate uses.
- describe visualization best practices.
- understand practical data visualization fundamentals in Python.
- use different approaches for effective visual communication of data science results.

**Contents**

1. Exploratory Data Analysis
   - 1.1 Location and variability
   - 1.2 Further exploration of data distribution
   - 1.3 Covariance and correlation

2. Data Visualization Principles
   - 2.1 Coordinates and axes
   - 2.2 Color spaces
   - 2.3 Graph types

3. Data Visualization Practice

3.1 Amounts, proportions, associations, and distributions
3.2 Time series and trends
3.3 Geo-spatial data

4. Visualization in Python – Matplotlib and Seaborn
   4.1 Introduction to PyPlot, Matplotlib, and Seaborn
   4.2 Basic plots
   4.3 Geo-spatial plots

5. Communicating Data Science
   5.1 Unclutter, focus, and capture attention
   5.2 Lessons from design
   5.3 Principles of storytelling with data

**Literature**

**Compulsory Reading**

**Further Reading**


- Anderson, C. (2015). Creating a data-driven organization. Sebastopol, CA: O'Reilly Media.
- Bruce, A., & Bruce, P. (2017). Practical statistics for data scientists. Sebastopol, CA: O'Reilly Media.
- Grobmann, T., & Dobler, M. (2019). Data visualization with Python. Birmingham: Packt Publishing.
- Nussbaumer Knaflic, C. (2015). Storytelling with data: A data visualization guide for business professionals. Chichester: John Wiley & Sons.
- Wilke, C. O. (2019). Fundamentals of data visualization. Sebastopol, CA: O'Reilly Media.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Written Assignment |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Online Tests |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Guideline |
| | ☑ Audio | |
| | ☑ Slides | |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Written Assignment |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests<br>☑ Guideline |

# Data Engineering

**Module Code: DLBDSEDE1**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Sahar Qaadan (Data Engineering )

**Contributing Courses to Module**

- Data Engineering (DLBDSEDE01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes<br><br>Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: On Campus<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Core concepts of data engineering and data-intensive applications
- Current storage technology and architectural patterns for data at scale
- Container technology
- Operational aspects of data pipelines
- Data security and protection

| Learning Outcomes | |
|---|---|
| **Data Engineering**<br>On successful completion, students will be able to<br>▪ understand important foundational concepts in data engineering.<br>▪ recognize established and commonly-employed NoSQL datastores and their salient characteristics.<br>▪ comprehend common architectural patterns for data processing at scale.<br>▪ explain the concept of containerization as a virtualization approach.<br>▪ analyze operational challenges in the set-up and maintenance of data pipelines.<br>▪ demonstrate familiarity with concepts relating to data security and protection. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field Data Science & Artificial Intelligence | All Bachelor Programs in the IT & Technology field |

# Data Engineering

**Course Code: DLBDSEDE01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

This course explores concepts of data engineering. Data engineering is concerned with the infrastructure aspects of data science such as data storage and provision, as well as the provisioning of suitable operational environments.After laying out foundational notions and concepts of the discipline, this course addresses important developments in storage technology; aspects of systems architecture for processing data at scale; containerization as a modern take on virtualization; and the logic of data pipelines and associated operational aspects. Important issues pertaining to data security and protection are also given appropriate attention.

**Course Outcomes**

On successful completion, students will be able to

- understand important foundational concepts in data engineering.
- recognize established and commonly-employed NoSQL datastores and their salient characteristics.
- comprehend common architectural patterns for data processing at scale.
- explain the concept of containerization as a virtualization approach.
- analyze operational challenges in the set-up and maintenance of data pipelines.
- demonstrate familiarity with concepts relating to data security and protection.

**Contents**

1. Foundations of Data Engineering
   - 1.1 Reliability
   - 1.2 Scalability
   - 1.3 Maintainability

2. NoSQL In Depth
   - 2.1 Fundamentals of NoSQL
   - 2.2 Established NoSQL solutions

3. Architectures for Data Processing at Scale
   - 3.1 Batch processing architectures
   - 3.2 Architectures for stream and complex event processing
   - 3.3 Lambda architecture

4. Containerization In Depth
   - 4.1 Docker containers
   - 4.2 Container management
5. Governance & Security
   - 5.1 Data protection
   - 5.2 Data security
   - 5.3 Data governance
6. Operational Aspects
   - 6.1 Defining principles of DataOps
   - 6.2 Building and maintaining data pipelines
   - 6.3 Metrics and monitoring

**Literature**

**Compulsory Reading**

**Further Reading**

- Adkins, H., Beyer, B., Blankinship, P., Lewandowski, P., Oprea, A., & Stubblefield, A. (2020). Building secure and reliable systems. O'Reilly.
- Franks, B. (2020). 97 things about ethics everyone in data science should know. O'Reilly.
- Kane, S. P., & Matthias, K. (2018). Docker: Up and running (2nd ed.). O'Reilly.
- Kleppmann, M. (2017). Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. O'Reilly.
- Narkhede, N., Palino, T., & Shapira, G. (2017). Kafka: The definitive guide. O'Reilly.

### Study Format Distance Learning

| Study Format | Course Type |
| --- | --- |
| Distance Learning | Online Lecture |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
| --- | --- | --- |
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

### Study Format On Campus

| Study Format | Course Type |
|---|---|
| On Campus | |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods |
|---|
| |

# Smart Services I

**Module Code: DLBDBESS1_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Holger Klus (Smart Services I)

**Contributing Courses to Module**

- Smart Services I (DLBINGSS01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Digitization and Disruption
- Potential of Smart Services
- Development and Specification of Smart Services
- Service Architectures
- Integration Platforms
- Technologies for Smart Services
- Quality and Operation of Smart Services

<table>
<tr><td colspan="2">
Learning Outcomes<br><br>
Smart Services I<br><br>
On successful completion, students will be able to
<ul>
<li>recognize the relevance of Smart Services in the context of digitization in general and Industry 4.0 in particular.</li>
<li>identify special features of digital business models and demonstrate them using the example of digital intermediaries.</li>
<li>apply methods to uncover digitization potentials and use the Business Model Canvas to classify them in a business model.</li>
<li>know and use models for the multi-perspective specification of services.</li>
<li>know selected architectures for the design and integration of services.</li>
<li>distinguish different technologies that are required for the development of services.</li>
<li>define the quality of services by means of Service Level Agreements.</li>
</ul>
</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Computer Science & Software Development</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the IT & Technology field</td></tr>
</table>

# Smart Services I

**Course Code: DLBINGSS01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In this course, students study concepts and methods for the development of Smart Services. For this purpose, an introduction of the term in the context of digitization and Industry 4.0 will be given. Based on this, this course shows how innovative services can have a disruptive effect on existing business models or even markets using the example of digital intermediaries. Subsequently, students will be taught selected methods and techniques with which digitization potentials can be recognized and modelled. In addition, selected architectures and platforms for the integration of services are presented. Finally, relevant technologies for the implementation of smart services are taught and it is briefly described how the quality of services can be agreed upon.

**Course Outcomes**

On successful completion, students will be able to

- recognize the relevance of Smart Services in the context of digitization in general and Industry 4.0 in particular.
- identify special features of digital business models and demonstrate them using the example of digital intermediaries.
- apply methods to uncover digitization potentials and use the Business Model Canvas to classify them in a business model.
- know and use models for the multi-perspective specification of services.
- know selected architectures for the design and integration of services.
- distinguish different technologies that are required for the development of services.
- define the quality of services by means of Service Level Agreements.

**Contents**

1. Introduction and Motivation
   - 1.1 Digitization and Cyber-Physical Production Systems
   - 1.2 Smart Services in Industry 4.0
   - 1.3 Examples of Smart Services

2. Digitization and Disruption
   - 2.1 Definition: Digital Business Models
   - 2.2 Strategies for Change and Innovation

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Chignell, M. et al. (Hrsg.) (2010): The Smart Internet. Current Research and Future Applications. Springer.<br>▪ Evans, E. (2003): Domain-Driven Design. Tackling Complexity in the Heart of Software. Addison-Wesley, Upper Saddle River.<br>▪ Hohpe, G./Woolf, B./Brown, K. (2012): Enterprise Integration Patterns. Designing, Building, and Deploying Messaging Solutions. 16th edition, Addison-Wesley.<br>▪ Nielsen, L. (2013): Personas – User Focused Design. Springer.<br>▪ Osterwalder, A/Pigneur, Y. (2010): Business Model Generation: A Handbook for Visionaries, Game Changers, John Wiley & Sons Inc. |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Online Tests |
| | ☑ Audio | |
| | ☑ Slides | |

# Smart Sevices II

**Module Code: DLBINGSS2_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Holger Klus (Smart Services II)

**Contributing Courses to Module**

- Smart Services II (DLBINGSS02_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Written Assessment: Project Report<br><br>Study Format: Distance Learning<br>Written Assessment: Project Report | |

**Weight of Module**

see curriculum

**Module Contents**

Analysis of a selected topic of Smart Services and design of a self-chosen assignment in a prototyping environment.

<table>
<tr><td colspan="2">Learning Outcomes<br><br>Smart Services II<br><br>On successful completion, students will be able to<br>▪ have an in-depth understanding of the technologies and standards in the context of Smart Services.<br>▪ apply technologies in the context of smart services using a simple practical example.<br>▪ design a hardware or software prototype for a selected technical task.<br>▪ document design and development activities in the form of a project report.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Computer Science & Software Development</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the IT & Technology field</td></tr>
</table>

# Smart Services II

**Course Code: DLBINGSS02_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In this course, the students select a concrete technical task from the provided topic catalogue in consultation with the seminar leader. They work on the task with the help of a prototyping environment that is suitable for the subject of the task. The environments can be hardware (e.g. prototyping boards) or software (e.g. technology-specific development environments). To complete the task, students apply the concepts, methods and tools taught in the Smart Services I course. They document their results in a project report.

**Course Outcomes**

On successful completion, students will be able to

- have an in-depth understanding of the technologies and standards in the context of Smart Services.
- apply technologies in the context of smart services using a simple practical example.
- design a hardware or software prototype for a selected technical task.
- document design and development activities in the form of a project report.

**Contents**

- A catalogue with currently available assignments is provided on the online learning platform. It provides the content basis of the module and can be supplemented or updated by the tutor.

**Literature**

**Compulsory Reading**

**Further Reading**


- Lee, K.-H., & Kim, D. (2019). A peer-to-peer (P2P) platform business model: The case of Airbnb. Service Business: An International Journal, 13(4), 647-669.
- Maleshkova, M., Kühl, N., & Jussen, P. (2020). Smart service management: Design guidelines and best practices. Springer.
- Osterwalder, A., & Pigneur, Y. (2010). Business model generation: A handbook for visionaries, game changers, and challengers [Electronic resource]. Wiley.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# Threat Modeling

**Module Code: DLBCSEEFT1_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLBCSRE01 | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Aleksandra Kornecka (Threat Modeling)

**Contributing Courses to Module**

- Threat Modeling (DLBCSEEFT01_E)

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Thinking C.I.A. and beyond
- Measuring the Cyber Threat
- Threat Modeling
- Attack libraries
- Rules, Regulations, and Law Enforcement
- Risk management
- Threat Mitigation

| Learning Outcomes | |
|---|---|
| **Threat Modeling**<br>On successful completion, students will be able to<br>▪ confidently think through eventual threats.<br>▪ model these threats using a common modelling methodology.<br>▪ find relevant techniques, tactics and procedures relating to a given scenario.<br>▪ calculate risk associate with the threat model.<br>▪ mitigate the risk by implementing design changes. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Threat Modeling

**Course Code: DLBCSEEFT01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | DLBCSRE01 or IREN01 |

**Course Description**

When a system or architecture is being created it is vital that possible threats are evaluated at the same time. By using both modeling methodologies and past observed attack patterns, it is possible to take a new or existing system and examine it for possible threats. With this analysis, possible risks and mitigations can be derived. While the most common methodologies are based on Attack Trees and the STRIDE model, recently attack modelling has also been using repositories of attacker techniques, tactics and procedures for inspiration.

**Course Outcomes**

On successful completion, students will be able to

- confidently think through eventual threats.
- model these threats using a common modelling methodology.
- find relevant techniques, tactics and procedures relating to a given scenario.
- calculate risk associate with the threat model.
- mitigate the risk by implementing design changes.

**Contents**

1. Thinking C.I.A. and beyond
   - 1.1 Confidentiality
   - 1.2 Integrity
   - 1.3 Availability
   - 1.4 Well-Known IT Security Issues

2. Measuring the Cyber Threat
   - 2.1 Concept of Threat Measuring
   - 2.2 Cyber Threat Metrics
   - 2.3 Measuring the Threat for an Organization
   - 2.4 Major Cyberattacks and their Impact
   - 2.5 Black Swan Events

3. Threat Modeling
   - 3.1 Attack Tree Methodology

3.2 STRIDE
3.3 DREAD
3.4 The Pyramid of Pain

4. Attack libraries
4.1 CAPEC
4.2 Solove's Taxonomy of Privacy
4.3 Mitre ATT&CK®
4.4 Identifying new Cyberattacks

5. Rules, Regulations, and Law Enforcement
5.1 Cyber Laws
5.2 Compliance and Law Enforcement

6. Risk management
6.1 Risk Management: An Overview
6.2 Incident Response and Crisis Management
6.3 Unpredictable Events (Black Swan)
6.4 Continuous Reevaluation

7. Threat Mitigation
7.1 Cyber Defense Tactics and Techniques
7.2 Risk Mitigation Strategies
7.3 Validation of Defenses
7.4 Security and Privacy by Design
7.5 Implementing Threat Mitigation in an Organization

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ CAPEC: Common Attack Pattern Enumeration and Classification. https://capec.mitre.org/<br>▪ Kim, P. (2014): The Hacker Playbook: Practical Guide to Penetration Testing. Secure Planet LLC.<br>▪ Kim, P. (2015): The Hacker Playbook 2: Practical Guide to Penetration Testing. Secure Planet LLC.<br>▪ Kim, P. (2018): The Hacker Playbook 3: Practical Guide to Penetration Testing. Secure Planet LLC.<br>▪ Mitre ATT&CK®. https://attack.mitre.org/<br>▪ Pfleeger, C. P. / Pfleeger, S. L. / Marguilies, J. (2015): Security in Computing. Fifth Edition, Pearson Education.<br>▪ Shostack, A. (2014): Threat Modeling: Designing for Security. John Wiley & Sons. |

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Information Security Standards

**Module Code: DLBCSEISS_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Andrew Adjah Sai (Information Security Standards)

**Contributing Courses to Module**

- Information Security Standards (DLBCSEISS01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| <u>Study Format: myStudies</u><br>Written Assessment: Case Study<br><br><u>Study Format: Distance Learning</u><br>Written Assessment: Case Study | |

**Weight of Module**

see curriculum

**Module Contents**

- Structure of the Information Security Standards
- Information Security Controls
- Information Security Management System (ISMS)
- Risk Management and Assessment

| **Learning Outcomes** | |
|---|---|
| **Information Security Standards**<br>On successful completion, students will be able to<br>▪ understand the general structure of information security standards.<br>▪ understand the normative content of the frameworks and standards.<br>▪ remember the required security controls.<br>▪ analyze existing Information Security Management Systems.<br>▪ evaluate Information Security Management Systems. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science & Software Development | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# Information Security Standards

**Course Code: DLBCSEISS01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | None |

## Course Description

Information security includes digital as well as non-digital information. The subset IT-Security deals only with electronical processed, stored and transferred information. Thus, information security is about the security referring to digital and non-digital assets of an organization.

## Course Outcomes

On successful completion, students will be able to

- understand the general structure of information security standards.
- understand the normative content of the frameworks and standards.
- remember the required security controls.
- analyze existing Information Security Management Systems.
- evaluate Information Security Management Systems.

## Contents

1. Introduction to Information Security
   - 1.1 Basic Definitions, Security Concepts and Information Security Objectives
   - 1.2 Standards and Regulatory Frameworks
   - 1.3 Security Standards: ISO 27000 Family and BSI Standards
   - 1.4 Information Security Management System (ISMS)

2. Initiating an Information Security Management System
   - 2.1 Initial Setup for the ISMS
   - 2.2 Analysis of the Organization
   - 2.3 Analysis of the Existing ISMS and Determination of the Maturity
   - 2.4 Defining the ISMS Scope and Security Policies

3. Implementation of the Information Security Management System
   - 3.1 Risk Assessment
   - 3.2 Statement of Applicability (SoA)
   - 3.3 Definition of the Organizational Structure for Information Security
   - 3.4 Document Management and Communication Plan
   - 3.5 Definition of Controls and Procedures

4. Controlling of the Information Security Management System
    4.1 Monitoring, Measurement, Analysis and Evaluation
    4.2 Internal Auditing
    4.3 Management Review

5. Improving of the Information Security Management System
    5.1 Treatment of Challenges and Non-conformities
    5.2 Continual Improvement
    5.3 Corrective and Preventive Action Plans

6. Controls of the Information Security Management System
    6.1 General Structure of Controls
    6.2 Controls of the ISO 27001 – Annex A
    6.3 Management of Controls
    6.4 Evaluating the Effectiveness of Controls

**Literature**

**Compulsory Reading**

**Further Reading**


- Alexander, D., Finch, A., & Sutton, D. (2013). Information Security Management Principles (2nd ed.). BCS, The Chartered Institute for IT.
- Chopra, A., & Chaudhary, M. (2020). Implementing an Information Security Management System: Security management based on ISO 27001 guidelines. Apress.
- Awad, A.I., Yen, N., & Fairhurst, M. (2018). Information security: Foundations, technologies and applications. The Institution of Engineering and Technology.
- van Publishing, H. (2015). Foundations of information security based on ISO27001 and ISO27002 (2nd ed.). Van Haren Publishing.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Online Tests |

# Statistics: Probability and Descriptive Statistics

**Module Code: DLBDSSPDS-01**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Veronica Mas (Statistics: Probability and Descriptive Statistics )

**Contributing Courses to Module**

- Statistics: Probability and Descriptive Statistics (DLBDSSPDS01-01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Probability
- Random variables
- Joint distributions
- Expectation and variance
- Inequalities and limit theorems

| **Learning Outcomes** | |
|---|---|
| **Statistics: Probability and Descriptive Statistics**<br>On successful completion, students will be able to<br>▪ define probability, random variable, and probability distribution.<br>▪ understand the concept of Bayesian statistics.<br>▪ grasp the definition of joint and marginal distributions.<br>▪ calculate expectation values and higher moments.<br>▪ comprehend important inequality equations and limit theorems. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Methods | **Links to other Study Programs of the University**<br>All Bachelor Programs in the Business & Management field |

# Statistics: Probability and Descriptive Statistics

**Course Code: DLBDSSPDS01-01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

Statistical description and analysis are the foundations for data-driven analysis and prediction methods. This course introduces the fundamentals, beginning with a formal definition of probabilities and introduction to the concepts underlying Bayesian statistics.Random variables and probability density distributions are then discussed, as well as the concept of joint and marginal distributions. The importance of various discrete and continuous distributions and their applications is stressed.Characterizing distributions is an important aspect of describing the behavior of probability distributions. Students are familiarized with expectation values, variance, and covariance. The concepts of algebraic and central moments and moment-generating functions complement the characterization of probability distributions.Finally, this course focuses on important inequalities and limit theorems such as the law of large numbers or the central limit theorem.

**Course Outcomes**

On successful completion, students will be able to

- define probability, random variable, and probability distribution.
- understand the concept of Bayesian statistics.
- grasp the definition of joint and marginal distributions.
- calculate expectation values and higher moments.
- comprehend important inequality equations and limit theorems.

**Contents**

1. Probability
   - 1.1 Definitions
   - 1.2 Independent events
   - 1.3 Conditional probability
   - 1.4 Bayesian statistics

2. Random Variables
   - 2.1 Random Variables
   - 2.2 Distribution functions and probability mass functions
   - 2.3 Important discrete probability distributions
   - 2.4 Important continous probability distributions

3. Joint Distributions
   - 3.1 Joint distributions
   - 3.2 Marginal distributions
   - 3.3 Independent random variables
   - 3.4 Conditional distributions

4. Expectation and Variance
   - 4.1 Expectation of a random variable, conditional expectations
   - 4.2 Variance and covariance
   - 4.3 Expectations and variances of important probability distributions
   - 4.4 Algebraic and central moments
   - 4.5 Moment-generating functions

5. Inequalities and Limit Theorems
   - 5.1 Probability inequalities
   - 5.2 Inequalities for expectations
   - 5.3 The law of large numbers
   - 5.4 Central limit theorem

**Literature**

**Compulsory Reading**

**Further Reading**


- Downey, A.B. (2014). Think stats (2nd ed.). O'Reilly.
- Rohatgi, V. K., & Saleh, A. K. E. (2015). An introduction to probability and statistics. John Wiley & Sons, Incorporated.
- Wagaman, A.S & Dobrow, R.P. (2021). Probability: With applications and R. Wiley.
- Triola , M.F. (2013). Elementary statistics. Pearson Education.

### Study Format myStudies

| **Study Format** myStudies | **Course Type** Lecture |
|---|---|

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Review Book |
| | ☑ Audio | ☑ Online Tests |
| | ☑ Slides | |

### Study Format Distance Learning

| Study Format | Course Type |
| --- | --- |
| Distance Learning | Online Lecture |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
| --- | --- | --- |
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Review Book |
| | ☑ Audio | ☑ Online Tests |
| | ☑ Slides | |

# Statistics - Inferential Statistics

**Module Code: DLBDSSIS**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLBDSSPDS01-01 | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Hashem Zarafat (Statistics - Inferential Statistics)

**Contributing Courses to Module**

- Statistics - Inferential Statistics (DLBDSSIS01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes<br><br>Study Format: myStudies<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Point estimation
- Uncertainties
- Bayesian inference & non-parametric techniques
- Statistical testing
- Statistical decision theory

<table>
<tr><td colspan="2">

**Learning Outcomes**

**Statistics - Inferential Statistics**

On successful completion, students will be able to

- understand point estimation methods.
- apply maximum likelihood and ordinary least squares method to estimate parameters.
- comprehend the concept of statistical and systematic errors.
- employ error propagation methods.
- utilize Bayesian inference and non-parametric techniques.
- evaluate statistical tests.
- grasp the fundamentals of statistical decision theory.

</td></tr>
<tr><td>

**Links to other Modules within the Study Program**

This module is similar to other modules in the field of Methods

</td><td>

**Links to other Study Programs of the University**

All Bachelor Programs in the Business & Management field

</td></tr>
</table>

# Statistics - Inferential Statistics

**Course Code: DLBDSSIS01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | DLBDSSPDS01-01 |

**Course Description**

Statistical analysis and understanding are the foundations of data-driven methods and machine learning approaches.This course gives a thorough introduction to point estimators and discusses various techniques to estimate and optimize parameters. Special focus is given to a detailed discussion of both statistical and systematic uncertainties as well as propagation of uncertainties.Bayesian statistics is fundamental to data-driven approaches, and this course takes a close look at Bayesian techniques such as Bayesian parameter estimation and prior probability functions.Furthermore, this course gives an in-depth overview of statistical testing and decision theory, focusing on aspects such as A/B testing, hypothesis testing, p-values, and multiple testing which are fundamental to statistical analysis approaches in a broad range of practical applications.

**Course Outcomes**

On successful completion, students will be able to

- understand point estimation methods.
- apply maximum likelihood and ordinary least squares method to estimate parameters.
- comprehend the concept of statistical and systematic errors.
- employ error propagation methods.
- utilize Bayesian inference and non-parametric techniques.
- evaluate statistical tests.
- grasp the fundamentals of statistical decision theory.

**Contents**

1. Point Estimation
   - 1.1 Method of moments
   - 1.2 Sufficient statistics
   - 1.3 Maximum likelihood
   - 1.4 Ordinary least squares
   - 1.5 Resampling techniques

2. Uncertainties
   - 2.1 Statistical and systematic uncertainties
   - 2.2 Propagation of uncertainties

3. Bayesian Inference & Non-parametric Techniques
   - 3.1 Bayesian parameter estimation
   - 3.2 Prior probability functions
   - 3.3 Parzen windows
   - 3.4 K-nearest-neighbours

4. Statistical Testing
   - 4.1 A/B testing
   - 4.2 Hypothesis tests & test statistics
   - 4.3 P-values & confidence intervals
   - 4.4 Multiple testing

5. Statistical Decision Theory
   - 5.1 The risk function
   - 5.2 Maximum likelihood, Minimax, and Bayes
   - 5.3 Admissibility and Stein's paradox

**Literature**

**Compulsory Reading**

**Further Reading**

- Hogg, R. V., McKean, J., & Craig, A. T. (2020). Introduction to mathematical statistics, global edition. Pearson.
- Gutman, Alex J., Goldmeier, Jordan. (2021). Becoming a Data Head – How to Think, Speak, and Understand Data Science, Statistics, and Machine Learning. John Wiley & Sons.
- Borek Puza. (2015). Bayesian Methods for Statistical Analysis. ANU eView.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Review Book<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Review Book<br>☑ Online Tests |

# Project: Agile DevSecOps Software Engineering

**Module Code: DLBCSEEDSO1_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | IWNF01_E or DLBWIWTMAS01 | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | | | English |

**Module Coordinator**

N.N. (Project: Agile DevSecOps Software Engineering)

**Contributing Courses to Module**

- Project: Agile DevSecOps Software Engineering (DLBCSEEDSO01_E)

| Module Exam Type | |
|---|---|
| **Module Exam**<br>Study Format: Distance Learning<br>Written Assessment: Project Report | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

This module provides the fundamental security principles for leveraging DevOps in software engineering, also known as the DevSecOps paradigm. Given a security-relevant scenario, this module will illustrate good DevSecOps practices like definition of security baselines, threat modelling approaches, and security automation as part of the continuous integration/continuous development (CI/CD) pipeline.

| Learning Outcomes | |
|---|---|
| **Project: Agile DevSecOps Software Engineering**<br>On successful completion, students will be able to<br>▪ apply basic thread modelling into DevOps scenarios,<br>▪ familiarize with relevant DevOps security baselines from international standards and industrial good practices,<br>▪ select the appropriate tools and automation approaches for DevSecOps,<br>▪ design continuous compliance monitoring into Infrastructure-as-a-Code scenarios. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Project: Agile DevSecOps Software Engineering

**Course Code: DLBCSEEDSO01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | IWNF01_E or DLBWIWTMAS01 |

**Course Description**

This course covers the basic security principles for leveraging the DevSecOps approach in software engineering scenarios. The content of this course will illustrate the adoption of DevSecOps to continuously and holistically improve the security of an organization, rather than just focusing on protecting the underlying software infrastructure (as in the case of traditional non-agile methodologies). By presenting DevSecOps principles like threat modelling, definition of security baselines, security automation/tools, and continuous compliance monitoring, this course will teach how security can be integrated while developing a software engineering product.

**Course Outcomes**

On successful completion, students will be able to

- apply basic thread modelling into DevOps scenarios,
- familiarize with relevant DevOps security baselines from international standards and industrial good practices,
- select the appropriate tools and automation approaches for DevSecOps,
- design continuous compliance monitoring into Infrastructure-as-a-Code scenarios.

**Contents**

- Despite the broad adoption of DevOps in the industry, the integration of security principles into this paradigm (i.e., DevSecOps) is still an open challenge for many practitioners. In this course the students will learn fundamental DevSecOps concepts like threat modelling, definition of security baselines, continuous compliance monitoring, and integration of security automation in DevOps.

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Johnson, E. (2020): Secure DevOps. A Practical Introduction. (URL: https://www.sans.org/ondemand/course/secure-dev-ops-a-practical-introduction [Retrieved: 15.08.2020]).<br>▪ Hsu, T. (2018): Hands-On Security in DevOps. Packt Publishing, UK.<br>▪ Microsoft. (2020): Secure DevOps. Making security principles and practices an integral part of DevOps while maintaining improved efficiency and productivity. (URL: https://www.microsoft.com/en-us/securityengineering/devsecops [Retrieved: 15.08.2020]).<br>▪ Schneider, C. (2015): Security DevOps. Staying secure in agile projects. (URL: https://owaspappseceurope2015.sched.com/event/378l/security-devops-staying-secure-in-agile-projects [Retrieved: 15.08.2020]).<br>▪ Yasar, H. (2016): An Introduction to Secure DevOps. Including Security in the Software Lifecycle. (URL: https://insights.sei.cmu.edu/devops/2016/11/an-introduction-to-secure-devops-including-security-in-the-software-lifecycle.html [Retrieved: 15.08.2020]). |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# 6. Semester

# Project: IT Service Management

**Module Code: DLBCSPITSM**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Dr. Frank Müller (Project: IT Service Management)

**Contributing Courses to Module**

- Project: IT Service Management (DLBCSPITSM01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Written Assessment: Project Report<br><br>Study Format: myStudies<br>Written Assessment: Project Report | |

**Weight of Module**

see curriculum

**Module Contents**

- All phases of an ITIL/IT project are carried out as part of an independent project.

| Learning Outcomes | |
|---|---|
| **Project: IT Service Management**<br>On successful completion, students will be able to<br>▪ analyze typical problems and company situations from the area of IT service management in different project variations.<br>▪ develop, plan, and implement proposed solutions.<br>▪ convert theory into a pragmatic approach to a solution with the help of methodical tools from IT service management and project management.<br>▪ draw and apply the right conclusions in relation to their specific project environment.<br>▪ conceptually apply their theoretical knowledge to company-specific environmental factors. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Computer Science & Software Development | **Links to other Study Programs of the University**<br>All Bachelor Programs in the IT & Technology field |

# Project: IT Service Management

**Course Code: DLBCSPITSM01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

## Course Description

Based on the contents of the course “IT Service Management”, selected aspects of the core processes of ITIL are deepened, discussed, selected, and applied within the framework of a project in a concept-related manner. All theoretical methods are considered and evaluated.

## Course Outcomes

On successful completion, students will be able to

- analyze typical problems and company situations from the area of IT service management in different project variations.
- develop, plan, and implement proposed solutions.
- convert theory into a pragmatic approach to a solution with the help of methodical tools from IT service management and project management.
- draw and apply the right conclusions in relation to their specific project environment.
- conceptually apply their theoretical knowledge to company-specific environmental factors.

## Contents

- Analysis, evaluation, and development of recommendations for taking action within the scope of concrete questions concerning aspects of IT Service Management. This is aided by the creation and planning of a project in the theoretical-theme context through all phases of project management.
- The quality assurance of the artefacts created is carried out both by the tutor and by students from the project groups.

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading** |


- Al-Ashmoery, Y., Haider, H., Haider, A., Nasser, N., & Al-Sarem, M. (2021). Impact of IT Service Management and ITIL Framework on the Businesses. 2021 International Conference of Modern Trends in Information and Communication Technology Industry (MTICTI), Modern Trends in Information and Communication Technology Industry (MTICTI), 2021 International Conference Of, 1–5.
- Limited, A. (2020). ITIL 4. Create, Deliver and Support. TSO.
- Limited, A. (2020). ITIL 4: Direct, Plan and Improve. TSO.
- Limited, A. (2019). ITIL foundation: ITIL (4th edition). The Stationery Office Ltd.
- Shastri, A., & Thampi, G. T. (2021). Automation of IT Service Management Processes. 2021 International Conference on Advances in Computing, Communication, and Control (ICAC3), Advances in Computing, Communication, and Control (ICAC3), 2021 International Conference On, 1–4.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# IT Law

**Module Code: DLBCSIITL**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Dr. Andreas Schmidt (IT Law)

**Contributing Courses to Module**

- IT Law (DLBCSIITL01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Written Assessment: Case Study<br><br>Study Format: myStudies<br>Written Assessment: Case Study | |

**Weight of Module**

see curriculum

**Module Contents**

- Basic Concepts of Legal Systems
- Internet and Domain Law
- Contracts
- Intellectual Property
- Data Protection / Privacy

<table>
<tr><td colspan="2">

**Learning Outcomes**

**IT Law**

On successful completion, students will be able to

- describe basic concepts of IT law.
- provide examples of different approaches to IT law in different countries.
- identify legal questions as they arise in IT.
- apply the core ideas of data protection and privacy in their work.
- distinguish the different types of contracts and intellectual property as they relate to IT.

</td></tr>
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**Links to other Modules within the Study Program**

This module is similar to other modules in the field of Computer Science & Software Developement

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**Links to other Study Programs of the University**

All Bachelor Programs in the IT & Technology field

</td></tr>
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# IT Law

**Course Code: DLBCSIITL01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

The application of IT is embedded in a legal framework which computer scientists need to know and adhere to in their work. This applies to the way their own work is performed which, for example, may be governed by contracts with suppliers and/or customers. Computer scientists create and use intellectual property, and this leads to questions of copyright, software patents, etc. Beyond this, IT strongly influences the social environment and therefore needs to abide by regulations such as data protection. The goal of this module is to provide students with a basic understanding of these legal aspects so they can take them into account, apply them in simple cases, and recognize when more specialised legal knowledge is required. Since IT is a topic that connects different countries and legal frameworks, the course looks at some of the common legal questions as they are handled in the European Union, the USA, and India.

**Course Outcomes**

On successful completion, students will be able to

- describe basic concepts of IT law.
- provide examples of different approaches to IT law in different countries.
- identify legal questions as they arise in IT.
- apply the core ideas of data protection and privacy in their work.
- distinguish the different types of contracts and intellectual property as they relate to IT.

**Contents**

1. Basic Concepts of Legal Systems
   - 1.1 The Role of Law in IT
   - 1.2 Basic Concepts of the Legal System in the European Union
   - 1.3 Basic Concepts of the Legal System in the USA
   - 1.4 Basic Concepts of the Legal System in India

2. Internet and Domain Law
   - 2.1 Web Sites and the Law
   - 2.2 Net Neutrality
   - 2.3 Domain Registration
   - 2.4 Internet Crime

3. Contracts
   - 3.1 Types of IT Contracts
   - 3.2 Electronic Contracts and Electronic Signatures
   - 3.3 Licences
   - 3.4 Free and Open Source Software
   - 3.5 Buying and Selling Off-the-Shelf Software
   - 3.6 Software Development Contracts

4. Intellectual Property
   - 4.1 Brands, Trade Marks and Domain Names
   - 4.2 Copyright
   - 4.3 Software Patents
   - 4.4 Digital and Data Ownership

5. Data Protection/Privacy
   - 5.1 Basic Concepts of Data Protection
   - 5.2 Data Protection in the European Union: the GDPR
   - 5.3 Data Protection in the USA
   - 5.4 Data Protection in India
   - 5.5 Trans-Border Data Flows

**Literature**

**Compulsory Reading**

**Further Reading**


- Hoeren, T., & Pinelli, S. (2018). Agile programming – Introduction and current legal challenges. Computer Law & Security Review, 34(5), pp. 1131-1138. Retrieved from www.uni-muenster.de/Jura.itm/hoeren/itm/wp-content/uploads/Hr.-Hoeren-29.10.pdf
- Lloyd, I. (2018). Information technology law (8th ed.). Oxford: Oxford University Press.
- Murray, A. (2019). Information technology law: The law and society (4th ed.). Oxford: Oxford University Press.
- Soma, J. T. (2014). Privacy law in a nutshell. St. Paul, MN: West Academic.
- Wikia.org. (n.d.). The IT law wiki [web encyclopedia]. Retrieved from https://itlaw.wikia.org/wiki/The_IT_Law_Wiki#

### Study Format Distance Learning

| Study Format<br>Distance Learning | Course Type<br>Online Lecture |
|---|---|

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Online Tests |

# Data Analytics and Big Data

**Module Code: DLBINGDABD_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Gereon Wellmann (Data Analytics and Big Data)

**Contributing Courses to Module**

- Data Analytics and Big Data (DLBINGDABD01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Written Assessment: Case Study<br><br>Study Format: Distance Learning<br>Written Assessment: Case Study | |

**Weight of Module**

see curriculum

**Module Contents**

- Introduction to Data Analysis
- Statistical Basics
- Data Mining
- Big Data Methods and Technologies
- Legal Aspects of Data Analysis
- Solution Scenarios
- Application of Big Data in the Industry

| Learning Outcomes |
|---|
| **Data Analytics and Big Data**<br>On successful completion, students will be able to<br>▪ distinguish between information and data and know the meaning of these terms for decision-making.<br>▪ derive the Big Data issue, especially in connection with Internet of Things, and describe it using examples.<br>▪ identify basics from statistics, which are necessary for the analysis of large data sets.<br>▪ identify the process of data mining and classify different methods in it.<br>▪ identify selected methods and technologies that are used in the Big Data context and apply them to simple examples.<br>▪ recognize the legal framework for the application of data analysis in Germany and internationally.<br>▪ identify the specific prospects and challenges of applying Big Data analyses in industry. |

| Links to other Modules within the Study Program | Links to other Study Programs of the University |
|---|---|
| This module is similar to other modules in the field of Data Science & Artificial Intelligence | All Bachelor Programs in the IT & Technology field |

# Data Analytics and Big Data

**Course Code: DLBINGDABD01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

The aim of the course is to familiarize students with selected methods and techniques of data analysis in the context of continuously increasing, heterogeneous data sets. To this end, the fundamental relevance of Big Data methods is presented by drawing on the historical development of stored data. One decisive factor here is the continuous transmission Internet of Things sensor data to other systems. This is followed by a short introduction to the essential statistical fundamentals before the individual steps of the data mining process are discussed. In distinction to these classical procedures, selected methods are presented with which stored data in the Big Data context can be made analyzable. As data analysis is subject to certain legal frameworks, this course also covers legal aspects such as data protection. The course concludes with an overview of the practical application of Big Data methods and tools. In particular, fields of application in the industrial context are examined.

**Course Outcomes**

On successful completion, students will be able to

- distinguish between information and data and know the meaning of these terms for decision-making.
- derive the Big Data issue, especially in connection with Internet of Things, and describe it using examples.
- identify basics from statistics, which are necessary for the analysis of large data sets.
- identify the process of data mining and classify different methods in it.
- identify selected methods and technologies that are used in the Big Data context and apply them to simple examples.
- recognize the legal framework for the application of data analysis in Germany and internationally.
- identify the specific prospects and challenges of applying Big Data analyses in industry.

**Contents**

1. Introduction to Data Analysis
   - 1.1 Decisions, Information, Data
   - 1.2 Historical Development of Data Storage and Evaluation
   - 1.3 Big Data: Features and Examples
   - 1.4 Data Analysis

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Akerkar, R., & Srinivas Sajja, P. (2016). Intelligent Techniques for Data Science. Springer.<br>▪ Hoeren, T., & Kolany-Raiser, B., (Eds.). (2018). Big data in context – Legal, social and technological insights. Springer Nature.<br>▪ Illowsky, B., & Dean, S. (2018). Introductory statistics. OpenStax CNX. Chapters 2 & 8.<br>▪ Curry, E., Auer, S., Berre, A., J., Metzger, A., Perez, M., S., & Zillner, S. (2022). Technologies and Applications for big data value. Springer. Pages 1–15 & 321–344.<br>▪ Jurafsky, D., & Martin, J. H. (2013). Speech and language processing: an introduction to natural language processing, computational linguistics, and speech recognition (2. ed.). Pearson Prentice Hall. |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Online Tests |

## Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Online Tests |

# Advanced Data Analysis

**Module Code: DLBDSEDA1**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Thomas Zöller (Advanced Data Analysis)

**Contributing Courses to Module**

- Advanced Data Analysis (DLBDSEDA01)

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Business performance analytics
- Text mining
- Web- and social media analytics
- Experimentation and testing

| Learning Outcomes | |
|---|---|
| **Advanced Data Analysis**<br>On successful completion, students will be able to<br>▪ identify important design considerations for business KPIs.<br>▪ explain various topics in business process analytics.<br>▪ utilize established techniques for web data analytics.<br>▪ understand analytical approaches to text mining and semantic analysis.<br>▪ disambiguate relevant questions in social media analytics.<br>▪ use the techniques and methods for experimentation and testing. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Data Science & Artificial Intelligence | All Bachelor Programs in the IT & Technology field |

# Advanced Data Analysis

**Course Code: DLBDSEDA01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

This course introduces several advanced analytics subjects of practical relevance. The subject areas covered span from business performance measurement and analytics, text mining, and web- and social media analytics to current trends in experimental design and setup. Along this journey topics such as the design of key performance indicators (KPIs), business process analytics, word frequency and semantic analysis, data science on clickstreams, social media interactions, and multi-armed bandit testing are addressed.

**Course Outcomes**

On successful completion, students will be able to

- identify important design considerations for business KPIs.
- explain various topics in business process analytics.
- utilize established techniques for web data analytics.
- understand analytical approaches to text mining and semantic analysis.
- disambiguate relevant questions in social media analytics.
- use the techniques and methods for experimentation and testing.

**Contents**

1. Business Performance Analytics
   - 1.1 KPI design considerations
   - 1.2 Common business performance indicators
   - 1.3 Business process mining
2. Text Analytics
   - 2.1 Word and document frequency (TF-IDF)
   - 2.2 Semantic analysis
3. Web Analytics
   - 3.1 Web metrics
   - 3.2 Clickstream analytics
   - 3.3 Recommender systems
4. Social Network Mining

4.1 Introduction to social media analytics
4.2 Mining common social media platforms

5. Testing and Experimentation
5.1 Practical A/B testing
5.2 Multivariate tests
5.3 Multi-armed bandit testing

**Literature**

**Compulsory Reading**

**Further Reading**


- Kaushik, A. (2009). Web analytics 2.0: The art of online accountability & science of customercentricity. Wiley.
- Lane, H., Howard, C., & Hapke, H. (2019). Natural language processing in action: Understanding,analyzing, and generating text with Python. Manning.
- Parmenter, D. (2019). Key performance indicators: Developing, implementing, and using winningKPIs (4th ed.). Wiley.
- Russell, M. A., & Klassen, M. (2019). Mining the social web: Data mining Facebook, Twitter, Linkedin,Instagram, Github, and more (3rd ed.). O'Reilly.
- Siroker, D., & Koomen, P. (2013). A/B testing: The most powerful way to turn clicks into customers.Wiley.

### Study Format myStudies

| Study Format | Course Type |
| --- | --- |
| myStudies | Lecture |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
| --- | --- | --- |
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| **Study Format**<br>Distance Learning | **Course Type**<br>Online Lecture |
|---|---|

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study**<br>90 h | **Contact Hours**<br>0 h | **Tutorial/Tutorial Support**<br>30 h | **Self Test**<br>30 h | **Independent Study**<br>0 h | **Hours Total**<br>150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Ses-sions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

# Smart Factory I

**Module Code: DLBDSESF1**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Sahar Qaadan (Smart Factory I)

**Contributing Courses to Module**

- Smart Factory I (DLBDSESF01)

| Module Exam Type | |
|---|---|
| **Module Exam**<br>Study Format: myStudies<br>Exam, 90 Minutes<br>Study Format: Distance Learning<br>Exam, 90 Minutes | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Motivation and Definition of Terms
- Development of Automation
- Technological Basics and Standards
- Basic concepts of a Smart Factory
- Reference Architectures
- Smart Factory Engineering
- Safety and Security

| Learning Outcomes | |
|---|---|
| **Smart Factory I**<br>On successful completion, students will be able to<br>▪ understand the term Smart Factory in the context of Industry 4.0.<br>▪ be able to trace the development of automation to a fully autonomous, non-centrally organized production plant.<br>▪ understand the basic technologies and standards used to design and operate a Smart Factory.<br>▪ understand the essential concepts of a Smart Factory.<br>▪ identify and differentiate between the individual elements of a Smart Factory using different reference architectures.<br>▪ understand the special engineering challenges in the Smart Energy context.<br>▪ understand the special safety risks of digitized and networked production plants and assign concrete recommendations for action. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Smart Factory I

**Course Code: DLBDSESF01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In this course, students will gain a deeper insight into the networking and digitization of production facilities by examining a Smart Factory. For this purpose, they will be familiarized with the basic goals of a Smart Factory in the context of the research complex Industry 4.0. After a brief introduction to the history of automation, students will learn the technical basics and standards required to design and operate a Smart Factory. Building on this, they will learn how these individual technologies are used to implement the central concepts of a Smart Factory. In order to understand which components a Smart Factory consists of, different reference architectures are presented and compared. The course concludes with the special engineering challenges of an autonomously acting and decentralized production plant. Above all, this includes IT security, which is particularly relevant due to the digital networking of production facilities and products.

**Course Outcomes**

On successful completion, students will be able to

- understand the term Smart Factory in the context of Industry 4.0.
- be able to trace the development of automation to a fully autonomous, non-centrally organized production plant.
- understand the basic technologies and standards used to design and operate a Smart Factory.
- understand the essential concepts of a Smart Factory.
- identify and differentiate between the individual elements of a Smart Factory using different reference architectures.
- understand the special engineering challenges in the Smart Energy context.
- understand the special safety risks of digitized and networked production plants and assign concrete recommendations for action.

**Contents**

1. Motivation and Definition of Terms
   - 1.1 Goals of Smart Factory
   - 1.2 Internet of Things
   - 1.3 Cyber-Physical Systems
   - 1.4 Cyber-Physical Production Systems
   - 1.5 Smart Factory as a Cyber-Physical (Production) System

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Butun, I. (2020). Industrial IoT: Challenges, design principles, applications, and security. Springer.<br>▪ Drossel, W. G., Ihlenfeldt, S., Lanzger, T., & Dumitrescu, R. (2019). Cyber-physical systems. In R. Neugebauer (Ed.), Digital transformation (pp. 189—213). Springer.<br>▪ Durakbasa, N. M., & Gençyılmaz, M. G. (Eds.). (2021). Digital conversion on the way to Industry 4.0. Springer.<br>▪ Ustundag, A., & Cevikcan, E. (2018). Industry 4.0: Managing the digital transformation. Springer. |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Practice Exam<br>☑ Online Tests |

# Smart Factory II

**Module Code: DLBDSESF2**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| Dr. Sahar Qaadan (Smart Factory II) |

| Contributing Courses to Module |
|---|
| ▪ Smart Factory II (DLBDSESF02) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br>Study Format: Distance Learning<br>Written Assessment: Project Report<br>Study Format: myStudies<br>Written Assessment: Project Report | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

| Module Contents |
|---|
| A catalogue with the currently provided tasks is provided on the online platform of the module. It provides the content basis of the module and can be supplemented or updated by the seminar leader. |

| Learning Outcomes | |
|---|---|
| **Smart Factory II**<br>On successful completion, students will be able to<br>▪ have a deeper understanding of the technologies and standards in the context of Smart Factory.<br>▪ apply technologies in the context of Smart Factory to a simple practical example.<br>▪ design a hardware or software prototype for a selected task.<br>▪ document, design, and develop activities in the form of a project report. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Smart Factory II

**Course Code: DLBDSESF02**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

## Course Description

In this course, students select a concrete task from the catalog of topics provided in consultation with the seminar leader. They will work on the task in a prototyping environment suited to the task, which can be either a hardware (e.g., prototyping boards) or software (e.g., technology-specific development environments) environment. To complete the task, students apply the concepts, methods, and tools taught in the Smart Factory I course. They document their results with a project report.

## Course Outcomes

On successful completion, students will be able to

- have a deeper understanding of the technologies and standards in the context of Smart Factory.
- apply technologies in the context of Smart Factory to a simple practical example.
- design a hardware or software prototype for a selected task.
- document, design, and develop activities in the form of a project report.

## Contents

- A catalogue with the currently provided tasks is provided on the online platform of the module. It provides the content basis of the module and can be supplemented or updated by the seminar leader.

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading** |

**Further Reading**


- Arey, D., Le, C. H. & Gao, J. (2021). Lean industry 4.0: a digital value stream approach to process improvement. Procedia Manufacturing, 54, 19–24.
- Hartmann, L., Meudt, T., Seifermann, S. & Metternich, J. (2018). Value stream method 4.0: holistic method to analyse and design value streams in the digital age. Procedia CIRP, 78, 249–254.
- Luscinski, S. & Ivanov, V. (2020). A Simulation Study of Industry 4.0 Factories based on the Ontology on Flexibility with using FlexSim Software. Management and Production Engineering Review (volume 11, number 3), S. 74–83.
- Meroni, G., Baresi, L., Montali, M. & Plebani, P. (2017). Multi-party business process compliance monitoring through IoT-enabled artifacts. Information Systems, 73, 61-78.
- OMG (2014). Business Process Model and Notation (BPMN). Version 2.0.2

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

### Study Format myStudies

| Study Format | Course Type |
| --- | --- |
| myStudies | Project |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Written Assessment: Project Report |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
| --- | --- |
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# Cryptography

**Module Code: DLBCSCT-01**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| Prof. Dr. Ralf Kneuper (Cryptography) |

| Contributing Courses to Module |
|---|
| ▪ Cryptography (DLBCSCT01-01) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br>Study Format: Distance Learning<br>Written Assessment: Case Study<br>Study Format: myStudies<br>Written Assessment: Case Study | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

| Module Contents |
|---|
| ▪ Protection Targets, Vulnerabilities, and Threats<br>▪ Foundations of Cryptology and its Core Components<br>▪ Basic Cryptographic Applications<br>▪ Authentication<br>▪ Single Computer Security<br>▪ Security Communication Network<br>▪ Security E-Commerce<br>▪ Secure Software Development |

| Learning Outcomes |
|---|
| **Cryptography**<br>On successful completion, students will be able to<br>▪ give an overview of different classes of cryptographic systems.<br>▪ give a basic description of symmetric cryptographic methods, in particular One-Time Pad, DES, and AES, and describe their operating principles by means of simple, concrete examples.<br>▪ describe the basic hash functions.<br>▪ describe basic asymmetric cryptographic methods, especially RSA, and their operating principles by means of simple, concrete examples.<br>▪ describe the areas of application of cryptographic procedures and their application scenarios. |

| Links to other Modules within the Study Program | Links to other Study Programs of the University |
|---|---|
| This module is similar to other modules in the field of Computer Science & Software Developement | All Bachelor Programs in the IT & Technology field |

# Cryptography

**Course Code: DLBCSCT01-01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

This course covers basic and targeted in-depth knowledge of cryptographic processes and the practical use of cryptographic systems. After an overview of cryptographic methods, hash functions, symmetric methods, and asymmetric methods are presented. The theoretical basics of selected procedures are taught and practically explained using simple examples. In addition, areas of application and application scenarios for cryptographic procedures are presented.

**Course Outcomes**

On successful completion, students will be able to

- give an overview of different classes of cryptographic systems.
- give a basic description of symmetric cryptographic methods, in particular One-Time Pad, DES, and AES, and describe their operating principles by means of simple, concrete examples.
- describe the basic hash functions.
- describe basic asymmetric cryptographic methods, especially RSA, and their operating principles by means of simple, concrete examples.
- describe the areas of application of cryptographic procedures and their application scenarios.

**Contents**

1. Protection Goals, Vulnerabilities, and Threats
   - 1.1 Protection Goals
   - 1.2 Vulnerabilities and Threats
2. Foundations of Cryptology and its Core Components
   - 2.1 Encoding
   - 2.2 Symmetrical Encryption
   - 2.3 Asymmetric Encryption
   - 2.4 One-way Functions and Cryptographic Hash Functions
3. Basic Cryptographic Applications
   - 3.1 Key Exchange and Hybrid Processes
   - 3.2 Digital Signature

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Paar, C. & Pelzl, J. (2010). Understanding Cryptography. A Textbook for Students and Practitioners. Springer.<br>▪ Singh, S. (1999). The code book [electronic resource] : the science of secrecy from ancient Egypt to quantum cryptography (1. ed.). Anchor Books.<br>▪ Smart, N. P. (2016). Cryptography Made Simple. Springer. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests |

# Attack Models and Threat Feeds

**Module Code: DLBCSEECTI1_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Dr. Christian Prause (Attack Models and Threat Feeds)

**Contributing Courses to Module**

- Attack Models and Threat Feeds (DLBCSEECTI01_E)

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Threat actors
- Modeling an Attack
- Attack Preparation TTPs
- Enterprise TTPs
- Industrial Control Systems TTPs
- Reporting

<table>
<tr><td colspan="2">Learning Outcomes<br><br>Attack Models and Threat Feeds<br><br>On successful completion, students will be able to<br>▪ understand a variety of threat modeling techniques.<br>▪ apply the Mitre ATT&CK Techniques, Tactics and Procedures.<br>▪ do a gap analysis on what is detection or defense technology is missing.<br>▪ utilize threat intelligence systems for diagnosis.<br>▪ write reports and recommendations.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Computer Science & Software Development</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the IT & Technology field</td></tr>
</table>

# Attack Models and Threat Feeds

**Course Code: DLBCSEECTI01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

## Course Description

In this course, we look in depth at modeling threats and using data to diagnose, analyze and make recommendations. After a broad look at threat actors, we look at a variety of ways of modeling threats. This spans from Attack Trees to Kill Chains, but whichever method works the best, it all boils down to adversary Techniques, Tactics and Procedures. We look into the various taxonomies of these as defined by Mitre's ATT&CK and determine what can be observed in data.It is rare that internal data is enough for a complete analysis and in practice the threat analysist must use external data sources. These are available in a variety of formats, but the industry is converging on STIX and the use of software platforms like ACT to do the parsing and provide a good user experience.After looking at examples of threat actors and reports on them, we tackle the problem of making recommendations and writing reports. In some cases, engaging with law enforcement is required in which case some particularities need to be observed.

## Course Outcomes

On successful completion, students will be able to

- understand a variety of threat modeling techniques.
- apply the Mitre ATT&CK Techniques, Tactics and Procedures.
- do a gap analysis on what is detection or defense technology is missing.
- utilize threat intelligence systems for diagnosis.
- write reports and recommendations.

## Contents

1. Threat Actors
   - 1.1 Script Kiddies
   - 1.2 eCrime Threat Actors
   - 1.3 Advanced Persistent Threat Actors (APT)
   - 1.4 Threat Researchers
2. Modeling an Attack
   - 2.1 Phases of an Attack
   - 2.2 Lockheed Martin Kill-Chain
   - 2.3 Attack Trees
   - 2.4 Models for Security Risks and Cyber Attacks

3. Attack preparation TTPs
   - 3.1 Observability of Attack Preparations
   - 3.2 Operational Security of an Organization

4. Enterprise TTPs
   - 4.1 Behaviors of the Attacker
   - 4.2 Observable Data in an Enterprise

5. Industrial Control Systems TTPs
   - 5.1 Critical Infrastructure
   - 5.2 Special Considerations with IoT/ICS Defense

6. Threat data exchange
   - 6.1 Indicators of Compromise vs. Indicators of Attack
   - 6.2 Threat Intelligence Reports
   - 6.3 Ad-hoc Data Formats
   - 6.4 STIX Format, TAXII Protocol
   - 6.5 Semantics of Threat Data using Mitre ATT&CK, CVEs, etc.

7. Examples of Threat Analysis Platforms
   - 7.1 ACT Platform
   - 7.2 MISP
   - 7.3 OpenCTI

8. Examples of Threat Actors and their Modus Operandi
   - 8.1 Threat Model
   - 8.2 Relevant Indicator Data
   - 8.3 Relevant CTI Data
   - 8.4 Diagnosing the Threat
   - 8.5 Data Coverage Gap Analysis

9. Reporting
   - 9.1 Mapping Raw Data to Mitre ATT&CK
   - 9.2 Making Defensive Recommendations
   - 9.3 Writing Reports for Technical Staff
   - 9.4 Writing Reports for Management
   - 9.5 Working with Law Enforcement

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Caltagirone, S., Pendergast, A., & Betz, C. (2013). The Diamond Model of Intrusion Analysis. Retrieved from http://www.activeresponse.org/wp-content/uploads/2013/07/diamond.pdf<br>▪ Hutchins, E. M., Cloppert, M. J., & Amin, R. M. (2010). Intelligence-Driven Computer Network Defense Informed by Analysis of Adversary Campaigns and Intrusion Kill Chains. Retrieved from https://lockheedmartin.com/content/dam/lockheed-martin/rms/documents/cyber/LMWhite-Paper-Intel-Driven-Defense.pdf<br>▪ MISP Project. (n.d.). Retrieved from https://www.misp-project.org/<br>▪ Mitre ATT&CK. (n.d.). Retrieved from https://attack.mitre.org/<br>▪ Obrst, L., Chase, P., & Markeloff, R. (2012). Developing an Ontology of the Cyber Security Domain. In Proceedings of the Seventh International Conference on Semantic Technologies for Intelligence, Defense, and Security. Fairfax, VA. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Machine Learning - Supervised Learning

**Module Code: DLBDSMLSL**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLBDSMFC01, DLBDSMFLA01, DLBDSSPDS01-01, DLBDSSIS01 | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Christian Müller-Kett (Machine Learning - Supervised Learning)

**Contributing Courses to Module**

- Machine Learning - Supervised Learning (DLBDSMLSL01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br><br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

<table>
<tr><td colspan="2">Module Contents<br>▪ Types of machine learning<br>▪ Classification<br>▪ Regression<br>▪ Support vector machines<br>▪ Decision trees</td></tr>
<tr><td colspan="2">Learning Outcomes<br>Machine Learning - Supervised Learning<br>On successful completion, students will be able to<br>▪ remember central notions and paradigms of machine learning.<br>▪ describe the key ideas of regression and pertaining regularization methods.<br>▪ know basic classification techniques.<br>▪ explain tree structured machine learning models.<br>▪ understand support vector machines and the related kernel approach.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Data Science & Artificial Intelligence</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the IT & Technology field</td></tr>
</table>

# Machine Learning - Supervised Learning

**Course Code: DLBDSMLSL01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | DLBDSMFC01, DLBDSMFLA01, DLBDSSPDS01-01, DLBDSSIS01 |

**Course Description**

This course provides a first introduction to the field of machine learning with a focus on supervised learning (i.e., learning from labeled data), where the most commonly used models in regression and classification are being introduced. Moreover, the course provides an introduction to the concepts of large margin classifiers and tree structured models.

**Course Outcomes**

On successful completion, students will be able to

- remember central notions and paradigms of machine learning.
- describe the key ideas of regression and pertaining regularization methods.
- know basic classification techniques.
- explain tree structured machine learning models.
- understand support vector machines and the related kernel approach.

**Contents**

1. Introduction to Machine Learning
   - 1.1 Pattern recognition systems
   - 1.2 The machine learning design cycle
   - 1.3 Technical notions of learning and adaptation
   - 1.4 Under- and overfitting
2. Regression
   - 2.1 Linear regression
   - 2.2 Lasso- and ridge Regularization
   - 2.3 Generalized linear models
   - 2.4 Logistic regression
3. Basic Classification Techniques
   - 3.1 K-nearest neighbour
   - 3.2 Naive Bayes

4. Support Vector Machines
    4.1 Large margin classification
    4.2 The kernel trick

5. Decision & Regression Trees
    5.1 Decision & regression trees
    5.2 Random forest
    5.3 Gradient boosting

**Literature**

**Compulsory Reading**

**Further Reading**


- Bishop, C. M. (2006). Pattern recognition and machine learning. Springer.
- Grus, J. (2019). Data science from scratch: First principles with Python (2nd ed.). O’Reilly.
- Mitchell, T. M. (1997). Machine learning. McGraw-Hill.

## Study Format myStudies

| Study Format | Course Type |
| --- | --- |
| myStudies | Lecture |

| Information about the examination | |
| --- | --- |
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
| --- | --- | --- |
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Practice Exam |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Online Tests |
| | ☑ Audio | |
| | ☑ Slides | |

## Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Machine Learning - Unsupervised Learning and Feature Engineering

**Module Code: DLBDSMLUSL**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | DLBDSMFC01, DLBDSMFLA01, DLBDSSPDS01-01, DLBDSSIS01 | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| Prof. Dr. Christian Müller-Kett (Machine Learning - Unsupervised Learning and Feature Engineering) |

| Contributing Courses to Module |
|---|
| ▪ Machine Learning - Unsupervised Learning and Feature Engineering (DLBDSMLUSL01) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Written Assessment: Case Study<br><br>Study Format: myStudies<br>Written Assessment: Case Study | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

| Module Contents | |
|---|---|
| ▪ Unsupervised machine learning<br>▪ Clustering<br>▪ Dimensionality reduction<br>▪ Manifold learning<br>▪ Feature engineering<br>▪ Feature selection<br>▪ Automation of feature generation and selection | |
| **Learning Outcomes**<br><br>**Machine Learning - Unsupervised Learning and Feature Engineering**<br><br>On successful completion, students will be able to<br>▪ explain the notions of unsupervised learning and feature selection.<br>▪ recall commonly-applied clustering models.<br>▪ understand the concept and utility of dimensionality reduction and manifold learning.<br>▪ describe effective approaches to feature engineering.<br>▪ discuss the methods of automatic feature generation and selection.<br>▪ reflect on societal and sustainability implications of applying the learned skills to different use cases including ethical questions. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Data Science & Artificial Intelligence | All Bachelor Programs in the IT & Technology field |

# Machine Learning - Unsupervised Learning and Feature Engineering

**Course Code: DLBDSMLUSL01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | DLBDSMFC01, DLBDSMFLA01, DLBDSSPDS01-01, DLBDSSIS01 |

**Course Description**

This course is concerned with the tools and techniques for unsupervised learning and feature engineering. Unsupervised learning denotes machine learning approaches that can be applied without label information. As such, the aim is to extract patterns or statistical regularities in data, and finding good features is key for the successful application of machine learning models. Therefore, having a solid set of approaches and tools for this task is of crucial importance for any data scientist. This course introduces the most relevant methods and shows how unsupervised learning techniques can be utilized to find robust and meaningful features. By doing so, concepts and techniques are demonstrated by tangible examples which reflect usage of these techniques to generate added value for the society as a whole as opposed to ethical questionable use cases.

**Course Outcomes**

On successful completion, students will be able to

- explain the notions of unsupervised learning and feature selection.
- recall commonly-applied clustering models.
- understand the concept and utility of dimensionality reduction and manifold learning.
- describe effective approaches to feature engineering.
- discuss the methods of automatic feature generation and selection.
- reflect on societal and sustainability implications of applying the learned skills to different use cases including ethical questions.

**Contents**

1. Introduction to Unsupervised Machine Learning and Feature Engineering
   - 1.1 Unsupervised machine learning
   - 1.2 Feature engineering

2. Clustering
   - 2.1 K-Means
   - 2.2 Gaussian mixture model clustering
   - 2.3 Hierarchical clustering

3. Dimensionality Reduction
   3.1 Principal component analysis
   3.2 Multi-dimensional scaling
   3.3 Locally linear embedding

4. Feature Engineering
   4.1 Numerical features
   4.2 Categorial features
   4.3 Text features

5. Feature Selection
   5.1 Feature importance
   5.2 Feature variance
   5.3 Correlation matrix
   5.4 Recursive feature selection

6. Automated Feature Generation
   6.1 Automated feature generation
   6.2 Feature engineering versus deep learning

**Literature**

**Compulsory Reading**

**Further Reading**


- Bonaccorso, G. (2019). Hands-on unsupervised learning with Python: Implement machine learning and deep learning models using Scikit-Learn, TensorFlow, and more. Packt Publishing Ltd.
- Celebi, M. E., & Aydin, K. (Eds.). (2016). Unsupervised learning algorithms. Springer International Publishing.
- Kane, F. (2017). Hands-on data science and Python machine learning. Packt Publishing Ltd.
- Patel, A. A. (2019). Hands-on unsupervised learning using Python: How to build applied machine learning solutions from unlabeled data. O'Reilly Media.

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests |

# Mathematics II

**Module Code: DLBCSM2**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Robert Graf (Mathematics II)

**Contributing Courses to Module**

- Mathematics II (DLBCSM201)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Exam, 90 Minutes<br>Study Format: Distance Learning<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Selected topics of linear algebra
- Selected chapters on graphs and algorithms

| Learning Outcomes | |
|---|---|
| **Mathematics II**<br>On successful completion, students will be able to<br>▪ understand basic concepts of linear algebra, their interrelations, and their application in IT and technology and be able solve tasks independently using these concepts.<br>▪ understand and distinguish the basic concepts and important algorithms for graphs and trees from the field of discrete mathematics as well as their application in IT and technology. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Methods | **Links to other Study Programs of the University**<br>All Bachelor Programs in the Business & Management field |

# Mathematics II

**Course Code: DLBCSM201**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

This course continues the introduction to topics of discrete mathematics which began in the module "Mathematics Fundamentals I". In this course, the concepts of linear algebra are introduced and knowledge about graphs and algorithms for graphs is deepened. Typical questions of applied computer science are selected, and students are shown how they can be solved with graphs.

**Course Outcomes**

On successful completion, students will be able to

- understand basic concepts of linear algebra, their interrelations, and their application in IT and technology and be able solve tasks independently using these concepts.
- understand and distinguish the basic concepts and important algorithms for graphs and trees from the field of discrete mathematics as well as their application in IT and technology.

**Contents**

1. Introduction to Matrices
   - 1.1 Basic Concepts of Matrices
   - 1.2 Addition of Matrices
   - 1.3 Scalar Multiplication and Product

2. Inverting Matrices
   - 2.1 Multiplication of Matrices
   - 2.2 Properties of Matrix Multiplication
   - 2.3 Inverse Matrices

3. Linear Systems of Equations
   - 3.1 Gauss Algorithm
   - 3.2 Example Applications of the Gaussian Algorithm

4. Introduction to Graphs
   - 4.1 Undirected Graphs
   - 4.2 Further Properties of Graphs

4.3 Adjacency Matrix

5. The Problem of the Shortest Routes
   - 5.1 Directional Graph or Digraph
   - 5.2 Weighted Graph
   - 5.3 Dijkstra's Algorithm

6. The Königsberg Bridge Problem
   - 6.1 Routing in Graphs
   - 6.2 Eulerian Graph
   - 6.3 Hierholzer's Algorithm
   - 6.4 The Postman Problem

7. A City Tour Where Each City is Visited Exactly Once.
   - 7.1 Special Graphs
   - 7.2 Hamiltonian Graph
   - 7.3 The Ore and Dirac Condition
   - 7.4 The Problem of the Traveling Salesman

8. Trees
   - 8.1 Properties of Trees
   - 8.2 Root Tree
   - 8.3 Spanning Tree
   - 8.4 Minimal Spanning Tree

**Literature**

**Compulsory Reading**

**Further Reading**


- Benjamin, A., Chartrand, G., and Zhang, P. (2017). The fascinating world of graph theory. Princeton University Press.
- Erciyes, J. (2021). Discrete mathematics and graph theory: A concise study companion and guide. Princeton University Press.
- Lewis, H., & Zax, R. (2019). Essential discrete mathematics for computer science. Princeton University Press.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Personal Career Plan

**Module Code: DLBKAENT1_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Heike Schiebeck (Personal Career Plan)

**Contributing Courses to Module**

- Personal Career Plan (DLBKAENT01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Advanced Workbook | |

**Weight of Module**

see curriculum

**Module Contents**

- Career Theories and Approaches
- Career Development
- Career Planning
- Personal Assessment
- Career Choice
- Develop a Career Strategy and Manage your Career
- Global Careers
- Search for Employment in Germany and Abroad

| Learning Outcomes | |
|---|---|
| **Personal Career Plan**<br>On successful completion, students will be able to<br>▪ understand, apply, and reflect presented career theory and models with regard to their personal situation to arrive at a concept or pictore of a desired career.<br>▪ understand and critically reflect the concept of career and career planning.<br>▪ understand the relevance of a strategically oriented career planning.<br>▪ understand the importance of and conduct a personal assessment to identify one's personality, values, motivation, strengths, competencies, skills, and interests.<br>▪ understand the necessity of building and maintaining their own personal brand.<br>▪ understand differing job search processes across national/international contexts, and to create context-sensitive job applications accordingly.<br>▪ understand the principles of global careers and how to effectively act in international environments. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Human Resources | All Bachelor Programs in the Human Resources field |

# Personal Career Plan

**Course Code: DLBKAENT01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In today's complex and ever-changing environment, the forms of careers vary depending on the context, understanding of values, and market dynamics. The 'classic career ladder' that one is climbing being the only predominant form of career is long outdated, and individuals are being confronted with a great number of opportunities regarding industry or job choice and working arrangements.Considering the great variety of options especially for well-educated individuals, has become more important than ever to make informed decisions. This course is designed to support students maneauvering themselves through these complexities of their personal career plan, whereby self-awareness, self-reflection, and goal-setting are important elements of this process. Guided by central elements of career theory, career models, and research outcomes, students will be given tools and reflection exercises to arrive at a solid, directly applicable strategy to further steet their professional progress and career steps.

**Course Outcomes**

On successful completion, students will be able to

- understand, apply, and reflect presented career theory and models with regard to their personal situation to arrive at a concept or pictore of a desired career.
- understand and critically reflect the concept of career and career planning.
- understand the relevance of a strategically oriented career planning.
- understand the importance of and conduct a personal assessment to identify one's personality, values, motivation, strengths, competencies, skills, and interests.
- understand the necessity of building and maintaining their own personal brand.
- understand differing job search processes across national/international contexts, and to create context-sensitive job applications accordingly.
- understand the principles of global careers and how to effectively act in international environments.

**Contents**

1. Career Theories and Approaches
   - 1.1 Traditional Career Theories and Models
   - 1.2 Protean Career Orientation
   - 1.3 Career Learning Cycle

2. Career Development

| Literature |
|---|
| **Compulsory Reading** |
| **Further Reading**<br>▪ Baruch, Y. (2022). Managing Careers and Employability. SAGE.<br>▪ Greenhaus, J.H., Callanan, G.A., & Godshalk, V.M. (2018). Career Management for Life (5th edition). College of Business & Public Management Faculty Books.<br>▪ Hoeckstra, H. (2011). A career roles model of career development. Journal of Vocational Behavior, 78(2), 159-173.<br>▪ Ibarra, H. (2004). Working Identity: Unconventional Strategies for Reinventing Your Career. Harvard Business School Press.<br>▪ Kingsley, T. (2022). Personal Branding. Independently published.<br>▪ Ng, T.W.H., Eby, L.T., Sorensen, K.L., & Feldman, D.C. (2005). Predictors of objective and subjective career success: A meta-analysis. Personnel psychology, 58(2), 367-408.<br>▪ Ng, T.W.H., & Feldman, D.C. (2014). Subjective career success: A meta-analytic review. Journal of Vocational Behavior, 85(2), 169-179. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Advanced Workbook |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed | ☑ Course Book | ☑ Online Tests |
| ☑ Intensive Live Sessions/Learning Sprint | ☑ Video | ☑ Guideline |
| | ☑ Audio | |
| | ☑ Slides | |

# Intercultural and Ethical Decision-Making

**Module Code: DLBCSIDM**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| Prof. Dr. Jürgen Matthias Seeler (Intercultural and Ethical Decision-Making) |

| Contributing Courses to Module |
|---|
| ▪ Intercultural and Ethical Decision-Making (DLBCSIDM01) |

| Module Exam Type | |
|---|---|
| **Module Exam** | **Split Exam** |
| Study Format: myStudies<br>Written Assessment: Case Study<br>Study Format: Distance Learning<br>Written Assessment: Case Study | |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- Basics of Intercultural Competence
- Cultural Concepts
- Culture and Ethics
- Implications of Current Ethical Problems in the Area of Interculturality, Ethics, and Diversity
- Intercultural Learning and Working
- Case Studies for Cultural and Ethical Conflicts

| Learning Outcomes | |
|---|---|
| **Intercultural and Ethical Decision-Making**<br>On successful completion, students will be able to<br>▪ explain the most important terms in the areas of interculturality, diversity, and ethics.<br>▪ distinguish different explanatory patterns of culture.<br>▪ understand culture at different levels.<br>▪ plan processes of intercultural learning and working.<br>▪ understand the interdependencies of culture and ethics.<br>▪ independently work on a case study on intercultural competence. | |
| **Links to other Modules within the Study Program**<br>This module is similar to other modules in the field of Business Administration & Management | **Links to other Study Programs of the University**<br>All Bachelor Programs in the Business & Management field |

# Intercultural and Ethical Decision-Making

**Course Code: DLBCSIDM01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In this course, students acquire the necessary knowledge to understand intercultural competencies and current developments in the fields of diversity and ethics. Students will understand how to systematically plan and implement learning processes for the development of competences important in these areas. First, important terms are clarified and differentiated from each other, and cultural aspects are explained from different perspectives. In addition, students learn that cultural issues are relevant at different levels, for example, within a state, company, or other group. In this context, students also recognize the connection between ethics and culture with different interdependencies. On the basis of this knowledge, students are then familiarized with the different possibilities and potentials of intercultural and ethical learning and working. Practical cases are used to illustrate the importance of the relationships learned for today's work context in many companies. The students then work on a case study in which the acquired knowledge is systematically applied.

**Course Outcomes**

On successful completion, students will be able to

- explain the most important terms in the areas of interculturality, diversity, and ethics.
- distinguish different explanatory patterns of culture.
- understand culture at different levels.
- plan processes of intercultural learning and working.
- understand the interdependencies of culture and ethics.
- independently work on a case study on intercultural competence.

**Contents**

1. Basics of Intercultural and Ethical Competence to Act
   - 1.1 Subject Areas, Terms, and Definitions
   - 1.2 Relevance of Intercultural and Ethical Action
   - 1.3 Intercultural Action - Diversity, Globalization, Ethics

2. Cultural Concepts
   - 2.1 Hofstedes Cultural Dimensions
   - 2.2 Culture Differentiation According to Hall
   - 2.3 Locus of Control Concept to Rotter

3. Culture and Ethics
   - 3.1 Ethics - Basic Terms and Concepts
   - 3.2 Interdependence of Culture and Ethics
   - 3.3 Ethical Concepts in Different Regions of the World

4. Current Topics in the Area of Interculturality, Ethics, and Diversity
   - 4.1 Digital Ethics
   - 4.2 Equality and Equal Opportunities
   - 4.3 Social Diversity

5. Intercultural Learning and Working
   - 5.1 Acculturation
   - 5.2 Learning and Working in Intercultural Groups
   - 5.3 Strategies for Dealing with Cultural Conflicts

6. Case Studies for Cultural and Ethical Conflicts
   - 6.1 Case Study: Interculturality
   - 6.2 Case Study: Diversity
   - 6.3 Case Study: Interculturality and Ethics

**Literature**

**Compulsory Reading**

**Further Reading**


- Al-Ali, E. & Masmoudi, M. (2023). Leadership and Workplace Culture in the Digital Era. Business Science Reference.
- Barmeyer, C., Bausch, M., & Mayrhofer, U. (2021). Constructive Intercultural Management.
- Edward Elgar Publishing.Ýeon Rossouw, & Leon van Vuuren. (2017). Business Ethics 6e: Vol. 6th edition. Oxford University Press Southern Africa.
- Nelly Berrones-Flemmig, Francoise Contreras, & Utz Dornberger. (2022). Business in the 21st Century : A Sustainable Approach: Vol. First edition. Emerald Publishing Limited.

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests |

# Conflict Management and Mediation

**Module Code: DLBWPKUM_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Hendrik Fenz (Conflict Management and Mediation)

**Contributing Courses to Module**

- Conflict Management and Mediation (DLBWPKUM01_E)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: Distance Learning<br>Exam, 90 Minutes<br><br>Study Format: myStudies<br>Exam, 90 Minutes | |

**Weight of Module**

see curriculum

**Module Contents**

- Forms of cooperation
- Basic concepts of conflict research
- Conflict Management
- Basics of communication psychology
- Conducting discussions and moderation
- Mediation

<table>
<tr><td colspan="2">Learning Outcomes<br>Conflict Management and Mediation<br>On successful completion, students will be able to<br>▪ explain the central characteristics of conflicts and reflect, analyze and assess their progression.<br>▪ analyze conflicts according to the degree of their escalation.<br>▪ explain how conflicts arise and how to avoid them.<br>▪ understand conflicts and negotiations as a process and plan and implement the necessary measures to solve them.<br>▪ use special conversation and question techniques.<br>▪ identify hidden messages in communication and develop suggestions for optimization.<br>▪ develop goals and strategies for conflict and negotiation management in order to contribute to successful conflict management and negotiation with a clear procedure.<br>▪ assess and apply mediation as a method of conflict resolution.</td></tr>
<tr><td>Links to other Modules within the Study Program<br>This module is similar to other modules in the field of Psychology</td><td>Links to other Study Programs of the University<br>All Bachelor Programs in the Social Sciences field</td></tr>
</table>

# Conflict Management and Mediation

**Course Code: DLBWPKUM01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

In the business world, different perspectives of negotiating partners or parties often clash. This often leads to conflicts because the parties involved pursue different goals and evaluate situations differently. Especially against the background of transformation and restructuring processes in companies, conflicts are often pre-programmed due to different interests. To ensure that the different perspectives of the parties involved do not conclude in escalation, knowledge of the nature and structure of conflicts, techniques for dealing with them and basic knowledge of the possibilities of successful communication at a verbal and non-verbal level are essential. This course will equip students with the necessary understanding and present necessary tools to recognize conflicts, to solve them and to lead negotiations. In this context, mediation is highlighted as an increasingly popular method of conflict resolution.

**Course Outcomes**

On successful completion, students will be able to

- explain the central characteristics of conflicts and reflect, analyze and assess their progression.
- analyze conflicts according to the degree of their escalation.
- explain how conflicts arise and how to avoid them.
- understand conflicts and negotiations as a process and plan and implement the necessary measures to solve them.
- use special conversation and question techniques.
- identify hidden messages in communication and develop suggestions for optimization.
- develop goals and strategies for conflict and negotiation management in order to contribute to successful conflict management and negotiation with a clear procedure.
- assess and apply mediation as a method of conflict resolution.

**Contents**

1. From Cooperation to Confrontation
    - 1.1 Cooperation and Competition
    - 1.2 Forms of Cooperation
    - 1.3 Game Theoretical Approaches
    - 1.4 The Way into the Conflict

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Coltri, L. (2020). Alternative dispute resolution (2nd ed.). McGraw Hill.<br>▪ Fisher, R., Ury, W., & Patton, B. (2011). Getting to yes: Negotiating agreement without giving in (3rd ed.). Penguin Books.<br>▪ Rosenberg, M. B. (2015). Nonviolent communication - A language of life: Life-changing tools for healthy relationships (3rd ed.). PuddleDancer Press. |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Exam, 90 Minutes |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 90 h | 0 h | 30 h | 30 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Practice Exam<br>☑ Online Tests |

# Collaborative Work

**Module Code: DLBCSCW**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Karin Halbritter (Collaborative Work)

**Contributing Courses to Module**

- Collaborative Work (DLBCSCW01)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| Study Format: myStudies<br>Oral Assignment<br><br>Study Format: Distance Learning<br>Oral Assignment | |

**Weight of Module**

see curriculum

**Module Contents**

- Self-Directed and Collaborative Learning
- Networking and Cooperation
- Performance in (Virtual) Teams
- Communication, Arguments, and Being Convincing
- Potentials for Conflict and Managing Conflicts
- Self-Management and Personal Skills

| Learning Outcomes | |
|---|---|
| **Collaborative Work**<br>On successful completion, students will be able to<br>▪ design their own learning processes both self-directed and collaborative with analog and digital media.<br>▪ initiate face-to-face and virtual cooperation and select suitable methods for shaping collaboration even in an intercultural context and across disciplinary boundaries.<br>▪ assess different forms of communication in relation to the goals and requirements of different situations and to reflect on their own communication and argumentation behavior in order to be able to shape conducive collaboration also in an interdisciplinary context.<br>▪ recognize social diversity including cultural and professional differences as a value, and to name and apply tools to deal with them constructively.<br>▪ explain conflict potentials and the role of emotions in conflicts and to describe the use of systemic methods in the target- and solution-oriented handling of conflicts.<br>▪ analyze one's own resources, present methods of self-leadership and self-motivation, and derive appropriate strategies. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Business Administration & Management | All Bachelor Programs in the Business & Management field |

# Collaborative Work

**Course Code: DLBCSCW01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

## Course Description

The course supports the students in building up and expanding important interdisciplinary competences for our networked world, and in doing so, students can take advantage of the opportunities for constructive cooperation with others. It presents essential forms and design possibilities of collaborative learning and working, imparts basic knowledge and tools for self-managed, flexible, and creative thinking, learning and acting and familiarizes students with the topics of empathy and emotional intelligence. Students are also encouraged to use the course contents. In this way, they promote their autonomous competence to act and their competence in the interactive application of tools and in interacting in heterogeneous groups.

## Course Outcomes

On successful completion, students will be able to

- design their own learning processes both self-directed and collaborative with analog and digital media.
- initiate face-to-face and virtual cooperation and select suitable methods for shaping collaboration even in an intercultural context and across disciplinary boundaries.
- assess different forms of communication in relation to the goals and requirements of different situations and to reflect on their own communication and argumentation behavior in order to be able to shape conducive collaboration also in an interdisciplinary context.
- recognize social diversity including cultural and professional differences as a value, and to name and apply tools to deal with them constructively.
- explain conflict potentials and the role of emotions in conflicts and to describe the use of systemic methods in the target- and solution-oriented handling of conflicts.
- analyze one's own resources, present methods of self-leadership and self-motivation, and derive appropriate strategies.

## Contents

1. Learning for a Networked World, in a Networked World
   - 1.1 Requirements and Opportunities in the “VUCA” World
   - 1.2 Learning, Knowing and Not-Knowing
   - 1.3 The 4C Model: Collective, Collaborative, Continuous, and Connected
   - 1.4 Monitoring Learning Behaviour

2. Networking & Cooperation
   - 2.1 Cooperation Partners
   - 2.2 Sustainable Relationships: Digital Interaction and Trust Building
   - 2.3 Organizing Collaboration
   - 2.4 Social Learning

3. Performance in (Online) Teams
   - 3.1 Goals, Roles, Organization and Performance Measurement
   - 3.2 Team Building and Team Flow
   - 3.3 Agile Project Management with Scrum
   - 3.4 Other Agile Methods

4. Communicating and Convincing
   - 4.1 Communication as Social Interaction
   - 4.2 Language, Images, Metaphors, and Stories
   - 4.3 Attitude: Open, Empathetic, and Appreciative Communication
   - 4.4 Active Listening
   - 4.5 Analyze Your Conversational and Argumentative Skills

5. Recognizing Conflict Potential — Managing Conflicts — Negotiating Effectively
   - 5.1 Respecting Diversity and Seizing Opportunities
   - 5.2 Empathy
   - 5.3 Systemic Solution Process Work
   - 5.4 Constructive Negotiation

6. Achieving Your Goals
   - 6.1 Effective Goal Setting
   - 6.2 The Agile Use of Time
   - 6.3 (Self-)Coaching Methods
   - 6.4 Self-Management and Motivation Strategies

7. Mobilizing Resources
   - 7.1 Recognizing Resources
   - 7.2 Reflection and Innovation
   - 7.3 Transfer Strength and Willpower

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Baber, A., Waymon, L., Alphonso, A., & Wylde, J. (2015). Strategic connections: The new face of networking in a collaborative world. New York, NY: AMACOM.<br>▪ Kaats, E., & Opheij, W. (2014). Creating conditions for promising collaboration: Alliances, networks, chains,strategic partnerships. Heidelberg, Germany: Springer.<br>▪ Martin, S. J., Goldstein, N. J., & Cialdini, R. B. (2014). The small BIG: Small changes that spark BIG influence. London, England: Profile Books.<br>▪ Oettingen, G. (2014). Rethinking positive thinking: Inside the new science of motivation. New York, NY:Current. |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Oral Assignment |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Learning Material**<br>☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | **Exam Preparation**<br>☑ Online Tests<br>☑ Guideline |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Online Lecture |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Oral Assignment |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| Instructional Methods | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Online Tests<br>☑ Guideline |

# DevOps and Continuous Delivery

**Module Code: DLBSEPDOCD_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum 1 semester | WiSe/SoSe | English |

**Module Coordinator**

Prof. Dr. Marian Benner-Wickner (DevOps and Continuous Delivery )

**Contributing Courses to Module**

- DevOps and Continuous Delivery (DLBSEPDOCD01_E)

| Module Exam Type | |
|---|---|
| **Module Exam**<br><u>Study Format: Distance Learning</u><br>Written Assessment: Case Study | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

- The DevOps Approach
- Service Architectures
- DevOps Environment
- Continuous Integration and Deployment
- Automated Testing
- Information Security in DevOps

| Learning Outcomes | |
|---|---|
| **DevOps and Continuous Delivery**<br>On successful completion, students will be able to<br>▪ discuss key aspects of DevOps culture,<br>▪ apply hands-on experience with techniques related to DevOps and continuous deployment,<br>▪ create, configure and deploy platform as a service container,<br>▪ manage (micro-)service architectures using platform as a service technique,<br>▪ construct and maintain a continuous deployment pipeline to develop and deploy an application iteratively and incrementally. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# DevOps and Continuous Delivery

**Course Code: DLBSEPDOCD01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

When developing modern applications from scratch, emerging approaches like microservice architectures, agile techniques and virtualization are becoming important. Agile development stands for very quick releases of small software increments. Since important recurring tasks for each release like testing, configuration and deployment are time-consuming, a highly automated software development and deployment process is required. As well, development and deployment more and more becomes one single task, triggered by a single code commit. Implementing a fully automated continuous delivery pipeline and putting development and operations into one DevOps team holistically responsible for one microservice are essential for modern software development. In this course, both approaches are introduced with a strong focus on tool practice.

**Course Outcomes**

On successful completion, students will be able to

- discuss key aspects of DevOps culture,
- apply hands-on experience with techniques related to DevOps and continuous deployment,
- create, configure and deploy platform as a service container,
- manage (micro-)service architectures using platform as a service technique,
- construct and maintain a continuous deployment pipeline to develop and deploy an application iteratively and incrementally.

**Contents**

1. The DevOps Approach
   - 1.1 Issues in Classic Approaches
   - 1.2 Goals of DevOps
   - 1.3 DevOps Case Studies
   - 1.4 DevSecOps

2. Service Architectures
   - 2.1 Microservice
   - 2.2 Domain-Driven Design
   - 2.3 Containerization and Platform as a Service
   - 2.4 Practical Examples

3. DevOps Environment
   3.1 Version Control Concepts
   3.2 Version Control Tools
   3.3 Code Repositories
   3.4 Package Manager
   3.5 Virtualization

4. Continuous Integration and Deployment
   4.1 Continuous Delivery Pipeline
   4.2 Build Tools
   4.3 CI/CD Engines and Server
   4.4 Configuration Management and Infrastructure as Code

5. Automated Testing
   5.1 Basic Concepts
   5.2 Static Analysis Tools
   5.3 Unit Testing Tools
   5.4 UI and Acceptance Tests Tools
   5.5 Performance Testing Tools

6. Information Security in DevOps
   6.1 Roles and Responsibilities
   6.2 Change Management

**Literature**

**Compulsory Reading**

**Further Reading**


- Chatley, R., & Procaccini, I. (2020). Threading DevOps Practices through a University Software Engineering Programme. In 2020 IEEE 32nd Conference on Software Engineering Education and Training (CSEE&T) (pp. 1–5). IEEE.
- Farcic, V. (2016). The DevOps 2.0 Toolkit. Packt Publishing.
- Hills, M. (2020). Introducing DevOps Techniques in a Software Construction Class. In 2020 IEEE 32nd Conference on Software Engineering Education and Training (CSEE&T) (pp. 1–5). IEEE.
- Kim, G., Humble, J., Debois, P., & Willis, J. (2016). The DevOps Handbook: How to create world-class agility, reliability, and security in technology organizations. IT Revolution Press.
- Leszo, R. (2019). Continuous Delivery with Docker and Jenkins: Create secure applications by building complete CI/CD pipelines (2nd ed.). Packt Publishing.

### Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Online Lecture |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** yes |
| **Type of Exam** | Written Assessment: Case Study |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 110 h | 0 h | 20 h | 20 h | 0 h | 150 h |

| **Instructional Methods** | | |
|---|---|---|
| **Tutorial Support** | **Learning Material** | **Exam Preparation** |
| ☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | ☑ Course Book<br>☑ Video<br>☑ Audio<br>☑ Slides | ☑ Online Tests |

# Project: Digitalization and Automation Hackathon

**Module Code: DLBCCOEDAH**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| (Project: Digitalization and Automation Hackathon ) |

| Contributing Courses to Module |
|---|
| ▪ Project: Digitalization and Automation Hackathon (DLBCCOEDAH01) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Portfolio | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

The Project: Digitalization and Automation Hackathon offers students the opportunity to gain practical experience in the field of Digitalization and Automation. The objective is to create a working Digitalization or Automation solution, which can include various elements such as no-code/low-code development, cloud computing, (web) applications, AI applications, AI modeling, or industrial programming. The solution should address a real-world problem encountered in practice.

| **Learning Outcomes** | |
|---|---|
| **Project: Digitalization and Automation Hackathon**<br>On successful completion, students will be able to<br>▪ identify relevant problems from the professional environment and explain it to an interested audience .<br>▪ apply established procedures to find a (prototypical) solution to the problem.<br>▪ understand relevant concepts or technologies for the solution and integrate them appropriately.<br>▪ evaluate the result with respect to its suitability for solving the practical problem.<br>▪ present the problem, the solution and the way to get there in a comprehensible and descriptive way.<br>▪ communicate in a group, solving conflicts and negotiating on responsibility scope, and collaborating with students from diverse backgrounds or work individually taking responsibility for all details, reflecting on tutorial feedback. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Project: Digitalization and Automation Hackathon

**Course Code: DLBCCOEDAH01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | none |

**Course Description**

The Hackathon module, designed to provide an immersive and hands-on experience for students across all Bachelor’s degree programs in the field of Computer Science and Information Technology, aims to foster creativity, collaboration, and problem-solving skills by engaging students in diverse project challenges. Throughout the module, students will have the opportunity to work in teams, apply their theoretical knowledge, and showcase their practical skills to address real-world problems. For this purpose, a working digitalization or automation solution is to be created. It can include various elements such as no-code/low-code development, cloud computing, (web) applications, AI applications, AI modeling, or industrial programming. The solution should address a real-world problem encountered in practice.

**Course Outcomes**

On successful completion, students will be able to

- identify relevant problems from the professional environment and explain it to an interested audience .
- apply established procedures to find a (prototypical) solution to the problem.
- understand relevant concepts or technologies for the solution and integrate them appropriately.
- evaluate the result with respect to its suitability for solving the practical problem.
- present the problem, the solution and the way to get there in a comprehensible and descriptive way.
- communicate in a group, solving conflicts and negotiating on responsibility scope, and collaborating with students from diverse backgrounds or work individually taking responsibility for all details, reflecting on tutorial feedback.

**Contents**

- At the beginning of the hackathon, students choose a specific task from the given examples in coordination with the tutor. The task should be derived from a relevant practical problem. Possible problems and use cases can be found in areas such as sustainability, smart factories, robotics, smart homes, electromobility, autonomous driving, human-machine interaction, data analytics, robotic process automation, or digital business models. Depending on the study program, the tutor should approve use cases of similar complexity based on their subject matter expertise. Students work on the task using a prototyping environment that is suitable for the subject of the task. The environments can be hardware, such as prototyping boards like Arduino, or software, such as technology-specific development environments like Matlab, Eclipse IDE, VS Code, Jupyter Notebook/Google Colab, or public cloud platforms. To complete the task, students apply the concepts, methods, and tools taught throughout the curriculum. The project results will be presented; additionally, the students are asked to publish the results, along with the underlying problem and chosen solution, on a platform so that they can be seen by other students. The results are evaluated in terms of their suitability to solve the previously selected problem. Aspects such as complexity, creativity, and practical relevance also play a role.

**Literature**

**Compulsory Reading**

**Further Reading**


- Knaflic, C. N. (2015). Storytelling with Data: A Data Visualization Guide for Business Professionals. Wiley.
- Ries, E. (2011). The Lean Startup. Crown Business.
- Swaminathan, A., & Meffert, J. (2017). Digital @ Scale: The Playbook You Need to Transform Your Company. PublicAffairs.
- Sweigart, A. (2015). Automate the Boring Stuff with Python. No Starch Press.
- Van Der Pijl, P., Lokitz, J., & Wijnen, R. (2016). Design a Better Business. Wiley.

## Study Format Distance Learning

| **Study Format** | **Course Type** |
|---|---|
| Distance Learning | Project |

| **Information about the examination** | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Portfolio |

| **Student Workload** | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| **Instructional Methods** | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# Internship: Bachelor Cloud Computing

**Module Code: DLBCCOEIBCC**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 30 | 900 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimaldauer:<br>1 Semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| (Internship: Bachelor Cloud Computing) |

| Contributing Courses to Module |
|---|
| ▪ Internship: Bachelor Cloud Computing (DLBCCOEIBCC01) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Reflection of Practical Experiences (passed / not passed) | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

| Module Contents |
|---|
| Within the framework of this internship, students document and reflect on their everyday practical experiences. This is based on knowledge they have acquired. Students now apply this theoretical knowledge in various fields of practice and reflect upon it. The fields of practice are chosen according to the training required for the course of study. |

| Learning Outcomes | |
|---|---|
| **Internship: Bachelor Cloud Computing**<br>On successful completion, students will be able to<br>▪ to transfer theoretical knowledge to practical problems.<br>▪ depending on the tasks undertaken, to independently address and manage practical challenges; to reflect on their success.<br>▪ to better assess the scope, significance, and limitations of theoretical concepts in light of practical demands. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Internship: Bachelor Cloud Computing

**Course Code: DLBCCOEIBCC01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 30 | none |

**Course Description**

Within the scope of this course, students document and reflect on their everyday practical experience, relating it to the subject-specific and related scientific knowledge bases they have previously learned and developed, as well as previously acquired skills and competencies for action. The students apply their theoretical knowledge in various practical fields and reflect upon it. The connection between theory and practice, the application of knowledge in the practical field, and the reflection of these experiences in relation to theory and personal development are the primary focus. The fields of practice are chosen according to the training required for the course of study.

**Course Outcomes**

On successful completion, students will be able to

- to transfer theoretical knowledge to practical problems.
- depending on the tasks undertaken, to independently address and manage practical challenges; to reflect on their success.
- to better assess the scope, significance, and limitations of theoretical concepts in light of practical demands.

**Contents**

- As part of the internship, students document and reflect on their everyday professional experiences in the field of program. The individual problems and questions that arise are reflected upon from the perspective of professional practice. This module provides students with the opportunity to apply the content they have learned in previous modules through practical reflection and to directly implement practical knowledge where it has been acquired. Various concepts and methods are concretely tested in practice and reflected upon in their specific applications. The basis for this is the documentation, evaluation, and presentation of approaches and methods in the chosen context of action. The internship can/should be completed in the following companies:
  - Amazon Web Service (the industry leader)
  - Microsoft Azure (the most widely used enterprise cloud provider in Germany)
  - Google Cloud Platform (the best choice for data scientists)
  - IBM Cloud (the oldest IT company, with AI and other capacities)
  - Oracle Cloud (the best for database)
  - VMware (the best for cloud-native technologies)

- Red Hat (the best for OpenShift and open-source technologies)
- Cisco (the best for networking techniques)
- Nvidia (the best for AI and IaaS hardware specialized for high performance)
- Dell Technologies (the best for hardware)
- HP Enterprice (HPE) (the best for data centers)
- Akamai Technologies (the best for content delivery)
- Adobe (the best for designers)
- Citrix (the best for remote services)
- Alibaba Cloud (the best for globalization)

**Literature**

**Compulsory Reading**

**Further Reading**

- Within the subject relation, the literature of each module in the program is relevant.

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Reflection of Practical Experiences (passed / not passed) |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 0 h | 0 h | 0 h | 0 h | 900 h | 900 h |

| Instructional Methods |
|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint |

# Cloud Programming

**Module Code: DLBSEPCP_E**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | None | BA | 5 | 150 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

| Module Coordinator |
|---|
| Georgi Dimchev (Cloud Programming) |

| Contributing Courses to Module |
|---|
| ▪ Cloud Programming (DLBSEPCP01_E) |

| Module Exam Type | |
|---|---|
| **Module Exam**<br><br>Study Format: Distance Learning<br>Portfolio<br><br>Study Format: myStudies<br>Portfolio | **Split Exam** |
| **Weight of Module**<br>see curriculum | |

**Module Contents**

The students employ and polish their knowledge of distributed computer systems so as to be able to plan, create, test, and document a scalable service deployed in the cloud. The module is focused on a practical realization and its documentation: Through the testable deployment, students guarantee that their project can be realized and has requirements of a cloud system, through the documentation, the student demonstrates the qualities of the realization and of its creation process.

| **Learning Outcomes** | |
|---|---|
| **Cloud Programming**<br>On successful completion, students will be able to<br>▪ associate characteristics of a cloud infrastructure as discussed in business with concrete implications for the machines deployed in the cloud.<br>▪ create a plan for a chosen cloud infrastructure provider and measure the achievement of this plan.<br>▪ specify by means of scripts, programs, documented web-platform usage, how the elements of a cloud service are created and measured.<br>▪ describe the risks, the protection measures, and the reaction measures of a cloud-service.<br>▪ demonstrate a running cloud-service created by the student and allow it to be tested in all its possible usage dimensions. | |
| **Links to other Modules within the Study Program** | **Links to other Study Programs of the University** |
| This module is similar to other modules in the field of Computer Science & Software Development | All Bachelor Programs in the IT & Technology field |

# Cloud Programming

**Course Code: DLBSEPCP01_E**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 5 | None |

### Course Description

The usage of commodity computing in the form of a service offered over a network interface is a major technical aspect of services made by IT organizations: The services function within a server environment and the ubiquity of the network make the service reachable from everywhere with high availability guarantees and flexible scalability. The course aims at a documented realization of a cloud service which displays all the attributes of a cloud service. In doing so the students employ and deepen their knowledge of distributed computer systems so as to be able to plan, create, deploy, test, measure, and document a scalable service in the cloud.

### Course Outcomes

On successful completion, students will be able to

- associate characteristics of a cloud infrastructure as discussed in business with concrete implications for the machines deployed in the cloud.
- create a plan for a chosen cloud infrastructure provider and measure the achievement of this plan.
- specify by means of scripts, programs, documented web-platform usage, how the elements of a cloud service are created and measured.
- describe the risks, the protection measures, and the reaction measures of a cloud-service.
- demonstrate a running cloud-service created by the student and allow it to be tested in all its possible usage dimensions.

### Contents

- In this course, students create a cloud service which demonstrates the core aspects of cloud service programming by an explicit documentation and by a measurable concrete realization. To do so, they choose a PaaS cloud service hoster, set-up a service, describe its interfaces (API) and how the core characteristics of cloud services are achieved:
  - Horizontal or vertical scalability: How the service can be enlarged or diminished in its usage of resources in order to react to variation to the demand.
  - High-availability: What guarantees a failover in case a component of the service is made inoperable and what kind of degradation can happen.
  - Measurability: How the usage of resources is measured and how these measures can allow a proactive planning.
  - Orchestration and provisioning: How the service is deployed and changes in its resources allocations are performed as needed by the usage of the service.

The cloud service should be testable and demonstratable by external users; a plan how to test it should be part of the documentation including the dimensions of the usage as well as the API definitions of the service. The service should fulfill a recognizable business need and be documented by an API definition and a user-interface for its usage runnable on any platform that has access to the internet. Being a service on the internet, its security restrictions should be accessible and understandable. Based on these ingredients, the students realize a work in the form of software artifacts in a versioning system and a human readable documentation of the realization and its process. The realization and its documentation should follow current trends in cloud engineering.

**Literature**

**Compulsory Reading**

**Further Reading**


- Johnston, C., Advanced Platform Development with Kubernetes. Springer, https://doi-org.pxz.iubh.de:8443/10.1007/978-1-4842-5611-4
- Jonas, E., Schleier-Smith, J., Sreekanti , V., Tsai, C.-c., Khandelwal ,A., Pu, Q., Shankar, V., Carreira, J., Krauth, K., Jayant Yadwadkar, N., Gonzalez, J., Popa, R.A., Stoica, I., Patterson, D.: Cloud Programming Simplified: A Berkeley View on Serverless Computing. CoRR abs/1902.03383 (2019) https://arxiv.org/abs/1902.03383
- Talia, D., A view of programming scalable data analysis: from clouds to exascale, Journal of Cloud Computing: Advances, Systems and Applications (2019-02-01). https://doi.org/10.1186/s13677-019-0127-x
- Ponelat, J.S., Rosenstock, L.L., Designing APIs with Swagger and OpenAPI, Manning Publications, ISBN 9781617296284, https://www.manning.com/books/designing-apis-with-swagger-and-openapi

## Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Project |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Portfolio |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 120 h | 0 h | 30 h | 0 h | 0 h | 150 h |

| Instructional Methods | |
|---|---|
| **Tutorial Support**<br>☑ Course Feed<br>☑ Intensive Live Sessions/Learning Sprint | **Exam Preparation**<br>☑ Guideline |

# Bachelor Thesis

**Module Code: DLBBT**

| Module Type | Admission Requirements | Study Level | CP | Student Workload |
|---|---|---|---|---|
| see curriculum | none | BA | 10 | 300 h |

| Semester / Term | Duration | Regularly offered in | Language of Instruction and Examination |
|---|---|---|---|
| see curriculum | Minimum<br>1 semester | WiSe/SoSe | English |

**Module Coordinator**

Degree Program Advisor (SGL) (Bachelor Thesis) / Degree Program Advisor (SGL) (Colloquium)

**Contributing Courses to Module**

- Bachelor Thesis (DLBBT01)
- Colloquium (DLBBT02)

**Module Exam Type**

| Module Exam | Split Exam |
|---|---|
| | Bachelor Thesis<br>• Study Format "myStudies": Bachelor Thesis<br>• Study Format "Distance Learning": Bachelor Thesis<br><br>Colloquium<br>• Study Format "myStudies": Colloquium<br>• Study Format "Distance Learning": Colloquium |

**Weight of Module**

see curriculum

| Module Contents |
|---|
| **Bachelor Thesis**<br>▪ Bachelor's thesis<br>▪ Colloquium on the bachelor's thesis<br><br>**Colloquium** |

| Learning Outcomes |
|---|
| **Bachelor Thesis**<br>On successful completion, students will be able to<br>▪ work on a problem from their major field of study by applying the specialist and methodological skills they have acquired during their studies.<br>▪ independently analyze selected tasks with scientific methods, critically evaluate them, and develop appropriate solutions under the guidance of an academic supervisor.<br>▪ record and analyze existing (research) literature appropriate to the topic of their bachelor's thesis.<br>▪ prepare a detailed written elaboration in compliance with scientific methods.<br><br>**Colloquium**<br>On successful completion, students will be able to<br>▪ present a problem from their field of study using academic presentation and communication techniques.<br>▪ reflect on the scientific and methodological approach chosen in their bachelor's thesis.<br>▪ demonstrate that they can actively answer subject-related questions from the subject experts (reviewers of the bachelor’s thesis). |

| Links to other Modules within the Study Program | Links to other Study Programs of the University |
|---|---|
| All modules in the Bachelor program | All Bachelor programs in distance learning |

# Bachelor Thesis

**Course Code: DLBBT01**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 9 | none |

### Course Description

The aim and purpose of the bachelor's thesis is to successfully apply the subject-specific and methodological competencies acquired during the course of study in the form of an academic dissertation with a thematic reference to the major field of study. The content of the bachelor's thesis can be a practical-empirical or theoretical-scientific problem. Students should prove that they can independently analyze a selected problem with scientific methods, critically evaluate it, and work out proposed solutions under the subject-methodological guidance of an academic supervisor. The topic chosen by the student from their respective field of study should meet the acquired scientific competences, deepening their academic knowledge and skills in order to meet the future needs of the field.

### Course Outcomes

On successful completion, students will be able to

- work on a problem from their major field of study by applying the specialist and methodological skills they have acquired during their studies.
- independently analyze selected tasks with scientific methods, critically evaluate them, and develop appropriate solutions under the guidance of an academic supervisor.
- record and analyze existing (research) literature appropriate to the topic of their bachelor's thesis.
- prepare a detailed written elaboration in compliance with scientific methods.

### Contents

- The bachelor's thesis must be written on a topic that relates to the content of the respective major field of study. In the context of the bachelor's thesis, the problem, as well as the scientific research goal, must be clearly emphasized. The work must reflect the current state of knowledge of the topic to be examined by means of an appropriate literature analysis. The student must prove their ability to use the acquired knowledge theoretically and/or empirically in the form of an independent and problem-solution-oriented application.

| Literature |
| --- |
| **Compulsory Reading** |
| **Further Reading**<br>▪ Lipson, C. (2018). How to write a BA thesis. A practical guide from your first ideas to your finished paper (2nd ed.). University of Chicago Press.<br>▪ Turabian, K. L. (2013). A Manual for Writers of Research Papers, theses, and dissertations (8th ed.). University of Chicago Press.<br>▪ Selection of literature according to topic |

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Thesis |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Bachelor Thesis |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 270 h | 0 h | 0 h | 0 h | 0 h | 270 h |

| Instructional Methods | |
|---|---|
| **Learning Material** | **Exam Preparation** |
| ☑ Slides | ☑ Review Book |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Thesis |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Bachelor Thesis |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 270 h | 0 h | 0 h | 0 h | 0 h | 270 h |

| Instructional Methods | |
|---|---|
| **Learning Material** | **Exam Preparation** |
| ☑ Slides | ☑ Review Book |

# Colloquium

**Course Code: DLBBT02**

| Study Level | Language of Instruction and Examination | Contact Hours | CP | Admission Requirements |
|---|---|---|---|---|
| BA | English | | 1 | none |

## Course Description

The colloquium will take place after the submission of the bachelor’s thesis. This is done at the invitation of the experts. During the colloquium, students must prove that they have independently produced the content and results of the written work. The content of the colloquium is a presentation of the most important work contents and research results by the student as well as the answering of questions by experts.

## Course Outcomes

On successful completion, students will be able to

- present a problem from their field of study using academic presentation and communication techniques.
- reflect on the scientific and methodological approach chosen in their bachelor's thesis.
- demonstrate that they can actively answer subject-related questions from the subject experts (reviewers of the bachelor’s thesis).

## Contents

- The colloquium includes a presentation of the most important results of the bachelor's thesis, followed by the student answering the reviewers' technical questions.

## Literature

### Compulsory Reading

### Further Reading

- Subject specific literature chosen by the student

### Study Format myStudies

| Study Format | Course Type |
|---|---|
| myStudies | Thesis Defense |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Colloquium |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 30 h | 0 h | 0 h | 0 h | 0 h | 30 h |

| Instructional Methods |
|---|
| **Learning Material**<br>☑ Slides |

### Study Format Distance Learning

| Study Format | Course Type |
|---|---|
| Distance Learning | Thesis Defense |

| Information about the examination | |
|---|---|
| **Examination Admission Requirements** | **Online Tests:** no |
| **Type of Exam** | Colloquium |

| Student Workload | | | | | |
|---|---|---|---|---|---|
| **Self Study** | **Contact Hours** | **Tutorial/Tutorial Support** | **Self Test** | **Independent Study** | **Hours Total** |
| 30 h | 0 h | 0 h | 0 h | 0 h | 30 h |

| Instructional Methods |
|---|
| **Learning Material**<br>☑ Slides |