MODULE HANDBOOK

Bachelor of Engineering

Bachelor Engineering (FS-OI-BAENG)

180 CP

Distance Learning

As of March 27th, 2024

INTERNATIONAL
UNIVERSITY OF
APPLIED SCIENCES

Classification: Undergraduate

Contents

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3. Semester

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4. Semester

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5. Semester

1. Semester

Engineering: Branches, Methods, Applications, Trends

Module Code: DLBENGEBMAT

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. Dorian Mora (Engineering: Branches, Methods, Applications, Trends)

Contributing Courses to Module

- Engineering: Branches, Methods, Applications, Trends (DLBENGEBMAT01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Exam or Written Assessment: Written Assignment, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Historical Evolution
- Branches
- Methods
- Applications
- Trends

Learning Outcomes	
Engineering: Branches, Methods, Applications, Trends On successful completion, students will be able to ▪ describe the historical evolution of engineering. ▪ understand the meaning of engineering and how its different branches evolved. ▪ name and describe the different branches of engineering and their common foundations. ▪ name and understand current and future trends in the field of engineering.	
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 Engineering	All Bachelor Programs in the IT & Technology field

Engineering: Branches, Methods, Applications, Trends

Course Code: DLBENGEBMAT01

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

Course Description

In the present days, the foundation for all engineering activities is comprehensive knowledge in the fields of natural science, mathematics, and computer science, whereas the influence of computer science is steadily growing due to the advances of the so-called digital transformation and its impact of the whole modern civilization. On this common foundation many different branches or disciplines evolved over the time, e.g., mechanical engineering, electrical engineering, biological engineering, and software engineering. This course, thus, provides an overview of the whole field of engineering, its historical evolution, and the formation of the different branches. When describing the evolution and the different branches, many important and prominent applications as well as methods will be presented, too. Finally, some selected and significant current and future trends are described.

Course Outcomes

On successful completion, students will be able to

- describe the historical evolution of engineering.
- understand the meaning of engineering and how its different branches evolved.
- name and describe the different branches of engineering and their common foundations.
- name and understand current and future trends in the field of engineering.

Contents

1. History and Evolution of Engineering
   - 1.1 Prehistoric Times and Ancient Era
   - 1.2 Middle Ages
   - 1.3 European Renaissance and Modern Era
   - 1.4 Common Inducements in all Eras
2. Common Foundations of Modern Engineering
   - 2.1 Engineering Basics
   - 2.2 Natural Science and Mathematics
   - 2.3 Methods and Technologies
   - 2.4 Computer Science
3. Main Classical Branches of Engineering

Literature

Compulsory Reading

Further Reading

- Basalla, G. (2010). The Evolution of Technology. Cambridge University Press.
- Blockley, D. (2012). Engineering: A Very Short Introduction. Oxford University Press Inc.
- Brain, M. (2015). The Engineering Book: From the Catapult to the Curiosity Rover, 250 Milestones in the History of Engineering. Sterling Publishing Co., Inc.
- Dorf, R. C. (2005). The Engineering Handbook (2 ed.). CRC Press LLC.
- Gribbin, J. (2003). Science: A History. Penguin Books Ltd.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Exam or Written Assessment: Written Assignment, 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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests ☑ Guideline

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 Basic Workbook (passed / not passed) Study Format: Distance Learning 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 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.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Methods	**Links to other Study Programs of the University** All Bachelor Programs in the Business 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

2.3 Data Protection and Affidavit
2.4 Orthography and Shape
2.5 Identification and Delimitation of Topics
2.6 Research Questions and Structure

3. Research Methods
3.1 Empirical Research
3.2 Literature and Reviews
3.3 Quantitative Data Collection
3.4 Qualitative Data Collection
3.5 Mix of Methods
3.6 Critique of Methods and Self-Reflection

4. Librarianship: Structure, Use, and Literature Management
4.1 Plagiarism Prevention
4.2 Database Search
4.3 Literature Administration
4.4 Citation and Author Guidelines
4.5 Bibliography

5. Scientific Work at the IU – Research Essay

6. Scientific Work at the IU - Project Report

7. Scientific Work at the IU - Case Study

8. Scientific Work at the IU - Bachelor Thesis

9. Scientific Work at the IU – Oral Assignment

10. Scientific Work at the IU – Oral Project Report

11. Scientific Work at the IU - Colloquium

12. Scientific Work at the IU - Portfolio

13. Scientific Work at the IU - Exam

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

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video	☑ Online Tests ☑ Guideline

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video	☑ Online Tests ☑ Guideline

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 Study Format: myStudies Exam, 90 Minutes Study Format: Distance Learning Exam, 90 Minutes	**Split Exam**
Weight of Module see curriculum	

Module Contents

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

Learning Outcomes	
Mathematics: Linear Algebra 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.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Methods	**Links to other Study Programs of the University** 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	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	☑ Online Tests
	☑ Slides	

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Review Book ☑ Online Tests

Fundamentals of Physics

Module Code: DLBWINGP_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. Christian Magnus (Fundamentals of Physics)

Contributing Courses to Module
▪ Fundamentals of Physics (DLBWINGP01_E)

Module Exam Type	
Module Exam Study Format: Distance Learning Exam, 90 Minutes	**Split Exam**
Weight of Module see curriculum	

Module Contents

- Mechanics
- Thermodynamic Basics
- Electricity Theory and Electric Fields
- Vibration Theory
- Optics & Acoustics
- Introduction to Particle Physics

Learning Outcomes	
Fundamentals of Physics On successful completion, students will be able to ▪ explain the basic concepts of mechanics and calculate the quantities of mechanics. ▪ explain the basic concepts of thermodynamics and calculate the quantities of thermodynamics. ▪ apply the physical laws of electricity to electrostatic and magnetic fields. ▪ explain free and forced oscillations and reproduce applications. ▪ explain phenomena of geometrical optics and wave optics. ▪ understand basic concepts of particle physics.	
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 Engineering	All Bachelor Programs in the IT & Technology field

Fundamentals of Physics

Course Code: DLBWINGP01_E

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

Course Description

Basic principles of physics form the foundation of many engineering applications. The basic principles of mechanics, thermodynamics, and electricity, for example, are implemented in almost all technical products and are considered in their design. The course provides a broad overview of the fundamentals of physics starting from the axioms of mechanics, thermodynamic principles, electricity theory, vibration theory, optics and acoustics up to modern aspects of physics in the context of atomic physics and nuclear physics. Thus, the course provides students with an overview of the various subfields of physics and an introduction to scientific problem-solving techniques.

Course Outcomes

On successful completion, students will be able to

- explain the basic concepts of mechanics and calculate the quantities of mechanics.
- explain the basic concepts of thermodynamics and calculate the quantities of thermodynamics.
- apply the physical laws of electricity to electrostatic and magnetic fields.
- explain free and forced oscillations and reproduce applications.
- explain phenomena of geometrical optics and wave optics.
- understand basic concepts of particle physics.

Contents

1. Introduction
   - 1.1 Physics Overview
   - 1.2 Physical Quantities and Units

2. Mechanics
   - 2.1 Forces and Mechanics of Rigid Bodies
   - 2.2 Elastostatics
   - 2.3 The Basic Laws of Classical Mechanics
   - 2.4 Kinematics and Kinetics
   - 2.5 Impulse, Work, and Energy
   - 2.6 Fluid Mechanics

3. Thermodynamics
   - 3.1 Heat and Temperature
   - 3.2 First Law of Thermodynamics and Enthalpy
   - 3.3 Second Law of Thermodynamics and Entropy
   - 3.4 Kinetic Theory of Gases
   - 3.5 Heat: Conduction, Convection, and Radiation

4. Electricity and Magnetism
   - 4.1 Voltage, Current, and Resistance
   - 4.2 Analysis of Direct Current Networks
   - 4.3 Electrostatic Fields
   - 4.4 Magnetic Fields
   - 4.5 Alternating Current Quantities and Circuits

5. Vibration Theory and Waves
   - 5.1 Free Oscillations
   - 5.2 Forced Oscillations
   - 5.3 Waves
   - 5.4 Doppler Effect
   - 5.5 Interference

6. Optics & Acoustics
   - 6.1 Basic Terms
   - 6.2 Reflection and Refraction
   - 6.3 Radiation Optical Images and Aberrations
   - 6.4 Wave Optics - Interference and Polarization
   - 6.5 Sound Waves - Fundamentals of Acoustics

7. Introduction to Particle Physics
   - 7.1 Atomic Models in Historical Overview
   - 7.2 The Periodic Table of Elements
   - 7.3 Quantum Optics
   - 7.4 Nuclear Fission and Fusion
   - 7.5 Radioactive Radiation and X-Rays

Literature
Compulsory Reading
Further Reading ▪ Knight, R. D. (2016). Physics for scientists and engineers : a strategic approach with modern physics. Pearson Education. ▪ Ohanian, H. C., Markert, J. T., & Ohanian, H. C. (2007). Physics for engineers and scientists (3rd ed.). W.W. Norton. ▪ Walker, J., Halliday, D., & Resnick, R. (2020). Halliday & Resnick's Principles of Physics (11th ed.). Wiley.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Review Book ☑ 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 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 Study Format: Distance Learning Exam, 90 Minutes Study Format: myStudies Exam, 90 Minutes	**Split Exam**
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 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.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Computer Science & Software	**Links to other Study Programs of the University** 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

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	Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Course Book ☑ Video ☑ Audio ☑ Slides	**Exam Preparation** ☑ Practice Exam ☑ Online Tests

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

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 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 Exam, 90 Minutes Study Format: Distance Learning 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

<table>
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Learning Outcomes

Introduction to Computer Science

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.

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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 Development.

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Links to other Study Programs of the University

All Bachelor Programs in the IT & Technology field.

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

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

2. Semester

Fundamentals of Chemistry

Module Code: DLBMETGC_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: 1 Semester	WiSe/SoSe	English

Module Coordinator

Tamer Abdalrahman (Fundamentals of Chemistry)

Contributing Courses to Module

- Fundamentals of Chemistry (DLBMETGC01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Atomic Structure
- Periodic Table of Elements
- Chemical Bonds
- Chemical Reactions
- Acid and Bases
- Electrochemistry
- Technical Chemistry

Learning Outcomes	
Fundamentals of Chemistry On successful completion, students will be able to ▪ understand the fundamentals and concepts of chemistry. ▪ answer basic theoretical and practical chemistry questions. ▪ describe the atomic structure. ▪ describe and differentiate chemical bonds. ▪ set up chemical reactions and balance them stoichiometrically. ▪ apply the law of mass action and chemical equilibrium to acids, bases, salts and buffer systems.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Natural Sciences	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology field

Fundamentals of Chemistry

Course Code: DLBMETGC01_E

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

Course Description

The fundamentals of chemistry form the foundation of many engineering applications. To this end, the module provides a broad overview of the fundamentals of chemistry, starting from atomic structure, elementary particles, and the periodic table, to chemical bonds and reactions, as well as acids, bases, and solutions. In addition, an overview of the fundamentals of organic, inorganic, physical and technical chemistry is provided. Thus, the course provides students with an overview of the various branches of chemistry and an introduction to scientific problem-solving techniques.

Course Outcomes

On successful completion, students will be able to

- understand the fundamentals and concepts of chemistry.
- answer basic theoretical and practical chemistry questions.
- describe the atomic structure.
- describe and differentiate chemical bonds.
- set up chemical reactions and balance them stoichiometrically.
- apply the law of mass action and chemical equilibrium to acids, bases, salts and buffer systems.

Contents

1. Atomic Structure and Elementary Particles
   - 1.1 Pure Substances and Mixtures
   - 1.2 Aggregate States
   - 1.3 Structure of Atoms from Elementary Particles
   - 1.4 Bohr's Atomic Model
   - 1.5 Orbital Model

2. Periodic Table of Elements
   - 2.1 Elements of the Periodic Table
   - 2.2 Structure of the Periodic Table
   - 2.3 Electron Configuration
   - 2.4 Isotopes and Nuclides

Literature
Compulsory Reading
Further Reading ▪ Agarwal, S. (2019). Engineering Chemistry Fundamentals and Applications. Journal of Chemical Information and Modeling (2nd ed.). Cambridge University Press. ▪ Daneș, F. E., Daneș, S., Petrescu, V., & Ungureanu, E.-M. (2021). Molecular Physical Chemistry for Engineering Applications. Molecular Physical Chemistry for Engineering Applications. Springer International Publishing. https://doi.org/10.1007/978-3-030-63896-2 ▪ Savitskaya, T., Kimlenka, I., Lu, Y., Hrynshpan, D., Sarkisov, V., Yu, J., ... Wang, L. (2021). Green Chemistry. Singapore: Springer Singapore. https://doi.org/10.1007/978-981-16-3746-9

Study Format Distance Learning

Study Format Distance Learning	**Course Type** Theory Course

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

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

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

Production Engineering Industry 4.0

Module Code: DLBDSEAR1

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. Hans Kerwat (Production Engineering Industry 4.0)

Contributing Courses to Module

- Production Engineering Industry 4.0 (DLBDSEAR01)

Module Exam Type

Module Exam	Split Exam
Study Format: myStudies Exam, 90 Minutes Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Introduction to Manufacturing Technology
- Main Production Groups According to DIN 8580
- Additive Manufacturing Processes
- Rapid Prototyping
- Rapid Tooling
- Direct/Rapid Manufacturing
- Cyber-Physical Production Plants

Learning Outcomes	
Production Engineering Industry 4.0 On successful completion, students will be able to ▪ understand the basic concepts and interrelationships of production engineering. ▪ understand current changes in manufacturing technology due to technologies such as additive manufacturing and megatrends such as cyber physical systems. ▪ assign different manufacturing processes to the main manufacturing groups according to DIN 8580. ▪ understand the basic principle of additive manufacturing processes. ▪ distinguish between different additive manufacturing processes. ▪ understand the terms Rapid Prototyping, Rapid Tooling, and Direct Manufacturing and name individual processes and application examples. ▪ understand the elements and properties of cyber-physical production plants.	
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 fields of Computer Science & Software Development	All Bachelor Programs in the IT & Technology fields

Production Engineering Industry 4.0

Course Code: DLBDSEAR01

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 provide students with an overview of the processes that have influenced and still influence production processes through technological developments under the generic term Industry 4.0, based on traditional, standardized manufacturing techniques. These include, in particular, technological advances in additive manufacturing processes that enable applications such as rapid prototyping, rapid tooling, and direct manufacturing. Finally, the course deals with the consequences of the digitalization and networking of production facilities and their elements in the sense of a cyber-physical system.

Course Outcomes

On successful completion, students will be able to

- understand the basic concepts and interrelationships of production engineering.
- understand current changes in manufacturing technology due to technologies such as additive manufacturing and megatrends such as cyber physical systems.
- assign different manufacturing processes to the main manufacturing groups according to DIN 8580.
- understand the basic principle of additive manufacturing processes.
- distinguish between different additive manufacturing processes.
- understand the terms Rapid Prototyping, Rapid Tooling, and Direct Manufacturing and name individual processes and application examples.
- understand the elements and properties of cyber-physical production plants.

Contents

1. Introduction to Manufacturing Technology
   - 1.1 Basic Terms and Contexts in Manufacturing Theory
   - 1.2 Historical Development of Production
   - 1.3 The Discussion About the Long Tail

2. Classification Of Manufacturing Processes
   - 2.1 Casting and Molding
   - 2.2 Forming
   - 2.3 Machining
   - 2.4 Joining

Literature
Compulsory Reading
Further Reading ▪ Anderson, C. (2012). Makers: The new industrial revolution. Crown Business. ▪ Gebhardt, A., Kessler, J. & Thurn, L. (2019). 3D printing: Understanding additive manufacturing (2nd ed). Hanser. ▪ Groover, M. P. (2012). Fundamentals of modern manufacturing: Materials, processes, and systems (5th ed.). Wiley.

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Mechanics - Statics

Module Code: DLBROMS_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. Moritz Venschott (Mechanics - Statics)

Contributing Courses to Module

- Mechanics - Statics (DLBROMS01_E)

Module Exam Type	
Module Exam Study Format: Distance Learning Exam, 90 Minutes	**Split Exam**
Weight of Module see curriculum	

Module Contents

- Bearing reactions
- Balance conditions
- Determinancy
- Structure
- Mechanics

Learning Outcomes	
Mechanics - Statics On successful completion, students will be able to ▪ calculate bearing reactions. ▪ describe the most important terms of statics and the static determination of systems. ▪ understand the importance of systems of forces on supporting structures. ▪ describe and calculate static processes through balance conditions. ▪ determine balance points.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Engineering	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology fields

Mechanics - Statics

Course Code: DLBROMS01_E

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

Course Description

In this course, participants will get an overview of the importance of systems of forces, frameworks and supporting structures and learn the basics of their calculation and corresponding methods.Students will learn to transform technical systems into suitable mechanical replacement models. Further, using balance conditions, students will be able to specify a complete load state on rigid systems by means of clearance cutting. Students can independently check systems for static determination. They can independently calculate bar forces of planar frameworks following diverse methods. Furthermore, students are able to calculate inner component load of simple mechanical systems by means of internal force variables. They can interpret stress values and independently evaluate the component load. Finally, limitations in rigid body statics are discussed.

Course Outcomes

On successful completion, students will be able to

- calculate bearing reactions.
- describe the most important terms of statics and the static determination of systems.
- understand the importance of systems of forces on supporting structures.
- describe and calculate static processes through balance conditions.
- determine balance points.

Contents

1. Basic Physical Quantities, Vectors
   - 1.1 Physical Quantities, Units
   - 1.2 Newton's Basic Axioms
   - 1.3 Scalars, Position and Force Vectors
   - 1.4 Vector Operations

2. Static Equilibrium
   - 2.1 Equilibrium of Particles
   - 2.2 Moment
   - 2.3 Center of Gravity
   - 2.4 Equilibrium of Rigid Bodies

2.5 Bearing Types, Static Determinacy

3. Planar Trusses
   3.1 Simple Triangular Trusses
   3.2 Analysis Using Methods of Joints
   3.3 Analysis Using Method of Sections
   3.4 The Principle of Virtual Work

4. Internal Forces
   4.1 Center of Areas, Moment of Inertia
   4.2 Beam Internal Loading
   4.3 Beams with Different Support Conditions

5. Solid State Friction
   5.1 Static Friction
   5.2 Sliding Friction
   5.3 Rolling Friction

Literature

Compulsory Reading

Further Reading

- Beer, F., Johnston. E., & Mazurek, D. (2019). Vector mechanics for engineers: Statics (12th ed.).McGraw Hill.
- Gross, D., Hauger, W., Schröder, J., Wall, W.A., & Rajapakse, N. (2013). Engineering mechanics 1,statics (2nd ed.). Springer.
- Hibbeler, R.C. (2016). Engineering mechanics: Statics (14th ed.). Pearson Prentice Hall.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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	

Automation Technology

Module Code: DLBROEIRA2_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. Guido Bayard (Automation Technology)

Contributing Courses to Module
▪ Automation Technology (DLBROEIRA02_E)

Module Exam Type	
Module Exam Study Format: Distance Learning Exam, 90 Minutes Study Format: myStudies Exam, 90 Minutes	**Split Exam**
Weight of Module see curriculum	

Module Contents

- Modern automation systems
- Programmable logic controllers
- Batch automation
- SCADA
- Industrial communications
- Distributed control systems
- Cyber-security

Learning Outcomes	
Automation Technology On successful completion, students will be able to ▪ understand modern automation systems. ▪ identify trends and challenges. ▪ design an industrial automation system for an application. ▪ name relevant cyber-security issues.	
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 Engineering	All Bachelor Programs in the IT & Technology fields

Automation Technology

Course Code: DLBROEIRA02_E

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

Course Description

Automation technology refers to the analysis, design and improvement of existing or new automation systems. Modern automation systems are characterized by the combination of many different devices, such as actuators, sensors, machines, which must be able to perform a coordinate action and to exchange data with each other. This course introduces such modern automation systems by listing their necessary components, presenting current challenges and trends and explaining communication technologies to build effective industrial automation networks. A brief overview on the topic of cyber-security is also given.

Course Outcomes

On successful completion, students will be able to

- understand modern automation systems.
- identify trends and challenges.
- design an industrial automation system for an application.
- name relevant cyber-security issues.

Contents

1. Introduction
   - 1.1 Evolution of Automation
   - 1.2 Industrial Revolutions
   - 1.3 Modern Automation Systems
   - 1.4 Challenges and Trends

2. An Introduction to Programmable Logic Controllers
   - 2.1 Hardware
   - 2.2 Internal Architecture
   - 2.3 I/O
   - 2.4 Ladder and Functional Block Programming
   - 2.5 Programming Methods

3. Batch Automation
   - 3.1 Basics

3.2 Applications

4. SCADA Systems
   4.1 Overview
   4.2 Components
   4.3 Communication Technologies
   4.4 Interfaces

5. Industrial Communication Technologies
   5.1 Industrial Networks
   5.2 HART
   5.3 PROFIBUS
   5.4 Wireless Communication
   5.5 OPC
   5.6 Konnex (EIB/KNX)
   5.7 LonWorks®

6. Distributed Control System
   6.1 Evolution of Control Systems
   6.2 Components of Distributed Control Systems

7. Cyber Security in Industrial Automation
   7.1 Plant Control Network
   7.2 Cyber Attacks
   7.3 Common Industrial Software Weaknesses

Literature

Compulsory Reading

Further Reading

- Dey, C., & Sen, S. (2020). Industrial automation technologies. CRC.
- Gardner, R. F. (2020). Introduction to plant automation and controls. CRC.
- Lehto, M., & Neittaanmäki, P. (2015). Cyber security: Analytics, technology and automation. Springer.
- Mehta, B. R., & Reddy, Y. J. (2014). Industrial process automation systems: Design and implementation. Elsevier.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam

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 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 Exam, 90 Minutes Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

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

Learning Outcomes	
Mathematics: Analysis 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.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Methods	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology field

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	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	☑ Online Tests
	☑ Slides	

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	☑ Online Tests
	☑ Slides	

Signals and Systems

Module Code: DLBROSS_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

Andrej Keksel (Signals and Systems)

Contributing Courses to Module

- Signals and Systems (DLBROSS01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Introduction to systems and signals
- Time-domain analysis of continuous-time systems
- Continuous-time system analysis using the Laplace Transform
- Continuous-time signal analysis: The Fourier Series and the Fourier Transform
- Sampling

Learning Outcomes	
Signals and Systems On successful completion, students will be able to ▪ classify systems and signals. ▪ analyze properties and solve problems involving systems and inputs. ▪ use the Laplace Transform to analyze linear time-invariant systems. ▪ apply the Fourier Series and Fourier Transform to analyze periodic and aperiodic signals. ▪ calculate measures of systems and signals, e.g. signal energy. ▪ understand sampling.	
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 Engineering	All Bachelor Programs in the IT & Technology fields

Signals and Systems

Course Code: DLBROSS01_E

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

Course Description

From a mathematical perspective almost everything can be seen and analyzed as being a system, i.e. a unit that processes signals and information and generates signals and information. This course provides the mathematical basics on signals and systems, with a particular emphasis on continuous time. In the first part, the mathematical preliminaries are given, and a classification of signals and systems is presented. The time-domain analysis is introduced, discussing how systems respond to external inputs and their internal conditions. To analyze systems and signals, however, further tools such as the Laplace Transform and the Fourier Series and Transform are widely implemented, because they give useful insights, especially into frequency behavior. The bridge between continuous-time and discrete time systems and signals, i.e. sampling, is also discussed.

Course Outcomes

On successful completion, students will be able to

- classify systems and signals.
- analyze properties and solve problems involving systems and inputs.
- use the Laplace Transform to analyze linear time-invariant systems.
- apply the Fourier Series and Fourier Transform to analyze periodic and aperiodic signals.
- calculate measures of systems and signals, e.g. signal energy.
- understand sampling.

Contents

1. Introduction to Systems and Signals
   - 1.1 Classification of Signals
   - 1.2 Signal Operations
   - 1.3 Classification of Systems
   - 1.4 System Models

2. Time-Domain Analysis of Continuous-Time Systems
   - 2.1 System Response to Internal Conditions and External Input
   - 2.2 System Stability

3. Continuous-Time System Analysis Using the Laplace Transform
   - 3.1 The Laplace Transform

3.2 The Inverse Laplace Transform
3.3 Solution of Differential Equations
3.4 Block Diagrams
3.5 Applications to Systems

4. Continuous-Time Signal Analysis: The Fourier Series and The Fourier Transform
4.1 The Fourier Series
4.2 The Fourier Transform
4.3 Properties
4.4 Signal Energy
4.5 Applications

5. Sampling
5.1 The Discrete-time Fourier Transform and the Sampling Theorem
5.2 Signal Reconstruction
5.3 Analog to Digital Conversion
5.4 Spectral Sampling
5.5 An Introduction to the Discrete and Fast Fourier Transforms

Literature

Compulsory Reading

Further Reading

- Oppenheim, A., Wilsky, A., & Hamid, S. (2013). Signals and systems: Pearson new internationaledition (2nd ed.). Pearson.
- Sadiku, M. N. O., & Ali, W. H. (2020). Signals and systems: A primer with Matlab. CRC Press.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Review Book ☑ Online Tests

3. Semester

Control Systems Engineering

Module Code: DLBROCSE_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLBROSS01_E	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. Matthias Eifler (Control Systems Engineering)

Contributing Courses to Module
▪ Control Systems Engineering (DLBROCSE01_E)

Module Exam Type	
Module Exam Study Format: Distance Learning Exam, 90 Minutes	**Split Exam**
Weight of Module see curriculum	

Module Contents

- Introduction to control systems
- Modeling in the frequency domain
- Time response
- Stability
- Steady-state errors
- The root locus
- The frequency response
- Design via frequency response

Learning Outcomes	
Control Systems Engineering On successful completion, students will be able to ▪ understand the components of a control system. ▪ analyze properties of systems in time and frequency domains. ▪ define dynamic and static requirements in time and frequency domains. ▪ analyze the stability of dynamic systems. ▪ understand and calculate the frequency-response of systems. ▪ design standard feedback controllers to achieve target performance.	
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 Engineering	All Bachelor Programs in the IT & Technology fields

Control Systems Engineering

Course Code: DLBROCSE01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBROSS01_E

Course Description

Control systems are an integral part of modern society. They are omnipresent in mechatronics, robotics, production engineering, manufacturing processes, and medical technology. A control system is made of subsystems and processes assembled for the purpose of obtaining a desired output with desired performance, given a specified input. Control systems engineering is the discipline which analyzes systems, intended to enable the design of controllers which ensure the desired performance. This course introduces the concept of control systems and provides further understanding of systems in terms of their dynamical properties. In particular, the frequency-domain description of systems, given by the application of the Laplace Transform, is used to gain qualitative and quantitative insights into the behavior of linear time-invariant systems. The concept of frequency response is introduced in detail and is used to allow for the design of linear time-invariant feedback controllers to reach the desired performance.

Course Outcomes

On successful completion, students will be able to

- understand the components of a control system.
- analyze properties of systems in time and frequency domains.
- define dynamic and static requirements in time and frequency domains.
- analyze the stability of dynamic systems.
- understand and calculate the frequency-response of systems.
- design standard feedback controllers to achieve target performance.

Contents

1. Introduction to Control Systems
   - 1.1 Introduction and History
   - 1.2 Open-loop and Closed-loop Systems
   - 1.3 Design Objectives
   - 1.4 The Design Process
   - 1.5 Trends in Control Systems

2. Modeling in the Frequency Domain
   - 2.1 Laplace and Inverse Laplace Transform
   - 2.2 The Transfer Function

2.3 Nonlinearities and Linearization
2.4 Algebra of Block Diagrams
2.5 Examples

3. Time Response
   3.1 Poles and Zeros
   3.2 First-order Systems
   3.3 Second-order Systems
   3.4 Higher-order Systems
   3.5 Effects of Nonlinearities

4. Stability
   4.1 Introduction to Stability
   4.2 Stability Criteria

5. Steady-state Errors
   5.1 Unity Feedback Systems
   5.2 Static Error Constants
   5.3 Steady-state Error Specifications
   5.4 Disturbances
   5.5 Non-unity Feedback Systems
   5.6 Sensitivity

6. The Root Locus
   6.1 Definition and Properties
   6.2 Sketching the Root Locus
   6.3 Design via Root Locus

7. The Frequency Response
   7.1 Introduction
   7.2 The Bode Plot
   7.3 The Nyquist Diagram
   7.4 Stability, Gain and Phase Margins

8. Design via Frequency Response
   8.1 Transient Response via Gain Adjustment
   8.2 PI Compensation
   8.3 Lag Compensation
   8.4 PD Compensation

8.5	Lead Compensation
8.6	Lead-Lag Compensation and PID compensation
8.7	Design Limitations
8.8	Time-Delay

Literature

Compulsory Reading

Further Reading

- Doyle, J. C., Francis, B. A., & Tannenbaum, A. R. (2009). Feedback control theory. Dover Publications.
- Nise, N. (2015). Control systems engineering (7th ed.). Wiley.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Review Book ☑ Online Tests

Materials Science for Engineers

Module Code: DLBMETGWK_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. (Materials Science for Engineers)

Contributing Courses to Module

- Materials Science for Engineers (DLBMETGWK01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Introduction to Materials Science
- Structure of Materials
- Properties of Materials
- Material Classes: Metals, Ceramics, Polymers and Composites
- Application of Engineering Materials

Learning Outcomes	
Materials Science for Engineers On successful completion, students will be able to ▪ understand basic relationships between microscopic and macroscopic processes and properties. ▪ understand the main differences and properties of the four classes of materials: metals, ceramics, polymers, and composites. ▪ use the properties of the material classes in material selection and application. ▪ consider common mechanisms that lead to the failure of materials.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Natural Sciences	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology field

Materials Science for Engineers

Course Code: DLBMETGWK01_E

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

Course Description

The course Material Science for Engineers gives an overview of the four material classes: metals, ceramics, polymers, and composites. Beginning with the microscopic structure of materials, the resulting mechanical, non-mechanical physical and chemical properties are considered. This knowledge gives the foundation for engineering use, enabling students to understand and actively design the lifecycle of materials from acquisition of raw materials through selection and use to end-of-life management. As a conclusion, examples and additional information are given from the fields of medical technology, mechanical engineering, electrical engineering, mechatronics, and robotics.

Course Outcomes

On successful completion, students will be able to

- understand basic relationships between microscopic and macroscopic processes and properties.
- understand the main differences and properties of the four classes of materials: metals, ceramics, polymers, and composites.
- use the properties of the material classes in material selection and application.
- consider common mechanisms that lead to the failure of materials.

Contents

1. Introduction to Materials Science and Engineering
   - 1.1 Subject and Meaning
   - 1.2 Basic Consideration of Material Properties
   - 1.3 Requirements for Materials

2. Structure and Classes of Materials
   - 2.1 Atomic Structure and Chemical Bonding
   - 2.2 Metals
   - 2.3 Ceramics
   - 2.4 Polymers
   - 2.5 Composites
   - 2.6 Basics of Heat Treatment

Literature
Compulsory Reading
Further Reading ▪ Brostow, W./Hagg Lobland, H. E. (2016): Materials: Introduction and Applications. Wiley. ▪ Callister, W. D./Rethwisch, D. G. (2018): Fundamentals of Materials Science and Engineering: An Integrated Approach. 5th Edition, Wiley. ▪ Wright, W./Askeland, D. (2021): The Science and Engineering of Materials, Enhanced Edition. 7th Edition, CL Engineering.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Review Book ☑ Online Tests

Sensor Technology

Module Code: DLBROST_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. Matthias Eifler (Sensor Technology)

Contributing Courses to Module
▪ Sensor Technology (DLBROST01_E)

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

Module Contents
▪ Sensors and transducers ▪ Resistive, capacitive, inductive, optical and acoustic sensor effects ▪ Transduction platforms and sensor systems ▪ Applications ▪ Advanced sensors

Learning Outcomes	
Sensor Technology On successful completion, students will be able to ▪ understand the main sensor characteristics. ▪ read and understand a typical sensor data sheet. ▪ understand sensor effects. ▪ understand and characterize sensor platforms. ▪ select the appropriate sensor technology for a given application.	
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 Engineering	All Bachelor Programmes in the IT & Technology fields

Sensor Technology

Course Code: DLBROST01_E

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

Course Description

Sensors are at the base of any modern engineering system, for example, control systems in robotics. This course provides the basic knowledge to understand sensors and their characteristics. A specific sensor is chosen for an application mainly based on its characteristics and on its physical effect. After an introduction on sensors and types of sensors, this course introduces the main characteristics such as accuracy, precision, resolution, sensitivity, linearity, static and dynamic properties. The second part of the course details the main sensor effects and shows how sensor systems can be built based on such effects and used in engineering applications. The last part of the course shows current trends and advanced applications of sensor technology.

Course Outcomes

On successful completion, students will be able to

- understand the main sensor characteristics.
- read and understand a typical sensor data sheet.
- understand sensor effects.
- understand and characterize sensor platforms.
- select the appropriate sensor technology for a given application.

Contents

1. Introduction to Measurement Uncertainty
   - 1.1 Measurement Uncertainty
   - 1.2 Confidence Intervals
   - 1.3 Expression of Uncertainty

2. Sensors
   - 2.1 Sensors and Transducers
   - 2.2 Selection of Sensors
   - 2.3 Sensor Characteristics
   - 2.4 Measurement Systems and Components

3. Resistive Sensors
   - 3.1 Resistivity and Resistance

Literature
Compulsory Reading
Further Reading ▪ Dertien, E., & Regtien, P. (2018). Sensors for mechatronics (2nd ed.). Elsevier. ▪ Lin, Y. L., Kyung, C. M., Yasuura, H., & Liu, Y. (Eds.) (2015). Smart sensors and systems. Springer International.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Electrical Engineering

Module Code: DLBINGET-01_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
Dr. Maedeh Ranjbar-Zefreh (Electrical Engineering)

Contributing Courses to Module
▪ Electrical Engineering (DLBINGET01-01_E)

Module Exam Type	
Module Exam	**Split Exam**
Study Format: myStudies Exam, 90 Minutes Study Format: Distance Learning Exam, 90 Minutes	
Weight of Module see curriculum	

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

Basic Terms
Introduction to Direct Current Technology
Calculation of Direct Current Networks
Electric Fields
Introduction to Alternating Current Technology
Calculation of Alternating Current Networks
Locus Curves
Transformers
Multiphase Systems
Transient Response
</td></tr>
<tr><td colspan="2">Learning Outcomes
Electrical Engineering
On successful completion, students will be able to

know the basic terms of electrical engineering.
calculate DC (direct current) circuits and networks.
know the different types of electrical fields.
calculate AC (alternating current) circuits and networks.
know methods for the construction of root locus curves.
know the basic structure of different types of transformers.
calculate equivalent circuit diagrams with transformers.
know multiphase systems and can distinguish them from single-phase systems.
measure performance in a three-phase system.
calculate the transient response with the Laplace transformation.
</td></tr>
<tr><td>Links to other Modules within the Study Program
This module is similar to other modules in the field of Engineering</td>
<td>Links to other Study Programs of the University
All Bachelor Programmes in the IT & Technology fields</td></tr>
</table>

Electrical Engineering

Course Code: DLBINGET01-01_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 offer students a broad insight into the basics of electrical engineering. First of all, the basic terms of electrical engineering and the relevant physical quantities are introduced. This is followed by two comprehensive sectionson direct current and alternating current technology. They are first briefly introduced using their essential elements and properties and then supplemented by methods for calculating the respective circuits and networks. Based on this, multi-phase systems and their application in public power supply are presented. The course concludes with a consideration of the transient response and its calculation using the Laplace transformation.

Course Outcomes

On successful completion, students will be able to

- know the basic terms of electrical engineering.
- calculate DC (direct current) circuits and networks.
- know the different types of electrical fields.
- calculate AC (alternating current) circuits and networks.
- know methods for the construction of root locus curves.
- know the basic structure of different types of transformers.
- calculate equivalent circuit diagrams with transformers.
- know multiphase systems and can distinguish them from single-phase systems.
- measure performance in a three-phase system.
- calculate the transient response with the Laplace transformation.

Contents

1. Basic Terms
   - 1.1 Charge, Electric Fields and Voltage
   - 1.2 Current and Resistance
   - 1.3 Electrical Energy and Power
2. Introduction to Direct Current Technology
   - 2.1 Kirchhoff's Laws
   - 2.2 Calculation of Series and Parallel Connections
   - 2.3 Voltage and Current Divider Rule

Literature
Compulsory Reading
Further Reading

- Dossis, N. (2013). Basic electronics for tomorrow’s inventors. McGraw-Hill.
- Herrick, C. N. (1997). Basic electronics math. Newnes.
- Nilsson, J. W. & Riedel, S. (2019). Electric circuits (11th ed.). Pearson.
- Narayana Rao, B. Y., & Anand, K. (2010). Electronics. Himalaya Publishing House.
- Tayal, D. C. (2010). Basic electronics. Himalaya Publishing House.

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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
	☑ Video	☑ Review Book
	☑ Audio	☑ Online Tests
	☑ Slides	

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Review Book ☑ Online Tests

Mechanics - Kinematics and Dynamics

Module Code: DLBROMKD_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLBBIGTM01-01 or DLBROMS01_E	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. (Mechanics - Kinematics and Dynamics)

Contributing Courses to Module

- Mechanics - Kinematics and Dynamics (DLBROMKD01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Kinematics
- Differential kinematics
- Trajectory planning
- Dynamics

Learning Outcomes	
Mechanics - Kinematics and Dynamics On successful completion, students will be able to ▪ describe the kinematics of a mass point, rigid body and multibody systems. ▪ describe the kinetics of a mass point and rigid body. ▪ differentiate and describe collision processes. ▪ model the dynamics of multibody systems.	
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 Engineering	All Bachelor Programs in the IT & Technology fields

Mechanics - Kinematics and Dynamics

Course Code: DLBROMKD01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBBIGTM01-01 or DLBROMS01_E

Course Description

Mechanical Engineering applies physical principles to technical systems and represents a fundamental discipline in engineering sciences. In addition to Statics and Elastostatics modules, the modules Kinematics and Dynamics enrich the engineering mechanics lecture series. Using kinematics, which deals with the motion of mass points and rigid bodies without addressing the cause of the motion, the foundation of kinetics is taught. Kinetics in turn describes the change of motion quantities under the influence of forces. Based on that, collision processes and associated specific momentum changes are described. Furthermore, the concept of mechanical oscillation is introduced. In this course, both the kinematic aspect (change of motion quantities) and the kinetic aspect (forces and moments) are treated.

Course Outcomes

On successful completion, students will be able to

- describe the kinematics of a mass point, rigid body and multibody systems.
- describe the kinetics of a mass point and rigid body.
- differentiate and describe collision processes.
- model the dynamics of multibody systems.

Contents

1. Kinematics
   - 1.1 Motion of a Point Mass
   - 1.2 Motion of Rigid Bodies
   - 1.3 Motion of Multibody Systems
   - 1.4 Kinematics of Relative Motion

2. Kinetics
   - 2.1 Dynamics of a Point Mass
   - 2.2 Dynamics of Systems of Point Masses
   - 2.3 Dynamics of Rigid Bodies

3. Collisions
   - 3.1 Impact Phases

3.2 Direct Impact
3.3 Oblique Impact
3.4 Central Impact
3.5 Eccentric Impact

4. Multibody System Dynamics
   4.1 Lagrangian
   4.2 Lagrange Equations
   4.3 D'Alembert's Principle
   4.4 Newton-Euler Equations

5. Oscillations
   5.1 Basic Concepts
   5.2 Free Vibrations
   5.3 Nonlinear Free Vibrations
   5.4 Forced Vibrations

Literature

Compulsory Reading

Further Reading

- Ben-Ari, M./Mondada, F. (2017): Elements of Robotics. Springer International Publishing, Cham.
- Corke, P. (2017): Robotics, Vision and Control: Fundamental Algorithms In MATLAB. 2nd ed., Springer International Publishing, Cham.
- Mihelj, M., et al (2018): Robotics. 2nd ed., Springer International Publishing, Cham.
- Siciliano, B./Khatib, O. (Eds.) (2016): Springer Handbook of Robotics. Springer International Publishing, Cham.
- Siciliano, B., Sciavicco, L., Villani, L. Oriolo, G. (2009): Robotics Modeling Planning and Control. Springer-Verlag London

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Technical Mechanics: Elastostatics

Module Code: DLBBIWTM_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. (Technical Mechanics: Elastostatics)

Contributing Courses to Module

- Technical Mechanics: Elastostatics (DLBBIWTM01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Stress and Strain on a Single Truss
- Introduction to Elasticity Theory
- Stress States and Law of Elasticity
- Bernoulli Beam Theory
- Stability and Equilibrium States
- Shear and Torsion
- Euler Buckling

Learning Outcomes	
Technical Mechanics: Elastostatics On successful completion, students will be able to ▪ determine stresses and deformations on the elastic truss. ▪ apply the energy principles to determine reaction and internal forces (stress resultants). ▪ describe stress- and strain conditions. ▪ discuss the stability of an equilibrium state. ▪ determine cross-section properties of any cross-section. ▪ determine beam deflections with and without the influence of normal force and temperature. ▪ calculate stresses and deformations in shear and torsion. ▪ investigate buckling in Euler bar-cases.	
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 Design, Architecture & Construction	All Bachelor Programs in the field of Civil Engineering

Technical Mechanics: Elastostatics

Course Code: DLBBIWTM01_E

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

Course Description

Solid mechanics applies physical principles to engineering systems and is a fundamental discipline in engineering. This course focuses on theory of elasticity. In contrast to statics, which assumes rigid bodies, theory of elasticity deals in principle with deformable bodies. Knowledge of elasticity theory is the basis for design and deformation calculations in reinforced and prestressed concrete structures, steel structures and timber structures. After successfully completing the module, students should understand the idealizations and model concepts used in theory of elasticity and carry out their own initial calculations of stresses and deformations on beam-shaped components. Solid mechanics is an important basic subject in civil engineering. Knowledge of Solid mechanics is a prerequisite for other modules in structural engineering.

Course Outcomes

On successful completion, students will be able to

- determine stresses and deformations on the elastic truss.
- apply the energy principles to determine reaction and internal forces (stress resultants).
- describe stress- and strain conditions.
- discuss the stability of an equilibrium state.
- determine cross-section properties of any cross-section.
- determine beam deflections with and without the influence of normal force and temperature.
- calculate stresses and deformations in shear and torsion.
- investigate buckling in Euler bar-cases.

Contents

1. Cross-Section Values
   - 1.1 Basic Terms
   - 1.2 Moments of Area
   - 1.3 Section Modulus
   - 1.4 Principal Axes and Principal Moments of Inertia

2. Normal Stress and Strain
   - 2.1 Basic Load Types
   - 2.2 Basic Concepts of Stress and Deformation

2.3 Strain Due to Forces and Temperature
2.4 Stress Concentration Effects

3. Stress State and Law of Elasticity
   3.1 Plane Stress State
   3.2 Mohr’s Stress Circle
   3.3 Hoop Stress Formula
   3.4 Strain States
   3.5 Hooke’s Law

4. Bending of Beams
   4.1 Bernoulli Beam Theory
   4.2 Uniaxial and Biaxial (Inclined) Beam Bending
   4.3 Bending with Axial Force
   4.4 Thermal Bending

5. Shear Force and Torsion for Simple Cross Sections
   5.1 Introduction to the Subject of Shear Stress
   5.2 Shear Stress Due to Shear Force
   5.3 Torsion in Circular and Annular Cross Sections
   5.4 Combined Loading from Shear Force and Torsion

6. Stability
   6.1 Basics
   6.2 Stability Problems
   6.3 Euler Buckling Cases

Literature

Compulsory Reading

Further Reading

- Engineering Mechanics 2 : Mechanics of Materials, Dietmar Gross, Werner Hauger, Jörg Schröder, Wolfgang A. Wall, Javier Bonet, 2nd edition. Berlin : Springer. 2018
- Engineering Mechanics : Volume 2: Stresses, Strains, Displacements, C. Hartsuijker, J.W. Welleman, Dordrecht : Springer. 2007
- Solid Mechanics, Hosford, William F., New York : Cambridge University Press. 2010

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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
	☑ Video	☑ Review Book
	☑ Audio	☑ Online Tests

4. Semester

Introduction to Electromagnetics

Module Code: DLBENGEEE1

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLBINGET01-01_E	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 Electromagnetics)

Contributing Courses to Module

- Introduction to Electromagnetics (DLBENGEEE01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Static Electric and Magnetic Fields
- Maxwell’s Equations and Electromagnetic Waves
- Transmission Lines and Antennas

Learning Outcomes	
Introduction to Electromagnetics On successful completion, students will be able to ▪ understand and apply mathematical principles of vector algebra and calculus. ▪ reiterate and understand basic concepts of electromagnetic field theory. ▪ understand and analyze electric and magnetic fields. ▪ reproduce and understand the fundamentals of electrodynamics, in particular Maxwell's equations. ▪ understand and analyze the fundamentals of wave propagation. ▪ understand and use transmission line theory. ▪ understand and analyze the operation of waveguides. ▪ reproduce and understand the fundamentals of radiation fields and antennas .	
Links to other Modules within the Study Program This module is similar to other modules in the field of Engineering	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology field

Introduction to Electromagnetics

Course Code: DLBENGEEE01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBINGET01-01_E

Course Description

Electromagnetic fields and waves are fundamental topics in engineering. In addition to providing a deeper understanding of the concepts of electrical circuits and networks, they introduce into the basis for the analysis of important phenomena in microelectronics, electrical power, and other fields. Most importantly, they provide the foundation for the study of advanced topics such as wireless networks and communication systems. For these reasons, the course begins by introducing the mathematical concepts necessary for the treatment of electromagnetic principles. The fundamentals of electric and magnetic fields are presented. A detailed explanation of Maxwell's equations provides the most important fundamentals of electrodynamics, followed by an explanation of wave propagation in different materials. To further present the applied side of electromagnetics, an overview of practical systems such as transmission lines and antennas is presented.

Course Outcomes

On successful completion, students will be able to

- understand and apply mathematical principles of vector algebra and calculus.
- reiterate and understand basic concepts of electromagnetic field theory.
- understand and analyze electric and magnetic fields.
- reproduce and understand the fundamentals of electrodynamics, in particular Maxwell's equations.
- understand and analyze the fundamentals of wave propagation.
- understand and use transmission line theory.
- understand and analyze the operation of waveguides.
- reproduce and understand the fundamentals of radiation fields and antennas .

Contents

1. Fundamental Concepts
   - 1.1 The Electromagnetic Model
   - 1.2 Units and Constants
   - 1.3 Scalars and Vectors
   - 1.4 Vector Algebra
   - 1.5 Vector Analysis

2. Static Electric Fields
   - 2.1 Coulomb's Law
   - 2.2 Gauss's Law and Electric Potential
   - 2.3 Materials in Static Electric Field
   - 2.4 Capacitance
   - 2.5 Energy and Forces

3. Static Magnetic Fields
   - 3.1 Biot-Savart Law
   - 3.2 Ampere's Law
   - 3.3 Magnetic Flux and Magnetic Flux Density
   - 3.4 Magnetic Materials & Permeability
   - 3.5 Inductance

4. Maxwell's Equations
   - 4.1 Time Varying Fields
   - 4.2 Maxwell's Equations
   - 4.3 Potential Functions
   - 4.4 Boundry Conditions
   - 4.5 Special Forms of Maxwell's Equations

5. Electromagnetic Waves
   - 5.1 The Wave Equation and its Solution
   - 5.2 The Electromagnetic Spectrum
   - 5.3 The Poynting Theorem and Poynting Vector
   - 5.4 Plane Waves in Materials
   - 5.5 Reflection and Refraction of Plane Waves

6. Transmission Lines and Waveguides
   - 6.1 Structure and Definitions
   - 6.2 Transverse Electromagnetic Wave in Transmission Line
   - 6.3 The Smith Chart
   - 6.4 Types of Waveguides
   - 6.5 Cavity Resonators

7. Antennas
   - 7.1 Electromagnetic Radiation
   - 7.2 Electric and Magnetic Dipoles

Literature

Compulsory Reading

Further Reading

- Balanis, C. (2015): Antenna Theory: Analysis and Design. 4. Auflage, John Wiley & Sons, New Jersey
- Cheng, D. (2014): Field and Wave Electromagnetics. 2.Auflage, Pearson, New York.
- Ida, N. (2015): Engineering Electromagnetics. 3.Auflage, Springer, Berlin.

Study Format Distance Learning

Study Format Distance Learning	**Course Type** Theory Course

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

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

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

Fundamentals of Systems Simulation

Module Code: DLBENGFSS

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. (Fundamentals of Systems Simulation)

Contributing Courses to Module
▪ Fundamentals of Systems Simulation (DLBENGFSS01)

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

Module Contents

- Computer Simulation
- Continuous-Time Systems
- Elementary Numerical Integration
- Intermediate Numerical Integration
- Discrete-Event Systems

<table>
<tr><td colspan="2">Learning Outcomes
Fundamentals of Systems Simulation
On successful completion, students will be able to
▪ run computer simulations of continuous-time systems.
▪ understand the main issues related to computer simulation.
▪ evaluate simulation results.
▪ use simulations for design of engineering systems.
▪ understand the main ideas behind discrete-event systems.</td></tr>
<tr><td>Links to other Modules within the Study Program
This module is similar to other modules in the field of Engineering</td><td>Links to other Study Programs of the University
All Bachelor Programs in the IT & Technology field</td></tr>
</table>

Fundamentals of Systems Simulation

Course Code: DLBENGFSS01

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

Course Description

Computer Simulation is a very powerful tools which allows for designing, exploring, understanding, testing as well as prototyping of ideas or solutions. Being able to set-up a good simulation should belong to the competence bag of any engineer. This course provides the basics to understand how simulation works and can be used. The first part focuses on continuous-time simulation, while the last part addresses the very basics of event-driven systems, which are ubiquitous in industry and applications.

Course Outcomes

On successful completion, students will be able to

- run computer simulations of continuous-time systems.
- understand the main issues related to computer simulation.
- evaluate simulation results.
- use simulations for design of engineering systems.
- understand the main ideas behind discrete-event systems.

Contents

1. Computer Simulation
   - 1.1 Introduction
   - 1.2 Continuous-Time Simulation
   - 1.3 Discrete-Event Simulation
   - 1.4 Monte-Carlo Simulation

2. Continuous-Time Systems
   - 2.1 First-Order Systems
   - 2.2 Second-Order Systems
   - 2.3 State Variables
   - 2.4 Nonlinear Systems

3. Elementary Numerical Integration
   - 3.1 Euler Integration
   - 3.2 Trapezoidal Integration

3.3 Discrete-State Equations
3.4 Improved and Modified Euler Integration

4. Intermediate Numerical Integration
   4.1 Runge-Kutta
   4.2 Adaptive Systems
   4.3 Multistep Methods
   4.4 Stiff Systems
   4.5 Discontinuities

5. Discrete-Event Systems
   5.1 Basics
   5.2 Modeling Framework
   5.3 Examples
   5.4 Application Frameworks

Literature

Compulsory Reading

Further Reading

- Banks, J., Carson, J. S. I., Nelson, B. L., & Nicol, D. M. (2009). Discrete-Event System Simulation (5th ed.). Pearson College.
- Choi, B. K., & Kang, D. (2013). Modeling and simulation of discrete-event systems. John Wiley & Sons Inc.
- Cassandras, C. G., & Lafortune, S. (2008). Introduction to discrete event systems. Springer US.
- Klee, H., & Allen, R. (2017). Simulation of dynamic systems with MATLAB and Simulink (3rd ed.). CRC Press.
- Loper, M. L. (Ed.). (2015). Modeling and Simulation in the Systems Engineering Life Cycle. London: Springer London.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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	

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 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 Exam, 90 Minutes Study Format: myStudies Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

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

Learning Outcomes	
Introduction to Data Protection and Cyber Security 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.	
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 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

3.3 Rights Check
3.4 Preservation of Evidence

4. Cyber Security Management
    4.1 Basic Concepts and Standards in Cyber Security Management
    4.2 Series of Standards ISO 2700x

5. Cyber Security Management in Everyday Life
    5.1 Password Management
    5.2 Data Backup
    5.3 Email Security
    5.4 Protection Against Viruses and Other Malware
    5.5 Protection Against Social Engineering Attacks

6. Network and Communication Security
    6.1 Firewall Technology
    6.2 Network Separation
    6.3 Security in WLAN, Mobile Networks, Bluetooth, and NFC

7. Cyber Security in the Development of Software and Systems
    7.1 Protection of the Development Environment
    7.2 Secure Development
    7.3 Common Criteria

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	Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Course Book ☑ Video ☑ Audio ☑ Slides	**Exam Preparation** ☑ Practice Exam ☑ Online Tests

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

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 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 Exam, 90 Minutes Study Format: Distance Learning 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 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.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Methods	**Links to other Study Programs of the University** 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	**Course Type**
myStudies	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	☑ Online Tests
	☑ Slides	

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Course Book ☑ Video ☑ Audio ☑ Slides	**Exam Preparation** ☑ Practice Exam ☑ Review Book ☑ 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	Split Exam
Study Format: myStudies Exam, 90 Minutes Study Format: Distance Learning Exam, 90 Minutes Study Format: On Campus Exam, 90 Minutes	

Weight of Module

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 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.	
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

3.2 Conditional statements
3.3 Loops
3.4 Iterators and comprehensions

4. Functions
   4.1 Function declaration
   4.2 Scope
   4.3 Arguments

5. Errors and Exceptions
   5.1 Errors
   5.2 Exception handling
   5.3 Logs

6. Modules and Packages
   6.1 Usage
   6.2 Namespaces
   6.3 Documentation
   6.4 Popular data science packages

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	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Study Format On Campus

Study Format	Course Type
On Campus	Theory Course

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
Tutorial Support ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions

Project: Simulation of Systems

Module Code: DLBENGPSS

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLBENGFSS01	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. (Project: Simulation of Systems)

Contributing Courses to Module
▪ Project: Simulation of Systems (DLBENGPSS01)

Module Exam Type	
Module Exam Study Format: Distance Learning Written Assessment: Project Report	**Split Exam**
Weight of Module see curriculum	

Module Contents
The course provides the main practical competences to set-up, run and evaluate simulations of systems.

Learning Outcomes	
Project: Simulation of Systems On successful completion, students will be able to ▪ set-up a simulation of a system (of systems). ▪ run a simulation and adjust simulation parameters to achieve better results. ▪ evaluate the output of the simulation.	
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 Engineering	All Bachelor Programs in the IT & Technology field

Project: Simulation of Systems

Course Code: DLBENGPSS01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBENGFSS01

Course Description

Simulation is a powerful tool for design, evaluating, exploring, prototyping and testing ideas and solutions. This course provides the main competences about systems simulation.

Course Outcomes

On successful completion, students will be able to

- set-up a simulation of a system (of systems).
- run a simulation and adjust simulation parameters to achieve better results.
- evaluate the output of the simulation.

Contents

- The course gathers the practical know-how about simulation of systems, with a particular emphasis on continuous-time simulation. The students will be able to set-up a simulation, initialize it, and evaluate/discuss its results.

Literature

Compulsory Reading

Further Reading

- Banks, J., Carson, J. S. I., Nelson, B. L., & Nicol, D. M. (2009). Discrete-Event System Simulation (5th ed.). Pearson College.
- Choi, B. K., & Kang, D. (2013). Modeling and simulation of discrete-event systems. John Wiley & Sons Inc.
- Cassandras, C. G., & Lafortune, S. (2008). Introduction to discrete event systems. Springer US.
- Klee, H., & Allen, R. (2017). Simulation of dynamic systems with MATLAB and Simulink (3rd ed.). CRC Press.
- Loper, M. L. (Ed.). (2015). Modeling and Simulation in the Systems Engineering Life Cycle. London: Springer London.

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	
Learning Material ☑ Slides	**Exam Preparation** ☑ Guideline

5. Semester

Fundamentals of Data-Driven Engineering

Module Code: DLBENGFDDE

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. (Fundamentals of Data-Driven Engineering)

Contributing Courses to Module

- Fundamentals of Data-Driven Engineering (DLBENGFDDE01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Written Assessment: Case Study	

Weight of Module

see curriculum

Module Contents

- Basic Optimization
- Static Models
- Linear System Identification
- Time-Frequency Analysis
- Singular Value Decomposition
- Compressed Sensing

Learning Outcomes	
Fundamentals of Data-Driven Engineering On successful completion, students will be able to ▪ set-up an optimization problem and solve it with the aid of software tools. ▪ apply models and fit them to data. ▪ identify linear models based on data and use them for prediction. ▪ understand the emerging field of compressed sensing and apply it to practical scenarios. ▪ use Singular Value Decomposition to identify the principal components in a data-driven system.	
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

Fundamentals of Data-Driven Engineering

Course Code: DLBENGFDDE01

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

Course Description

Data are driving the way in which we nowadays perform several activities. Data enable understanding phenomena which would be otherwise very complex. To this aim, practitioners and engineers need to develop appropriate competences and know-how about analyzing data for specific applications. This course offers an overview and provides the fundamental knowledge about how to get the most out of data for engineering applications.

Course Outcomes

On successful completion, students will be able to

- set-up an optimization problem and solve it with the aid of software tools.
- apply models and fit them to data.
- identify linear models based on data and use them for prediction.
- understand the emerging field of compressed sensing and apply it to practical scenarios.
- use Singular Value Decomposition to identify the principal components in a data-driven system.

Contents

1. Basic Optimization
   - 1.1 Derivative-Free Unconstrained Optimization
   - 1.2 Unconstrained Optimization with Derivative Methods
   - 1.3 Linear Programming
   - 1.4 Simplex Method
   - 1.5 Genetic Algorithms

2. Static Models
   - 2.1 Least Squares
   - 2.2 Polynomials
   - 2.3 Splines
   - 2.4 Neural Networks

3. Linear System Identification
   - 3.1 Model Structure

3.2 Time-Series Models
3.3 Models with Output Feedback
3.4 Models without Output Feedback
3.5 Excitation Signals

4. Time-Frequency Analysis
4.1 The Fourier Series and Fourier Transform
4.2 Windowed Fourier Transforms
4.3 Wavelets

5. Singular Value Decomposition
5.1 Basics
5.2 Principal Component Analysis (PCA)
5.3 Proper Orthogonal Modes
5.4 Robust PCS

6. Compressed Sensing
6.1 The L1 Norm
6.2 Sparsity and Compression
6.3 Signal Reconstruction
6.4 Data Reconstruction

Literature

Compulsory Reading

Further Reading

- Bittanti, S. (2019). Model Identification and Data Analysis. Wiley.
- Kutz, J. N. (2013). Data-Driven Modeling & Scientific Computation. Oxford University Press.
- Nelles, O. (2020). Nonlinear System Identification. Nonlinear System Identification (2nd ed.). Springer International Publishing. https://doi.org/10.1007/978-3-030-47439-3

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Online Tests ☑ Guideline

Seminar: The Big Data Society

Module Code: DLBENGSTBDS

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. (Seminar: The Big Data Society)

Contributing Courses to Module
▪ Seminar: The Big Data Society (DLBENGSTBDS01)

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

Module Contents
The course provides an overview on how Big Data technologies and practices are changing our society and societies.

Learning Outcomes	
Seminar: The Big Data Society On successful completion, students will be able to ▪ understand the impact of Big Data on our societal systems. ▪ understand how Big Data can be used to improve society. ▪ understand the main issues and risks connected to the use (and misuse) of Big Data.	
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

Seminar: The Big Data Society

Course Code: DLBENGSTBDS01

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

Course Description

Big Data are reconfiguring the way in which our society works, for instance in the fields of business, government relations, methods, academic, social, industry. Understanding and describing the huge impact of such a collection of novel technologies and practices is an important aspect to be considered. This course gives an overview on how big data is changing our society.

Course Outcomes

On successful completion, students will be able to

- understand the impact of Big Data on our societal systems.
- understand how Big Data can be used to improve society.
- understand the main issues and risks connected to the use (and misuse) of Big Data.

Contents

- The course provides an overview on how Big Data technologies and practices are changing our society and societies.

Literature

Compulsory Reading

Further Reading

- Meier, P. (2015). Digital humanitarians : how big data is changing the face of humanitarian response. Routledge.
- Japkowicz, N., & Stefanowski, J. (Eds.). (2016). Big Data Analysis: New Algorithms for a New Society. Springer International. https://doi.org/10.1007/978-3-319-26989-4
- O'Neil, C. (2017). Weapons of math destruction : how big data increases inequality and threatens democracy. Penguin.
- Lushetisch, N. (2020). Big Data - A New Medium? Routledge.

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	
Learning Material	**Exam Preparation**
☑ Slides	☑ Guideline

Electrical Machines and Energy Technology

Module Code: DLBAETEME_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E	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. (Electrical Machines and Energy Technology)

Contributing Courses to Module

- Electrical Machines and Energy Technology (DLBAETEME01_E)

Module Exam Type	
Module Exam Study Format: Distance Learning Exam, 90 Minutes	**Split Exam**
Weight of Module see curriculum	

Module Contents

- Electrical Signals and Electronic Circuit Elements
- Transistor Amplifiers
- Operational Amplifers
- Feedback and Stability
- OpAmp circuits
- Active Filters
- Applications

Learning Outcomes	
Electrical Machines and Energy Technology On successful completion, students will be able to ▪ name the basic properties of electrical machines, recall them when required and apply them to technical problems. ▪ describe the peculiarities of different types of direct current and alternating current machines in motor and generator operation. ▪ perform simple calculations for the design of electrical machines. ▪ explain the design and application of converters and power converters.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Engineering	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology field

Electrical Machines and Energy Technology

Course Code: DLBAETEME01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E

Course Description

Knowledge of electrical drive and power generation components is part of the basic qualification of electrical engineers. This include, among other things, the ability to calculate the behavior of motors and generators in steady-state operation. These fundamentals are required in many professional fields, for example in power engineering, in drive technology or also in mechatronics or robotics. In addition, other courses build on these fundamentals, for example electrical drive engineering. Knowledge of electrical machines and power engineering is thus a tool that should be mastered to pass the education of an electrical engineer. The contents of the module therefore focus on the different types and modes of operation of electrical machines.

Course Outcomes

On successful completion, students will be able to

- name the basic properties of electrical machines, recall them when required and apply them to technical problems.
- describe the peculiarities of different types of direct current and alternating current machines in motor and generator operation.
- perform simple calculations for the design of electrical machines.
- explain the design and application of converters and power converters.

Contents

1. Fundamentals of Electrical Machines and Power Engineering
   - 1.1 Energy Demand and Energy Coverage
   - 1.2 Power Generation
   - 1.3 Three-Phase Networks
   - 1.4 Energy Transmission

2. Direct Current Machines
   - 2.1 Structure and Components
   - 2.2 Air-Gap Field and Torque
   - 2.3 SeriesMachine
   - 2.4 Shunt Machine

2.5 Brushless DC Motor

3. Transformer
   3.1 Ideal Transformer
   3.2 Real Transformer
   3.3 Pointer Diagrams

4. Three-Phase Asynchronous Machine
   4.1 Structure and Components
   4.2 Rotary Field, Voltage Induction and Torque
   4.3 Characteristic Curves
   4.4 Motor and Generator Operation

5. Three-Phase Synchronous Machine
   5.1 Structure and Components
   5.2 Full Pole Machine
   5.3 Motor and Generator Operation

Literature

Compulsory Reading

Further Reading

- Erickson, R. W., & Maksimović, D. (2020). Fundamentals of Power Electronics. Fundamentals of Power Electronics. Springer International Publishing. https://doi.org/10.1007/978-3-030-43881-4
- Melkebeek, J. A. (2018). Electrical Machines and Drives. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-72730-1
- Vukosavic, S. N. (2013). Electrical Machines. Electrical Machines. Springer New York. https://doi.org/10.1007/978-1-4614-0400-2

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	

Project: Control Unit Design for a Mechanical System

Module Code: DLBENGEESD1

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLBROCSE01_E, DLBROMK01_E	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. (Project: Control Unit Design for a Mechanical System)

Contributing Courses to Module

- Project: Control Unit Design for a Mechanical System (DLBENGEESD01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Written Assessment: Project Report	

Weight of Module

see curriculum

Module Contents

This course focuses on the application of an embedded system as a control unit, more precisely a motion control unit or motion controller for a mechanical system. In this course, the students will follow a well-defined process to design and implement such a motion controller for a real and given mechanical system.

Learning Outcomes	
Project: Control Unit Design for a Mechanical System	
On successful completion, students will be able to ▪ understand the relation between an embedded system and a motion controller. ▪ understand and describe the process of designing a motion controller. ▪ name the major steps or rather phases of the introduced process. ▪ apply the introduced process to similar mechanical systems.	
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 Engineering	All Bachelor Programs in the IT & Technology field

Project: Control Unit Design for a Mechanical System

Course Code: DLBENGEESD01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBROCSE01_E, DLBROMK01_E

Course Description

An embedded system consists of hardware and software. In general, it is dedicated to a larger, all-embracing system, where it fulfills special functions, mainly in the context of information processing. In many mechanical systems, equipped with actuators and sensors, an embedded system is applied to control the motion of the mechanical system. In that case the software of the embedded system contains a control algorithm and the whole embedded system works as a motion control unit or motion controller. In this course, the students will learn how embedded systems und motion controllers are related to each other. Furthermore, they will learn about the process of designing a motion controller in general. And finally, the students will apply the process to a given real system.

Course Outcomes

On successful completion, students will be able to

- understand the relation between an embedded system and a motion controller.
- understand and describe the process of designing a motion controller.
- name the major steps or rather phases of the introduced process.
- apply the introduced process to similar mechanical systems.

Contents

- In this course, the students will learn how to design and implement a control algorithm for a given mechanical system by following three major steps: At first the dynamic behavior of the mechanical system will be modelled. On basis of the obtained dynamic-model the control algorithm will be derived. After that the control algorithm will be implemented in the software of an embedded system, which itself is integrated in a real mechanical system, more precisely a mechatronic system. Finally, the performance of the embedded system in its function as a motion controller for a real mechanical system will be tested and evaluated in reality.

Literature
Compulsory Reading
Further Reading ▪ Bolton, W. (2019). Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering (7th ed.). Pearson Education, New York. ▪ Klee, H., & Allen, R. (2017). Simulation of dynamic systems with MATLAB and Simulink (3rd ed.). CRC Press, Boca Raton, Florida. ▪ Nise, N.S. (2019). Control Systems Engineering (8th ed.). John Wiley & Sons, Hoboken, New Jersey. ▪ Russell, K., Shen, Q., & Sodhi, R. S. (2018). Kinematics and dynamics of mechanical systems: implementation in MATLAB and SimMechanics (2nd ed.). CRC Press, Boca Raton, Florida.

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	
Learning Material ☑ Slides	**Exam Preparation** ☑ Guideline

Introduction to Electronics and Electronic Circuits

Module Code: DLBENGEIEEC

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLBINGET01-01_E	BA	10	300 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 Electronics) / N.N. (Introduction to Electronic Circuits)

Contributing Courses to Module

- Introduction to Electronics (DLBENGEEE02)
- Introduction to Electronic Circuits (DLBENGEECEMET01)

Module Exam Type

Module Exam	Split Exam
	Introduction to Electronics • Study Format "Distance Learning": Exam, 90 Minutes Introduction to Electronic Circuits • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents	
Introduction to Electronics ▪ Fundamentales of Quantum Mechanics ▪ Structure of Atoms and Crystals ▪ Energy Bands and Carrier Transport ▪ Diodes and Transistors **Introduction to Electronic Circuits** ▪ Electrical Signals and Electronic Circuit Elements ▪ Transistor Amplifiers ▪ Operational Amplifers ▪ Feedback and Stability ▪ OpAmp circuits ▪ Active Filters ▪ Applications	
Learning Outcomes **Introduction to Electronics** On successful completion, students will be able to ▪ understand the basics of quantum mechanics. ▪ understand the properties of semiconductor atoms and crystals. ▪ reproduce and understand the electronic properties of semiconductor materials. ▪ understand and analyze the structure and function of semiconductor circuit elements. **Introduction to Electronic Circuits** On successful completion, students will be able to ▪ understand the operation and transistors. ▪ analyze amplifier circuits and recognize and reproduce different structures. ▪ understand and analyze the structure and behavior of operational amplifiers. ▪ understand and analyze the fundamentals of feedback and stability. ▪ understand and reproduce the structure and elements of active filters. ▪ understand and analyze oscillators and their applications.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Engineering	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology field

Introduction to Electronics

Course Code: DLBENGEEE02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBINGET01-01_E

Course Description

This course teaches the fundamentals necessary for understanding how electronic components work. These are very important for the understanding of microelectronic circuits and systems. The course introduces the relevant concepts from quantum mechanics and extends them with a discussion of semiconductor physics. This is followed by a discussion of important concepts in atomic structure, crystals, and the band model of solids. Based on this, the structure and operation of the basic building blocks of electronic circuits are described.

Course Outcomes

On successful completion, students will be able to

- understand the basics of quantum mechanics.
- understand the properties of semiconductor atoms and crystals.
- reproduce and understand the electronic properties of semiconductor materials.
- understand and analyze the structure and function of semiconductor circuit elements.

Contents

1. Fundamental Concepts
    - 1.1 Electronics and Semiconductors
    - 1.2 Quantum Mechanics
    - 1.3 Wave-Particle Duality
    - 1.4 Uncertainty Principle
    - 1.5 Schrödinger‘s Equation

2. Structure of Atoms and Crystals
    - 2.1 The Bohr Model
    - 2.2 Free Electrons and the Periodic Table
    - 2.3 Types of Atomic Bonding
    - 2.4 Crystal Structure and Miller Indices
    - 2.5 Wafer Fabrication

3. Energy Bands, Doping and Carrier Transport
    - 3.1 Band Modell of Solids

3.2 Intrinsic and Extrinsic Semiconductors
3.3 Drift Current
3.4 Diffusion Current
3.5 Generation and Recombination

4. PN Junctions and Diodes
4.1 Structure and Definitions
4.2 PN-Junction without External Voltage
4.3 PN-Junction with External Voltage
4.4 Capacitance of a PN-Junction
4.5 Heterojunctions

5. Bipolar Junction Transistors
5.1 Definition of the Transistor
5.2 Structure and Simple Model
5.3 Ebers-Moll Equations and Model
5.4 Current-Voltage-Characteristics
5.5 Amplification Parameters

6. Metal-Semiconductor Contacts and Field-Effect Transistors
6.1 Schottky and Ohmic Contacts
6.2 Types of Field Effect Transistors
6.3 The MOS Capacitor
6.4 The MOSFET
6.5 Equations and Characteristic Curve

Literature

Compulsory Reading

Further Reading

- Sedra, A., Smith, K. (2015): Microelectronic Circuits. 7. edition, Oxford University Press, New York.
- Sze, S. (2007): Physics of Semiconductor Devices. 3. edition, John Wiley & Sons, New York
- Sze, S. (2002): Semiconductor Devices Physics and Technology. 2. edition, John Wiley & Sons, New York

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 Electronic Circuits

Course Code: DLBENGEECEMET01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBINGET01-01_E

Course Description

Electronic circuits are critically important for numerous systems in engineering. Numerous applications in analog and digital data processing, process control and communication systems rely on electronic circuits to perform the required function. This course presents an overview of the large field of electronic circuits. A discussion of basic electronic building blocks is presented with focus on operation and fundamental circuits. Based upon this, the operational amplifier is introduced. Important concepts of feedback and stability are presented, in addition to widely used OpAmp configurations. Finally, active filters are introduced in addition to a discussion of important applications.

Course Outcomes

On successful completion, students will be able to

- understand the operation and transistors.
- analyze amplifier circuits and recognize and reproduce different structures.
- understand and analyze the structure and behavior of operational amplifiers.
- understand and analyze the fundamentals of feedback and stability.
- understand and reproduce the structure and elements of active filters.
- understand and analyze oscillators and their applications.

Contents

1. Introduction
   - 1.1 Electric Signals
   - 1.2 Frequency Spectrum of a Signal
   - 1.3 Analog and Digital Signals
   - 1.4 Amplifier
   - 1.5 Equivalent Circuit and Frequency Response

2. Electronic Circuit Elements
   - 2.1 Diodes and Rectifiers
   - 2.2 MOSFET Structure and Operation
   - 2.3 MOSFET Applications
   - 2.4 BJT Structure and Operation

8.2 Oscillators
8.3 Analog Signal Processing
8.4 Data Converters
8.5 Communication Systems

Literature

Compulsory Reading

Further Reading

- Clayton, G. B. , Winder, S. (2003): Operational Amplifiers. 5. Edition, Elsevier, Amsterdam.
- Sedra, A., Smith, K. (2015): Microelectronic Circuits. 7. Edition, Oxford University Press, New York.
- Razavi, B. (2015): Design of Analog CMOS Integrated Circuits . 2. Edition, McGraw-Hill Education, New York.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	

Mechatronic Systems and Design

Module Code: DLBENGEMSD

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	Minimaldauer: 1 Semester	WiSe/SoSe	English

Module Coordinator
Prof. Dr. Torsten Bruns (Mechatronic Systems) / N.N. (Design of Mechatronic Systems)

Contributing Courses to Module
▪ Mechatronic Systems (DLBROMSY01_E) ▪ Design of Mechatronic Systems (DLBMECEMS01_E)

Module Exam Type	
Module Exam	**Split Exam** <u>Mechatronic Systems</u> • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes <u>Design of Mechatronic Systems</u> • Study Format "Distance Learning": Exam or Advanced Workbook, 90 Minutes
Weight of Module see curriculum	

Module Contents	
Mechatronic Systems ▪ Modeling ▪ Electrical drives ▪ Machines and drivetrains ▪ Actuators and sensors **Design of Mechatronic Systems** ▪ Design process / development process ▪ Function orientation ▪ Function Modeling ▪ Mechatronic composition ▪ Structuring mechanisms ▪ Software tools	
Learning Outcomes	
Mechatronic Systems On successful completion, students will be able to ▪ understand the basics of mathematical modeling of engineering systems. ▪ model and simulate common mechatronic systems. ▪ apply mechatronic systems for a given application. ▪ understand the basics of actuators, sensors, and system integration. **Design of Mechatronic Systems** On successful completion, students will be able to ▪ name and explain the essential characteristics and interrelationships of systems and processes. ▪ describe the essential phases of the classic, conventional product development process. ▪ explain the special requirements of mechatronic systems in the context of product development or the development and design process. ▪ explain comprehensively the "mechatronic composition" phase as an extension of the conventional ▪ explain important ordering and structuring mechanisms for mastering the increasing complexity of technical systems in general and mechatronic systems in particular. ▪ describe the main types of software tools that can be used during the development and design process of mechatronic systems.	
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 IT & Technology	All Bachelor Programs in the engineering field

Mechatronic Systems

Course Code: DLBROMSY01_E

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

Course Description

Numerous processes and products experience an increasing combination of traditional and advanced mechanics with electronics. Especially with information processing, this development leads to a so-called mechatronic system, with the purpose to improve overall performance. This course illustrates the development of mechatronics and focuses on some important aspects, such as modeling techniques (which are relevant for system simulation, design and optimization), common electric drives, machines and drivetrains, actuators and sensors.

Course Outcomes

On successful completion, students will be able to

- understand the basics of mathematical modeling of engineering systems.
- model and simulate common mechatronic systems.
- apply mechatronic systems for a given application.
- understand the basics of actuators, sensors, and system integration.

Contents

1. Introduction
   - 1.1 Mechatronic Systems
   - 1.2 Examples

2. Modeling
   - 2.1 Fundamental Equations
   - 2.2 Energy Balance
   - 2.3 Connection of Process Elements
   - 2.4 Dynamics of Mechanical Systems
   - 2.5 Mechanical Elements

3. Electrical Drives
   - 3.1 Electromagnets
   - 3.2 Direct Current Motors
   - 3.3 Alternating Current Motors

4. Machines and Drivetrains
    - 4.1 Complete Machines
    - 4.2 Characteristics and Stability of Machines
    - 4.3 Motors and Pumps
    - 4.4 Automobile Drivetrain
    - 4.5 Signal Energy
    - 4.6 Applications

5. Actuators and Sensors
    - 5.1 Basic Structures
    - 5.2 Electromechanical Drives
    - 5.3 Hydraulic Actuators
    - 5.4 Pneumatic Actuators
    - 5.5 Unconventional Actuators

Literature

Compulsory Reading

Further Reading

- Boukas, E. K./Al-Sunni, F. M. (2012): Mechatronic systems: Analysis, design and implementation. Springer, Berlin.
- Davim, J. P. (2011): Mechatronics. John Wiley & Sons, Hoboken, NJ.
- Isermann, R. (2005): Mechatronic systems: Fundamentals. Springer, London.
- Janschek, K./Richmond, K. (2012): Mechatronic systems design methods, models, concepts. Springer, Berlin

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Ses-sions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Design of Mechatronic Systems

Course Code: DLBMECEMS01_E

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

Course Description

In the beginning this course briefly introduces the conventional development and design process for developing new products in the context of design theory. It starts with a task clarification and product planning phase. This is followed by the concept development phase, and by the product design phase. Products in the sense of mechatronic systems place special demands on this process since they differ from other product types by some special features. In mechatronic systems, the function of the system is the focus of interest and this function orientation is often not sufficiently taken into account in the in practice established design processes. In this course, these special requirements are described. Subsequently, the conventional design process is extended by the so-called "mechatronic composition" in order to meet the requirements. Mechatronic systems usually have a high degree of complexity, which is expected to increase in the future. This complexity must be dealt with adequately already in the development and design process in order to master it. To this end, suitable ordering and structuring mechanisms are presented in this course. Today, the entire development and design process of mechatronic systems is completely computer-based. Ideally, a complete digital image or model of the system already exists before the first prototype is manufactured. Based on this model, the system can be analyzed, designed and optimized in detail, especially with regard to its functionality, purely virtual in the computer. The types of software tools used in this context will also be briefly introduced at the end of this course.

Course Outcomes

On successful completion, students will be able to

- name and explain the essential characteristics and interrelationships of systems and processes.
- describe the essential phases of the classic, conventional product development process.
- explain the special requirements of mechatronic systems in the context of product development or the development and design process.
- explain comprehensively the "mechatronic composition" phase as an extension of the conventional
- explain important ordering and structuring mechanisms for mastering the increasing complexity of technical systems in general and mechatronic systems in particular.
- describe the main types of software tools that can be used during the development and design process of mechatronic systems.

Contents

Literature
Compulsory Reading
Further Reading ▪ Boukas, E.-K. & AL-Sunni, F. M. (2011). Mechatronic Systems - Analysis, Design and Implementation. Springer ▪ Janschek, K. (2012). Mechatronic Systems Design: Methods, Models, Concepts. Springer London. Springer. ▪ Just, V., Illg, I., Zeineldin, T. & Trächtler, A. (2010). Efficient Design of Complex Mechatronic Products Using the Example of the Separation-Process in an ATM. 10.1115/IMECE2010-38646, pp. 13-22. ▪ Pahl, G., Beitz, W., Feldhusen, J. & Grote, K.-H. (2007). Engineering Design: A Systematic Approach (3rd edition). Springer London.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Exam or Advanced Workbook, 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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Robot Kinematics and Dynamics

Module Code: DLBWINWMKD_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	300 h

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

Module Coordinator

Prof. Dr. Gabriele Bleser-Taetz (Mechanics - Kinematics) / Maedeh Ranjbar-Zefreh (Mechanics - Dynamics)

Contributing Courses to Module

- Mechanics - Kinematics (DLBROMK01_E)
- Mechanics - Dynamics (DLBROMD01_E)

Module Exam Type	
Module Exam	**Split Exam** <u>Mechanics - Kinematics</u> • Study Format "Distance Learning": Exam, 90 Minutes <u>Mechanics - Dynamics</u> • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents
Mechanics - Kinematics ▪ Motion of Rigid Bodies ▪ Direct Kinematics ▪ Inverse Kinematics ▪ Differential Kinematics **Mechanics - Dynamics** ▪ Dynamics of Rigid Bodies ▪ Typical Joint Actuators ▪ Direct Dynamics ▪ Inverse Dynamics

Learning Outcomes
Mechanics - Kinematics On successful completion, students will be able to ▪ understand and describe the motion of rigid bodies. ▪ understand and calculate the direct and inverse kinematic of typical robotic structures. ▪ calculate the differential kinematics of typical robotic structures . **Mechanics - Dynamics** On successful completion, students will be able to ▪ to understand the dynamics of rigid bodies and the basic physical laws. ▪ to model the dynamics of robots based on the Lagrange and Newton approaches. ▪ to establish dynamic equations for the design, optimization, analysis of robots. ▪ to understand how robot control based on a dynamic model can be realized.

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 Engineering	All Bachelor Programs in the IT & Technology fields

Mechanics - Kinematics

Course Code: DLBROMK01_E

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

Course Description

The word robot denotes a high variety of mechanical structures ranging from anthropomorphic industrial robots, to robots which mimic animals. This course provides the necessary preliminary background to develop, analyze, model, and simulate mechanical robotic structures of any kind from the viewpoint of the kinematics, i.e., neglecting forces and torques. The first part introduces the kinematics, i.e., a way to describe a robot as a kinematic chain of rigid bodies, which is important to represent position and orientation of the robotic end-effector in the operational space as function of each joint variable. The differential kinematics gives the relationship between joint velocities and corresponding velocity of the end-effector. The important problem of inverse kinematics, unavoidable when designing trajectories of the robot, is also discussed and methods for solutions are presented.

Course Outcomes

On successful completion, students will be able to

- understand and describe the motion of rigid bodies.
- understand and calculate the direct and inverse kinematic of typical robotic structures.
- calculate the differential kinematics of typical robotic structures .

Contents

1. Introduction
   - 1.1 Configuration Space
   - 1.2 Degrees of Freedom
   - 1.3 Topology
   - 1.4 Task Space and Workspace
2. Rigid Body Motions
   - 2.1 Pose of a Rigid Body
   - 2.2 Representations of Orientation
   - 2.3 Homogeneous Transformations
   - 2.4 Exponential Coordinate Representation
3. Forward Kinematics

Literature

Compulsory Reading

Further Reading

- Lynch, K. M., & Park, F. C. (2017). Modern robotics: Mechanics, planning, and control. Cambridge University Press.
- Siciliano, B., Sciavicco, L., Villani, L., & Oriolo, G. (2009). Robotics: Modelling, planning and control. Springer Science & Business Media.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	

Mechanics - Dynamics

Course Code: DLBROMD01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBROMK01_E

Course Description

The kinematics of a robot allows describing the position and orientation (the pose) of the end-effector based on the joint variables. The presence of forces and torques, i.e., the dynamics of the motion, is completely neglected. The dynamics relates joint variables' velocities and accelerations to the forces and toques acting on the robot. This course introduces the dynamics of rigid bodies and how it can be described mathematically to be used in models, for instance for simulation purposes. The course then introduces two approaches to describe the dynamics of robots, namely the Euler-Lagrange approach and the Newton-Euler one. The Newton-Euler approach yields an iterative algorithm which can be implemented in an efficient way and can be used to calculate necessary torques to achieve required motion dynamics. The necessary torques are the input to various actuating mechanism which must be considered in the overall dynamics. This course shows how to consider the presence of DC motors and gearings in the dynamic model. Finally, the main aspects relating dynamics and control are discussed briefly.

Course Outcomes

On successful completion, students will be able to

- to understand the dynamics of rigid bodies and the basic physical laws.
- to model the dynamics of robots based on the Lagrange and Newton approaches.
- to establish dynamic equations for the design, optimization, analysis of robots.
- to understand how robot control based on a dynamic model can be realized.

Contents

1. Basics
   - 1.1 Dynamics of a Rigid Body
   - 1.2 Classical Formulation
   - 1.3 Twist-Wrench Formulation

2. Lagrange Formulation
   - 2.1 Preliminaries
   - 2.2 General Formulation
   - 2.3 Properties
   - 2.4 Understanding the Dynamic Model

3. Newton-Euler Formulation
   - 3.1 Link Acceleration
   - 3.2 Recursive Algorithm

4. Forward and Inverse Dynamics
   - 4.1 Basic Concepts
   - 4.2 Forward Dyanamics for Open Chains
   - 4.3 Newton-Euler Inverse Dynamics
   - 4.4 Dynamics in the Task Space
   - 4.5 Constrained Dynamics
   - 4.6 Robot Dynamics in the Universal Robot Description Framework

5. Actuation
   - 5.1 DC Motors and Gearings
   - 5.2 Friction
   - 5.3 Joint and Link Flexibility

6. Introduction to Motion Control
   - 6.1 The Control Problem
   - 6.2 Control in the Joint Space
   - 6.3 Control in the Operational Space

Literature

Compulsory Reading

Further Reading

- Corke, P. (2017). Robotics, vision, and control: Fundamental algorithms in MATLAB (2nded.). Springer.
- Kurdila, A. J., & Ben-Tzvi, P. (2019). Dynamics and control of robotic systems. Wiley.
- Siciliano, B., & Khatib, O. (Eds.) (2016). Springer handbook of robotics. Springer.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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	

Supply Chain Management and Innovation

Module Code: DLBENGESCMI-01

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 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Alex Leberling (Supply Chain Management I) / Diana Murtgah-Böhm (Entrepreneurship and Innovation)

Contributing Courses to Module

- Supply Chain Management I (DLBDSESCM01)
- Entrepreneurship and Innovation (DLBBAEI01-01_E)

Module Exam Type

Module Exam	Split Exam
	Supply Chain Management I • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Entrepreneurship and Innovation • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

Supply Chain Management I

- Historical and Terminological Aspects of the SCM Concept
- Motives for the Creation of Cross-Company Value Creation Networks
- Design Principles and Effects of Value Creation Networks
- Logistical Core Processes and SCM
- Information Technology Aspects of the SCM Concept
- Coordination and Collaboration of the Network Partners
- Industry-Specific Solutions of the SCM

Entrepreneurship and Innovation

- Entrepreneurship
- The Entrepreneur
- The Entrepreneurial Process
- Innovation
- Planning, Business Models and Strategy

Learning Outcomes

Supply Chain Management I

On successful completion, students will be able to

- explain the importance of cross-company value creation processes.
- understand common concepts for modeling cross-company value creation processes.
- understand dynamic effects in supply chains and can systematize their causes and effects.
- explain important theoretical concepts for describing the characteristics and challenges of cross-company value creation processes.
- explain the approaches and problem categories commonly used in the context of supply chain management.
- understand important reference and/or management models for the concretization of supply chain systems.
- name and detail important roles and tasks in the SCM network.
- deal with the coordination problem of SCM and describe the common solution approaches.

Entrepreneurship and Innovation

On successful completion, students will be able to

- understand the core principles of entrepreneurship.
- define the main characteristics of entrepreneurs as well as their motivations and their behavior.
- describe the entrepreneurial process with its different stages.
- recognize problems and negative side effects of entrepreneurship.
- define innovation and explain the innovation lifecycle.
- understand a business plan and what defines a business model.

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 fields of Transportation & Logistics and Business Administration & Management	All Bachelor Programmes in the Business and Management fields

Supply Chain Management I

Course Code: DLBDSESCM01

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

Course Description

SCM proves to be an extremely multi-faceted construct from both a theoretical and a practical point of view. An adequate understanding of the problem dimensions and modes of action of (global) cross-company value creation networks requires a multidimensional approach. It starts by considering logistical processes, with modern process, flow, and network standards forming an important basis for SCM. On the basis of such an approach, students should gain a fundamental understanding of SCM. From the point of view of a holistic approach, it also makes sense to also examine a number of other typical problem areas in addition to the logistical challenges of this concept. This includes IT aspects of SCM (e.g., APS systems), and questions to do with the collaboration and coordination of network partners. This course also considers selected industry specific SCM solutions (ECR or VMI).

Course Outcomes

On successful completion, students will be able to

- explain the importance of cross-company value creation processes.
- understand common concepts for modeling cross-company value creation processes.
- understand dynamic effects in supply chains and can systematize their causes and effects.
- explain important theoretical concepts for describing the characteristics and challenges of cross-company value creation processes.
- explain the approaches and problem categories commonly used in the context of supply chain management.
- understand important reference and/or management models for the concretization of supply chain systems.
- name and detail important roles and tasks in the SCM network.
- deal with the coordination problem of SCM and describe the common solution approaches.

Contents

1. Fundamentals of the Supply Chain Concept
   - 1.1 Terminological and Conceptual Fundamentals
   - 1.2 Supply Chain Typology According to Otto
   - 1.3 Supply Chain Typology According to Bechtel/Jayaram
   - 1.4 Dynamic Aspects of Supply Chains

2. Selected Theoretical Concepts for the Supply Chain Concept
   - 2.1 New Institutional Economics
   - 2.2 Game Theory
   - 2.3 Network Approach
   - 2.4 Other Theoretical Additions

3. Supply Chain Management
   - 3.1 Basic Information on the Goals and Scope of SCM
   - 3.2 Popular Problem Areas of the SCM
   - 3.3 Supply Chain Management as an Evolutionary Step in Logistics
   - 3.4 Supply Chain Management as Cooperation Management

4. SCM Model
   - 4.1 Basic Information on the Term SCM Models
   - 4.2 SCOR Model
   - 4.3 SCM Task Model

5. SCM as a Coordination Problem
   - 5.1 Basic Information on the Concept of Coordination
   - 5.2 Coordination Concepts, Context, and Perspectives of SCM
   - 5.3 Coordination Instruments

Literature

Compulsory Reading

Further Reading

- Bowersox, J., Closs, D., & Cooper, M. B. (2020). Supply chain logistics management (5th ed.). McGraw Hill Education.
- Chopra, S., & Meindl, P. (2019). Supply chain management: Strategy, planning, and operation (7th ed., Global ed.). Pearson Education.
- Es-Satty, Asmaa; Lemghari, Radouane; Okar, Chafik. (2020). Supply Chain Digitalization Overview SCOR model implication. In: 2020 IEEE 13th International Colloquium of Logistics and Supply Chain Management (LOGISTIQUA) Logistics and Supply Chain Management (LOGISTIQUA), 2020 IEEE 13th International Colloquium of. :1-7 Dec, 2020; IEEE Language: English, Datenbank: IEEE Xplore Digital Library.
- Tarigan, Z. J. H., Siagian, H., & Jie, F. (2021). Impact of enhanced enterprise resource planning (ERP) on firm performance through green supply chain management. Sustainability, 13(8), article 4358.

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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	

Entrepreneurship and Innovation

Course Code: DLBBAEI01-01_E

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

Course Description

Entrepreneurship and innovation are the basis and one of the driving forces of every economy. Entrepreneurship and innovation are of great importance in every phase of the economic development cycle. They are important drivers for competition, competitiveness and survival in globalized markets. In this module, students are familiarized with the ideas, motives and concepts of entrepreneurship. They also get an overview of the identification, evaluation and further development of innovations.

Course Outcomes

On successful completion, students will be able to

- understand the core principles of entrepreneurship.
- define the main characteristics of entrepreneurs as well as their motivations and their behavior.
- describe the entrepreneurial process with its different stages.
- recognize problems and negative side effects of entrepreneurship.
- define innovation and explain the innovation lifecycle.
- understand a business plan and what defines a business model.

Contents

1. Entrepreneurship
   - 1.1 Defining Entrepreneurship
   - 1.2 Benefits of Entrepreneurial Activity
   - 1.3 Types of Entrepreneurs
   - 1.4 Global Trends in Entrepreneurship

2. The Entrepreneur
   - 2.1 Defining Entrepreneur
   - 2.2 Characteristics of Entrepreneurs
   - 2.3 Entrepreneurial Motivation and Behavior

3. The Entrepreneurial Process
   - 3.1 Stages of the Entrepreneurial Process

3.2 Venture Creation 3.3 Creativity Management and Time Pressure 4. Innovation 4.1 Defining Innovation 4.2 Innovation Lifecycle 4.3 Sources of Innovation 4.4 Encouraging Entrepreneurship and Innovation 5. Planning, Business Models and Strategy 5.1 Business Plan 5.2 Designing a Business Model 5.3 Developing a Business Strategy

Literature
Compulsory Reading
Further Reading ▪ Bessant, J., & Tidd, J. (2015). Innovation and entrepreneurship. Wiley. ▪ Parker, S. C. (2018). The economics of entrepreneurship (2nd ed.). Cambridge University Press. ▪ Scarborough, N., & Cornwall, J. (2018). Essentials of entrepreneurship and small business management (Global ed.). Pearson Education.

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Course Book ☑ Video ☑ Slides	**Exam Preparation** ☑ Practice Exam ☑ Online Tests

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Course Book ☑ Video ☑ Slides	**Exam Preparation** ☑ Practice Exam ☑ Online Tests

Operating Systems, Networks and Network Forensics

Module Code: DLBENGEOSNNF

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	300 h

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

Module Coordinator

Prof. Dr. Paul Libbrecht (Operating Systems, Computer Networks, and Distributed Systems) / Prof. Dr. Stephan Spitz (Introduction to Network Forensics)

Contributing Courses to Module

- Operating Systems, Computer Networks, and Distributed Systems (DLBIBRVS01_E)
- Introduction to Network Forensics (DLBCSEINF01_E)

Module Exam Type

Module Exam	Split Exam
	Operating Systems, Computer Networks, and Distributed Systems • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes Introduction to Network Forensics • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents	
Operating Systems, Computer Networks, and Distributed Systems ▪ Operating Systems ▪ Computer Networks ▪ Distributed Systems ▪ Mobile Computing **Introduction to Network Forensics** ▪ Network Protocols and Services ▪ World Wide Web ▪ Log Data Analysis ▪ Network Forensics	
Learning Outcomes	
Operating Systems, Computer Networks, and Distributed Systems 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. **Introduction to Network Forensics** On successful completion, students will be able to ▪ interact with the network at a low level. ▪ understand the idiosyncrasies of Internet protocols. ▪ understand how to read RFCs in self-study when protocols are modified, or new ones added. ▪ understand common attacks against these protocols. ▪ understand how encryption is used in the Internet, and how it can be subverted. ▪ deploy and use IDPS systems. ▪ recognize security events in a SIEM that uses the IDPS data.	
Links to other Modules within the Study Program This module is similar to other modules in the fields of Computer Science & Software Development	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology fields

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	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Study Format myStudies

Study Format	**Course Type**
myStudies	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Introduction to Network Forensics

Course Code: DLBCSEINF01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBIBRVS01_E or DLBIBRVS01

Course Description

Network forensics is the art and science of capturing, recording and analysis of network events in order to discover attacks. This requires an in-depth knowledge of the core Internet protocols, how they are used and how they can be attacked.In this course, we will look at the most commonly used network protocols in Internet-based networking. We take a practical approach and look at actual network traces to discover how protocols are layered on each other. At its core there is TCP/IP. Other protocols, like HTTP, are built on that layer. Others, like DNS are based on the alternative UDP protocol. The major services that make up the Internet will be discussed. For instance, DNS is a protocol, but also a distributed database system. The ICANN organization oversees IP addresses and they are allocated to regional organizations and distributed to Autonomous Systems. This requires routing which is handled by other protocols.Encryption is provided for confidentiality of data but often also for authentication and integrity reasons. It is implemented in a variety of forms with an equal variety of trade-offs.The forensic practitioner requires a variety of tools, ranging from simple probing tools to collection and analysis tools. These are usually packaged as Intrusion Detection and Prevention Systems as well as SIEMs for the actual analysis. However, security event data usually needs to be augmented with external data sources for accurate diagnosis, and a variety of data sources will be discussed.

Course Outcomes

On successful completion, students will be able to

- interact with the network at a low level.
- understand the idiosyncrasies of Internet protocols.
- understand how to read RFCs in self-study when protocols are modified, or new ones added.
- understand common attacks against these protocols.
- understand how encryption is used in the Internet, and how it can be subverted.
- deploy and use IDPS systems.
- recognize security events in a SIEM that uses the IDPS data.

Contents

1. Why network forensics?
   - 1.1 Goals of investigations
   - 1.2 Network evidence gathering
   - 1.3 Intrusion detection

1.4 (D)Dos detection and mitigation
1.5 Tools of the trade

2. Basic protocol layering
   2.1 Internet protocol hierarchy
   2.2 Connection and connectionless protocols
   2.3 Reading RFCs and related documentation

3. TCP vs UDP
   3.1 Connectionless UDP
   3.2 TCP Connection establishment
   3.3 Missing packets and retransmission
   3.4 SOCKS proxying
   3.5 Attacks against TCP and UDP

4. The Internet Protocol
   4.1 IP addresses, IPv4 and IPv6
   4.2 Obtaining an IPv4 and IPv6 addresses
   4.3 The role of ICANN
   4.4 IP Firewalls and IP Network Address Translation
   4.5 SOCKS Proxying Protocol and Attack Vector

5. Routing the link layer
   5.1 ARP (Address Resolution Protocol)
   5.2 RIP dynamic routing
   5.3 BGP peering
   5.4 Autonomous System numbers
   5.5 Attacks against routing

6. Domain Name System
   6.1 Host name hierarchy
   6.2 DNS as a distributed database
   6.3 DNSSEC
   6.4 SPF, DMARC and other special records

7. Common application layer protocols
   7.1 HTTP
   7.2 HTTP/2
   7.3 SMTP

8. Transport Layer Encryption
   - 8.1 SSH
   - 8.2 IPSEC
   - 8.3 TLS
   - 8.4 Man in the middle attacks
   - 8.5 Certificates and certificate authorities
9. Intrusion detection and prevention systems
   - 9.1 Sensor and event types
   - 9.2 Netflow monitoring
   - 9.3 Rules, false positive and false negatives
   - 9.4 SIEMs
   - 9.5 Attack prevention technologies
10. Correlation and enrichment data sources
    - 10.1 Enrichment of data
    - 10.2 DNS data sources: DNSBLs, passive DNS, DNS repositories
    - 10.3 AS numbers, IP blocks, GeoIP and WhoIs data
    - 10.4 Certificate Transparency
    - 10.5 Correlation methods

Literature

Compulsory Reading

Further Reading

- Cole, E., Krutz, R. L., & Conley, J. (2009). Network security bible. John Wiley & Sons.
- Kurose, J., & Ross, K. (2016). Computer networking: A top-down approach. Pearson Education.
- Stevens, F. (2014). TCP/IP illustrated (2nd ed., Vol. 1—The protocols). Pearson.Tanenbaum, A., & Wetherall, D. (2013). Computer networks. Pearson Education.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	**Learning Material** ☑ Course Book ☑ Video ☑ Audio ☑ Slides	**Exam Preparation** ☑ Practice Exam ☑ Online Tests

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Functional Programming with Python and Inferential Statistics

Module Code: DLBENGEFPPIS

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	300 h

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

Module Coordinator

Prof. Dr. Max Pumperla (Object Oriented and Functional Programming in Python) / Hashem Zarafat (Statistics - Inferential Statistics)

Contributing Courses to Module

- Object Oriented and Functional Programming in Python (DLBDSOOFPP01)
- Statistics - Inferential Statistics (DLBDSSIS01)

Module Exam Type

Module Exam	Split Exam
	<u>Object Oriented and Functional Programming in Python</u> • Study Format "Distance Learning": Portfolio • Study Format "myStudies": Portfolio <u>Statistics - Inferential Statistics</u> • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

Object Oriented and Functional Programming in Python

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.

Statistics - Inferential Statistics

- Point Estimation
- Uncertainties
- Bayesian Inference & Non-Parametric Techniques
- Statistical Testing
- Statistical Decision Theory

Learning Outcomes

Object Oriented and Functional Programming in Python

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.

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.

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 fields of Data Science & Artificial Intelligence and Methods	All Bachelor Programmes in the IT & Technology and Business & Management fields

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 ▪ 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. ▪ Lutz, M. (2013): Learning Python. 5th ed., O'Reilly. ▪ 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. ▪ 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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ 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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ Guideline

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	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	☑ Online Tests
	☑ Slides	

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	☑ Online Tests
	☑ Slides	

6. Semester

Electro Mobility

Module Code: DLBAETWEM_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E; DLBAETEME01, DLBAETESF01 or DLBENGEEE01	BA	10	300 h

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

Module Coordinator
N.N. (Electrical Drive Technology) / N.N. (Battery Technology)

Contributing Courses to Module
▪ Electrical Drive Technology (DLBAETWEM01_E) ▪ Battery Technology (DLBAETWEM02_E)

Module Exam Type	
Module Exam	**Split Exam** <u>Electrical Drive Technology</u> • Study Format "Distance Learning": Exam, 90 Minutes <u>Battery Technology</u> • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents
Electrical Drive Technology ▪ Magnetic Fields in Electrical Machines ▪ Static Behavior of Electrical Machines ▪ Dynamic Behavior of Electrical Machines ▪ Drive and Control of Electrical Machines ▪ Power Electronics for Electrical Machines ▪ Sensorless Control of Electrical Machines **Battery Technology** ▪ Introduction ▪ Capacitors ▪ Accumulators ▪ Lithium Ion Batteries ▪ Battery Production ▪ Raw Materials and Recycling

Learning Outcomes
Electrical Drive Technology On successful completion, students will be able to ▪ know, model, and explain basic properties of electric drives in steady-state and transient operation. ▪ explain the special features in thermal management and speed control of electrical drives. ▪ select the appropriate drive form for a given problem and perform its design. ▪ discuss the special features of various (partially) electric drive systems in vehicles. **Battery Technology** On successful completion, students will be able to ▪ understand technology and areas of application of energy storage systems for the energy transition. ▪ select and size energy storage systems. ▪ understand the functioning of the lithium-ion technology. ▪ explain specifics of battery production and recycling.

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 Engineering	All Bachelor Programs in the IT & Technology field

Electrical Drive Technology

Course Code: DLBAETWEM01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E; DLBAETEME01, DLBAETESF01 or DLBENGEEE01

Course Description

Due to current technical and political developments, electric drives - whether in stationary machines, passenger cars or e-bikes - are becoming increasingly important. Electric drives can be found in a variety of forms, designs, and performance classes. Expertise in the specifics of electric drives is one of the key qualifications of electrical engineers. The contents of the module therefore focus on the fundamentals of different types and modes of operation of electric drives.

Course Outcomes

On successful completion, students will be able to

- know, model, and explain basic properties of electric drives in steady-state and transient operation.
- explain the special features in thermal management and speed control of electrical drives.
- select the appropriate drive form for a given problem and perform its design.
- discuss the special features of various (partially) electric drive systems in vehicles.

Contents

1. Magnetic Fields in Electrical Machines
   - 1.1 Coils
   - 1.2 Permanent Magnets
   - 1.3 Energy (Density and Storage)

2. Static Behavior of Electrical Machines
   - 2.1 Torque/Speed Characteristics
   - 2.2 DC Machines
   - 2.3 Synchronous Machines
   - 2.4 Asynchronous Machines

3. Dynamic Behavior of Electrical Machines
   - 3.1 DC Machines

Literature

Compulsory Reading

Further Reading

- Melkebeek, J. A. (2018). Electrical Machines and Drives. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-72730-1
- Pyrhonen, J./Jokinen, T./Hrabovcova, V. (2013): Design of rotating electrical machines. 2nd edition, John Wiley & Sons, Hoboken.
- Vukosavic, S. N. (2013). Electrical Machines. Electrical Machines. Springer New York. https://doi.org/10.1007/978-1-4614-0400-2

Study Format Distance Learning

Study Format Distance Learning	**Course Type** Theory Course

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

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

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

Battery Technology

Course Code: DLBAETWEM02_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E; DLBAETEME01, DLBAETESF01 or DLBENGEEE01

Course Description

Through progress in science and technology, but also through political will, battery electric storage systems for stationary and moving applications have become an alternative to conventional methods of energy provision and storage. Battery systems are finding use in new application fields such as passenger cars, e-bikes, or e-scooters, in addition to their use in classic consumer electronic devices. Expertise in the specifics of battery systems is one of the in-depth qualifications of electrical engineers. The contents of the module therefore focus on the fundamentals of different types of electrical energy storage as well as on accumulators and battery systems.

Course Outcomes

On successful completion, students will be able to

- understand technology and areas of application of energy storage systems for the energy transition.
- select and size energy storage systems.
- understand the functioning of the lithium-ion technology.
- explain specifics of battery production and recycling.

Contents

1. Introduction
   - 1.1 Overview of (Electrical) Energy Storage Systems
   - 1.2 Use Cases and Special Features

2. Capacitors
   - 2.1 Standard Capacitors
   - 2.2 Double Layer Capacitors
   - 2.3 Hybrid Capacitors

3. Accumulators
   - 3.1 Chemical Energy

Literature

Compulsory Reading

Further Reading

- Bansal, R. C., Agarwal, A., & Jadoun, V. K. (Eds.). (2022). Advances in Energy Technology. Singapore: Springer Singapore. https://doi.org/10.1007/978-981-16-1476-7
- Petrovic, S. (2021). Battery Technology Crash Course. Battery Technology Crash Course. Springer International Publishing. https://doi.org/10.1007/978-3-030-57269-3
- Thaler, A., & Watzenig, D. (Eds.). (2014). Automotive Battery Technology. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-02523-0

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	

Digital and Information Technology and Programming with C/C++

Module Code: DLBENGEDITPCC

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 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Marian Benner-Wickner (Digital and Information Technology) / Dr. Hajck Karapetjan (Programming with C/C++)

Contributing Courses to Module

- Digital and Information Technology (DLBAETDIT01_E)
- Programming with C/C++ (DLBROEPRS01_E)

Module Exam Type	
Module Exam	**Split Exam** Digital and Information Technology • Study Format "Distance Learning": Exam, 90 Minutes Programming with C/C++ • Study Format "myStudies": Portfolio • Study Format "Distance Learning": Portfolio

Weight of Module

see curriculum

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Module Contents

Digital and Information Technology

- Mathematical foundations of digital logic
- Representation, synthesis and analysis of Boolean functions
- Combinational logic
- Sequential logic
- Arithmatic circuits
- Introduction to programmable logic

Programming with C/C++

- C and C++ for programming of applications and robots

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Learning Outcomes

Digital and Information Technology

On successful completion, students will be able to

- understand and apply the mathematical principles of digital logic.
- understand the different ways in which combinational logic and sequential logic work.
- analyze and evaluate digital arithmaticcircuits.
- understand the characteristics of programmable logic devices and develop simple arithmaticcircuits on them.

Programming with C/C++

On successful completion, students will be able to

- know the main characteristics of C and C++ programming languages.
- apply C and C++ for programming of applications.
- apply C and C++ for programming of robotic systems.

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Links to other Modules within the Study Program

This module is similar to other modules in the fields of Engineering and Computer Science & Software Development

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Links to other Study Programs of the University

All Bachelor Programs in the IT & Technology field

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Digital and Information Technology

Course Code: DLBAETDIT01_E

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

Course Description

Digital and information technology is one of the basic subjects in electrical engineering and provides interdisciplinary basic knowledge for advanced courses. These basics are required in many courses and modules, including the realization of transistor circuits or the design of hardware-related embedded systems. Due to advances in technology, digital systems are becoming increasingly important and often replace traditional analog systems. Digital and information technology is thus a tool for the electrical engineer that should be mastered in order to gain access to more advanced know-how. This module therefore focuses not only on the theoretical fundamentals of digital and information technology (mathematical principles, combinational logic and sequential logic) but also on the practical realization of digital systems such as arithmaticcircuits in programmable logic devices.

Course Outcomes

On successful completion, students will be able to

- understand and apply the mathematical principles of digital logic.
- understand the different ways in which combinational logic and sequential logic work.
- analyze and evaluate digital arithmaticcircuits.
- understand the characteristics of programmable logic devices and develop simple arithmaticcircuits on them.

Contents

1. Mathematical Foundations of Digital Logic
   - 1.1 Boolean Functions and Algebra
   - 1.2 Number Systems (Dual, Octal, Decimal, Hexadecimal) and their Application
   - 1.3 Basic Arithmetic Operations in Number Systems (Addition, Subtraction, Multiplication, Division)
   - 1.4 Coding Methods (BCD, Gray, ASCII Code)
   - 1.5 Introduction to Modulation Techniques

2. Representation, Synthesis and Analysis of Boolean Functions
   - 2.1 Disjunctive and Conjunctive Normal Form
   - 2.2 Karnaugh-Veitch Map
   - 2.3 Quine-McCluskey Algorithm

Literature

Compulsory Reading

Further Reading

- Mano, M.,/Ciletti, M. (2013): Digital Design. With an Introduction to the Verilog HDL. 5th edition, Pearson, London.
- Holdsworth, B./Woods, C. (2002): Digital Logic Design. 4th edition, Newnes, London.
- Gazi, O (2019): A Tutorial Introduction to VHDL Programming. 1st edition, Springer, Singapore.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	**Learning Material** ☑ Course Book ☑ Video ☑ Audio ☑ Slides	**Exam Preparation** ☑ Practice Exam ☑ Online Tests

Programming with C/C++

Course Code: DLBROEPRS01_E

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

Course Description

C and C++ belong to the class of programming languages which have been adopted in a broad field of applications, ranging from embedded systems (where they are dominant) to fast and reliable user interfaces and industrial applications. In fact, C++ is one of the most popular legacy programming languages for robotics, and a combination of C++ and robotics hardware is used in many leading industries. Knowledge on how to design in and write C/C++ code is an imperative capability for the practicing roboticist, especially in the industrial arena.

Course Outcomes

On successful completion, students will be able to

- know the main characteristics of C and C++ programming languages.
- apply C and C++ for programming of applications.
- apply C and C++ for programming of robotic systems.

Contents

- This course introduces the main aspects of C and C++ programming languages, such as data types, variables, arithmetic expressions, flow control, functions, classes, arrays, and pointers. The programming skills will then be applied to design parts of robotic systems based on popular hardware.

Literature

Compulsory Reading

Further Reading

- Kernighan, B. W. & Ritchie, D. M. (2000). The C Programming Language, Second Edition. Pearson Education.
- Lippman, S. B., Lajoie, J., Moo, B. (2012). C++ Primer, Fifth Edition. Addison Wesley.
- Margolis, M. (2011). Arduino Cookbook. O'Reilly Media.
- Dogan, I. (2021). Nucleo Boards Programming with the STM32CubeIDE. Elektor.

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	☑ Slides	☑ Guideline

Study Format Distance Learning

Study Format Distance Learning	**Course Type** Project

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

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

Instructional Methods		
Tutorial Support ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	**Learning Material** ☑ Slides	**Exam Preparation** ☑ Guideline

Energy Technology

Module Code: DLBAETWET_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	300 h

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

Module Coordinator

N.N. (High Voltage Technology) / N.N. (Energy Industry)

Contributing Courses to Module

- High Voltage Technology (DLBAETWET01_E)
- Energy Industry (DLBAETWET02_E)

Module Exam Type

Module Exam	Split Exam
	<u>High Voltage Technology</u> • Study Format "Distance Learning": Exam, 90 Minutes <u>Energy Industry</u> • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

High Voltage Technology

- Fundamentals of high-voltage engineering and electric strength
- Properties of dielectrics and insulating materials
- High voltage generation, quality assurance and applications

Energy Industry

- Fundamentals of the energy industry
- Nuclear energy and fossil fuels
- Electricity markets
- Energy and environment

Learning Outcomes

High Voltage Technology

On successful completion, students will be able to

- understand and apply the fundamentals of high voltage engineering.
- understand and reproduce the meaning of electric strength.
- understand and reproduce the properties of dielectrics and insulating materials.
- understand and apply the basics of high voltage generation and quality assurance fundamentals in high voltage engineering

Energy Industry

On successful completion, students will be able to

- understand and reflect the fundamentals of the energy industry.
- understand and reflect technical as well as economic constraints of nuclear energy and fossil fuels.
- understand and analyze the fundamentals of electricity markets and grid fees.
- understand and analyze the relationship between energy generation production, environmental protection and climate change.

Links to other Modules within the Study Program	Links to other Study Programs of the University
All Bachelor Programs in IT & Engineering	Builds on modules from the engineering field

High Voltage Technology

Course Code: DLBAETWET01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	Either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E; DLBAETEME01_E

Course Description

High voltage engineering is an important area of power engineering. In particular, knowledge of electric strength plays a central role in the design of insulation systems, especially in the specification of electrical safety. First, electric fields are introduced, with a focus on high electric field strengths and voltages. The properties of dielectrics and insulation materials are presented in detail. Practical aspects such as generation and measurement of high voltages up to diagnostic techniques are also discussed.

Course Outcomes

On successful completion, students will be able to

- understand and apply the fundamentals of high voltage engineering.
- understand and reproduce the meaning of electric strength.
- understand and reproduce the properties of dielectrics and insulating materials.
- understand and apply the basics of high voltage generation and quality assurance fundamentals in high voltage engineering

Contents

1. Introduction
    - 1.1 The Function of High Voltage Engineering
    - 1.2 Applications and perspectives of High Voltage Engineering

2. Electrical Stresses
    - 2.1 Electric Fields and Energy
    - 2.2 Electrical Stresses in High Voltage Engineering
    - 2.3 Homogeneous and Inhomogeneous Dielectrics
    - 2.4 Numerical Field Calculation Methods
    - 2.5 Travelling Waves

3. Electric Strength
    - 3.1 Introduction to Statistics
    - 3.2 Gas Discharges

Literature
Compulsory Reading
Further Reading ▪ Hugh, M. Ryan. (2013): High-Voltage Engineering and Testing, 3rd edition. The Institution of Engineering and Technology, London ▪ Küchler, A. (2018): High Voltage Engineering. Springer Vieweg, Berlin. ▪ Schon, K. (2019): High voltage measurement techniques: fundamentals, measuring instruments, and measuring methods. Springer International Publishing, Basel

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	

Energy Industry

Course Code: DLBAETWET02_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E

Course Description

Energy is the backbone or rather the lifeblood of modern society. However, energy generation and supply are not only a technical issue, but also an extremely important economic one. Energy is by no means infinite; rather, it is a resource that is becoming scarce. Therefore, it must be managed and its generation, distribution, and prices must be regulated. This course teaches the basics of energy management and establishes the aforementioned link between technical and economic aspects. After discussing nuclear energy, fossil fuels, and electricity markets, the critical issues of energy generation related to climate change are also discussed.

Course Outcomes

On successful completion, students will be able to

- understand and reflect the fundamentals of the energy industry.
- understand and reflect technical as well as economic constraints of nuclear energy and fossil fuels.
- understand and analyze the fundamentals of electricity markets and grid fees.
- understand and analyze the relationship between energy generation production, environmental protection and climate change.

Contents

1. Introduction
    - 1.1 Energy Economics and Energy Demand
    - 1.2 Energy Economics Calculations
    - 1.3 Energy Markets
    - 1.4 Goals and Tasks of Energy Policy
2. Fundamentals of the Energy Industry
    - 2.1 Main theorems of thermodynamics and Definitions
    - 2.2 Primary and Secondary Energy Sources
    - 2.3 The Energy Balance
    - 2.4 Energy Markets
    - 2.5 Resource Economics

3. Nuclear Energy
    - 3.1 The foundations of Nuclear Technology
    - 3.2 Nuclear Power Plants
    - 3.3 Nuclear Power Market
    - 3.4 Nuclear Power in Germany, Nuclear Phase-Out and Concepts for Nuclear Fusion

4. Fossil Fuels
    - 4.1 Coal
    - 4.2 Crude Oil Market
    - 4.3 Natural Gas Economy
    - 4.4 Transport and Logistics
    - 4.5 Resources and Reserves

5. Electricity Markets
    - 5.1 Features of Electricity Markets
    - 5.2 Economics of Electrical Grids
    - 5.3 Regulation of Grid Fees
    - 5.4 Electric Power Grids in Germany and the EU
    - 5.5 Unbundling

6. Energy and Environment
    - 6.1 The Greenhouse Gas Problem and Global Warming
    - 6.2 Emissions and Possible Consequences of Climate Change
    - 6.3 Climate Policy and Climate Protection Agreement
    - 6.4 Emissions Trading

Literature

Compulsory Reading

Further Reading

- Glachant, J.M., Joskow P., Politt, M. (2021): Handbook on Electricity Markets. Edward Elgar Publishing, Cheltenham, UK.
- Zweifel, P., Praktiknjo, A., Erdmann, G. (2017): Energy Economics: Theory and Application. Springer,Berlin.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	

Electrical Drive Technology and Fluid Mechanics

Module Code: DLBENGEEDTFM

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	300 h

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

Module Coordinator
N.N. (Electrical Drive Technology) / N.N. (Fluid Mechanics)

Contributing Courses to Module
▪ Electrical Drive Technology (DLBAETWEM01_E) ▪ Fluid Mechanics (DLBMABSM01_E)

Module Exam Type	
Module Exam	**Split Exam** Electrical Drive Technology • Study Format "Distance Learning": Exam, 90 Minutes Fluid Mechanics • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents
Electrical Drive Technology ▪ Magnetic Fields in Electrical Machines ▪ Static Behavior of Electrical Machines ▪ Dynamic Behavior of Electrical Machines ▪ Drive and Control of Electrical Machines ▪ Power Electronics for Electrical Machines ▪ Sensorless Control of Electrical Machines **Fluid Mechanics** ▪ Dimensional analysis ▪ Hydrostatics ▪ Hydrodynamics ▪ Conservation of Mass, Momentum, Energy ▪ Navier-Stokes Equations ▪ Compressible Flows ▪ Incompressible Fluids ▪ Gas Dynamics

Learning Outcomes
Electrical Drive Technology On successful completion, students will be able to ▪ know, model, and explain basic properties of electric drives in steady-state and transient operation. ▪ explain the special features in thermal management and speed control of electrical drives. ▪ select the appropriate drive form for a given problem and perform its design. ▪ discuss the special features of various (partially) electric drive systems in vehicles. **Fluid Mechanics** On successful completion, students will be able to ▪ name the quantities relevant in fluid mechanics. ▪ mathematically describe the fundamentals of fluid mechanics of incompressible and compressible fluids. ▪ describe practical questions through the initial equations of mass, energy, and impulse. ▪ understand the importance of numerics in fluid mechanics. ▪ distinguish laminar and turbulent flows. ▪ explain the basics of gas dynamics.

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 Engineering	All Bachelor Programs in the IT & Technology field

Electrical Drive Technology

Course Code: DLBAETWEM01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E; DLBAETEME01, DLBAETESF01 or DLBENGEEE01

Course Description

Due to current technical and political developments, electric drives - whether in stationary machines, passenger cars or e-bikes - are becoming increasingly important. Electric drives can be found in a variety of forms, designs, and performance classes. Expertise in the specifics of electric drives is one of the key qualifications of electrical engineers. The contents of the module therefore focus on the fundamentals of different types and modes of operation of electric drives.

Course Outcomes

On successful completion, students will be able to

- know, model, and explain basic properties of electric drives in steady-state and transient operation.
- explain the special features in thermal management and speed control of electrical drives.
- select the appropriate drive form for a given problem and perform its design.
- discuss the special features of various (partially) electric drive systems in vehicles.

Contents

1. Magnetic Fields in Electrical Machines
   - 1.1 Coils
   - 1.2 Permanent Magnets
   - 1.3 Energy (Density and Storage)

2. Static Behavior of Electrical Machines
   - 2.1 Torque/Speed Characteristics
   - 2.2 DC Machines
   - 2.3 Synchronous Machines
   - 2.4 Asynchronous Machines

3. Dynamic Behavior of Electrical Machines
   - 3.1 DC Machines

3.2 Synchronous Machines
3.3 Asynchronous Machines

4. Drive and Control of Electrical Machines
   4.1 DC Machines
   4.2 Synchronous Machines
   4.3 Asynchronous Machines

5. Power Electronics for Electrical Machines
   5.1 Voltage Amplifier
   5.2 H-bridge
   5.3 Inverter
   5.4 Duty Cycle and PWM
   5.5 Space Vector Modulation

6. Sensorless Control of Electrical Machines
   6.1 Back-EMF-Based Techniques
   6.2 Anisotropy-Based Techniques
   6.3 Advantages and Disadvantages of Sensorless Techniques
   6.4 Applications

Literature

Compulsory Reading

Further Reading

- Melkebeek, J. A. (2018). Electrical Machines and Drives. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-72730-1
- Pyrhonen, J./Jokinen, T./Hrabovcova, V. (2013): Design of rotating electrical machines. 2nd edition, John Wiley & Sons, Hoboken.
- Vukosavic, S. N. (2013). Electrical Machines. Electrical Machines. Springer New York. https://doi.org/10.1007/978-1-4614-0400-2

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Fluid Mechanics

Course Code: DLBMABSM01_E

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

Course Description

The course teaches the fundamentals of fluid mechanics. A distinction is made between hydrostatics and hydrodynamics as well as between compressible and incompressible fluids. The basic equations of conservation of mass, conservation of momentum, and conservation of energy are introduced in general terms so that students can simplify them to the specific application. Students learn the added value and procedure of dimensional analysis and apply it to the basic equations of fluid mechanics.In addition, the course provides an outlook on more advanced content of fluid mechanics with numerics.

Course Outcomes

On successful completion, students will be able to

- name the quantities relevant in fluid mechanics.
- mathematically describe the fundamentals of fluid mechanics of incompressible and compressible fluids.
- describe practical questions through the initial equations of mass, energy, and impulse.
- understand the importance of numerics in fluid mechanics.
- distinguish laminar and turbulent flows.
- explain the basics of gas dynamics.

Contents

1. Basics
   - 1.1 Subject of Fluid Mechanics
   - 1.2 Fluid
   - 1.3 Characterization of Flows
   - 1.4 Dimensional Analysis

2. Hydrostatics
   - 2.1 Hydrostatic Pressure Distribution
   - 2.2 Forces on Container Walls
   - 2.3 Translational Movement
   - 2.4 Rotatory Movement
   - 2.5 Hydrostatic Lift

3. Transport and Conservation of Mass, Momentum & Energy
   - 3.1 Kinematics of Fluids
   - 3.2 Continuity Equation
   - 3.3 Navier-Stokes Equations
   - 3.4 Energy Equation
   - 3.5 Diffusion and Dissipation

4. Flow Models of Incompressible Fluids
   - 4.1 One-dimensional Flows
   - 4.2 Bidimensional Frictionless Flows
   - 4.3 Bidimensional Flows with Friction
   - 4.4 Throughflows

5. Gas Dynamics
   - 5.1 Introduction to Gas Dynamics
   - 5.2 Basic Equations
   - 5.3 Stationary One-dimensional Case
   - 5.4 One-dimensional Case with Variable Cross Section
   - 5.5 Sonic Booms

6. Advanced Fluid Mechanics
   - 6.1 Dimensionless Balance Equations
   - 6.2 Computational Fluid Dynamics

Literature

Compulsory Reading

Further Reading

- Pozrikidis, C. (2016). Fluid dynamics: Theory, computation, and numerical simulation, third edition. Springer US
- Sharma, A. (2022). Introduction to Computational Fluid Dynamics. Springer International Publishing.
- Visconti, G., & Ruggieri, P. (2020). Fluid Dynamics. Springer International Publishing.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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 ☑ Video ☑ Audio	☑ Practice Exam ☑ Review Book ☑ Online Tests

Simulation and Control of Robots

Module Code: DLBWINWMSSR_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	300 h

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

Module Coordinator
Ha Ngo (Project: Modeling and Simulation of Robots) / Ha Ngo (Project: Introduction to Robot Control)

Contributing Courses to Module
▪ Project: Modeling and Simulation of Robots (DLBROPMSR01_E) ▪ Project: Introduction to Robot Control (DLBROPIRC01_E)

Module Exam Type	
Module Exam	**Split Exam** <u>Project: Modeling and Simulation of Robots</u> • Study Format "Distance Learning": Written Assessment: Project Report <u>Project: Introduction to Robot Control</u> • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents
Project: Modeling and Simulation of Robots Mathematical modeling of robots will be seen from a practical perspective. The students will learn how to build a static or dynamic model of robots in a simulation environment, to perform design, testing, and analysis activities. **Project: Introduction to Robot Control** This course provides an introduction to the design of servo-level robot controllers. The students will learn how to set up a simulation model of a robot which considers the presence of actuators, sensors, and control systems. Standard control approaches will be tested and evaluated.

Learning Outcomes
Project: Modeling and Simulation of Robots On successful completion, students will be able to ▪ perform simulation of dynamic systems. ▪ name issues related to the numeric simulation of continuous-time systems. ▪ implement the dynamic model of a robot in a simulation environment. ▪ generate and discuss valid simulation results . **Project: Introduction to Robot Control** On successful completion, students will be able to ▪ understand the lower levels of a robot control system. ▪ name standard control approaches for robot motion. ▪ implement the controllers and evaluate the performance in simulation .

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 Engineering	All Bachelor Programmes in the IT & Technology fields

Project: Modeling and Simulation of Robots

Course Code: DLBROPMSR01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	either DLBROMK01_E and DLBROMD01_E or DLBROMKD01_E

Course Description

Mathematical modeling of robots is very important to be able to perform design and analysis. In the context of industrial internet of things, or Industry 4.0, the building of a so-called digital twin by means of simulation models is a central activity to many other processes, such as real-time optimization of tasks as well as fault-detection and diagnosis. In this course the students will learn how a mathematical model can be implemented in a simulation environment, to perform analysis, design, and optimization.

Course Outcomes

On successful completion, students will be able to

- perform simulation of dynamic systems.
- name issues related to the numeric simulation of continuous-time systems.
- implement the dynamic model of a robot in a simulation environment.
- generate and discuss valid simulation results .

Contents

- The course provides the basics in simulation of dynamic systems and implementation of simulation models in computer-aided simulation environments. A simulation model for industrial or mobile robots is built and students will learn how to perform analysis of the model, and use it for design optimization.

Literature

Compulsory Reading

Further Reading

- Corke, P. (2017). Robotics, Vision and Control: Fundamental Algorithms In MATLAB® (2nd ed.). Springer International Publishing, Basel.
- Klee, H., & Allen, R. (2017). Simulation of dynamic systems with MATLAB and Simulink (3rd ed.). CRC Press, Boca Raton, Florida.
- Russell, K., Shen, Q., & Sodhi, R. S. (2018). Kinematics and dynamics of mechanical systems : implementation in MATLAB and SimMechanics (2nd ed.). CRC Press, Boca Raton, Florida.

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Slides	☑ Guideline

Project: Introduction to Robot Control

Course Code: DLBROPIRC01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBROPMSR01_E

Course Description

Robot control allows a robot to perform the required task. Complex tasks, sometimes called missions, are subdivided into simpler subtasks that constitute elementary actions to be performed by the robot. The robot control system acts at different levels. This course focuses on the lower levels, which deal with the execution of elementary actions and are based on the real-time interaction of the robot system with the environment as well as with the actuators moving the joints. The students will learn how to implement and evaluate standard control approaches, such as Proportional-Integral-Derivative controllers, on a mathematical model of a robot.

Course Outcomes

On successful completion, students will be able to

- understand the lower levels of a robot control system.
- name standard control approaches for robot motion.
- implement the controllers and evaluate the performance in simulation .

Contents

- This course provides an introduction to the design of servo-level robot controllers. The students will learn how to set up a simulation model of a robot which considers the presence of actuators, sensors, and control systems. Standard control approaches will be tested and evaluated.

Literature

Compulsory Reading

Further Reading

- Corke, P. (2017). Robotics, Vision and Control: Fundamental Algorithms In MATLAB® (2nd ed.). Springer International Publishing, Basel.
- Klee, H., & Allen, R. (2017). Simulation of dynamic systems with MATLAB and Simulink (3rd ed.). CRC Press, Boca Raton, Florida.
- Russell, K., Shen, Q., & Sodhi, R. S. (2018). Kinematics and dynamics of mechanical systems : implementation in MATLAB and SimMechanics (2nd ed.). CRC Press, Boca Raton, Florida.

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Slides	☑ Guideline

Mechatronic Systems and Programming with C/C++

Module Code: DLBENGEMSPC

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 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Torsten Bruns (Mechatronic Systems) / Dr. Hajck Karapetjan (Programming with C/C++)

Contributing Courses to Module

- Mechatronic Systems (DLBROMSY01_E)
- Programming with C/C++ (DLBROEPRS01_E)

Module Exam Type

Module Exam	Split Exam
	<u>Mechatronic Systems</u> • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes <u>Programming with C/C++</u> • Study Format "myStudies": Portfolio • Study Format "Distance Learning": Portfolio

Weight of Module

see curriculum

Module Contents	
Mechatronic Systems ▪ Modeling ▪ Electrical Drives ▪ Machines and Drivetrains ▪ Actuators and Sensors **Programming with C/C++** C and C++ for programming of applications and robots	
Learning Outcomes **Mechatronic Systems** On successful completion, students will be able to ▪ understand the basics of mathematical modeling of engineering systems. ▪ model and simulate common mechatronic systems. ▪ apply mechatronic systems for a given application. ▪ understand the basics of actuators, sensors, and system integration. **Programming with C/C++** On successful completion, students will be able to ▪ know the main characteristics of C and C++ programming languages. ▪ apply C and C++ for programming of applications. ▪ apply C and C++ for programming of robotic systems.	
Links to other Modules within the Study Program This module is similar to other modules in the fields of Engineering and Computer Science & Software Development	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology fields

Mechatronic Systems

Course Code: DLBROMSY01_E

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

Course Description

Numerous processes and products experience an increasing combination of traditional and advanced mechanics with electronics. Especially with information processing, this development leads to a so-called mechatronic system, with the purpose to improve overall performance. This course illustrates the development of mechatronics and focuses on some important aspects, such as modeling techniques (which are relevant for system simulation, design and optimization), common electric drives, machines and drivetrains, actuators and sensors.

Course Outcomes

On successful completion, students will be able to

- understand the basics of mathematical modeling of engineering systems.
- model and simulate common mechatronic systems.
- apply mechatronic systems for a given application.
- understand the basics of actuators, sensors, and system integration.

Contents

1. Introduction
   - 1.1 Mechatronic Systems
   - 1.2 Examples

2. Modeling
   - 2.1 Fundamental Equations
   - 2.2 Energy Balance
   - 2.3 Connection of Process Elements
   - 2.4 Dynamics of Mechanical Systems
   - 2.5 Mechanical Elements

3. Electrical Drives
   - 3.1 Electromagnets
   - 3.2 Direct Current Motors
   - 3.3 Alternating Current Motors

4. Machines and Drivetrains
   - 4.1 Complete Machines
   - 4.2 Characteristics and Stability of Machines
   - 4.3 Motors and Pumps
   - 4.4 Automobile Drivetrain
   - 4.5 Signal Energy
   - 4.6 Applications

5. Actuators and Sensors
   - 5.1 Basic Structures
   - 5.2 Electromechanical Drives
   - 5.3 Hydraulic Actuators
   - 5.4 Pneumatic Actuators
   - 5.5 Unconventional Actuators

Literature

Compulsory Reading

Further Reading

- Boukas, E. K./Al-Sunni, F. M. (2012): Mechatronic systems: Analysis, design and implementation. Springer, Berlin.
- Davim, J. P. (2011): Mechatronics. John Wiley & Sons, Hoboken, NJ.
- Isermann, R. (2005): Mechatronic systems: Fundamentals. Springer, London.
- Janschek, K./Richmond, K. (2012): Mechatronic systems design methods, models, concepts. Springer, Berlin

Study Format myStudies

Study Format	**Course Type**
myStudies	Theory Course

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	Theory Course

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	

Programming with C/C++

Course Code: DLBROEPRS01_E

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

Course Description

C and C++ belong to the class of programming languages which have been adopted in a broad field of applications, ranging from embedded systems (where they are dominant) to fast and reliable user interfaces and industrial applications. In fact, C++ is one of the most popular legacy programming languages for robotics, and a combination of C++ and robotics hardware is used in many leading industries. Knowledge on how to design in and write C/C++ code is an imperative capability for the practicing roboticist, especially in the industrial arena.

Course Outcomes

On successful completion, students will be able to

- know the main characteristics of C and C++ programming languages.
- apply C and C++ for programming of applications.
- apply C and C++ for programming of robotic systems.

Contents

- This course introduces the main aspects of C and C++ programming languages, such as data types, variables, arithmetic expressions, flow control, functions, classes, arrays, and pointers. The programming skills will then be applied to design parts of robotic systems based on popular hardware.

Literature

Compulsory Reading

Further Reading

- Kernighan, B. W. & Ritchie, D. M. (2000). The C Programming Language, Second Edition. Pearson Education.
- Lippman, S. B., Lajoie, J., Moo, B. (2012). C++ Primer, Fifth Edition. Addison Wesley.
- Margolis, M. (2011). Arduino Cookbook. O’Reilly Media.
- Dogan, I. (2021). Nucleo Boards Programming with the STM32CubeIDE. Elektor.

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	☑ Slides	☑ 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	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 ☑ Intensive Live Sessions/Learning Sprint	☑ Slides	☑ Guideline

Agile Project Management and Smart Products

Module Code: DLBENGEAPMSP

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 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Inga Schlömer (Agile Project Management) / Dr. Hajck Karapetjan (Project: Smart Product Solutions)

Contributing Courses to Module

- Agile Project Management (DLBCSAPM01)
- Project: Smart Product Solutions (DLBIEPSPS01)

Module Exam Type

Module Exam	Split Exam
	Agile Project Management • Study Format "myStudies": Written Assessment: Project Report • Study Format "Distance Learning": Written Assessment: Project Report Project: Smart Product Solutions • Study Format "Distance Learning": Oral Project Report • Study Format "myStudies": Oral Project Report

Weight of Module

see curriculum

Module Contents
Agile Project Management In this course, students are taught action competences in the field of agile project management. They will be familiarized with the values, activities, roles, and artifacts of agile procedures using Scrum as an example. **Project: Smart Product Solutions** This course focuses on the application of agile engineering methods for smart product solutions within the framework of a practice-oriented project. The architecture and mechanics of smart product solutions will be described by means of their integrated business model components.

Learning Outcomes
Agile Project Management On successful completion, students will be able to ▪ explain the differences between agile and plan-driven project management. ▪ explain agile principles. ▪ work together in an agile manner according to the values defined in Scrum. ▪ apply the activities defined in Scrum. ▪ take responsibility for the roles defined in Scrum. ▪ create and maintain the artefacts defined in Scrum. ▪ consider the increasing relevance of international, intercultural and virtual collaboration in projects. **Project: Smart Product Solutions** On successful completion, students will be able to ▪ answer the question of the relevance of dynamic business models of smart product solutions for business practice. ▪ describe and analyze smart product solutions by means of the business model architecture and mechanics. ▪ select and apply the right tools from the engineering methodology toolbox of smart product solutions for the modelling and analysis of digital business models in a practice-oriented way. ▪ develop management cockpits to support decision-making in the implementation of smart product solutions.

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 fields of Project Management and Computer Science & Software Development	All Bachelor Programs in the Business & Management and IT & Technology fields

Agile Project Management

Course Code: DLBCSAPM01

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

Course Description

Students will receive a practical introduction to agile project management in this course.
In addition to teaching its individual basic principles, the differences between agile project management and plan-driven project management will be examined in detail. In order to understand and experience agile project management, the values, activities, roles, and artefacts of typical agile procedures are presented using Scrum and then practiced on an example project.

Course Outcomes

On successful completion, students will be able to

- explain the differences between agile and plan-driven project management.
- explain agile principles.
- work together in an agile manner according to the values defined in Scrum.
- apply the activities defined in Scrum.
- take responsibility for the roles defined in Scrum.
- create and maintain the artefacts defined in Scrum.
- consider the increasing relevance of international, intercultural and virtual collaboration in projects.

Contents

- This course teaches students various skills in the field of agile project management. In contrast to plan-driven project management, the principles of agility used in modern software development are taught. Using the example of Scrum, students will acquire skills in applying an agile approach, and then apply their knowledge of respective roles and activities in a simple project to gain initial practical experience, documenting it in a project report. The content of the projects results from the individual abilities and requirements of the students.

Literature
Compulsory Reading
Further Reading ▪ Apress. Agile Alliance (2021). Subway Map to Agile Practices. ▪ Beck, K. et al. (2001). Manifesto for Agile Software Development. ▪ Chovanova, H. et al. (2020). Agile Project Management – What is It? Publisher: IEEE. In 18th International Conference on Emerging eLearning Technologies and Applications (ICETA), Emerging eLearning Technologies and Applications (ICETA), 2020 18th International Conference. ▪ Dalton, Jeff (2019). Great Big Agile. An OS for Agile Leaders. ▪ Douglass, B. P. (2016). Agile systems engineering. Morgan Kaufmann, p. 151-160. ▪ Hohl, P., Klünder, J., van Bennekum, A., Lockard, R., Gifford, J., Münch, J., Stupperich, M., & Schneider, K. (2018). Back to the future: origins and directions of the “Agile Manifesto” – views of the originators. Journal of Software Engineering Research and Development, 6(1). ▪ Project Management Institute (2017). Agile Practice Guide. Project Management Institute. ▪ Measey P./Radtac (2015). Agile Foundations - Principles, Practices and Frameworks. BCS The Chartered Institute for IT, p. 131-140, p. 148-152. ▪ Schwaber, K./Sutherland, J. (2020). The Scrum Guide. ▪ Hohl, P., Klünder, J., van Bennekum, A., Lockard, R., Gifford, J., Münch, J., Stupperich, M., & Schneider, K. (2018). Back to the future: origins and directions of the “Agile Manifesto” – views of the originators. Journal of Software Engineering Research and Development, 6(1).

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ 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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ Guideline

Project: Smart Product Solutions

Course Code: DLBIEPSPS01

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

Course Description

Smart product solutions have the potential to increase the efficiency of existing business models in the context of digital transformation. In addition to the expansion and optimization of traditional business models, smart product solutions also create completely new business models, in which, for example, revenues are not linked to the transfer of ownership of the product, but to its use. In practice, however, the design and analysis of smart product solutions and their business models is difficult for many companies, as the complexity of these smart solutions results in insufficient methodological know-how. Against this background, the students apply various instruments and modelling tools to describe and analyze smart product solutions within the framework of a practice-oriented project.

Course Outcomes

On successful completion, students will be able to

- answer the question of the relevance of dynamic business models of smart product solutions for business practice.
- describe and analyze smart product solutions by means of the business model architecture and mechanics.
- select and apply the right tools from the engineering methodology toolbox of smart product solutions for the modelling and analysis of digital business models in a practice-oriented way.
- develop management cockpits to support decision-making in the implementation of smart product solutions.

Contents

- By means of an agile engineering approach, students learn about the complex interrelationships of smart product solutions in a project-oriented setting. In addition to the structural description, students also gain a comprehensive insight into the quantitative modeling of the dynamic interrelationships of smart product solutions and their business models at a specific product solution level. The consistent application of techniques and tools from the engineering construction kit of smart product solutions enables the development of new business models as well as the adaptation of existing business models through the flexible configuration of interdependent components. Radical innovations with a completely new benefits are just as possible as incremental adjustments in a more evolutionary transformation process. Through the abstract description of the architecture and the dynamic modelling of the mechanics of the smart product solutions and their business models, students learn the basics for effective decision support in practice, which ensures continuous learning in a digital world with growing dynamic complexity.

Literature

Compulsory Reading

Further Reading

- Boßlau, M. (2021). Business Model Engineering for Smart Product-Service Systems. Procedia CIRP, 104, 565–570.
- Boßlau, M. (2021). Digital Engineering of Dynamic Business Models for Smart Product-Service Systems (Proceedings of the International System Dynamics Conference). Chicago. (Available on the Internet)
- Negash, Y. T., & Calahorrano Sarmiento, L. S. (2023). Smart product-service systems in the healthcare industry: Intelligent connected products and stakeholder communication drive digital health service adoption. Heliyon, 9(2), e13137.
- Pöppelbuß, J., & Durst, C. (2019). Smart Service Canvas – A tool for analyzing and designing smart product-service systems. Procedia CIRP, 83, 324–329.
- Zawadzki, P./Żywicki, K. (2016): Smart Product Design and Production Control for Effective Mass Customization in the Industry 4.0 Concept. Management and Production Engineering Review, 7(3), 105–112.

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 ☑ 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	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	
Learning Material	**Exam Preparation**
☑ Slides	☑ Guideline

Pentesting and DevSecOps

Module Code: DLBENGEPD

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	

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

Module Coordinator
Prof. Dr. Ahmed Taha (System Pentesting Basics) / N.N. (DevSecOps and Common Software Weaknesses)

Contributing Courses to Module

- System Pentesting Basics (DLBCSESPB01_E)
- DevSecOps and Common Software Weaknesses (DLBCSEDCSW01_E)

Module Exam Type

Module Exam	Split Exam
	System Pentesting Basics • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes DevSecOps and Common Software Weaknesses • Study Format "myStudies": Written Assessment: Written Assignment • Study Format "Distance Learning": Written Assessment: Written Assignment

Weight of Module

see curriculum

Module Contents

System Pentesting Basics

- Penetration testing process
- Host-based penetration testing
- Exploitation of network services
- Web App penetration testing
- System hardening
- Ethical hacking

DevSecOps and Common Software Weaknesses

- Common code bugs
- Software Development Lifecycle
- DevOps
- DevSecOps
- Vulnerability reporting and bug bounty programs
- Patch management

Learning Outcomes

System Pentesting Basics

On successful completion, students will be able to

- understand the basic organizational and compliance needs for penetration testing.
- identify the relevant components of modern-day IT system that may be exploitable.
- understand the underlying processes comprising a penetration testing.
- understand the most common attack vectors associated to hosts, networks and Web Apps as well as how to defend against those.
- familiarize themselves with real-world tools used by professional penetration testers.

DevSecOps and Common Software Weaknesses

On successful completion, students will be able to

- avoid common software implementation and design mistakes.
- design a software development lifecycle process based on DevSecOps principles.
- incorporate vulnerability reporting and response into the SDL.
- organize and manage a bug bounty program.
- implement and manage a corporate patch management process.

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 fields of Computer Science & Software Development	All Bachelor Programs in the IT & Technology fields

System Pentesting Basics

Course Code: DLBCSESPB01_E

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

Course Description

System penetration testing is a vital process for finding and supporting the mitigation of vulnerabilities in IT systems before the attackers can exploit them. For that reason, many organizations employ such “pentesters”, or ethical hackers, to test their software and hardware base (connectivity included) and fix the security issues that are found. This has become a cornerstone of modern security concepts. However, in order to be successful in this endeavor, a good knowledge of the different types of targeted IT systems is required. We refer to hosts, networks, Web Apps, and even cloud computing. In this course we present the fundamental aspects of IT systems, along with the processes, tools and techniques that comprise the industrial practice of penetration testing. Equipped with this knowledge, students will understand the mechanisms of a given attack, and start down the path of pentesting themselves.

Course Outcomes

On successful completion, students will be able to

- understand the basic organizational and compliance needs for penetration testing.
- identify the relevant components of modern-day IT system that may be exploitable.
- understand the underlying processes comprising a penetration testing.
- understand the most common attack vectors associated to hosts, networks and Web Apps as well as how to defend against those.
- familiarize themselves with real-world tools used by professional penetration testers.

Contents

1. Penetration Testing Goals and Industrial Perspective
   - 1.1 Organizational Benefits
   - 1.2 Ethical Hacking Framework
   - 1.3 Legal and Compliance Aspects
   - 1.4 Responsible Disclosure of Vulnerabilities
   - 1.5 Professional Penetration Testing Services and Certifications

2. Background Concepts
   - 2.1 Operating Systems
   - 2.2 Hardware Architectures
   - 2.3 Networking and Protocols

Literature
Compulsory Reading
Further Reading ▪ Hooley, G., Piercy, N., & Nicoulaud, B. (2011). Marketing strategy and competitive positioning (5th ed.). Prentice Hall. ▪ Kaplan, R., Norton, D., & Rugelsjoen, B. (2010). Managing alliances with the balanced scorecard. Harvard Business Review, 88(1/2), 114–120. ▪ Hackman, J. R., & Walton, R. E. (1986). Leading groups in organizations. In P. S. Goodman (Ed.), Designing effective work groups (pp. 72–119). Jossey-Bass.

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	

DevSecOps and Common Software Weaknesses

Course Code: DLBCSEDCSW01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBCSESPB01_E or DLBCSESPB01_D

Course Description

Modern organizations are run by software to some degree or another. In many cases, it is the custom software in business processes or products that is the key differentiator. But even companies that do no development of their own, are dependent on software and understanding software vulnerabilities is vital to their operations, as recent ransomware attacks have shown.In this course, we look at modern software development and lifecycle processes. Since its beginnings with Extreme Programming, there has been a shift away from the waterfall design to an agile development process. More recently, the Shift-Left movement has advocated for security to be considered from the start and not as an afterthought.In order to design secure software, it is naturally important to understand how insecurities creep into code. We look at the most important enumerations of software bugs: OWASP and Mitre’s CWEs. Lastly, patch management has become the most import defensive tool for an organization. We look at this topic both from a software development perspective as well as from the customer’s point of view.

Course Outcomes

On successful completion, students will be able to

- avoid common software implementation and design mistakes.
- design a software development lifecycle process based on DevSecOps principles.
- incorporate vulnerability reporting and response into the SDL.
- organize and manage a bug bounty program.
- implement and manage a corporate patch management process.

Contents

1. Introduction to the software development process
   - 1.1 Traditional software development: Waterfall design
   - 1.2 Iterative design
   - 1.3 Agile software development
   - 1.4 Operations as a separate process
   - 1.5 Infrastructure as code
   - 1.6 Merging Development and Operations: DevOps

2. DevOps best practices
   - 2.1 Coding: code development and review, source code management tools, code merging.

2.2 Building: continuous integration tools, build status.
2.3 Testing: continuous testing tools that provide quick and timely feedback on business risks.
2.4 Packaging: artifact repository, application pre-deployment staging.
2.5 Releasing: change management, release approvals, release automation.
2.6 Configuring: infrastructure configuration and management, infrastructure as code tools.
2.7 Monitoring: applications performance monitoring, end-user experience.

3. Sources of security bugs
3.1 General classes of bugs
3.2 Looking at the OWASP top ten
3.3 Looking at the Mitre CWE™

4. DevSecOps
4.1 Protection goals
4.2 Threat modeling
4.3 Choice of programming language, tool chain and infrastructure
4.4 Linting for code security issues
4.5 Testing for security
4.6 Security by design/Shifting Left
4.7 Security as a people problem
4.8 Designing in a bug reporting and response process
4.9 Managing a bug bounty program

5. Patch management
5.1 Dilemma: software update churn vs security
5.2 Vulnerability disclosures and the Mitre CVE™ process
5.3 Coordinated vulnerability disclosure
5.4 Program security vs Software-as-a-Service patching
5.5 Deployment strategies for catching bugs early

6. Summary and research problems

Literature
Compulsory Reading
Further Reading ▪ Forsgren, N., Humble, J., & Kim, G. (2018). Accelerate: The science behind DevOps: Building and scaling high performing technology organizations (Illustrated ed.). IT Revolution Press. ▪ Kim, G., Humble, J., Debois, P., Willis, J., & Forsgren, N. (2021). The DevOps handbook: How to create world-class agility, reliability, & security in technology organizations (2nd ed.). IT Revolution Press. ▪ Toesland, F. (2019). The rise of DevSecOps. Computer Weekly.

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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	
Learning Material ☑ Course Book ☑ Video ☑ Audio ☑ Slides	**Exam Preparation** ☑ Online Tests ☑ Guideline

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Guideline
	☑ Audio	
	☑ Slides	

Machine Learning - Supervised and Unsupervised Learning

Module Code: DLBENGEMLSUL

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLBDSMFC01, DLBDSMFLA01, DLBDSSPDS01-01, DLBDSSIS01	BA	10	300 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) / Prof. Dr. Christian Müller-Kett (Machine Learning - Unsupervised Learning and Feature Engineering)

Contributing Courses to Module
▪ Machine Learning - Supervised Learning (DLBDSMLSL01) ▪ Machine Learning - Unsupervised Learning and Feature Engineering (DLBDSMLUSL01)

Module Exam Type	
Module Exam	**Split Exam** <u>Machine Learning - Supervised Learning</u> • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes <u>Machine Learning - Unsupervised Learning and Feature Engineering</u> • Study Format "Distance Learning": Written Assessment: Case Study • Study Format "myStudies": Written Assessment: Case Study

Weight of Module
see curriculum

Module Contents

Machine Learning - Supervised Learning

- Types of machine learning
- Classification
- Regression
- Support vector machines
- Decision trees

Machine Learning - Unsupervised Learning and Feature Engineering

- Unsupervised machine learning
- Clustering
- Dimensionality reduction
- Manifold learning
- Feature engineering
- Feature selection
- Automation of feature generation and selection

Learning Outcomes

Machine Learning - Supervised Learning

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.

Machine Learning - Unsupervised Learning and Feature Engineering

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.

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 fields of Data Science & Artificial Intelligence	All Bachelor Programmes in the IT & Technology fields

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	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

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	Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Course Book ☑ Video ☑ Audio ☑ Slides	**Exam Preparation** ☑ Online Tests

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Course Book ☑ Video ☑ Audio ☑ Slides	**Exam Preparation** ☑ Online Tests

Autonomous Driving

Module Code: DLBDSEAD

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	BA	10	150 h

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

Module Coordinator

Ha Ngo (Self-Driving Vehicles) / Ha Ngo (Seminar: Current Topics and Trends in Self-Driving Technology)

Contributing Courses to Module

- Self-Driving Vehicles (DLBDSEAD01)
- Seminar: Current Topics and Trends in Self-Driving Technology (DLBDSEAD02)

Module Exam Type

Module Exam	Split Exam
	Self-Driving Vehicles • Study Format "Duales myStudium": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Seminar: Current Topics and Trends in Self-Driving Technology • Study Format "Distance Learning": Written Assessment: Research Essay • Study Format "Duales myStudium": Written Assessment: Research Essay

Weight of Module

see curriculum

Module Contents

Self-Driving Vehicles

- Safety standards
- Sensor fusion
- Computer vision
- Localization & motion
- Motion planning

Seminar: Current Topics and Trends in Self-Driving Technology

The seminar covers current topics of autonomous vehicles. The choice of topics can include (but are not limited to) recent technical advances as well as philosophical issues or implications for society, law, or relevant industries.

Learning Outcomes

Self-Driving Vehicles

On successful completion, students will be able to

- cite relevant safety standards.
- grasp the concepts of sensors and sensor fusion.
- apply computer vision techniques to detect features.
- evaluate images in terms of semantic segmentation.
- understand motion models and localization approaches.
- utilize motion planning techniques.

Seminar: Current Topics and Trends in Self-Driving Technology

On successful completion, students will be able to

- transfer theoretical knowledge and methods to new domains.
- understand recent developments in self-driving vehicles.
- create new insights based on detailed studies of current research and technology.

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 Engineering	All Bachelor Programmes in the IT & Technology fields

Self-Driving Vehicles

Course Code: DLBDSEAD01

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

Course Description

This course focuses on the foundations of autonomous vehicles and starts with a detailed introduction to relevant safety standards in terms of functional and IT security.This course continues with a presentation of the concept of sensor fusion and discusses relevant aspects of computer vision techniques such as feature detection, calibration, and semantic segmentation.A large part of the course concerns localization and motion planning. Relevant motion models are introduced and localization techniques such as odometry, triangulation, and satellite-based systems are discussed in detail, along with path planning, motion prediction, and trajectory generation.

Course Outcomes

On successful completion, students will be able to

- cite relevant safety standards.
- grasp the concepts of sensors and sensor fusion.
- apply computer vision techniques to detect features.
- evaluate images in terms of semantic segmentation.
- understand motion models and localization approaches.
- utilize motion planning techniques.

Contents

1. Sensors
   - 1.1 Physical principles of sensors
   - 1.2 Types of sensors
   - 1.3 Sensor calibration
   - 1.4 Application scenarios

2. Sensor Fusion
   - 2.1 Elaborating data from sensors
   - 2.2 The Kalman filter
   - 2.3 Object tracking

3. Computer Vision
   - 3.1 Pixels and filters

3.2 Feature detection
3.3 Semantic segmentation

4. Localization & Motion
   4.1 Motion models
   4.2 Trilateration
   4.3 Satellite-based localization

5. Motion planning
   5.1 Mission planning
   5.2 Behavior Planning
   5.3 Local Planning

6. Safety Standards
   6.1 Functional Safety
   6.2 Safety of Intended Functionality
   6.3 IT Security

Literature

Compulsory Reading

Further Reading

- Sciavicco, L., Villani, L., Oriolo, G., & Siciliano, B. (2009). Robotics : modelling, planning andcontrol. Springer.
- Thrun, S. (2002). Probabilistic robotics. Communications of the ACM, 45(3), 52-57.
- LaValle, S. M. (2006). Planning algorithms. Cambridge University Press.
- Watzenig, D., & Horn, M. (2016). Automated driving: Safer and more efficient future driving. Springer.

Study Format Duales myStudium

Study Format	Course Type
Duales myStudium	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	

Seminar: Current Topics and Trends in Self-Driving Technology

Course Code: DLBDSEAD02

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

Course Description
This courses focuses on recent developments in the field of self-driving vehicles. Following the course Self-Driving Vehicles (DLBDSEAD01), in this course students will focus on a particular topic in the context of autonomous driving, applying the knowledge they have obtained in the first course.Finally, a research essay will be written.
Course Outcomes
On successful completion, students will be able to ▪ transfer theoretical knowledge and methods to new domains. ▪ understand recent developments in self-driving vehicles. ▪ create new insights based on detailed studies of current research and technology.
Contents
▪ The seminar covers current topics of autonomous vehicles. The choice of topics can include (but are not limited to) recent technical advances as well as philosophical issues or implications for society, law, or relevant industries.

Literature
Compulsory Reading
Further Reading ▪ Ben-Ari, M./Mondada, F. (2018): Elements of robotics. Springer, Cham. ▪ European Union. (2001): Directive 2001/95/EG. (Available on the Internet) ▪ Fisher, R. B., et al. (2016): Dictionary of computer vision and image processing. John Wiley & Sons, Chichester. ▪ Smith, D. J./Simpson, K. (2016): The safety critical systems handbook. 4th ed., Elsevier, Oxford. ▪ Smith, D. J. (2017): Reliability, maintainability, and risk. 9th ed., Elsevier, Oxford. ▪ Society of Automobile Engineers International. (2012): SAE J3061. (Available on the Internet) ▪ Szelski, R. (2022): Computer vision: Algorithms and applications. 2nd ed., Springer VS, Wiesbaden. ▪ Wang, P. K.-C. (2015): Visibility-based optimal path and motion planning (vol. 568). Springer, Cham.

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	**Learning Material**	**Exam Preparation**
☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	☑ Slides	☑ Guideline

Study Format Duales myStudium

Study Format	Course Type
Duales myStudium	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	**Learning Material**	**Exam Preparation**
☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	☑ Slides	☑ Guideline

Embedded Systems, Microcontrollers and Logical Circuits

Module Code: DLBENGEESMLC

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	300 h

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

Module Coordinator

Jacko Nudzor (Embedded Systems) / Prof. Dr. Marian Benner-Wickner (Project: Microcontrollers and Logical Circuits)

Contributing Courses to Module

- Embedded Systems (DLBROES01_E)
- Project: Microcontrollers and Logical Circuits (DLBAETPMLS01_E)

Module Exam Type

Module Exam	Split Exam
	Embedded Systems • Study Format "Distance Learning": Exam, 90 Minutes Project: Microcontrollers and Logical Circuits • Study Format "Distance Learning": Oral Project Report

Weight of Module

see curriculum

Module Contents

Embedded Systems

- Embedded systems architecture
- Embedded hardware
- Embedded software
- Embedded Operating Systems
- Distributed systems and IoT architecture

Project: Microcontrollers and Logical Circuits

The students should work independently through the complete flow of logic circuit design on the basis of a given problem. This includes the following steps: setting up a concept, module/ component design, programming the modules, simulation and testing/implementation on a development board.

Learning Outcomes

Embedded Systems

On successful completion, students will be able to

- understand the architecture of embedded systems.
- understand real-time embedded systems.
- design the main architecture of embedded systems for robotics, automation and IoT infrastructure.

Project: Microcontrollers and Logical Circuits

On successful completion, students will be able to

- link the theoretical knowledge acquired in previous courses and apply it to a practical problem.
- independently plan solutions for simple digital circuits.
- successfully apply industry-used logic circuit design tools or usemicrocontroller programming tools.

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 Engineering	All Bachelor Programs in the IT & Technology field

Embedded Systems

Course Code: DLBROES01_E

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

Course Description

To realize working engineering systems, embedded systems are required. Through embedding microprocessor-based systems capable of networking, data exchange and processing, the functionality of products and systems can be enhanced in terms of features, precision, accuracy, dynamic properties, intelligence. Actually, an embedded system is where everything begins. This course provides the basics on embedded system, by focusing on the architectural patterns of modern systems and platforms. The embedded hardware and software aspects are addressed. This course also introduces connectivity and networking aspects, which are required to build distributed systems for the internet of things and the industrial internet of things (finally yielding Cyber-Physical Systems).

Course Outcomes

On successful completion, students will be able to

- understand the architecture of embedded systems.
- understand real-time embedded systems.
- design the main architecture of embedded systems for robotics, automation and IoT infrastructure.

Contents

1. Introduction
   - 1.1 Embedded Systems Overview
   - 1.2 Hardware Elements of an Embedded System
   - 1.3 Standards, Compilers and Programming Languages

2. Elements of a Microcontroller
   - 2.1 Central Processing Units
   - 2.2 Volatile and non-volatile memory
   - 2.3 Digital/Analog Input/Output
   - 2.4 Timing peripherals
   - 2.5 Communication peripherals

3. Programming a Microcontroller

	3.1	Bone Structure of a Microcontroller Software
	3.2	Low-Level Programming
	3.3	Usage of Middle-Level Libraries
	3.4	Common IDEs and Tools
4.	Embedded Operating Systems	
	4.1	Task Management
	4.2	Scheduler
	4.3	Examples of Embedded Operating Systems
5.	Distributed Systems and IoT Architecture	
	5.1	Network Interfaces
	5.2	The Internet Protocol
	5.3	Examples of Distributed Systems

Literature

Compulsory Reading

Further Reading

- Noergaard, T. (2013). Embedded systems architecture: A comprehensive guide for engineers and programmers (2nd ed.). Newnes.
- White, E. (2011). Making embedded systems: Design patterns for great software. O'Reilly Media.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	

Project: Microcontrollers and Logical Circuits

Course Code: DLBAETPMLS01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBAETDIT01_E

Course Description

The "Project: Microcontrollers and Logic Circuits" is intended to give students the opportunity to combine previously acquired knowledge of digital circuits with practical skills and to apply it to new problems. The handling of microcontrollers and logic circuits is a key qualification for many jobs in industry. In many electronic products with limited functionality, microcontrollers are used because of their special advantages. In edge computing, image processing, prototypes for communication networks and also for the realization of artificial intelligence, logic circuits are often used, either to provide a fast result or to meet special requirements. The "Project: Microcontroller and Logic Circuits" gives students the chance to develop their own microcontroller application or logic circuit.

Course Outcomes

On successful completion, students will be able to

- link the theoretical knowledge acquired in previous courses and apply it to a practical problem.
- independently plan solutions for simple digital circuits.
- successfully apply industry-used logic circuit design tools or usemicrocontroller programming tools.

Contents

- In the "Project: Microcontroller and Logic Circuits" the students have to work through the programming of an application on a microcontroller or the complete flowof the design of logic circuits independently on the basis of a given problem. The students will be given a catalog of possible problems. It is up to the students whether they solve the problem by a microcontroller application or by a logic circuit.
- The problems are supposed to be simple tasks as they are often encountered in industry, for example the reading of a sensor and conditional switching of an output, if a certain temperature, acceleration or light intensity is measured. Alternatively, interested students should also have the opportunity to contribute their own problems. In solving the problems, the students combine what they have learned in previous lectures with practical skills that they will acquire while working on the project. In addition tools will be applied that are also used in industry when working on the project.
- By the end of the project, students will have independently developed their own microcontrollerapplication or a separate logic circuit will be implemented.

- If the students decide to solve their project with a microcontroller application, the steps to be carried out as well as the report to be submitted should include the following points:
  - Developing a concept for solving the problem: Based on theproblem, students should develop a concept and document how the problem can be solved with a microcontroller.
  - Familiarization with the programming of microcontrollers: Based on their knowledge ofthe Python programming language, students will learn how to program microcontrollers using C++ and document their progress.
  - Transfer the concept into functional blocks and functions: Students decomposetheir concept into individual functional blocks and functions. They describe the interfaces between the blocks and the flow of the functions.
  - Implementing the code: Students program all functions. The procedure is documented and discussed.
  - Testing of the project on the target hardware (e.g. MikroElektronika MIKROE-483) and creation of the project documentation: Finally, the functionality of the solution is verifiedon a development board.
- Should students decide to solve their project with a logic circuit,then the steps to be taken, as well as the report to be submitted, should include the following points:
  - Developing a concept for solving the problem: Based on the problem, students should develop a concept and document how the problem can be solved with a logic circuit.
  - Translating the concept into a logical circuit at module/component level:
The students break down their concept into individual components and describe the interfaces between the components, as well as the functional flow within the components.
  - Programming the modules: The previously specified components are programmed by the students in VHDL.
  - Simulation of the logic circuit: Testbenches are created for the individual components, as well as for the overall system, and their function is simulated. The results are documented and discussed.
  - Testing the project on the target hardware (e.g. Seeed Spartan Edge Accelerator Board - Arduino FPGA Shield) and creating the project documentation: Finally, the functionality of the solution is verified on a development board.
- Ideally, the students will work off, within the framework of the "Project: Microcontroller and logical circuits", all the points mentioned above for a solution path of their choice.

Literature
Compulsory Reading
Further Reading ▪ Parab, J./Shelake, V./Kamat, R./Naik, G. (2007): Exploring C for Microcontrollers: A Hands on Approach. 1st edition, Springer Netherlands, Dordrecht ▪ LaMeres, B. J. (2016): Introduction to Logic Circuits & Logic Design with VHDL. Springer International Publishing, Basel. ▪ LaMeres, B. J. (2019): Quick Start Guide to VHDL. Springer International Publishing, Basel.

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	
Learning Material ☑ Slides	**Exam Preparation** ☑ Guideline

Embedded Systems and Programming with C/C++

Module Code: DLBENGEESPC

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 1 semester	WiSe/SoSe	English

Module Coordinator
Jacko Nudzor (Embedded Systems) / Dr. Hajck Karapetjan (Programming with C/C++)

Contributing Courses to Module
▪ Embedded Systems (DLBROES01_E) ▪ Programming with C/C++ (DLBROEPRS01_E)

Module Exam Type	
Module Exam	**Split Exam** Embedded Systems • Study Format "Distance Learning": Exam, 90 Minutes Programming with C/C++ • Study Format "myStudies": Portfolio • Study Format "Distance Learning": Portfolio
Weight of Module see curriculum	

Module Contents

Embedded Systems

- Embedded systems architecture
- Embedded hardware
- Embedded software
- Distributed systems and IoT architecture
- Embedded operating systems

Programming with C/C++

- C and C++ for programming of applications and robots

Learning Outcomes

Embedded Systems

On successful completion, students will be able to

- understand the architecture of embedded systems.
- understand real-time embedded systems.
- design the main architecture of embedded systems for robotics, automation and IoT infrastructure.

Programming with C/C++

On successful completion, students will be able to

- know the main characteristics of C and C++ programming languages.
- apply C and C++ for programming of applications.
- apply C and C++ for programming of robotic systems.

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 fields of Engineering and Computer Science & Software Development	All Bachelor Programmes in the IT & Technology fields

Embedded Systems

Course Code: DLBROES01_E

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

Course Description

To realize working engineering systems, embedded systems are required. Through embedding microprocessor-based systems capable of networking, data exchange and processing, the functionality of products and systems can be enhanced in terms of features, precision, accuracy, dynamic properties, intelligence. Actually, an embedded system is where everything begins. This course provides the basics on embedded system, by focusing on the architectural patterns of modern systems and platforms. The embedded hardware and software aspects are addressed. This course also introduces connectivity and networking aspects, which are required to build distributed systems for the internet of things and the industrial internet of things (finally yielding Cyber-Physical Systems).

Course Outcomes

On successful completion, students will be able to

- understand the architecture of embedded systems.
- understand real-time embedded systems.
- design the main architecture of embedded systems for robotics, automation and IoT infrastructure.

Contents

1. Introduction
   - 1.1 Embedded Systems Overview
   - 1.2 Hardware Elements of an Embedded System
   - 1.3 Standards, Compilers and Programming Languages
2. Elements of a Microcontroller
   - 2.1 Central Processing Units
   - 2.2 Volatile and non-volatile memory
   - 2.3 Digital/Analog Input/Output
   - 2.4 Timing peripherals
   - 2.5 Communication peripherals
3. Programming a Microcontroller

Literature

Compulsory Reading

Further Reading

- Noergaard, T. (2013). Embedded systems architecture: A comprehensive guide for engineers and programmers (2nd ed.). Newnes.
- White, E. (2011). Making embedded systems: Design patterns for great software. O’Reilly Media.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Programming with C/C++

Course Code: DLBROEPRS01_E

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

Course Description

C and C++ belong to the class of programming languages which have been adopted in a broad field of applications, ranging from embedded systems (where they are dominant) to fast and reliable user interfaces and industrial applications. In fact, C++ is one of the most popular legacy programming languages for robotics, and a combination of C++ and robotics hardware is used in many leading industries. Knowledge on how to design in and write C/C++ code is an imperative capability for the practicing roboticist, especially in the industrial arena.

Course Outcomes

On successful completion, students will be able to

- know the main characteristics of C and C++ programming languages.
- apply C and C++ for programming of applications.
- apply C and C++ for programming of robotic systems.

Contents

- This course introduces the main aspects of C and C++ programming languages, such as data types, variables, arithmetic expressions, flow control, functions, classes, arrays, and pointers. The programming skills will then be applied to design parts of robotic systems based on popular hardware.

Literature

Compulsory Reading

Further Reading

- Kernighan, B. W. & Ritchie, D. M. (2000). The C Programming Language, Second Edition. Pearson Education.
- Lippman, S. B., Lajoie, J., Moo, B. (2012). C++ Primer, Fifth Edition. Addison Wesley.
- Margolis, M. (2011). Arduino Cookbook. O’Reilly Media.
- Dogan, I. (2021). Nucleo Boards Programming with the STM32CubeIDE. Elektor.

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	☑ Slides	☑ 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	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 ☑ Intensive Live Sessions/Learning Sprint	☑ Slides	☑ Guideline

Smart Services

Module Code: DLBINGSS_E

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 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Holger Klus (Smart Services I) / Prof. Dr. Holger Klus (Smart Services II)

Contributing Courses to Module

- Smart Services I (DLBINGSS01_E)
- Smart Services II (DLBINGSS02_E)

Module Exam Type

Module Exam	Split Exam
	<u>Smart Services I</u> • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes <u>Smart Services II</u> • Study Format "myStudies": Written Assessment: Project Report • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

Module Contents
Smart Services I ▪ 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 **Smart Services II** Analysis of a selected topic of Smart Services and design of a self-chosen assignment in a prototyping environment.

Learning Outcomes
Smart Services I 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. **Smart Services II** 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.

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 fields of Computer Science & Software Development	All Bachelor Programs in the IT & Technology fields

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 ▪ Chignell, M. et al. (Hrsg.) (2010): The Smart Internet. Current Research and Future Applications. Springer. ▪ Evans, E. (2003): Domain-Driven Design. Tackling Complexity in the Heart of Software. Addison-Wesley, Upper Saddle River. ▪ Hohpe, G./Woolf, B./Brown, K. (2012): Enterprise Integration Patterns. Designing, Building, and Deploying Messaging Solutions. 16th edition, Addison-Wesley. ▪ Nielsen, L. (2013): Personas – User Focused Design. Springer. ▪ 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	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Study Format Distance Learning

Study Format Distance Learning	**Course Type** Theory Course

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Course Book ☑ Video ☑ Audio ☑ Slides	**Exam Preparation** ☑ Practice Exam ☑ Online Tests

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ 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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ Guideline

Renewable Energies

Module Code: DLBAETWEE_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E; DLBAETEME01_E	BA	10	300 h

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

Module Coordinator
N.N. (Power Plant Technology) / N.N. (Regenerative Energy)

Contributing Courses to Module
▪ Power Plant Technology (DLBAETWEE01_E) ▪ Regenerative Energy (DLBAETWEE02_E)

Module Exam Type	
Module Exam	**Split Exam** Power Plant Technology • Study Format "Distance Learning": Exam, 90 Minutes Regenerative Energy • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents

Power Plant Technology

- Introduction to Energy Conversion and Types of Energy Carriers
- Fundamentals of Thermodynamics
- Fossil-Fuel Power Station Processes and Network Layouts for Energy Transmission

Regenerative Energy

- Basic Terms of Renewable Energy
- Renewable Generation of Heat
- Renewable Energy Generation with Solar Power, Hydropower and Wind Power
- Utilization of Biomass and Waste
- Political Framework Conditions for Renewable Energies

Learning Outcomes

Power Plant Technology

On successful completion, students will be able to

- understand the basic power plant processes.
- understand thermodynamic fundamentals of power plant engineering.
- calculate efficiencies of processes.
- calculate processes for energy conversion.
- understand the network layout for energy transmission.

Regenerative Energy

On successful completion, students will be able to

- reproduce and understand the basic concepts of renewable energy.
- understand processes of geothermal and solar thermal energy.
- understand the function of heat pumps and design associated processes.
- understand processes for generating energy with wind power, hydropower, biomass and solar power.
- calculate energy generation with wind power, hydropower, biomass and solar power.

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 Engineering	All Bachelor Programs in the IT & Technology fields

Power Plant Technology

Course Code: DLBAETWEE01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E; DLBAETEME01_E

Course Description

The aim of the course is to give students an overview of interrelationships in power engineering. Different power plant processes for energy conversion are considered and analyzed how electrical energy can be generated by them and subsequently be transmitted through the electrical grid.

Course Outcomes

On successful completion, students will be able to

- understand the basic power plant processes.
- understand thermodynamic fundamentals of power plant engineering.
- calculate efficiencies of processes.
- calculate processes for energy conversion.
- understand the network layout for energy transmission.

Contents

1. Introduction to Energy Conversion
    - 1.1 Types of Energy
    - 1.2 Basic Terms of Power Plant Technology
    - 1.3 Thermal Energy and Electrical Energy
    - 1.4 Energy Conversion
    - 1.5 Energy Conversion Efficiency

2. Types of Energy Carriers
    - 2.1 Primary Energy Carriers
    - 2.2 Secondary Energy Carriers
    - 2.3 Fuels and their Properties

3. Fundamentals of Thermodynamics
    - 3.1 First Law of Thermodynamics
    - 3.2 Internal Energy, Heat and Thermodynamic Work
    - 3.3 Enthalpy
    - 3.4 Second Law of Thermodynamics

3.5	Entropy
4.	Thermodynamic Power Plant Processes
4.1	Basics of Thermodynamic Cycles
4.2	Heat Engines
4.3	Changes of State Functions in Power Plant Processes
4.4	Examples
5.	Conventional Power Station Processes
5.1	Chemical Transformations during Combustion
5.2	Steam-Electric Power Stations
5.3	Nuclear Fission and Fusion
5.4	Thermal Energy Conversion Efficiency
6.	Network Layout for Energy Transmission
6.1	Conversion of Heat into Electrical Energy
6.2	Conversion of Mechanical Energy into Electrical Energy
6.3	Network Technology for AC and DC Powertrains
6.4	Transmission of Electrical Energy
6.5	Distribution of Electrical Energy

Literature

Compulsory Reading

Further Reading

- Elias P. Gyftopoulos, Gian Paolo Beretta. Thermodynamics : Foundations and Applications. Dover Publications; 2012. Accessed July 21, 2021
- Krischer, Katharina Schönleber, Konrad. (2015). Physics of Energy Conversion. De Gruyter
- Pawel Madejski. Thermal Power Plants - New Trends and Recent Developments. IntechOpen; 2018

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Regenerative Energy

Course Code: DLBAETWEE02_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	either DLBAETLET01 and DLBAETEFW01 or DLBINGET01-01_E; DLBAETEME01_E

Course Description

The aim of the course is to give students an overview of renewable energy technologies. The first topic is how heat can be generated with the help of geothermal energy and solar thermal energy. Furthermore, the basics of energy generation with wind power, hydropower and solar power are presented.

Course Outcomes

On successful completion, students will be able to

- reproduce and understand the basic concepts of renewable energy.
- understand processes of geothermal and solar thermal energy.
- understand the function of heat pumps and design associated processes.
- understand processes for generating energy with wind power, hydropower, biomass and solar power.
- calculate energy generation with wind power, hydropower, biomass and solar power.

Contents

1. Basic Terms of Renewable Energy
   - 1.1 Energy Return on Investment and Energy Payback Time
   - 1.2 Carbon Dioxide Amortization
   - 1.3 Energy Efficiency
2. Regenerative Generation of Heat
   - 2.1 Heat Pumps
   - 2.2 Thermodynamic Considerations of Heat Pumps
   - 2.3 Geothermal Energy
   - 2.4 Solar Thermal Energy
3. Renewable Energy Generation with Light Energy
   - 3.1 Functional Principle of Photovoltaics
   - 3.2 Use in the Power Grid

4. Renewable Energy Generation with Hydropower and Wind Power
   - 4.1 Hydroelectric Power Plants and Turbines
   - 4.2 Wind Turbines
   - 4.3 Location Factors for Wind Turbines and Hydropower Plants

5. Utilization of Biomass and Waste
   - 5.1 Biogas Plants
   - 5.2 Waste Incineration
   - 5.3 Examples

6. Political Framework Conditions for Renewable Energies
   - 6.1 EEG
   - 6.2 Legal Framework for New Wind Turbines
   - 6.3 Future Requirements for Energy Storage and Generation

Literature

Compulsory Reading

Further Reading

- Anani, Nader. (2020). Renewable Energy Technologies and Resources. Artech House.
- Krischer, Katharina Schönleber, Konrad. (2015). Physics of Energy Conversion. De Gruyter.
- Sallam, Abdelhay A. Malik, Om P.. (2021). Power Grids with Renewable Energy - Storage, Integration and Digitalization. Institution of Engineering and Technology.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Cryptography and IT-Law

Module Code: DLBENGECITL-01

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 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Ralf Kneuper (Cryptography) / Dr. Mohammad Shackow (IT Law)

Contributing Courses to Module

- Cryptography (DLBCSCT01-01)
- IT Law (DLBCSIITL01)

Module Exam Type

Module Exam	Split Exam
	Cryptography • Study Format "Distance Learning": Written Assessment: Case Study • Study Format "myStudies": Written Assessment: Case Study IT Law • Study Format "Distance Learning": Written Assessment: Case Study • Study Format "myStudies": Written Assessment: Case Study

Weight of Module

see curriculum

Module Contents

Cryptography

- Protection Targets, Vulnerabilities, and Threats
- Foundations of Cryptology and its Core Components
- Basic Cryptographic Applications
- Authentication
- Single Computer Security
- Security Communication Network
- Security E-Commerce
- Secure Software Development

IT Law

- Basic Concepts of Legal Systems
- Internet and Domain Law
- Contracts
- Intellectual Property
- Data Protection / Privacy

Learning Outcomes

Cryptography

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.

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.

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 fields of Computer Science & Software Developement	All Bachelor Programmes in the IT & Technology fields

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 ▪ Paar, C. & Pelzl, J. (2010). Understanding Cryptography. A Textbook for Students and Practitioners. Springer. ▪ Singh, S. (1999). The code book [electronic resource] : the science of secrecy from ancient Egypt to quantum cryptography (1. ed.). Anchor Books. ▪ Smart, N. P. (2016). Cryptography Made Simple. Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Online Tests

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

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	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Online Tests

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Databases and Explorative Data Analysis and Visualization

Module Code: DLBENGEDEDAV

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	300 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) / Prof. Dr. Visieu Lac (Explorative Data Analysis and Visualization)

Contributing Courses to Module
▪ Database Modeling and Database Systems (DLBCSDMDS01) ▪ Explorative Data Analysis and Visualization (DLBDSEDAV01)

Module Exam Type	
Module Exam	**Split Exam** Database Modeling and Database Systems • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Explorative Data Analysis and Visualization • Study Format "Distance Learning": Written Assessment: Written Assignment
Weight of Module see curriculum	

Module Contents

Database Modeling and Database Systems

- 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

Explorative Data Analysis and Visualization

- 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

Database Modeling and Database Systems

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.

Explorative Data Analysis and Visualization

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.

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

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

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

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 Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Guideline
☑ Recorded Live Sessions	☑ Audio	
	☑ Slides	

Mastering Prompts

Module Code: DLBWMP_E

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 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Kristina Schaaff (Artificial Intelligence) / Knut Linke (Project: AI Excellence with Creative Prompting Techniques)

Contributing Courses to Module

- Artificial Intelligence (DLBDSEAIS01)
- Project: AI Excellence with Creative Prompting Techniques (DLBPKIEKPT01_E)

Module Exam Type

Module Exam	Split Exam
	Artificial Intelligence • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "Duales myStudium": Exam, 90 Minutes Project: AI Excellence with Creative Prompting Techniques • Study Format "Duales myStudium": Oral Project Report • Study Format "Distance Learning": Oral Project Report

Weight of Module

see curriculum

Module Contents
Artificial Intelligence **Project: AI Excellence with Creative Prompting Techniques**

Learning Outcomes

Artificial Intelligence

On successful completion, students will be able to

- chart the historical developments in artificial intelligence.
- understand the approach of contemporary AI systems.
- comprehend the concepts behind reinforcement learning.
- analyze natural language using basic NLP techniques.
- scrutinize images and their contents.

Project: AI Excellence with Creative Prompting Techniques

On successful completion, students will be able to

- comprehend and apply basic prompting techniques in generative AI applications.
- analyze and evaluate the effectiveness of the basic prompts.
- apply ethical considerations to the design and use of AI for basic prompting techniques.
- design, implement, and refine effective prompts to real-world scenarios through hands-on exercises.
- showcase creative and innovative thinking in the application of prompting techniques to solve complex problems in their field of studies.

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

Artificial Intelligence

Course Code: DLBDSEAIS01

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

Course Description

The quest for artificial intelligence (AI) has captured humanity's interest for many decades and has been an active research area since the 1960s. This course will give a detailed overview of the historical developments, successes, and set-backs in AI, as well as modern approaches in the development of artificial intelligence.This course gives an introduction to reinforcement learning, a process similar to how humans and animals experience the world: exploring the environment and inferring the best course of action.This course also covers the principles of natural language processing and computer vision, both of which are key ingredients for an artificial intelligence to be able to interact with its environment.

Course Outcomes

On successful completion, students will be able to

- chart the historical developments in artificial intelligence.
- understand the approach of contemporary AI systems.
- comprehend the concepts behind reinforcement learning.
- analyze natural language using basic NLP techniques.
- scrutinize images and their contents.

Contents

1. History of AI
   - 1.1 Historical Developments
   - 1.2 AI Winter
   - 1.3 Expert Systems
   - 1.4 Notable Advances
2. Modern AI Systems
   - 2.1 Narrow versus General AI
   - 2.2 Application Areas
3. Reinforcement Learning
   - 3.1 What is Reinforcement Learning?
   - 3.2 Markov Chains and Value Function

Literature

Compulsory Reading

Further Reading

- Bear, F., Barry, W., & Paradiso, M. (2020). Neuroscience: Exploring the brain (4th ed.). Lippincott Williams & Wilkins.
- Chollet, F. (2018). Deep learning with Python. Manning.
- Geron, A. (2017). Hands-on machine learning with Scikit-Learn and TensorFlow. O'Reilly.
- Géron, A. (2019). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems (2nd ed.). O'Reilly.
- Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT Press.
- Grus, J. (2019). Data science from scratch: First principles with Python. O'Reilly.
- Jurafsky, D., & Martin, J. H. (2022). Speech and language processing (3rd ed.). Prentice Hall.
- Russell, S. J., & Norvig, P. (2022). Artificial Intelligence: A modern approach (4th ed., global ed.). Pearson.
- Sutton, R. S., & Barto, A. G. (2018). Reinforcement learning: An introduction (2nd ed.). MIT Press. (Adaptive Computation and Machine Learning series).
- Szeliski, R. (2022). Computer vision: Algorithms and applications (2nd ed.). Springer. (Texts in Computer Science series).

Study Format myStudies

Study Format	Course Type
myStudies	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video	☑ Practice Exam ☑ Online Tests

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video	☑ Practice Exam ☑ Online Tests

Study Format Duales myStudium

Study Format	**Course Type**
Duales myStudium	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video	☑ Practice Exam ☑ Online Tests

Project: AI Excellence with Creative Prompting Techniques

Course Code: DLBPKIEKPT01_E

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

Course Description
In this course, students explore the fascinating world of prompting in generative AI applications. They engage in hands-on exercises to create new AI-generated content including text, images, and videos. Through these exercises, students learn how to effectively use, analyze, and evaluate these systems within their respective fields of study.

Course Outcomes

On successful completion, students will be able to

- comprehend and apply basic prompting techniques in generative AI applications.
- analyze and evaluate the effectiveness of the basic prompts.
- apply ethical considerations to the design and use of AI for basic prompting techniques.
- design, implement, and refine effective prompts to real-world scenarios through hands-on exercises.
- showcase creative and innovative thinking in the application of prompting techniques to solve complex problems in their field of studies.

Contents

- In this course, students work on a basic practical implementation of a generative AI use case by choosing from a selection provided in the complementary guideline. The course provides practical examples as learning materials and exercises with basic prompting techniques for open-source text, image, and video generation use cases. The exercises are designed to inspire and guide students in completing their own generative AI use case work, which includes a use case description, chosen prompting techniques, outcomes, and critical evaluations from both technical and ethical perspectives.

Literature
Compulsory Reading
Further Reading ▪ Dang, H., Mecke, L., Lehmann, F., Goller, S., & Buschek, D. (2022). How to prompt? Opportunities and challenges of zero- and few-shot learning for human-AI interaction in creative applications of generative models. arXiv. https://arxiv.org/pdf/2209.01390.pdf ▪ Eapen, T. T., Finkenstadt, D. J., Folk, J., & Venkataswamy, L. (2023). How generative AI can augment human creativity. Harvard Business Review, July–August, 56–64. ▪ Wei, J., Wang, X., Schuurmans, D., Bosma, M. Ichter, B., Xia, F., Chi, E. H., Le., Q. V., & Zhou, D. (2023). Chain-of-though prompting elicit reasoning in large language models. arXiv. https://arxiv.org/pdf/2201.11903.pdf

Study Format Duales myStudium

Study Format	Course Type
Duales myStudium	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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ 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	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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ Guideline

Career Development

Module Code: DLBKAENT_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		BA	10	300 h

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

Module Coordinator
Prof. Dr. Heike Schiebeck (Personal Career Plan) / Prof. Dr. Heike Schiebeck (Personal Elevator Pitch)

Contributing Courses to Module
▪ Personal Career Plan (DLBKAENT01_E) ▪ Personal Elevator Pitch (DLBKAENT02_E)

Module Exam Type	
Module Exam	**Split Exam** Personal Career Plan • Study Format "Duales myStudium": Advanced Workbook • Study Format "Distance Learning": Advanced Workbook Personal Elevator Pitch • Study Format "Duales myStudium": Concept Presentation • Study Format "Distance Learning": Concept Presentation
Weight of Module see curriculum	

Module Contents

Personal Career Plan

- Career Theories and Models
- Career Development
- Choosing Possible Careers
- Personal Branding
- Career Strategy
- Global Careers
- Employment Search

Personal Elevator Pitch

Through the application of self-reflection, self-awareness based on relevant career success parameters students should develop career goals, career stages, and their career strategy. Taking into account their current professional and/or study situation, the central elements of a short-, and medium-term career planning are worked out by the students for their individual case. At the end of the course, students will be able to present their personal elevator pitch and communicate it in a proper way that is appropriate for the target group or audience. In this way, they will reflect on their current professional situation. The personal elevator pitch, being at hear of personal branding, supports the conveyance of this vision during personal networking activities.

Learning Outcomes

Personal Career Plan

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.

Personal Elevator Pitch

On successful completion, students will be able to

- identify their career goals, career stages, and the personal status quo with regard to their achievement.
- reflect their current situation and define where they want to aim.
- develop a career strategy by creating personal career goals and a coherent action plan.
- understand and apply the process of building a personal brand.
- define their identity, skills, profession, reasons to believe and necessary investments.
- identify their personal strengths and their core driver.
- understand the power of effective communication, networking, and storytelling.
- understand the principles and apply the process of designing a strong personal elevator pitch.
- critically reflect and adapt their personal elevator pitch to the specificities of the context, audience, target group, and way of delivery.

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

- Baruch, Y. (2022). Managing Careers and Employability. SAGE.
- Greenhaus, J.H., Callanan, G.A., & Godshalk, V.M. (2018). Career Management for Life (5th edition). College of Business & Public Management Faculty Books.
- Hoeckstra, H. (2011). A career roles model of career development. Journal of Vocational Behavior, 78(2), 159-173.
- Ibarra, H. (2004). Working Identity: Unconventional Strategies for Reinventing Your Career. Harvard Business School Press.
- Kingsley, T. (2022). Personal Branding. Independently published.
- 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.
- 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 Duales myStudium

Study Format	Course Type
Duales myStudium	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video	☑ Online Tests ☑ Guideline

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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 ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Course Book ☑ Video	☑ Online Tests ☑ Guideline

Personal Elevator Pitch

Course Code: DLBKAENT02_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		5	DLBKAENT01_E

Course Description

The forms of careers vary depending on the context or personal preferences in today's ever-changing, demanding, and complex environment. Changes in the environment, as for example technology, sustainability, and the rise of artificial intelligence, push individuals to take career transitions into their own hands. Personal endeavors to develop one's career through the acquisition of, for instance, new projects, jobs, or employers, require the right strategies to be successful. Contacts through targeted networking and the development of one's own brand play a special role here. Evenly so for individuals starting their careers after having accomplished their education, effective networking is key to career entry and development in these turbulent times. In addition, personal branding is a concept that not only has gained relevance in research but is also widely used in career counseling. Developing and conveying a personal brand is central to this course. Using the personal branding approach during networking activities, individuals can actively contribute to their career success.

Course Outcomes

On successful completion, students will be able to

- identify their career goals, career stages, and the personal status quo with regard to their achievement.
- reflect their current situation and define where they want to aim.
- develop a career strategy by creating personal career goals and a coherent action plan.
- understand and apply the process of building a personal brand.
- define their identity, skills, profession, reasons to believe and necessary investments.
- identify their personal strengths and their core driver.
- understand the power of effective communication, networking, and storytelling.
- understand the principles and apply the process of designing a strong personal elevator pitch.
- critically reflect and adapt their personal elevator pitch to the specificities of the context, audience, target group, and way of delivery.

Contents

- The core element of this course is a personal elevator pitch with the use of a personal branding canvas. The creation of a personal brand is not only relevant for self-employed freelancers or entrepreneurs but is as well helpful for individuals who strive for their own further development on the career ladder within their organization or for those who are seeking employment. Having understood the characteristics of and reasoning behind personal branding and the underlying process, students will be able to apply this process to their own person and situation.

- Self-awareness being the main 'ingredient' for an effective personal brand, students will be encouraged to go on an intensive self-reflection journey to deepen their understanding of their identity, skills, profession, and reasons to believe for a personal brand, and subsequently, for a personal elevator pitch.
- Being at the heart of and the essence of personal branding, the elevator pitch enables individuals to impactfully present themselves in a nutshell to important individuals and potential employers. Having understood the principles and key success factors characterizing an elevator pitch, students will be able to develop their own one. They will learn to consider aspects like timing, benefit, clear positioning, target audience through an oral form of delivery. In addition, the role of communication, networking and storytelling principles will be highlighted.
- Knowledge of the core elements and success factors of the personal elevator pitch within the framework of the individual career development.

Literature

Compulsory Reading

Further Reading

- Dowling, D. (2009). How to Perfect an Elevator Pitch About Yourself. Harvard Business Review. https://hbr.org/2009/05/how-to-perfect-an-elevator-pit.
- Gorbatov, S., Khapova, S.N., & Lysova, E.I. (2018). Personal branding: Interdisciplinary systematic review and research agenda. Frontiers in psychology, 2238.
- Gorbatov, S., Khapova, S.N., & Lysova, E.I. (2019). Get noticed to get ahead: The impact of personal branding on career success. Frontiers in psychology, 2662.
- Jourdan Jr., Louis F., Deis, M., & Lysova, E.I. (2010). Getting Your Elevator Pitch To The Plate. Business Journal for Entrepreneurs, 2010(1), 43-47.
- Woodside, A.G. (2010). Brand consumer storytelling theory and research: Introduction to a Psychology & Marketing special issue. Psychology & Marketing, 27(6), 531-540.

Study Format Duales myStudium

Study Format	Course Type
Duales myStudium	Project

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Concept Presentation

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ 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	Concept Presentation

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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ 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 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 • Study Format "myStudies": Bachelor Thesis • Study Format "Distance Learning": Bachelor Thesis Colloquium • Study Format "myStudies": Colloquium • Study Format "Distance Learning": Colloquium

Weight of Module

see curriculum

Module Contents

Bachelor Thesis

- Bachelor's thesis
- Colloquium on the bachelor's thesis

Colloquium

Learning Outcomes

Bachelor Thesis

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.

Colloquium

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).

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 ▪ 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. ▪ Turabian, K. L. (2013). A Manual for Writers of Research Papers, theses, and dissertations (8th ed.). University of Chicago Press. ▪ Selection of literature according to topic

Study Format myStudies

Study Format	Course Type
myStudies	Thesis Course

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		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ Slides	☑ Review Book

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Thesis Course

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		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	☑ 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 Course

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	
Tutorial Support ☑ Intensive Live Ses-sions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Thesis Course

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	
Tutorial Support ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Learning Material** ☑ Slides