MODULE HANDBOOK

Bachelor of Engineering

Bachelor Industrial Engineering and Management (FS-OI-WINGE-01)

180 ECTS

Distance Learning and myStudies

KING'S CORNERSTONE INTERNATIONAL COLLEGE

In partnership with

INTERNATIONAL UNIVERSITY OF APPLIED SCIENCES

Classification: Undergraduate

Contents

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5. Semester

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6. Semester

2021-09-01

1. Semester

Business 101

Module Code: DLBBAB_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. Markus Prandini (Business 101)

Contributing Courses to Module

- Business 101 (DLBBAB01_E)

Module Exam Type

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

Weight of Module

see curriculum

Module Contents	
- Businesses and their environment - Types of business organizations - Management and structure of business - Production of goods and services - Marketing of products and services - Management of labor - Accounting in business	
Learning Outcomes	
Business 101 On successful completion, students will be able to - apply business and economic thinking and working methods. - explain economic subjects and questioning models of business administration. - classify and formulate corporate goals. - describe and apply a general business decision-making process. - recognize and design the organizational structure and process organization in the company.	
Links to other Modules within the Study Program This module is similar to other modules in the fields of Business Administration & Management	**Links to other Study Programs of the University** All Bachelor Programmes in the Business & Management fields

Business 101

Course Code: DLBBAB01_E

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

Course Description

Business 101 deals with the basics of general business administration. It provides students with an understanding of the fundamental questions of doing business. In addition, basic organizational approaches of companies are shown. With the successful completion of the course, the students have gained fundamental knowledge in general business administration. This course lays the foundation for the advanced modules in the further course of their studies.

Course Outcomes

On successful completion, students will be able to

- apply business and economic thinking and working methods.
- explain economic subjects and questioning models of business administration.
- classify and formulate corporate goals.
- describe and apply a general business decision-making process.
- recognize and design the organizational structure and process organization in the company.

Contents

1. Businesses and their environment
   - 1.1 Concepts of business
   - 1.2 A system of economic relationships
   - 1.3 Business environment

2. Types of business organizations
   - 2.1 Companies in production and service
   - 2.2 Divisions of companies

3. Management and structure of business
   - 3.1 Basics of Business Management
   - 3.2 Functions of organizations, managers and control
   - 3.3 The decision making process
   - 3.4 Organizational structure of business

4. Production of goods and services
   - 4.1 Origin and development of the production process
   - 4.2 Industrial strategy of business

5. Marketing of goods and services
   - 5.1 Goals and types of marketing
   - 5.2 Marketing mix

6. Management of labor
   - 6.1 Process of management of labor
   - 6.2 Demand in labor
   - 6.3 Human relations in organizations

7. Accounting in business
   - 7.1 Functions and goals of accounting
   - 7.2 Spheres of accounting
   - 7.3 Fundamental principles of accounting

Literature

Compulsory Reading

Further Reading

- Collins, J. (2011). Good to great: Why some companies make the leap…and others don’t. Harper Business.
- Covey, S., Foreword, C. J.-, Covey, S. R. & Audio, S. S. (2020). The 7 Habits of Highly Effective People: 30th Anniversary Edition . Simon & Schuster Audio.
- Miller, J. (2004). QBQ! The question behind the question. Penguin.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam or Written Assessment: Written Assignment, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam or Written Assessment: Written Assignment, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

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. Maya Stagge (Introduction to Academic Work)

Contributing Courses to Module

- Introduction to Academic Work (DLBCSIAW01)

Module Exam Type	
Module Exam Study Format: myStudies Basic Workbook (passed / not passed) Study Format: Distance Learning Basic Workbook (passed / not passed)	**Split Exam**
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 Programmes in the Business & Management field

Introduction to Academic Work

Course Code: DLBCSIAW01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

2. Application of Good Scientific Practice
    - 21 Research Ethics
    - 22 Evidence Teaching
    - 23 Data Protection and Affidavit
    - 24 Orthography and Shape
    - 25 Identification and Delimitation of Topics
    - 26 Research Questions and Structure

3. Research Methods
    - 31 Empirical Research
    - 32 Literature and Reviews
    - 33 Quantitative Data Collection
    - 34 Qualitative Data Collection
    - 35 Mix of Methods
    - 36 Critique of Methods and Self-Reflection

4. Librarianship: Structure, Use, and Literature Management
    - 41 Plagiarism Prevention
    - 42 Database Search
    - 43 Literature Administration
    - 44 Citation and Author Guidelines
    - 45 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 myStudies	Course Type Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Basic Workbook (passed / not passed)

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format Distance Learning	Course Type Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Basic Workbook (passed / not passed)

Student Workload					
Self Study	Contact Hours	Tutorial	Self Test	Independent Study	Hours Total
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Collaborative Work

Module Code: DLBCSCW

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

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

Module Coordinator
Prof. Dr. Karin Halbritter (Collaborative Work)

Contributing Courses to Module
- Collaborative Work (DLBCSCW01)

Module Exam Type	
Module Exam Study Format: myStudies Oral Assignment Study Format: Distance Learning Oral Assignment	**Split Exam**
Weight of Module see curriculum	

Module Contents

- Self-Directed and Collaborative Learning
- Networking and Cooperation
- Performance in (Virtual) Teams
- Communication, Arguments, and Being Convincing
- Potentials for Conflict and Managing Conflicts
- Self-Management and Personal Skills

Learning Outcomes	
Collaborative Work On successful completion, students will be able to ▪ design their own learning processes both self-directed and collaborative with analog and digital media. ▪ initiate face-to-face and virtual cooperation and select suitable methods for shaping collaboration even in an intercultural context and across disciplinary boundaries. ▪ assess different forms of communication in relation to the goals and requirements of different situations and to reflect on their own communication and argumentation behavior in order to be able to shape conducive collaboration also in an interdisciplinary context. ▪ recognize social diversity including cultural and professional differences as a value, and to name and apply tools to deal with them constructively. ▪ explain conflict potentials and the role of emotions in conflicts and to describe the use of systemic methods in the target- and solution-oriented handling of conflicts. ▪ analyze one's own resources, present methods of self-leadership and self-motivation, and derive appropriate strategies.	
Links to other Modules within the Study Program This module is similar to other modules in the fields of Business Administration & Management	**Links to other Study Programs of the University** All Bachelor Programmes in the Business & Management fields

Collaborative Work

Course Code: DLBCSCW01

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

Course Description
The course supports the students in building up and expanding important interdisciplinary competences for our networked world, and in doing so, students can take advantage of the opportunities for constructive cooperation with others. It presents essential forms and design possibilities of collaborative learning and working, imparts basic knowledge and tools for self-managed, flexible, and creative thinking, learning and acting and familiarizes students with the topics of empathy and emotional intelligence. Students are also encouraged to use the course contents. In this way, they promote their autonomous competence to act and their competence in the interactive application of tools and in interacting in heterogeneous groups.

Course Outcomes

On successful completion, students will be able to

- design their own learning processes both self-directed and collaborative with analog and digital media.
- initiate face-to-face and virtual cooperation and select suitable methods for shaping collaboration even in an intercultural context and across disciplinary boundaries.
- assess different forms of communication in relation to the goals and requirements of different situations and to reflect on their own communication and argumentation behavior in order to be able to shape conducive collaboration also in an interdisciplinary context.
- recognize social diversity including cultural and professional differences as a value, and to name and apply tools to deal with them constructively.
- explain conflict potentials and the role of emotions in conflicts and to describe the use of systemic methods in the target- and solution-oriented handling of conflicts.
- analyze one's own resources, present methods of self-leadership and self-motivation, and derive appropriate strategies.

Contents

1. Learning for a Networked World in a Networked World
   - 1.1 Requirements and Opportunities of the VUCA World
   - 1.2 Learning, Information, and Dealing with Knowledge and Ignorance
   - 1.3 C-Model: Collective – Collaborative – Continuous – Connected
   - 1.4 Checking Your Own Learning Behaviour

2. Networking and Cooperation
    - 2.1 Finding and Winning Suitable Cooperation Partners
    - 2.2 Sustainable Relationships: Digital Interaction and Building Trust
    - 2.3 Collaboration: Organizing Locally and Virtually and Using Media
    - 2.4 Social Learning: Agile, Collaborative, and Mobile Planning of Learning Processes

3. Performance in (Virtual) Teams
    - 3.1 Goals, Roles, Organization and Performance Measurement
    - 3.2 Team Building and Team Flow
    - 3.3 Scrum as a Framework for Agile Project Management
    - 3.4 Design Thinking, Kanban, Planning Poker, Working-in-Progress-Limits & Co

4. Communicate and Convince
    - 4.1 Communication as Social Interaction
    - 4.2 Language, Images, Metaphors, and Stories
    - 4.3 It's the Attitude that Counts: Open, Empathetic, and Appreciative Communication
    - 4.4 Listen Actively - Argue - Convince - Motivate
    - 4.5 Analyze Your Own Conversational and Argumentational Skills

5. Recognize Conflict Potentials - Handle Conflicts - Negotiate Effectively
    - 5.1 Respecting Diversity - Seizing Opportunities
    - 5.2 Developing Empathy for Yourself and Others
    - 5.3 Systemic Work Solutions and Reframing
    - 5.4 Negotiate Constructively: Finding Clear Words - Interests Instead of Positions

6. Realize Your Own Projects
    - 6.1 Set Goals Effectively - Focus - Reflect
    - 6.2 The Agile Use of One's Own Time
    - 6.3 (Self-)Coaching and Inner Team
    - 6.4 Strategies and Methods for Self-Management and Self-Motivation

7. Mobilize Your Resources
    - 7.1 Recognizing Resources - Regulating Emotions
    - 7.2 Reflection and Innovation - Lateral Thinking and Creativity
    - 7.3 Transfer Strength and Willpower: Analyzing and Controlling Condition Factors

Literature
Compulsory Reading
Further Reading

- Baber, A., Waymon, L., Alphonso, A., & Wylde, J. (2015): Strategic connections. The new face of networking in a collaborative world. New York: AMACOM.
- Boulton, J. G., Allen, P. M., & Bowman, C. (2015): Embracing complexity. Strategic perspectives for an age of turbulence. 1. ed. Oxford: Oxford Univ. Press.
- Chang, B., & Kang, H. (2016): Challenges facing group work online. In: Distance Education 37 (1), S. 73–88. DOI: 10.1080/01587919.2016.1154781.
- Duhigg, C. (2013): The power of habit. Why we do what we do and how to change. London: Random House Books.
- Fisher, R., & Ury, W. (2012): Getting to yes. Negotiating an agreement without giving in. Updated and rev., 3. ed. London: Random House Business Books.
- Kaats, E., & Opheij, W. (2014): Creating conditions for promising collaboration. Alliances, networks, chains, strategic partnerships. Berlin, Heidelberg, s.l.: Springer Berlin Heidelberg (SpringerBriefs in Business).
- Martin, S. J., Goldstein, N. J., & Cialdini, R. B. (2015). The small BIG: Small changes that spark BIG influence. London, England: Profile Books.
- Oettingen, G. (2014). Rethinking positive thinking: Inside the new science of motivation. New York, NY: Current.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

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	Split Exam
<u>Study Format: Distance Learning</u> Exam, 90 Minutes <u>Study Format: myStudies</u> Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

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

Learning Outcomes	
Introduction to the Internet of Things 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 fields of Computer Science & Software	**Links to other Study Programs of the University** All Bachelor Programmes in the IT & Technology fields

Introduction to the Internet of Things

Course Code: DLBINGEIT01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

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

Literature

Compulsory Reading

Further Reading

- Firouzi, F., Chakrabarty, K., & Nassif, S. (2020). Intelligent Internet of Things: From device to fog and cloud. Springer.
- Hanes, D., Salgueiro, G., Grossetete, P., Barton, R., & Henry, J. (2017). IoT fundamentals: Networking technologies, protocols, and use cases for the Internet of Things. Cisco Press.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Scientific and Technical Fundamentals

Module Code: DLBINGNAG_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. Emanuele Grasso (Scientific and Technical Fundamentals)

Contributing Courses to Module
• Scientific and Technical Fundamentals (DLBINGNAG01_E)

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

- Part 1: Introduction
  - Overview
  - Mathematical principles
- Part 2: Physics
  - Thermodynamics
  - Electricity and magnetism
- Part 3: Materials science
  - Solid-State Physics
  - Materials
- Part 4: Engineering Mechanics
  - Statics
  - Dynamics
  - Strength of Materials

Learning Outcomes

Scientific and Technical Fundamentals

On successful completion, students will be able to

- identify basic methods and subject areas in natural sciences.
- know mathematical basics for utilisation in physics.
- identify the basics of thermodynamics, electricity and magnetism.
- identify the physical properties of solids.
- distinguish solids with their bonding and conductivity types and differentiate materials with regard to their properties.
- identify basic tasks of statics and apply them.
- recognize the laws of dynamics and apply them.
- identify different stress types and calculate them.

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

Scientific and Technical Fundamentals

Course Code: DLBINGNAG01_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 give students an overview of essentials in natural sciences relevant to Engineering Studies. For this purpose, selected areas of physics, materials science and technical mechanics are considered.In the first part, this course introduces elementary scientific principles and incorporates mathematical basics. In the second part, thermodynamics, electricity and magnetism are used to give an overview of selected areas of physics. The third part deals with physical properties of solids and how they are used in Materials Science. The course concludes with a fourth topic, which deals with selected aspects of Technical Mechanics.

Course Outcomes

On successful completion, students will be able to

- identify basic methods and subject areas in natural sciences.
- know mathematical basics for utilisation in physics.
- identify the basics of thermodynamics, electricity and magnetism.
- identify the physical properties of solids.
- distinguish solids with their bonding and conductivity types and differentiate materials with regard to their properties.
- identify basic tasks of statics and apply them.
- recognize the laws of dynamics and apply them.
- identify different stress types and calculate them.

Contents

1. Introduction to methods and disciplines
   - 1.1 Scientific method
   - 1.2 Disciplines
   - 1.3 Key ares and quantities of physics
   - 1.4 Description of chemical structures

2. Mathematical principles
   - 2.1 Complex numbers
   - 2.2 Differential calculus
   - 2.3 Integral Calculus

3. Thermodynamics
   - 3.1 Basics
   - 3.2 Fundamental principles
   - 3.3 Change of state theory

4. Electricity and magnetism
   - 4.1 Definitions and laws
   - 4.2 Transfer of charges
   - 4.3 Fields

5. Solid-State Physics
   - 5.1 Atomic and quantum physics basics
   - 5.2 Binding types of solids
   - 5.3 Crystalline, amorphous and macromolecular solids
   - 5.4 Conductors, semiconductors and insulators
   - 5.5 Superconductor

6. Materials Science
   - 6.1 Properties of materials
   - 6.2 Metallic materials
   - 6.3 Plastics
   - 6.4 Ceramic materials
   - 6.5 Composite materials

7. Statics
   - 7.1 Basics
   - 7.2 Fundamental tasks
   - 7.3 Trusses

8. Dynamics
   - 8.1 Movement theory
   - 8.2 Rotational movements
   - 8.3 Work and performance

9. Theory of Strength of Materials
   - 9.1 Basic terms
   - 9.2 Stress types
   - 9.3 Surface pressure and moments in metric space

Literature
Compulsory Reading
Further Reading • Arnold, B. (2017): Werkstofftechnik für Wirtschaftsingenieure. 2. Auflage, Springer, Heidelberg. • Balmer, T. (2011): Modern Engineering Thermdynamics. Elsevier, Burlington. • Böge, A./Böge, W. (2019): Technische Mechanik. Statik – Reibung – Dynamik – Festigkeitslehre – Fluidmechanik. 33. Auflage, Springer Vieweg, Wiesbaden. • Eichler, J. (2018): Physik für das Ingenieurstudium. 6. Auflage, Springer Vieweg, Wiesbaden. • Gross, D. et al. (2018): Engineering Mechanics 2. Mechanics of Materials. 2. Auflage, Springer, Heidelberg. • Gross, D. et al. (2014): Engineering Mechanics 3. Dynamics. 2. Auflage, Springer, Heidelberg. • Gross, D. et al. (2013): Engineering Mechanics 1. Statics. 2. Auflage, Springer, Heidelberg. • Halliday, D./Resnick, R./Walker, J. (2018): Fundamentals of Physics. 11. Auflage, Wiley, Cern. • Hering, E./Martin, R./Stohrer, M. (Hrsg.) (2017): Physik für Ingenieure. 12. Auflage, Springer, Heidelberg. • Kittel, C./Hunklinger, S. (2013): Einführung in die Festkörperphysik. 15. Auflage, Oldenbourg, München. • Knight, R. D. (2016): Physics for scientists and engineers. A strategic approach. 4. Auflage, Pearson, Boston. • Otto, M. (2019): Rechenmethoden für Studierende der Physik im ersten Jahr: Einfach und praktisch erklärt. 2. Auflage, Spektrum Akademischer Verlag, Heidelberg. • Rattan, K./Klingbeil, N. (2014): Introductory Mathematics for Engineering Applications. Wiley, New Jersey

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☑ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Mathematics II

Module Code: DLBCSM2

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

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

Module Coordinator

Prof. Dr. Leonardo Riccardi (Mathematics II)

Contributing Courses to Module

- Mathematics II (DLBCSM201)

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

- Selected topics of linear algebra
- Selected chapters on graphs and algorithms

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

Mathematics II

Course Code: DLBCSM201

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format Distance Learning	Course Type Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

2. Semester

Introduction to Robotics

Module Code: DLBROIR_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 (Introduction to Robotics)

Contributing Courses to Module

- Introduction to Robotics (DLBROIR01_E)

Module Exam Type

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

Weight of Module

see curriculum

Module Contents

- Introduction to Robotics
- Trends
- Industrial Robots
- Mobile Robots
- Applications

Learning Outcomes	
Introduction to Robotics On successful completion, students will be able to - name important developments in the field of robotics. - understand the mechanical structure and characteristics of robots. - name characteristics and challenges of industrial robots. - name characteristics and challenges of mobile robots. - understand the role of robots in applications. - name and understand current trends in the field of robotics.	
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

Introduction to Robotics

Course Code: DLBROIR01_E

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

Course Description

Robotics is experiencing very interesting developments, which experts describe as being a transition to a new generation of robots. We have moved from the “4Ds” of Robotics 1.0 (dull, dirty, dumb, dangerous) to the “4Ss” of Robotics 2.0 (smarter, safer, sensors, simple), but we still need to proceed further to the “4Ms” of Robotics 3.0 (multitasking, emotive, morphing, multiagent). This course, thus, provides the required background to understand the main development of robotics looking at industrial as well as at mobile robots, their main characteristics, issues, challenges, applications, and development trends.

Course Outcomes

On successful completion, students will be able to

- name important developments in the field of robotics.
- understand the mechanical structure and characteristics of robots.
- name characteristics and challenges of industrial robots.
- name characteristics and challenges of mobile robots.
- understand the role of robots in applications.
- name and understand current trends in the field of robotics.

Contents

1. What is Robotics?
   - 1.1 Basics and Definitions
   - 1.2 History and Cultural Influence
   - 1.3 Challenges and Trends (from Robotics 1.0 to Robotics 3.0)

2. Robots
   - 2.1 Mechanical Structure
   - 2.2 Kinematic Chains
   - 2.3 Market Overview

3. Industrial Robots
   - 3.1 Components of Industrial Robot Systems
   - 3.2 Characteristics
   - 3.3 Common Industrial Robots
   - 3.4 Applications
   - 3.5 Trends

4. Mobile Robots
   - 4.1 Components of Mobile Robot Systems
   - 4.2 Characteristics
   - 4.3 Common Mobile Robots
   - 4.4 Applications
   - 4.5 Trends

5. Applications
   - 5.1 Industrial Robots
   - 5.2 Healthcare
   - 5.3 Agriculture or Field Robotics
   - 5.4 Space and Defense
   - 5.5 Warehouse and Logistics
   - 5.6 Construction
   - 5.7 Wearables
   - 5.8 Social Robots

Literature

Compulsory Reading

Further Reading

- Mihelj, M., Bajd, T., Ude, A., Lenarcic, J., Stanovnik, A., Munih, M., Rejc, J., & Slajpah, S. (2019). Robotics(2nd ed.). Springer.
- Ben-Ari, M., & Mondada, F. (2017). Elements of robotics. Springer.
- Siciliano, B., & Khatib, O. (Eds.). (2016). Springer handbook of robotics. Springer

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam or Written Assessment: Written Assignment, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam or Written Assessment: Written Assignment, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

International Marketing

Module Code: DLBDSEIMB1

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

Caterina Fox (International Marketing)

Contributing Courses to Module

- International Marketing (DLBDSEIMB01)

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

- International marketing strategy
- Cultural differences and their significance for marketing
- International marketing mix (product, price, promotion, and distribution decisions in an international environment)
- International market research and consumer behavior
- Ethical aspects in international marketing
- International marketing controlling and six sigma

Learning Outcomes	
International Marketing On successful completion, students will be able to - understand basic aspects of international strategic marketing. - analyze cultural differences and their impact on international marketing. - apply selected concepts of the international marketing mix. - describe the possibilities of international market research and its influence on consumer behavior. - recognize the necessity of international brand controlling and quality management. - reproduce theoretical knowledge using case studies.	
Links to other Modules within the Study Program This module is similar to other modules in the fields of Marketing & Sales	**Links to other Study Programs of the University** All Bachelor Programmes in the Marketing & Communication fields

International Marketing

Course Code: DLBDSEIMB01

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

Course Description

Students are taught the necessity for strategic marketing in an international context. They will learn about essential cultural differences and their influences on international marketing management. The basic decisions, standardizations, and adaptations in international marketing are experienced by the students on the basis of different concepts in the international marketing mix. The necessity of international market research, strategic planning, and control are taught to the students, along with the ethical aspects in international marketing. The students analyze current topics in international marketing management and reflect on them in connection with the concepts they have learned in this course.

Course Outcomes

On successful completion, students will be able to

- understand basic aspects of international strategic marketing.
- analyze cultural differences and their impact on international marketing.
- apply selected concepts of the international marketing mix.
- describe the possibilities of international market research and its influence on consumer behavior.
- recognize the necessity of international brand controlling and quality management.
- reproduce theoretical knowledge using case studies.

Contents

1. Strategic International Marketing
   - 1.1 Internationalization
   - 1.2 Theoretical Foundations of International Market Entry Strategies
   - 1.3 Forms of International Market Entry
2. Cultural Differences as an Aspect of International Marketing
   - 2.1 Overview of Culture
   - 2.2 Cultural Model Based on Hofstede
   - 2.3 Cultural Model Based on Trompenaars

3. Case Studies in International Market Entry and Marketing Strategies
    - 3.1 Case Study: Nivea in South Korea
    - 3.2 Case Study: Bosch and Siemens Hausgeräte GmbH in China
    - 3.3 Case Study: Siemens Mobile in China
    - 3.4 Case Study: Siemens in China

4. International Product Management and Product Development
    - 4.1 Goals of International Product Management
    - 4.2 Framework Conditions for International Product Management
    - 4.3 International Product Decisions
    - 4.4 International Product Development

5. Exchange Rate Fluctuations and International Price Calculation
    - 5.1 Tasks and Objectives of International Price Management
    - 5.2 Factors Influencing International Price Management
    - 5.3 Instruments of International Price Management

6. International Communication and International Sales Policy
    - 6.1 International Communication Management
    - 6.2 International Sales Management

7. International Marketing and Ethics
    - 7.1 Overview of International Marketing and Ethics
    - 7.2 Business Ethics in International Companies
    - 7.3 Case Study: Nestlé

8. Applied Market Research and Its Influence on Consumer Behavior
    - 8.1 Scope of International Market Research
    - 8.2 Requirements for International Market Research Information
    - 8.3 International Secondary Research
    - 8.4 International Primary Research

9. Monitoring and Control in International Marketing
    - 9.1 Controlling in International Management

10. Six Sigma, Brand Management, and Rebranding
    - 10.1 Six Sigma: Basics, Definitions, and Processes
    - 10.2 Brand Management
    - 10.3 Rebranding

Literature
Compulsory Reading
Further Reading • Armstrong, G., Kotler, P., & Opresnik, M. O. (2019). Marketing: An introduction (14th ed.). Pearson. • Green, M. C., & Keegan, W. J. (2020). Global marketing (10th ed.). Pearson. • Hofstede, G., Hofstede, G. J., & Minkov, M. (2010). Cultures and organizations—Software of the mind: Intercultural cooperation and its importance for survival. McGraw-Hill. • Hollensen, S. (2020). Global marketing (8th ed.). Pearson. • Mooij, M. (2018). Global marketing and advertising: Understanding cultural paradoxes (5th ed.). Sage Publications.

Study Format myStudies

Study Format myStudies	Course Type Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Managerial Economics

Module Code: DLBBWME_E

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

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

Module Coordinator

Prof. Dr. Andreas Simon (Managerial Economics)

Contributing Courses to Module

- Managerial Economics (DLBBWME01_E)

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

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

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

Managerial Economics

Course Code: DLBBWME01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

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

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

Literature
Compulsory Reading
Further Reading

Further Reading

- Acemoglu, D., Laibson, & D., List, J. A. (2018). Microeconomics, Global edition (2nd ed.). Pearson.
- Case, K. E., Osten, S. M., & Fair, R. C. (2019). Principles of economics, Global edition (13th ed.). Harlow.
- Keat, P. G., & Young, P. K. Y. (2013). Managerial economics, Global Edition (7th ed.). Pearson Education Limited.
- Leyton-Brown, K., & Shoham, Y. (2008). Essentials of game theory: A concise multidisciplinary introduction.
- Mankiw, N. G. (2017). Principles of economics (8th ed.). Cengage Learning.
- Pindyck, R. S., & Rubinfeld, D. L. (2017). Microeconomics (9th ed.). Pearson.
- Parkin, M. (2019). Economics (13th ed.). Harlow.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

DLBBWME01_E

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
Prof. Dr. Moustafa Nawito (Electrical Engineering)

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

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	
- 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	
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.	
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 Programmes in the IT & Technology fields

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

3. Calculation of Direct Current Networks
   - 3.1 Mesh-Current and Node-Voltage Method
   - 3.2 Superposition Method
   - 3.3 Wye-Delta Transformation of Circuits
   - 3.4 Examples

4. Introduction to Alternating Current Technology
   - 4.1 Electrostatic and Magnetic Fields
   - 4.2 Capacitor and Inductor
   - 4.3 Alternating Variables and their Calculation
   - 4.4 Network Analysis with Complex-Valued Variables

5. Calculation of Alternating Current Networks
   - 5.1 Simple AC Circuits and their Calculation
   - 5.2 Power Types in the AC Circuit
   - 5.3 Oscillating Circuits
   - 5.4 Examples

6. Root Locus Curves
   - 6.1 The Root Locus Concept
   - 6.2 Construction of Various Root Locus Curves
   - 6.3 Examples

7. Transformers
   - 7.1 Basic Functionality
   - 7.2 Equivalent Circuit Diagram
   - 7.3 Measurement Methods

8. Multiphase Systems
   - 8.1 Three-Phase Current Technology (Three-Phase Systems)
   - 8.2 Power Measurement in Three-Phase Systems

9. Transient Response
   - 9.1 Description of Time Dependent Processes with Differential Equations
   - 9.2 Setting up Differential Equations of Electrical Circuits
   - 9.3 Introduction to the Laplace Transformation
   - 9.4 Calculation of Transient Response

Literature
Compulsory Reading
Further Reading ▪ Hagmann, G. (2013): Grundlagen der Elektrotechnik. 16. Auflage, AULA-Verlag, Wiebelsheim. ▪ Scherz, P. (2016): Practical Electronics for Inventors. 4. Auflage, Mcgraw-Hill Education, New York. ▪ Weißgerber, W. (2015): Elektrotechnik für Ingenieure 1. 10. Auflage, Springer, Wiesbaden. ▪ Weißgerber, W. (2015): Elektrotechnik für Ingenieure 2. 9. Auflage, Springer, Wiesbaden. ▪ Weißgerber, W. (2015): Elektrotechnik für Ingenieure 3. 9. Auflage, Springer, Wiesbaden.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

DLBINGET01-01_E

Production Engineering

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. Mario Boßlau (Production Engineering)

Contributing Courses to Module

- Production Engineering (DLBDSEAR01)

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

- 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 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 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

Production Engineering

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

Literature
Compulsory Reading
Further Reading • Anderson, C. (2012): Makers. The new industrial revolution. Crown Business, New York. • Gebhardt, A. (2012): Understanding Additive Manufacturing. Rapid Prototyping – Rapid Tooling – Rapid Manufacturing. Hanser, München/Cincinnati. • Gibson, I., Rosen, D., Stucker, B., & Khorasani, M. (2021). Additive Manufacturing Technologies (3rd ed.). Springer International Publishing. • Groover, M. P., (2019). Fundamentals of Modern Manufacturing: Materials, Processes, and Systems (7th ed.). Wiley. • Kalpakjian, S., & Schmid, S.R. (2020). Manufacturing Engineering and Technology (8th ed.). Pearson.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

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

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 This module is similar to other modules in the field of Engineering	**Links to other Study Programs of the University** 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

9. Advanced Sensor Technology
   - 9.1 Organic Sensors
   - 9.2 Sensors for Health and Environment
   - 9.3 Wearable Sensors
   - 9.4 Wireless Sensors in Industrial Environments

Literature

Compulsory Reading

Further Reading

- Kalantar-Zadeh, K. (2013): Sensors: An Introductory Course. Springer US, New York, NY.
- Lin, Y. L. et al (eds.) (2015): Smart Sensors and Systems. Springer International Publishing, Cham.
- Mukhopadhyay, S. C. (ed.) (2016): Next Generation Sensors and Systems. In: Smart Sensors, Measurement and Instrumentation, Vol. 16. Springer International Publishing, Cham.
- Regtien, P./Dertien, E. (2018): Sensors for Mechatronics. 2nd ed., Elsevier, Amsterdam.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

DLBROST01_E

3. Semester

Management Accounting

Module Code: DLBMAE

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. Muhammad Ashfaq (Management Accounting)

Contributing Courses to Module
Management Accounting (DLBMAE01)

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

Module Contents	
■ Management accounting and control function ■ Differences between management accounting, and financial accounting ■ Cost terms, cost categories, and cost behavior ■ Cost allocation ■ General and specific cost allocation methods ■ Break-even analysis ■ Planning and budgeting	
Learning Outcomes **Management Accounting** On successful completion, students will be able to ■ differentiate the management accounting and control function from the financial accounting and the financial management function. ■ understand the cost structure and discuss the cost aspects of business operation. ■ analyze and apply the tools for viewing and differentiating costs and utilize them to ameliorate business decision-making. ■ discuss how the budgeting process and variance analysis works to implement the management control function.	
Links to other Modules within the Study Program This module is similar to other modules in the fields of Finance & Tax Accounting	**Links to other Study Programs of the University** All Bachelor Programmes in the Business & Management fields

Management Accounting

Course Code: DLBMAE01

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

Course Description

Management accounting is an important function to operate an organization. Managers need to understand this function in order to be able to run an organization efficiently. In most organizations, decisions, actions and human behavior are directly linked to the feature, use and focus of management accounting information. This course is about understanding the preparation and use of information provided by management accounting. Cost accounting as a central part of the management accounting informs the management about the profitability of its core business. The cost and performance measurement serves the internal decision, control and budgeting process.

Course Outcomes

On successful completion, students will be able to

- differentiate the management accounting and control function from the financial accounting and the financial management function.
- understand the cost structure and discuss the cost aspects of business operation.
- analyze and apply the tools for viewing and differentiating costs and utilize them to ameliorate business decision-making.
- discuss how the budgeting process and variance analysis works to implement the management control function.

Contents

1. Introduction to Management Accounting
   - 1.1 Financial vs. Management/Cost Accounting
   - 1.2 Definition of Cost
   - 1.3 Considering the Contemporary Business World Context
   - 1.4 Cost Behavior: Fixed and Variable Costs

2. Cost-Volume-Profit Analysis
   - 2.1 Break-Even Analysis
   - 2.2 Cost Structure and Operating Leverage
   - 2.3 Cost Structure and Variabilization

Literature
Compulsory Reading
Further Reading • Atkinson, A. A., Kaplan, R., Matsumura, E. M., & Young, S. M. (2012). Management accounting: Information for decision-making and strategy execution (6th ed.). Pearson. • Drury, C. (2019). Management accounting for business (7th ed.). Cengage.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam or Written Assessment: Written Assignment, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam or Written Assessment: Written Assignment, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

DLBMAE01

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

N.N. (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

- Gupta, A. K./Arora, S. K./Westcott, J. R. (2016): Industrial automation and robotics. Mercury Learning & Information, Herndon, VA.
- Mehta, B. R./Reddy, Y. J. (2014): Industrial process automation systems: Design and implementation. Elsevier Inc, Amsterdam.
- Merz, H./Hansemann, T./Hübner, C. (2018): Building Automation. Springer International Publishing, Cham.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	**Course Type**
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Technical Drawing

Module Code: DLBROTD_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. Hans Kerwat (Technical Drawing)

Contributing Courses to Module

- Technical Drawing (DLBROTD01_E)

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

- Technical drawing
- Descriptive geometry
- Design process
- Technical communication

Learning Outcomes	
Technical Drawing On successful completion, students will be able to ▪ formulate product ideas by creating technical drawings. ▪ read and interpret technical drawings. ▪ analyze design processes. ▪ optimize design processes.	
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

Technical Drawing

Course Code: DLBROTD01_E

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

Course Description

The content of this course focuses on reading, understanding and creating technical drawings. Students will be introduced to the fields of Engineering and Design. In addition, students will acquire basic knowledge in technical drawing and descriptive geometry. In doing so, they learn about the design and development process. The aim of this course is for students to understand the relevance of design in product development. They can analyze problems by reading drawings and will be able to formulate and create product ideas out of them.Technical drawing is the foundation for the description of technical products as well as technical communication and, thus, a basic qualification for engineering work.

Course Outcomes

On successful completion, students will be able to

- formulate product ideas by creating technical drawings.
- read and interpret technical drawings.
- analyze design processes.
- optimize design processes.

Contents

1. Illustration in Technical Drawings
   - 1.1 Sketches (by Hand)
   - 1.2 Axonometric Projection
2. Basics of Technical Drawing
   - 2.1 Types of Drawings
   - 2.2 Drawing Format
3. Views
   - 3.1 Three-Panel Projection
   - 3.2 Projection Methods (1 & 3)
   - 3.3 Cuts/Breakout

4. Dimensioning
    - 4.1 Line Types
    - 4.2 Dimensioning Rules

5. Surfaces
    - 5.1 Definition
    - 5.2 Illustration

6. Tolerances
    - 6.1 Dimensioning
    - 6.2 Standardized Fitting System
    - 6.3 Basic Shaft/Basic Hole
    - 6.4 Calculation of Tolerance Chains

7. Standards
    - 7.1 Classification of Standards
    - 7.2 Technical Drawing Standards
    - 7.3 Standard Parts

Literature

Compulsory Reading

Further Reading

- Henzold, G. (2006). Geometrical dimensioning and tolerancing for design, manufacturing and inspection (2nd ed.). Elsevier.
- Madsen, D. A., & Madsen, D. P. (2016). Engineering drawing and design (6th ed.). Cengage Learning.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Corporate Finance and Investment

Module Code: DLBCFIE

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. Muhammad Ashfaq (Corporate Finance and Investment)

Contributing Courses to Module

- Corporate Finance and Investment (DLBCFIE01)

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

Module Contents

- Introduction to Corporate Finance
- Ownership and Corporate Governance
- Understanding Financial Statements and Key Performance Indicators
- Basic Concepts of Financial Theory
- Types of Capital and Financing
- Short-term Financing Decisions
- Capital Budgeting and Decision-Making Methods in Investment

Learning Outcomes	
Corporate Finance and Investment On successful completion, students will be able to ▪ recognize the targets and scope of corporate finance and the role of financial markets . ▪ understand agency-problems in corporations and how incentives and institutional and market mechanisms are used to mitigate agency costs . ▪ interpret financial statements and key performance indicators and draw conclusions about financing alternatives and potentials of a corporation. ▪ consider the time value of money and calculate the cost of capital used to optimize future project cash flow streams. ▪ implement a long-term financing strategy and structure for corporations based on an appropriate mix of equity, debt, leasing, and hybrid financial instruments. ▪ effectively utilize cash management and working capital management to reduce short-term financing needs and costs. ▪ prepare investment decisions, estimate expected project cash flows and incorporate cash flow related risks into the decision process. ▪ apply investment decision methodologies to evaluate and select favorable corporate investment projects.	
Links to other Modules within the Study Program This module is similar to other modules in the fields of Finance & Tax Accounting	**Links to other Study Programs of the University** All Bachelor Programmes in the Business & Management fields

Corporate Finance and Investment

Course Code: DLBCFIE01

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

Course Description

This course introduces students to the targets and scope of corporate finance and the role of financial markets. The separation of ownership and control is a constituent feature of corporations; students explore the resulting agency problems and the mechanisms available to mitigate the costs of agency relationships.Students will be introduced to fundamentals of theory and practice regarding principles of modern corporate finance. They will learn to read and analyze financial statements from a financing point of view and develop a detailed understanding of concepts such as the time value of money, interest rates, and cost of capital. After introducing basic concepts, equity and debt financing will be discussed at length. The financial leverage effect on rates of return will be explored and leasing and hybrid financial instruments as an alternative to pure equity and debt financing are presented. Students will study how corporations apply short-term measures of financing and how effective cash and working capital management is used to reduce short-term financing needs and costs.This course will conclude with a discussion on the investment processes of corporations with a particular focus on the challenge of estimating expected cash flows. Students will learn how to include risk as a factor in the decision process and be able to analyse applied investment rules and methodologies.

Course Outcomes

On successful completion, students will be able to

- recognize the targets and scope of corporate finance and the role of financial markets .
- understand agency-problems in corporations and how incentives and institutional and market mechanisms are used to mitigate agency costs .
- interpret financial statements and key performance indicators and draw conclusions about financing alternatives and potentials of a corporation.
- consider the time value of money and calculate the cost of capital used to optimize future project cash flow streams.
- implement a long-term financing strategy and structure for corporations based on an appropriate mix of equity, debt, leasing, and hybrid financial instruments.
- effectively utilize cash management and working capital management to reduce short-term financing needs and costs.
- prepare investment decisions, estimate expected project cash flows and incorporate cash flow related risks into the decision process.
- apply investment decision methodologies to evaluate and select favorable corporate investment projects.

Contents

Literature

Compulsory Reading

Further Reading

- Brigham, E. F., & Houston, J. F. (2019). Fundamentals of financial management (15th ed.). Southwestern-Cengage.
- Zutter, C. J., & Smart, S. B. (2019). Principles of managerial finance (15th ed.). Pearson .

Study Format Distance Learning

Study Format Distance Learning	Course Type Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study 110 h	Contact Hours 0 h	Tutorial 20 h	Self Test 20 h	Independent Study 0 h	Hours Total 150 h

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

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

Instructional Methods

☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

DLBCFIE01

Supply Chain Management I

Module Code: DLBDSESCM1

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. Hubert Vogl (Supply Chain Management I)

Contributing Courses to Module

- Supply Chain Management I (DLBDSESCM01)

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

- 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

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.	
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	All Bachelor Programmes in the Transport & Logistics 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

- Bolstorff, P., & Rosenbaum, R. (2011). Supply chain excellence: A handbook for dramatic improvement using the SCOR model. AMACOM.
- 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.
- Kurbel, K. E. (2013). Enterprise resource planning and supply chain management: Functions, business processes and software for manufacturing companies. Springer.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Mechatronic Systems

Module Code: DLBROMSY_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. (Mechatronic Systems)

Contributing Courses to Module

- Mechatronic Systems (DLBROMSY01_E)

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

- Modeling
- Electrical drives
- Machines and drivetrains
- Actuators and sensors

<table>
<tr><td colspan="2">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.</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 fields</td></tr>
</table>

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
    41 Complete Machines
    42 Characteristics and Stability of Machines
    43 Motors and Pumps
    44 Automobile Drivetrain
    45 Signal Energy
    46 Applications

5. Actuators and Sensors
    51 Basic Structures
    52 Electromechanical Drives
    53 Hydraulic Actuators
    54 Pneumatic Actuators
    55 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	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format Distance Learning	Course Type Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

4. Semester

Entrepreneurship and Innovation

Module Code: DLBBAEI_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. Mirko Bendig (Entrepreneurship and Innovation)

Contributing Courses to Module

- Entrepreneurship and Innovation (DLBBAEI01_E)

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

Module Contents

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

Learning Outcomes	
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 This module is similar to other modules in the fields of Business Administration & Management	**Links to other Study Programs of the University** All Bachelor Programmes in the Business and Management fields

Entrepreneurship and Innovation

Course Code: DLBBAEI01_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	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Project: Design Thinking

Module Code: DLBINGDT_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. (Project: Design Thinking)

Contributing Courses to Module

- Project: Design Thinking (DLBINGDT01_E)

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

Module Contents	
- Basic principles of Design Thinking - The Design Thinking microvprocess - The Design Thinking macro process - Methods for early phases of the process - Methods for idea generation - Methods for prototyping and testing - Space concepts for Design Thinking - Examples and case studies	
Learning Outcomes **Project: Design Thinking** On successful completion, students will be able to - know the mindset of Design Thinking. - know the individual phases of the incremental micro cycle and carry them out on an example project. - know the individual stages of prototyping and apply them in an example project. - know and use methods and tools for the individual steps of the micro cycle. - know different space concepts for Design Thinking work environments. - know examples for the application of Design Thinking by means of business case studies.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Design	**Links to other Study Programs of the University** All Bachelor Programs in the Design, Architecture & Construction fields

Project: Design Thinking

Course Code: DLBINGDT01_E

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

Course Description

In this course students will receive a practical introduction to Design Thinking. In addition to teaching the individual basic principles, the procedures in Design Thinking will also be examined in detail. In order not only to understand Design Thinking but also to experience it, selected methods for the individual process steps will be presented and practiced on an example project.

Course Outcomes

On successful completion, students will be able to

- know the mindset of Design Thinking.
- know the individual phases of the incremental micro cycle and carry them out on an example project.
- know the individual stages of prototyping and apply them in an example project.
- know and use methods and tools for the individual steps of the micro cycle.
- know different space concepts for Design Thinking work environments.
- know examples for the application of Design Thinking by means of business case studies.

Contents

1. Basic Principles of Design Thinking
2. The Design Thinking Micro Process
3. The Design Thinking Macro Process
4. Methods for Early Phases of the Process
5. Methods for Idea Generation
6. Methods for Prototyping and Testing
7. Examples and Case Studies

Literature

Compulsory Reading

Further Reading

- Brown, T. (2008): Design Thinking. In: Harvard Business Review, June, p. 84–95.
- Brown, T./Kātz, B. (2019): Change by design: How design thinking transforms organizations and inspires innovation (Revised and updated edition). Harper Busienss, New York City, NY.
- IDEO (2015): The field guide to human-centered design: Design kit. 1st edition, IDEO, San Francisco, CL.
- Lewrick, M./Patrick, L./Leifer, L. (2018:. The design thinking playbook: Mindful digital transformation of teams, products, services, businesses and ecosystems. JOHN WILEY & Sons, Hoboken, NJ.
- Lewrick, M./Patrick, L./Leifer, L. (2020). Design Thinking Toolbook. JOHN WILEY & Sons, Hoboken, NJ.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Data Analytics and Big Data

Module Code: DLBINGDABD_E

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

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

Module Coordinator

N.N. (Data Analytics and Big Data)

Contributing Courses to Module

- Data Analytics and Big Data (DLBINGDABD01_E)

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

Module Contents

- Introduction to Data Analysis
- Statistical Basics
- Data Mining
- Big Data Methods and Technologies
- Legal Aspects of Data Analysis
- Solution Scenarios
- Application of Big Data in the Industry

Learning Outcomes	
Data Analytics and Big Data On successful completion, students will be able to • distinguish between information and data and know the meaning of these terms for decision-making. • derive the Big Data issue, especially in connection with Internet of Things, and describe it using examples. • identify basics from statistics, which are necessary for the analysis of large data sets. • identify the process of data mining and classify different methods in it. • identify selected methods and technologies that are used in the Big Data context and apply them to simple examples. • recognize the legal framework for the application of data analysis in Germany and internationally. • identify the specific prospects and challenges of applying Big Data analyses in industry.	
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 fields

Data Analytics and Big Data

Course Code: DLBINGDABD01_E

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

Course Description

The aim of the course is to familiarize students with selected methods and techniques of data analysis in the context of continuously increasing, heterogeneous data sets. To this end, the fundamental relevance of Big Data methods is presented by drawing on the historical development of stored data. One decisive factor here is the continuous transmission Internet of Things sensor data to other systems. This is followed by a short introduction to the essential statistical fundamentals before the individual steps of the data mining process are discussed. In distinction to these classical procedures, selected methods are presented with which stored data in the Big Data context can be made analyzable. As data analysis is subject to certain legal frameworks, this course also covers legal aspects such as data protection. The course concludes with an overview of the practical application of Big Data methods and tools. In particular, fields of application in the industrial context are examined.

Course Outcomes

On successful completion, students will be able to

- distinguish between information and data and know the meaning of these terms for decision-making.
- derive the Big Data issue, especially in connection with Internet of Things, and describe it using examples.
- identify basics from statistics, which are necessary for the analysis of large data sets.
- identify the process of data mining and classify different methods in it.
- identify selected methods and technologies that are used in the Big Data context and apply them to simple examples.
- recognize the legal framework for the application of data analysis in Germany and internationally.
- identify the specific prospects and challenges of applying Big Data analyses in industry.

Contents

7. Application of Big Data in the Industry
   - 7.1 Production and Logistics
   - 7.2 Increased Efficiency in the Supply Chain
   - 7.3 Key-Factor Data
   - 7.4 Examples and Conclusion

Literature

Compulsory Reading

Further Reading

- Gandomi, A./Haider, M. (2015): Beyond the hype. Big data concepts, methods, and analytics. In: International Journal of Information Management, 35. Jg.,Journal 2, p. 137–144.
- Provost, F./Fawcett, T. (2013): Data science for business. What You Need to Know About Data Mining and Data-Aalytic Thinking. O'Reilly, Sebastopol (CA).

Study Format myStudies

Study Format myStudies	**Course Type** Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format Distance Learning	**Course Type** Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Seminar: Human-Robot Interaction

Module Code: DLBROSHRI_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. (Seminar: Human-Robot Interaction)

Contributing Courses to Module

- Seminar: Human-Robot Interaction (DLBROSHRI01_E)

Module Exam Type	
Module Exam Study Format: Distance Learning Written Assessment: Research Essay Study Format: myStudies Written Assessment: Research Essay	**Split Exam**
Weight of Module see curriculum	

Module Contents

In this course several aspects in the design field of human-robot interaction will be investigated, ranging from fundamentals (design basics, ethics) to application in robot design, such as finding metrics for the assessment of the emotional impact of a robot design, as well as ongoing and future developments (e.g., use of artificial intelligence).

<table>
<tr><td colspan="2">Learning Outcomes
Seminar: Human-Robot Interaction
On successful completion, students will be able to
▪ understand state-of-the-art human-robot interaction approaches and accompanying problems.
▪ name important design issues for social robots.
▪ measure the emotional component of robots.
▪ apply design patterns to develop social robots.</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>

Seminar: Human-Robot Interaction

Course Code: DLBROSHRI01_E

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

Course Description

Over the past few years, significant technological development has been made in the field of Robotics and Design. Whereas industrial robots have replaced a significant proportion of human workers in industrial environments, the last decades have witnessed the development of robots designed to work together with humans. With this developments Human-Robot Interaction, i.e., a robot design methodology which considers theses interactions, has become a requirement. Robots are increasingly becoming a part of human lives and will impact human lives even more in the future. Innovative design approaches such as emotional design, based on pleasure and usability, are effective methods to develop innovative robots that can properly interact and communicate with humans, also at an emotional level. This course provides an overview on technological and design issues about "social robot design".

Course Outcomes

On successful completion, students will be able to

- understand state-of-the-art human-robot interaction approaches and accompanying problems.
- name important design issues for social robots.
- measure the emotional component of robots.
- apply design patterns to develop social robots.

Contents

- In this course several aspects in the design field of human-robot interaction will be investigated, ranging from fundamentals (design basics, ethics) to application in robot design, such as finding metrics for the assessment of the emotional impact of a robot design, as well as ongoing and future developments (e.g., use of artificial intelligence).

Literature
Compulsory Reading
Further Reading - Ayanoğlu, H./Duarte, E. (Eds.) (2019): Emotional Design in Human-Robot Interaction. Springer International Publishing, Chams. - Brooks, R. A. (2003): Flesh and machines: how robots will change us. Vintage Books, New York City, NY. - Kanda, T./Ishiguro, H. (2013): Human-Robot Interaction in Social Robotics. CRC Press, Boca Raton, FL.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Seminar

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Study Format myStudies

Study Format	Course Type
myStudies	Seminar

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Agile Project Management

Module Code: DLBCSAPM

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. Inga Schlömer (Agile Project Management)

Contributing Courses to Module
• Agile Project Management (DLBCSAPM01)

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

Module Contents

- 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.

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.	
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 Programmes in the 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. (URL: https://www.agilealliance.org/agile101/subway-map-to-agile-practices/ [last accessed on 23.06.2021]).
- Beck, K. et al. (2001). Manifesto for Agile Software Development. (URL: https://agilemanifesto.org/ [last accessed on 23.06.2021]).
- Chovanova, H. et al. (2020). Agile Project Management — What is It?: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
- 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. (URL: https://scrumguides.org/docs/scrumguide/v2020/2020-Scrum-Guide-US.pdf#zoom=100 [last accessed on 23.06.2021])

Study Format myStudies

Study Format	Course Type
myStudies	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Intercultural and Ethical Decision-Making

Module Code: DLBCSIDM

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

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

Module Coordinator

Prof. Dr. Jürgen Matthias Seeler (Intercultural and Ethical Decision-Making)

Contributing Courses to Module

- Intercultural and Ethical Decision-Making (DLBCSIDM01)

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

Module Contents

- Basics of Intercultural Competence
- Cultural Concepts
- Culture and Ethics
- Implications of Current Ethical Problems in the Area of Interculturality, Ethics, and Diversity
- Intercultural Learning and Working
- Case Studies for Cultural and Ethical Conflicts

Learning Outcomes

Intercultural and Ethical Decision-Making

On successful completion, students will be able to

- explain the most important terms in the areas of interculturality, diversity, and ethics.
- distinguish different explanatory patterns of culture.
- understand culture at different levels.
- plan processes of intercultural learning and working.
- understand the interdependencies of culture and ethics.
- independently work on a case study on intercultural competence.

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 Business Administration & Management	All Bachelor Programs in the Business & Management fields

Intercultural and Ethical Decision-Making

Course Code: DLBCSIDM01

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

Course Description

In this course, students acquire the necessary knowledge to understand intercultural competencies and current developments in the fields of diversity and ethics. Students will understand how to systematically plan and implement learning processes for the development of competences important in these areas. First, important terms are clarified and differentiated from each other, and cultural aspects are explained from different perspectives. In addition, students learn that cultural issues are relevant at different levels, for example, within a state, company, or other group. In this context, students also recognize the connection between ethics and culture with different interdependencies. On the basis of this knowledge, students are then familiarized with the different possibilities and potentials of intercultural and ethical learning and working. Practical cases are used to illustrate the importance of the relationships learned for today's work context in many companies. The students then work on a case study in which the acquired knowledge is systematically applied.

Course Outcomes

On successful completion, students will be able to

- explain the most important terms in the areas of interculturality, diversity, and ethics.
- distinguish different explanatory patterns of culture.
- understand culture at different levels.
- plan processes of intercultural learning and working.
- understand the interdependencies of culture and ethics.
- independently work on a case study on intercultural competence.

Contents

1. Basics of Intercultural and Ethical Competence to Act
   - 1.1 Subject Areas, Terms, and Definitions
   - 1.2 Relevance of Intercultural and Ethical Action
   - 1.3 Intercultural Action - Diversity, Globalization, Ethics

2. Cultural Concepts
   - 2.1 Hofstedes Cultural Dimensions
   - 2.2 Culture Differentiation According to Hall
   - 2.3 Locus of Control Concept to Rotter

3. Culture and Ethics
    3.1 Ethics - Basic Terms and Concepts
    3.2 Interdependence of Culture and Ethics
    3.3 Ethical Concepts in Different Regions of the World

4. Current Topics in the Area of Interculturality, Ethics, and Diversity
    4.1 Digital Ethics
    4.2 Equality and Equal Opportunities
    4.3 Social Diversity

5. Intercultural Learning and Working
    5.1 Acculturation
    5.2 Learning and Working in Intercultural Groups
    5.3 Strategies for Dealing with Cultural Conflicts

6. Case Studies for Cultural and Ethical Conflicts
    6.1 Case Study: Interculturality
    6.2 Case Study: Diversity
    6.3 Case Study: Interculturality and Ethics

Literature

Compulsory Reading

Further Reading

- Boylan, M. (Eds.). (2014). Business ethics. (2nd ed.). Wiley-Blackwell.
- Thomas, A., Kinast, E. U., Schroll-Machl, S. (Eds.). (2010). Handbook of intercultural communication and cooperation. Basics and areas of application. Vandenhoeck & Ruprecht .

Study Format myStudies

Study Format myStudies	**Course Type** Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

5. Semester

Product Development in Industry 4.0

Module Code: DLBINGPE_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 (Product Development in Industry 4.0)

Contributing Courses to Module

- Product Development in Industry 4.0 (DLBINGPE01_E)

Module Exam Type

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

Weight of Module

see curriculum

Module Contents

- Introduction to modern product development
- Fundamentals of product development
- Methods in the product development process
- Alternative design approaches
- Digitalization of product design
- Customized mass production
- Outlook: Digital engineering and operation

Learning Outcomes	
Product Development in Industry 4.0 On successful completion, students will be able to - recall the historical development of industrial production. - name current trends in the context of the "fourth industrial revolution" and their impact on product development. - know the basic methods in product development. - know the traditional product development process from design theory. - differentiate alternative approaches to product development. - name selected tools in the context of digital and virtual product design. - explain the lot size problem and determine lot sizes for traditional production types. - distinguish traditional production types from modern strategies such as customized mass production and rapid manufacturing. - name current approaches to the complete digitalization of product creation and production processes in terms of digital 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 fields

Product Development in Industry 4.0

Course Code: DLBINGPE01_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 give students an overview of current approaches to modern product development in the context of Industry 4.0. Based on traditional methods and tools of product development, relevant alternative design approaches are described, which put the consumer in the center of the design. In addition, modern tools to support product design are presented with which an engineer can digitally capture and simulate both the static/geometric and dynamic properties of a product. In addition, aspects of customized mass production will be discussed and compared with traditional production types. As an outlook on future developments, current research approaches for consistently digitalized product development are presented.

Course Outcomes

On successful completion, students will be able to

- recall the historical development of industrial production.
- name current trends in the context of the "fourth industrial revolution" and their impact on product development.
- know the basic methods in product development.
- know the traditional product development process from design theory.
- differentiate alternative approaches to product development.
- name selected tools in the context of digital and virtual product design.
- explain the lot size problem and determine lot sizes for traditional production types.
- distinguish traditional production types from modern strategies such as customized mass production and rapid manufacturing.
- name current approaches to the complete digitalization of product creation and production processes in terms of digital engineering.

Contents

1. Introduction to Modern Product Development
   1.1 Terms of Industrial Production
   1.2 The Fourth Industrial Revolution
   1.3 Turnaround in the Factors of Production
   1.4 Trends in Product Development

Literature

Compulsory Reading

Further Reading

- Kull, H. (2015): Mass Customization. Opportunities, Methods, and Challenges for Manufacturers. Apress, Berkeley/New York.
- Kahn, K. B. (2004): The PDMA handbook of new product development. John Wiley & Sons, Inc, Hoboken, NJ.
- Levy, J. (2015): UX strategy: How to devise innovative digital products that people want. 1st edition, O'Reilly Media, Inc., Sebastopol, CA.
- Olsen, D. (2015): The Lean product playbook: How to innovate with minimum viable products and rapid customer feedback. Wiley, Hoboken, NJ.
- Reinertsen, D. G. (2009): The principles of product development flow: Second generation Lean product development. Celeritas, Redondo Beach, CA.
- Stark, J. (2011): Product lifecycle management: 21st century paradigm for product realisation. Springer, London.
- Ulrich, K. T./Eppinger, S. D. (2015): Product design and development. 6th edition, Mc-Graw Hill, New York, NY.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Project: Smart Product Solutions

Module Code: DLBIEPSPS

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. (Project: Smart Product Solutions)

Contributing Courses to Module

- Project: Smart Product Solutions (DLBIEPSPS01)

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

Module Contents

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	
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 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

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

- Avlonitis, V. (2013): PSS readiness manual. A workbook in the PROTEUS series: # 3. 1st edition, Kongens Lyngby: Technical University of Denmark.
- Bejbro Andersen, J. (2013): PSS business models. A workbook in the PROTEUS series: # 7. 1st edition, Kongens Lyngby: Technical University of Denmark.
- Meier, H./Boßlau, M. (2013): Design and Engineering of Dynamic Business Models for Industrial Product-Service Systems. In Y. Shimomura & K. Kimita (Eds.), Lecture Notes in Production Engineering. The Philosopher's Stone for Sustainability: Proceedings of the 4th CIRP International Conference on Industrial Product-Service Systems, Tokyo, Japan, November 8th - 9th, 2012 (pp. 179–184). Springer, Berlin, Heidelberg.
- Sakao, T./Lindahl, M. (2009): Introduction to Product/Service-System Design. Springer, London.
- 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	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Smart Devices

Module Code: DLBINGSD_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

N.N. (Smart Devices I) / N.N. (Smart Devices II)

Contributing Courses to Module

- Smart Devices I (DLBINGSD01_E)
- Smart Devices II (DLBINGSD02_E)

Module Exam Type	
Module Exam	**Split Exam** Smart Devices I • Study Format "Fernstudium": Exam, 90 Minutes Smart Devices II • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

Module Contents

Smart Devices I

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

Smart Devices II

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

Learning Outcomes

Smart Devices I

On successful completion, students will be able to

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

Smart Devices II

On successful completion, students will be able to

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

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 Devices I

Course Code: DLBINGSD01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

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

Literature
Compulsory Reading
Further Reading

- Fortino, G./Trunfio, P. (2014): Internet of Things Based on Smart Objects. Technology, Middleware and Applications. Springer International Publishing, Cham.
- López, Tomás Sánchez et al. (2011): Taxonomy, Technology and Applications of Smart Bbjects. In: Information Systems Frontiers, No. 13, Issue 2, p. 281–300.
- McTear, M./Callejas, Z./Griol, D. (2016): The Conversational Interface. Talking to Smart Devices. Springer International Publishing, Cham.
- Nihtianov, S./Luque, A. (2014): Smart Sensors and MEMS. Intelligent Devices and Microsystems for Industrial Applications. Woodhead, Burlington.
- Poslad, S. (2009): Ubiquitous Computing. Smart Devices, Environments and Interactions. 2nd edition, Wiley, Hoboken, NJ.
- Sendler, U. (Ed.) (2018): The Internet of Things – Industrie 4.0 Unleashed. Springer, Berlin.
- Vinoy, K. J. et al. (Ed.) (2014): Micro and Smart Devices and Systems. Springer India, New Delhi.

Study Format Fernstudium

Study Format	Course Type
Fernstudium	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Smart Devices II

Course Code: DLBINGSD02_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

Literature

Compulsory Reading

Further Reading

Study Format Distance Learning

Study Format Distance Learning	Course Type Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Smart Factory

Module Code: DLBDSESF

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. Mario Boßlau (Smart Factory I) / Prof. Dr. Mario Boßlau (Smart Factory II)

Contributing Courses to Module

- Smart Factory I (DLBDSESF01)
- Smart Factory II (DLBDSESF02)

Module Exam Type	
Module Exam	**Split Exam** Smart Factory I • Study Format "Distance Learning": Exam, 90 Minutes Smart Factory II • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents

Smart Factory I

- Motivation and Definition of Terms
- Development of Automation
- Technological Basics and Standards
- Basic concepts of a Smart Factory
- Reference Architectures
- Smart Factory Engineering
- Safety and Security

Smart Factory II

A catalogue with the currently provided tasks is provided on the online platform of the module. It provides the content basis of the module and can be supplemented or updated by the seminar leader.

Learning Outcomes

Smart Factory I

On successful completion, students will be able to

- understand the term Smart Factory in the context of Industry 4.0.
- be able to trace the development of automation to a fully autonomous, non-centrally organized production plant.
- understand the basic technologies and standards used to design and operate a Smart Factory.
- understand the essential concepts of a Smart Factory.
- identify and differentiate between the individual elements of a Smart Factory using different reference architectures.
- understand the special engineering challenges in the Smart Energy context.
- understand the special safety risks of digitized and networked production plants and assign concrete recommendations for action.

Smart Factory II

On successful completion, students will be able to

- have a deeper understanding of the technologies and standards in the context of Smart Factory.
- apply technologies in the context of Smart Factory to a simple practical example.
- design a hardware or software prototype for a selected task.
- document, design, and develop activities in the form of a project report.

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 Programmes in the IT & Technology fields

Smart Factory I

Course Code: DLBDSESF01

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

Course Description

In this course, students will gain a deeper insight into the networking and digitization of production facilities by examining a Smart Factory. For this purpose, they will be familiarized with the basic goals of a Smart Factory in the context of the research complex Industry 4.0. After a brief introduction to the history of automation, students will learn the technical basics and standards required to design and operate a Smart Factory. Building on this, they will learn how these individual technologies are used to implement the central concepts of a Smart Factory. In order to understand which components a Smart Factory consists of, different reference architectures are presented and compared. The course concludes with the special engineering challenges of an autonomously acting and decentralized production plant. Above all, this includes IT security, which is particularly relevant due to the digital networking of production facilities and products.

Course Outcomes

On successful completion, students will be able to

- understand the term Smart Factory in the context of Industry 4.0.
- be able to trace the development of automation to a fully autonomous, non-centrally organized production plant.
- understand the basic technologies and standards used to design and operate a Smart Factory.
- understand the essential concepts of a Smart Factory.
- identify and differentiate between the individual elements of a Smart Factory using different reference architectures.
- understand the special engineering challenges in the Smart Energy context.
- understand the special safety risks of digitized and networked production plants and assign concrete recommendations for action.

Contents

1. Motivation and Definition of Terms
   - 1.1 Goals of Smart Factory
   - 1.2 Internet of Things
   - 1.3 Cyber-Physical Systems
   - 1.4 Cyber-Physical Production Systems
   - 1.5 Smart Factory as a Cyber-Physical (Production) System

2. Development of Automation
   - 2.1 Automation Pyramid
   - 2.2 Networked, Decentralized Organization of Production
   - 2.3 Future Challenges

3. Technological Basics and Standards
   - 3.1 Identification of Physical Objects
   - 3.2 Formal Description Languages and Ontologies
   - 3.3 Digital Object Memory
   - 3.4 Physical Situation Recognition
   - 3.5 (Partially) Autonomous Action and Cooperation
   - 3.6 Human-Machine Interaction
   - 3.7 Machine to Machine Communication

4. Basic Concepts of a Smart Factory
   - 4.1 Order-Controlled Production
   - 4.2 Bundling of Machine and Production Data
   - 4.3 Supporting People in Production
   - 4.4 Intelligent Products and Resources
   - 4.5 Smart Services

5. Reference Architectures
   - 5.1 Purpose and Properties of Reference Architectures
   - 5.2 Overview of Standardization Initiatives
   - 5.3 CyProS Reference Architecture
   - 5.4 RAMI 4.0 (DIN SPEC 91345)

6. Smart Factory Engineering
   - 6.1 Classification of Different Engineering Tools
   - 6.2 Virtual Engineering
   - 6.3 User-Centered Design
   - 6.4 Requirements Engineering
   - 6.5 Modelling
   - 6.6 Integration of Classic and Smart Components

Literature
Compulsory Reading
Further Reading • Butun, I. (2020). Industrial IoT: Challenges, design principles, applications, and security. Springer. • Drossel, W. G., Ihlenfeldt, S., Lanzger, T., & Dumitrescu, R. (2019). Cyber-physical systems. In R. Neugebauer (Ed.), Digital transformation (pp. 189—213). Springer. • Durakbasa, N. M., & Gençyılmaz, M. G. (Eds.). (2021). Digital conversion on the way to Industry 4.0. Springer. • Ustundag, A., & Cevikcan, E. (2018). Industry 4.0: Managing the digital transformation. Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Smart Factory II

Course Code: DLBDSESF02

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

Course Description

In this course, students select a concrete task from the catalog of topics provided in consultation with the seminar leader. They will work on the task in a prototyping environment suited to the task, which can be either a hardware (e.g., prototyping boards) or software (e.g., technology-specific development environments) environment. To complete the task, students apply the concepts, methods, and tools taught in the Smart Factory I course. They document their results with a project report.

Course Outcomes

On successful completion, students will be able to

- have a deeper understanding of the technologies and standards in the context of Smart Factory.
- apply technologies in the context of Smart Factory to a simple practical example.
- design a hardware or software prototype for a selected task.
- document, design, and develop activities in the form of a project report.

Contents

- A catalogue with the currently provided tasks is provided on the online platform of the module. It provides the content basis of the module and can be supplemented or updated by the seminar leader.

Literature

Compulsory Reading

Further Reading

Study Format Distance Learning

Study Format Distance Learning	**Course Type** Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☑ Slides

Smart Mobility

Module Code: DLBINGSM_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

N.N. (Smart Mobility I) / N.N. (Smart Mobility II)

Contributing Courses to Module

- Smart Mobility I (DLBINGSM01_E)
- Smart Mobility II (DLBINGSM02_E)

Module Exam Type	
Module Exam	**Split Exam** Smart Mobility I • Study Format "Distance Learning": Exam, 90 Minutes Smart Mobility II • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

Module Contents

Smart Mobility I

- Introduction and Definitions
- Overview over traditional mobility infrastructure approaches
- Alternative approaches to mobility
- Services for smart mobility
- Overview over relevant technologies and standards
- Car2X Communication
- Examples and use-cases

Smart Mobility II

In-depth analysis of a specific topic in the context of Smart Mobility in form of a prototype report.

Learning Outcomes

Smart Mobility I

On successful completion, students will be able to

- remember several types of mobility.
- understand distinct reasons for designing intelligent mobility systems.
- analyze diverse types of mobility infrastructure regarding their properties and access requirements.
- understand various alternative mobility approaches.
- remember a range of services that relevant for Smart Mobility.
- understand the relevant technologies and standards for connecting infrastructure elements and services.
- understand use cases for Car2X communication and the relevant standards and technologies.
- remember example projects in the context of Smart Mobility.

Smart Mobility II

On successful completion, students will be able to

- have an in-depth understanding of the technologies and standards in the context of Smart Mobility.
- apply technologies in the context of Smart Mobility using a simple practical example.
- design a hardware or software prototype for a selected task.
- document design choices and development tasks 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 Mobility I

Course Code: DLBINGSM01_E

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

Course Description

This course gives an introduction and overview into the future of mobility. Starting from an understanding of traditional and current mobility infrastructure, alternative approaches are introduced. The course discusses a range of services that are typical for smart mobility solutions. The course includes a detailed discussion on technologies and standards relevant for smart mobility, in particular in Car2X communication. A range of projects and examples are discussed to illustrate the application of smart mobility approaches in a real-life context.

Course Outcomes

On successful completion, students will be able to

- remember several types of mobility.
- understand distinct reasons for designing intelligent mobility systems.
- analyze diverse types of mobility infrastructure regarding their properties and access requirements.
- understand various alternative mobility approaches.
- remember a range of services that relevant for Smart Mobility.
- understand the relevant technologies and standards for connecting infrastructure elements and services.
- understand use cases for Car2X communication and the relevant standards and technologies.
- remember example projects in the context of Smart Mobility.

Contents

1. Introduction and Definitions
   - 1.1 Types of Mobility
   - 1.2 Smart Mobility and Smart City
   - 1.3 Efficient use of energy
   - 1.4 Emissions
   - 1.5 Security
   - 1.6 Comfort
   - 1.7 Cost Effectiveness

2. Overview over traditional mobility infrastructure approaches
   - 2.1 Properties and Access Requirements
   - 2.2 Infrastructure Planning
   - 2.3 Disadvantages of Isolated Infrastructures

3. Alternative approaches to mobility
   - 3.1 Park and Ride
   - 3.2 Car-Sharing
   - 3.3 Rent A Bike
   - 3.4 Carpooling

4. Services for smart mobility
   - 4.1 Authorization
   - 4.2 Payment
   - 4.3 Booking
   - 4.4 Navigation
   - 4.5 Security
   - 4.6 Hybrid Services

5. Overview over relevant technologies and standards
   - 5.1 Mobile Devices
   - 5.2 Mobile Networks and Wireless LAN
   - 5.3 NFC and RFID
   - 5.4 Outdoor and Indoor Localization
   - 5.5 Technologies for Traffic Monitoring

6. Car2X Communication
   - 6.1 Use Cases
   - 6.2 Elements of a Car2X System
   - 6.3 Technologies and Standards
   - 6.4 Sample Implementations

7. Examples and use-cases
   - 7.1 Octopus (Hong Kong)
   - 7.2 Amsterdam Practical Trial
   - 7.3 Mobincity

Literature
Compulsory Reading
Further Reading • Fluegge, B. (2017): Smart Mobility – Connecting Everyone: Trends, Concepts and Best Practices Paperback. Springer/Vierweg, Wiesbaden. • Handke, V./Jonuschat, H. (2013): Flexible Ridesharing. New Opportunities and Service Concepts for Sustainable Mobility. Springer, Berlin/Heidelberg. • Inderwildi, O./King, D. (Eds.) (2012): Energy, Transport, & the Environment. Addressing the Sustainable Mobility Paradigm. Springer, London. • Nathanail, E./Karakikes, I. (2018): Data Analytics: Paving the Way to Sustainable Urban Mobility: Proceedings of 4th Conference on Sustainable Urban Mobility (CSUM2018). Springer, London. • Papa, R./Fistola, R./Gargiulo, C. (2018): Smart Planning: Sustainability and Mobility in the Age of Change (Green Energy and Technology). Springer, London. • Planing, P. et al (2020): Innovations for Metropolitan Areas: Intelligent Solutions for Mobility, Logistics and Infrastructure designed for Citizens. Springer, London. • Sashinskaya, M. (2015): Smart Cities in Europe. Open Data in a Smart Mobility Context. Createspace Independent Publishing Platform.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Smart Mobility II

Course Code: DLBINGSM02_E

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

Course Description

In the course Smart Mobility II, students are asked to choose an assignment provided by the course tutor to apply the concepts and methods covered in Smart Mobility I in a specific use case or application area. The students will develop a prototype focused on a specific topic related to smart mobility. The prototype can be developed either as a hardware setup or a software solution. The students 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 Mobility.
- apply technologies in the context of Smart Mobility using a simple practical example.
- design a hardware or software prototype for a selected task.
- document design choices and development tasks in the form of a project report.

Contents

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

Literature
Compulsory Reading
Further Reading

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

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

N.N. (Smart Services I) / N.N. (Smart Services II)

Contributing Courses to Module

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

Module Exam Type

Module Exam	Split Exam
	Smart Services I • Study Format "Distance Learning": Exam, 90 Minutes Smart Services II • 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
   - 2.3 Digital Intermediaries
   - 2.4 Examples of Disruptive Business Models

3. Recognizing Potential for Smart Services
   - 3.1 Business Model Canvas
   - 3.2 Personas
   - 3.3 Customer Journeys
   - 3.4 Domain-Driven Design

4. Development and Specification of Smart Services
   - 4.1 Modelling of the System Context
   - 4.2 Modelling of Business Processes
   - 4.3 Modelling of Technical Interfaces
   - 4.4 Tools for API Specification

5. Service Architectures
   - 5.1 Infrastructure/Platform/Software-as-a-Service
   - 5.2 Everything-as-a-Service
   - 5.3 Service-oriented Architectures
   - 5.4 Micro Services

6. Integration Platforms
   - 6.1 Features and Purpose of Integration Platforms
   - 6.2 Enterprise Integration Patterns
   - 6.3 External Integration with Zapier, IFTTT & Others

7. Technologies for Smart Services
   - 7.1 Formats for Data Exchange
   - 7.2 Internet Communication Protocols
   - 7.3 Semantic Descriptions
   - 7.4 Complex Event Processing
   - 7.5 Security

8. Quality and Operation of Smart Services
   - 8.1 Quality Characteristics and Maturity of APIs
   - 8.2 Service Level Agreements
   - 8.3 Service Level Management

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

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

Study Format Distance Learning

Study Format Distance Learning	Course Type Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Service Robotics

Module Code: DLBROESR_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

N.N. (Mobile Robotics) / N.N. (Soft Robotics)

Contributing Courses to Module

- Mobile Robotics (DLBROESR01_E)
- Soft Robotics (DLBROESR02_E)

Module Exam Type	
Module Exam	**Split Exam** Mobile Robotics • Study Format "Distance Learning": Module Exam (50) Soft Robotics • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents

Mobile Robotics

- Locomotion
- Kinematics and dynamics
- Perception
- Mobile manipulators
- Path motion and task planning
- Localization and mapping

Soft Robotics

- Soft robotics
- Actuators for soft robots
- Sensors for soft robots
- Applications of soft robots

Learning Outcomes

Mobile Robotics

On successful completion, students will be able to

- understand mobile robot locomotion, kinematics, and dynamics.
- model and simulate a wheeled, legged, or aerial mobile robot.
- understand common approaches for localization and mapping.
- apply and simulate path, motion, and task planning algorithms.
- simulate and understand mobile manipulators.

Soft Robotics

On successful completion, students will be able to

- know the basics behind soft robots.
- understand and analyze common structures of soft robots.
- choose the best soft robot 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

Mobile Robotics

Course Code: DLBROESR01_E

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

Course Description

Modern robots are mobile robots, able to move in spaces and perform tasks autonomously. This is for instance what is done by household robots, or by robots working in warehouses. In the last years, such robots have been improved by the implementation of advanced localization and task planning algorithms, which are based on the fundamentals of mobile robot kinematics and dynamics. This course starts with an introduction to the main concepts of robot locomotion, presenting the three main categories of mobile robots, namely legged, wheeled and aerial (often called drones). As second focus lies on the necessary mathematical foundation. This course, thus, discusses kinematics and dynamics of mobile robots. The topic of how a mobile robot can perceive the surrounding world is treated in detail in a third part of this course, where sensors for mobile robots are introduced together with an introduction on advanced topics such as robot vision and image processing. The last part of this course describes the main approaches for localization, mapping and motion and task planning. A brief overview on combination of mobile robots and manipulators, i.e., mobile manipulators, is also given.

Course Outcomes

On successful completion, students will be able to

- understand mobile robot locomotion, kinematics, and dynamics.
- model and simulate a wheeled, legged, or aerial mobile robot.
- understand common approaches for localization and mapping.
- apply and simulate path, motion, and task planning algorithms.
- simulate and understand mobile manipulators.

Contents

1. Locomotion
    - 1.1 Basics
    - 1.2 Legged Mobile Robots
    - 1.3 Wheeled Mobile Robots
    - 1.4 Aerial Mobile Robots

7. Localization and Mapping
   - 7.1 Sensor Imperfections
   - 7.2 Relative Localization
   - 7.3 Absolute Localization
   - 7.4 Localization, Calibration and Sensor Fusion
   - 7.5 Simultaneous Localization and Mapping
   - 7.6 Examples

Literature

Compulsory Reading

Further Reading

- Corke, P. (2017): Robotics, Vision and Control: Fundamental Algorithms In MATLAB. 2nd ed., Springer International Publishing, Cham.
- Siciliano, B./Khatib, O. (eds.) (2016): Springer Handbook of Robotics. Springer International Publishing, Cham.
- Siegwart, R./Nourbakhsh, I. R./Scaramuzza, D. (2011): Introduction to Autonomous Mobile Robots. The MIT Press, Cambridge, MS.
- Tzafestas, S. G. (2013): Introduction to Mobile Robot Control. Elsevier Inc, Amsterdam.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Module Exam

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Soft Robotics

Course Code: DLBROESR02_E

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

Course Description

Classic robots are made of rigid links and structures. In the last years, the field of robotics has been strongly influenced and inspired by biological processes. Instead of rigid structures, soft structures, materials, and surfaces are characterizing innovative, soft robots. This new generation of robots can be used in several applications where highly dynamic tasks must be performed in unsafe or rough environments, and especially where the interaction with humans is necessary. This course provides the basics in the fast-changing field of soft robotics, starting with an overview of materials and technologies for soft actuators, proceeding with an overview on innovative sensors, and concluding with an overview on modeling approaches for soft robots. The last part summarizes some relevant state-of-the-art applications.

Course Outcomes

On successful completion, students will be able to

- know the basics behind soft robots.
- understand and analyze common structures of soft robots.
- choose the best soft robot technology for a given application.

Contents

1. Introduction
   - 1.1 Soft Robots
   - 1.2 Challenges
   - 1.3 Trends
   - 1.4 Applications

2. Actuators
   - 2.1 Materials and Properties of Soft Actuators
   - 2.2 Thermo-driven Soft Actuators
   - 2.3 Electro-driven Soft Actuators
   - 2.4 Light-driven Soft Actuators
   - 2.5 Magneto-driven Soft Actuators
   - 2.6 Pneumatic Actuators
   - 2.7 Examples

3. Sensors
   - 3.1 Basics
   - 3.2 Proximity Sensing
   - 3.3 Mechano-sensing
   - 3.4 Examples

4. Modeling
   - 4.1 Artificial Muscles
   - 4.2 Interactions
   - 4.3 Compliance Control
   - 4.4 Variable-stiffness Actuators

5. Applications
   - 5.1 Soft Bionic Hands
   - 5.2 Healthcare and Surgery
   - 5.3 Underwater and Aquatic Propulsion
   - 5.4 Bio-inspired Aerial Robots

Literature

Compulsory Reading

Further Reading

- Asaka, K./Okuzaki, H. (eds.) (2019): Soft actuators: materials, modeling, applications, and future perspectives. Springer, Singapore.
- Kim, J. (2017): Microscale Soft Robotics. Springer International Publishing, Cham.
- Siciliano, B./Khatib, O. (eds.) (2016): Springer Handbook of Robotics. Springer International Publishing, Cham.
- Verl, A., et al (eds.) (2015): Soft Robotics: Transferring Theory to Application. Soft Robotics. Springer, Berlin.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Introduction to Cognitive Robotics

Module Code: DLBROEICR_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

N.N. (Digital Signal Processing) / N.N. (Fundamentals of NLP and Computer Vision)

Contributing Courses to Module

- Digital Signal Processing (DLBROEICR01_E)
- Fundamentals of NLP and Computer Vision (DLBROEICR02_E)

Module Exam Type	
Module Exam	**Split Exam** Digital Signal Processing • Study Format "Distance Learning": Exam, 90 Minutes (50) Fundamentals of NLP and Computer Vision • Study Format "Distance Learning": Exam, 90 Minutes (50)

Weight of Module

see curriculum

Module Contents

Digital Signal Processing

- Signal sampling and quantization
- Digital signals and systems
- Discrete Fourier Transform
- z-Transform
- Digital signal processing and filters

Fundamentals of NLP and Computer Vision

- Introduction to Natural Language Processing
- Introduction to Computer Vision
- Applications to Robotics

Learning Outcomes

Digital Signal Processing

On successful completion, students will be able to

- analyze discrete time systems.
- apply analysis tools such as the Discrete Fourier Transform.
- apply the z-Transform.
- analyze properties of discrete systems.
- design finite and infinite impulse response filters.
- implement filters in hardware and software.

Fundamentals of NLP and Computer Vision

On successful completion, students will be able to

- name central problems and challenges in natural language processing and computer vision.
- understand common methods used in natural language processing and computer vision.
- name common use-case scenarios in which NLP and computer vision techniques are applied.
- design basic language processing and computer vision solutions for use in robotics.

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

Digital Signal Processing

Course Code: DLBROEICR01_E

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

Course Description

Digital signal processing enables digital audio and video extraction, as well as extraction of important features from any other kind of signal, for instance medial imagery or diagnostic tools. This course provides the students with expertise on the theory and practice of digital signal processing. In the first part, theoretical concepts are introduced, presenting the main tools for analysis of digital, i.e., sampled or discrete-time systems. The core of digital signal processing resides in the design of a digital filter. The second part of the course focuses on different filter-design approaches, i.e. a discussion on finite impulse response and infinite impulse response filters. The last part gives important insights into the hardware and software implementation of digital signal processing, bridging theory with applied practice.

Course Outcomes

On successful completion, students will be able to

- analyze discrete time systems.
- apply analysis tools such as the Discrete Fourier Transform.
- apply the z-Transform.
- analyze properties of discrete systems.
- design finite and infinite impulse response filters.
- implement filters in hardware and software.

Contents

1. Introduction
   - 1.1 Basic Concepts
   - 1.2 Applications

2. Signal Sampling and Quantization
   - 2.1 Sampling
   - 2.2 Signal reconstruction
   - 2.3 Analog-to-digital Conversion
   - 2.4 Digital-to-Analog Conversion
   - 2.5 Quantization

3. Digital Signals and Systems
   - 3.1 Digital Signals
   - 3.2 Difference Equations and Impulse Responses
   - 3.3 BIBO-Stability
   - 3.4 Digital Convolution

4. Discrete Fourier Transform
   - 4.1 Discrete Fourier Transform
   - 4.2 Amplitude and Power Spectrum
   - 4.3 Spectral Estimation

5. The z-Transform
   - 5.1 Definition
   - 5.2 Properties
   - 5.3 Inverse z-Transform
   - 5.4 Solution of Difference Equations

6. Digital Signal Processing Systems and Filters
   - 6.1 Difference Equation and Transfer Function
   - 6.2 Poles, Zeros and Stability
   - 6.3 Digital Filter Frequency Response
   - 6.4 Basic Filtering
   - 6.5 Realization of Digital Filters
   - 6.6 Applications

7. Finite Impulse Response Filter Design
   - 7.1 Basics
   - 7.2 Fourier Transform Design
   - 7.3 Window Method
   - 7.4 Frequency Sampling Design Method
   - 7.5 Optimal Design Method
   - 7.6 Applications

8. Infinite Impulse Response Filter Design
   8.1 Basics
   8.2 Bilinear Transformation Design Method
   8.3 Butterworth and Chebyschev Filter Designs
   8.4 Higher-Order Infinite Impulse Response Filter Design
   8.5 Pole-Zero Placement for Simple Filters
   8.6 Applications

9. Hardware and Software for Digital Signal Processing
   9.1 Digital Signal Processor Architecture
   9.2 Digital Signal Processor Hardware Units
   9.3 Fixed-Point and Floating-Point Formats
   9.4 Implementation of FIR and IIR Filters in Fixed-Point
   9.5 DSP Programming Examples

Literature

Compulsory Reading

Further Reading

- Manolakis, D. G./Ingle, V. K. (2011): Applied digital signal processing: theory and practice. Cambridge University Press, Cambridge.
- Tan, L./Jiang, J. (2013): Digital signal processing: fundamentals and applications. 2nd ed., Academic Press, Cambridge, MS.
- Vetterli, M./Kovačević, J./Goyal, V. K. (2014): Foundations of signal processing. 2nd ed., Cambridge University Press, Cambridge.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Fundamentals of NLP and Computer Vision

Course Code: DLBROEICR02_E

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

Course Description

Innovative robots, belonging to the so-called generation 3.0, need to sense and understand the environment in many ways, for instance using vision and language understanding and processing. This course introduces the topics of natural language processing (NLP) and computer vision, discussing the main techniques of both fields as well as their application in the field of robotics.

Course Outcomes

On successful completion, students will be able to

- name central problems and challenges in natural language processing and computer vision.
- understand common methods used in natural language processing and computer vision.
- name common use-case scenarios in which NLP and computer vision techniques are applied.
- design basic language processing and computer vision solutions for use in robotics.

Contents

1. Introduction to NLP
   - 1.1 History
   - 1.2 Basics Concepts of NLP
   - 1.3 Feature Extraction Methods
2. Applications of NLP
   - 2.1 Topic Modeling
   - 2.2 Text Summarization and Generation
   - 2.3 Sentiment Analysis
   - 2.4 Translation
   - 2.5 Chatbots

3. Introduction to Computer Vision
   - 3.1 Light and Color
   - 3.2 Image Formation
   - 3.3 Image Processing
   - 3.4 Image Feature Extraction
   - 3.5 Stereo Vision

4. Applications of Computer Vision
   - 4.1 Image Classification, Motion Tracking
   - 4.2 Semantic Segmentation
   - 4.3 Object Identification and Tracking
   - 4.4 Eigenfaces and Facial Recognition

5. NLP and Computer Vision in Robotics
   - 5.1 Camera Calibration
   - 5.2 Pose Estimation
   - 5.3 Visual Servoing
   - 5.4 Human-Robot Interaction
   - 5.5 Privacy Issues

Literature

Compulsory Reading

Further Reading

- Bird S., Klein, E./Loper, E. (2009): Natural language processing with Python. 2nd ed., O‘Reilly, Sebastopol, CA.
- Fisher, R. B., et al (2016) : Dictionary of computer vision and image processing. John Wiley & Sons, Chichester.
- Jurafsky, D./Martin, J. H. (2008): Speech and language processing. Prentice Hall, Upper Saddle River, NJ.
- Szelski, R. (2011): Computer vision: Algorithms and applications. 2nd ed., Springer VS, Wiesbaden.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

DLBROEICR02_E

Programming of Robotic Systems

Module Code: DLBROEPRS_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. Emanuele Grasso (Programming with C/C++) / N.N. (Programming PLCs)

Contributing Courses to Module

- Programming with C/C++ (DLBROEPRS01_E)
- Programming PLCs (DLBROEPRS02_E)

Module Exam Type	
Module Exam	**Split Exam** Programming with C/C++ • Study Format "myStudies": Portfolio • Study Format "Distance Learning": Portfolio Programming PLCs • Study Format "Fernstudium": Oral Assignment

Weight of Module

see curriculum

Module Contents	
Programming with C/C++ - C and C++ for programming of applications and robots **Programming PLCs** - Architectures of programmable logic controllers - Ladder and Functional Block Programming - IL, SFC and ST Programming Methods - Elements of PLC programming - Applications of PLC programming	
Learning Outcomes **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. **Programming PLCs** On successful completion, students will be able to - understand the architecture of PLC systems. - program PLC devices. - apply PLC programming methods for control of simple processes.	
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 Programmes in the IT & Technology fields

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	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format Distance Learning	Course Type Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☑ Slides

Programming PLCs

Course Code: DLBROEPRS02_E

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

Course Description

Programmable logic controllers (PLCs) are used extensively for industrial automation in modern factories and smart houses, either as compact controllers, modular controllers or distributed controllers. PLC algorithms are developed using specific programming languages created for the particular PLC. This course introduces the purpose, architecture, and programming methods of modern PLC systems for use in industrial automation and robotics.

Course Outcomes

On successful completion, students will be able to

- understand the architecture of PLC systems.
- program PLC devices.
- apply PLC programming methods for control of simple processes.

Contents

1. Introduction
   - 1.1 Programmable Logic Controllers
   - 1.2 Hardware
   - 1.3 PLC Architecture
   - 1.4 PLC Systems
   - 1.5 Trends
2. Digital Systems
   - 2.1 The Binary, Octal and Hexadecimal Systems
   - 2.2 Binary Arithmetic
   - 2.3 PLC Data Types
   - 2.4 Combinational and Sequential Logic

3. I/O Processing
    - 3.1 Input/Output Units
    - 3.2 Signal Conditioning
    - 3.3 Remote Connections
    - 3.4 Networks
    - 3.5 I/O addresses

4. Ladder and Functional Block Programming
    - 4.1 Ladder Diagrams
    - 4.2 Logic Functions
    - 4.3 Latching
    - 4.4 Multiple Outputs
    - 4.5 Entering Programs
    - 4.6 Function Blocks
    - 4.7 Examples

5. IL, SFC and ST Programming Methods
    - 5.1 Instruction List
    - 5.2 Sequential Function Charts
    - 5.3 Structured Text
    - 5.4 Examples

6. Elements of PLC Programming
    - 6.1 Internal Relays
    - 6.2 Jump and Call
    - 6.3 Timers
    - 6.4 Counters
    - 6.5 Shift Registers
    - 6.6 Data Handling

7. Applications
    - 7.1 PLC and Safety
    - 7.2 Testing Software and Fault Finding
    - 7.3 Examples of Process Control

Literature
Compulsory Reading
Further Reading • Barkalov, A./Titarenko, L./Mazurkiewicz, M. (2019): Foundations of Embedded Systems. Springer International Publishing, Cham. • Bolton, W. (2015): Programmable logic controllers. 6th ed., Newnes/Elsevier, Amsterdam. • Petruzella, F. D. (2016): Programmable logic controllers. 5th ed., McGraw-Hill Education, New York City, NY.

Study Format Fernstudium

Study Format	Course Type
Fernstudium	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

DLBROEPRS02_E

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
N.N. (Self-Driving Vehicles) / N.N. (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 "Distance Learning": Exam, 90 Minutes Seminar: Current Topics and Trends in Self-Driving Technology • Study Format "Distance Learning": 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 calibaration
   - 1.4 Application scenarios
2. Sensor Fusion
   - 2.1 Elaborating data from sensors
   - 2.2 Kalman filter
   - 2.3 Object tracking

3. Computer Vision
   - 3.1 Pixels and filters
   - 3.2 Feature detection
   - 3.3 Distortions and calibration
   - 3.4 Semantic segmentation

4. Localization & Motion
   - 4.1 Motion models
   - 4.2 Odometry
   - 4.3 Triangulation
   - 4.4 Satellite-based localization

5. Motion planning
   - 5.1 Path planning
   - 5.2 Motion prediction
   - 5.3 Trajectory generation

6. Safety Standards
   - 6.1 Functional Safety
   - 6.2 IT Security Standards
   - 6.3 Safety development approaches

Literature

Compulsory Reading

Further Reading

- Ben-Ari, M./Mondada, F. (2018): Elements of robotics. Springer, Cham.
- European Union. (2001).:Directive 2001/95/EG. (URL: https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A32001L0095 [Retrieved: 28.02.2020])
- Fisher, R. B., et al. (2016): Dictionary of computer vision and image processing. John Wiley & Sons, Chichester.
- International Electrotechnical Commission. (2015): IEC 61508. (URL: https://www.iec.ch/functionalsafety/ [Retrieved: 28.02.2020])
- International Organization for Standardization. (2009): ISO 15408. (URL: https://www.iso.org/standard/50341.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 25119. (URL: https://www.iso.org/standard/69026.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 26262. (URL: https://www.iso.org/standard/68383.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (n.d.): ISO 21434. (URL: https://www.iso.org/standard/70918.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO/IEC 27001. (URL: https://www.iso.org/isoiec-27001-information-security.html [Retrieved: 28.02.2020])
- Rausand, M. (2014): Reliability of safety-critical systems: Theory and applications. Wiley, Hoboken, NJ.
- 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. (URL: https://www.sae.org/standards/content/j3061/ [Retrieved: 28.02.2020])
- Szelski, R. (2011): 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 Distance Learning	Course Type Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ 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

Further Reading

- Ben-Ari, M./Mondada, F. (2018): Elements of robotics. Springer, Cham.
- European Union. (2001).:Directive 2001/95/EG. (URL: https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A32001L0095 [Retrieved: 28.02.2020])
- Fisher, R. B., et al. (2016): Dictionary of computer vision and image processing. John Wiley & Sons, Chichester.
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- 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. (URL: https://www.sae.org/standards/content/j3061/ [Retrieved: 28.02.2020])
- Szelski, R. (2011): 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	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Applied Sales

Module Code: DLBDSEAS

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. Patrick Geus (Applied Sales I) / Prof. Dr. Patrick Geus (Applied Sales II)

Contributing Courses to Module

- Applied Sales I (DLBDSEAS01)
- Applied Sales II (DLBDSEAS02)

Module Exam Type	
Module Exam	**Split Exam** Applied Sales I • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes Applied Sales II • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents

Applied Sales I

- Fundamentals of Applied Sales
- The Distribution System
- Personal Sales
- Sales Plans
- New Customer Acquisition
- A Sales Visit
- Conversational Tactics
- Conducting Negotiations
- Other Sales Channels

Applied Sales II

- Marketing and Sales
- Customer Satisfaction as a Success Factor
- Personalities in Sales
- Customer-Oriented Communication
- Presentation and Rhetoric
- Customer Loyalty
- Networking
- Case Study

Learning Outcomes

Applied Sales I

On successful completion, students will be able to

- understand the fundamentals of applied sales and place them in the context of the company.
- understand the interaction of the individual facets of applied sales.
- differentiate between and evaluate individual sales systems.
- describe current sales types and sales characteristics.
- oversee and classify the entire sales process from customer acquisition to customer retention.
- understand the basics of sales and negotiation management and apply them.
- name the usual sales instruments, recognize their advantages and disadvantages, and reflect on essential fields of application and possibilities.

Applied Sales II

On successful completion, students will be able to

- understand the interaction and the respective areas of responsibility of marketing and sales.
- reflect on and classify the goals and measures within the framework of the applied sales system.
- assess the relevance of customer satisfaction and retention. In addition, the students will be familiar with the central design elements of CRM.
- reflect on and assess alternative approaches to customer loyalty and relationship management and apply them in business practice.
- understand the meaning of the terms customer life cycle and customer value, and develop approaches to manage them in the sense of the respective sales targets.
- use descriptive presentation techniques in order to convince customers and other sales partners.
- understand the relevance of networking and develop strategies to broaden the contact base.
- develop and evaluate their own market analyses and sales concepts on the basis of practical experience within the framework of the case study.

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 Marketing & Sales	All Bachelor Programmes in the Marketing & Communication fields

Applied Sales I

Course Code: DLBDSEAS01

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

Course Description

The demands on sales thinking are growing every day. Globalized demand combined with high competition is making it increasingly difficult for companies to compete for customers. At the same time, customers are becoming better informed, while traditional supply markets are saturated and at overcapacity. In order to be successful in such an environment, sales thinking and action are required along with a new type of salesperson. Within the course Applied Sales I (Introduction), the participants are familiarized with the basic concepts of applied sales. You will learn about sales organization, dealing with alternative sales channels, and get to know the dedicated sales planning process. The contents of the module are complemented by the successful acquisition of new customers, whereby particular attention is paid to the organization and implementation of customer visits and the conduct of discussions and negotiations.

Course Outcomes

On successful completion, students will be able to

- understand the fundamentals of applied sales and place them in the context of the company.
- understand the interaction of the individual facets of applied sales.
- differentiate between and evaluate individual sales systems.
- describe current sales types and sales characteristics.
- oversee and classify the entire sales process from customer acquisition to customer retention.
- understand the basics of sales and negotiation management and apply them.
- name the usual sales instruments, recognize their advantages and disadvantages, and reflect on essential fields of application and possibilities.

Contents

1. Fundamentals of Applied Sales and Distribution
   - 1.1 Tasks and Forms of Applied Distribution
   - 1.2 Marketing as the Basis of Sales
   - 1.3 Distribution, Sales, and Other Terms
   - 1.4 Sales in Different Economic Sectors

8. Conducting Negotiations
   - 8.1 Psychology of Negotiation
   - 8.2 Negotiation Structure
   - 8.3 Objection Handling
   - 8.4 Price Negotiations

9. Other Sales Channels
   - 9.1 Telemarketing
   - 9.2 Catalogue and Brochure Sales
   - 9.3 Internet and E-Commerce

Literature

Compulsory Reading

Further Reading

- Bloomfield, J. (2020). NeuroSelling: Mastering the customer conversation using the surprising science of decision making. Axon Publishing.
- Jobber, D., Lancaster, G., & Le Meunier-FitzHugh, K. (2019). Selling and sales management (10th ed.). Pearson.
- Peppers, D., & Rogers, M. (2016). Managing customer experience and relationships: A strategic framework (3rd ed.). Wiley.
- Pink, D. H. (2012). To sell is human: The surprising truth about moving others. Riverhead Books.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Applied Sales II

Course Code: DLBDSEAS02

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

Course Description

The course Applied Sales II builds on the basics taught in the course "Applied Sales I" and broadens and deepens them. First, the tension between marketing and sales is examined in more detail. Based on this, essential backgrounds and central target figures for successful sales management (e.g., customer satisfaction and loyalty as well as the customer life cycle) are derived and operationalized in order to create the basis for efficient and effective customer relationship management. As the process progresses, attention will also be paid to mental processes and consumer behavior in general. In addition, strategies and paths to successful negotiation are deepened and supplemented by convincing communication techniques. The course concludes with a case study in the course of which the students have the opportunity to apply what they have learned in a practice-oriented manner.

Course Outcomes

On successful completion, students will be able to

- understand the interaction and the respective areas of responsibility of marketing and sales.
- reflect on and classify the goals and measures within the framework of the applied sales system.
- assess the relevance of customer satisfaction and retention. In addition, the students will be familiar with the central design elements of CRM.
- reflect on and assess alternative approaches to customer loyalty and relationship management and apply them in business practice.
- understand the meaning of the terms customer life cycle and customer value, and develop approaches to manage them in the sense of the respective sales targets.
- use descriptive presentation techniques in order to convince customers and other sales partners.
- understand the relevance of networking and develop strategies to broaden the contact base.
- develop and evaluate their own market analyses and sales concepts on the basis of practical experience within the framework of the case study.

Contents

Literature

Compulsory Reading

Further Reading

- Jobber, D./Lancaster, G./Le Meunier-Fitzhugh, K. (2019): Selling and Sales Management, 11th Ed.; Pearson
- Johnston, M.W./Marshall (2021): Sales Force Management: Leadership, Innovation, Technology; Routledge
- Jordan, J./Vazzana, M. (2011): Cracking the Sales Management Code: The Secrets to Measuring and Managing Sales Performance; 13th Ed.; McGraw Hill
- Kumar, V./Reinartz, W. (2018): Customer Relationship Management: Concept, Strategy, and Tools; 3rd Ed.; Springer Texts in Business and Economics
- Marcos, J./Davies, M. (2019): Implementing Key Account Management: Designing Customer-Centric Processes for Mutual Growth; KoganPage
- Peppers, D./Rogers, M. (2011): Managing Customer Relationships : A Strategic Framework; 2nd Ed.; Wiley

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Applied Robotics

Module Code: DLBWINWAR_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
N.N. (Embedded Systems) / N.N. (Project: Applied Robotics with Robotic Platforms)

Contributing Courses to Module
• Embedded Systems (DLBROES01_E) • Project: Applied Robotics with Robotic Platforms (DLBROPARRP01_E)

Module Exam Type	
Module Exam	**Split Exam** Embedded Systems • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Project: Applied Robotics with Robotic Platforms • Study Format "myStudies": Oral Project Report • Study Format "Distance Learning": Oral Project Report
Weight of Module see curriculum	

Module Contents **Embedded Systems** - Embedded systems architecture - Embedded hardware - Embedded software - Distributed systems and IoT architecture - Embedded operating systems **Project: Applied Robotics with Robotic Platforms** This module provides students with the basic competence to use existing robotic software and hardware platforms to design, create and implement 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. **Project: Applied Robotics with Robotic Platforms** On successful completion, students will be able to - name several existing open-source robotic platforms. - understand the basic principles of robotic platforms. - work with existing robotic platforms. - carry out a robotic project by means of robotic platforms.	
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 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
    - 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

- Barkalov, A./Titarenko, L./Mazurkiewicz, M. (2019): Foundations of Embedded Systems. In: Kacprzyk, J.: Studies in Systems, Decision and Control, Volume 195, Springer Nature, Chams.
- Lacamera, D. (2018): Embedded systems architecture: explore architectural concepts, pragmatic design patterns, and best practices to produce robust systems. Packt Publishing, Birmingham.
- Noergaard, T. (2013): Embedded Systems Architecture. Elsevier Inc, Amsterdam.
- Siegesmund, M. (2014): Embedded C Programming. Elsevier Inc, Amsterdam.
- Simon, D. E. (1999): An embedded software primer. Addison Wesley, Boston, MS.
- White, E. (2011): Making Embedded Systems. O’Reilly, Sebastopol, CL.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Project: Applied Robotics with Robotic Platforms

Course Code: DLBROPARRP01_E

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

Course Description

In the last years several robotic software and hardware platforms have been developed. The existing diverse robotic systems provide an affordable and reliable basis to build next generation robots. Some of those systems are open source and constantly developed by the community of roboticists. Of course, such systems require a minimal understanding of robotics as well as of other robotics-related issues which are important in today’s technical community, such as internet of things and communication interfaces. This course provides the basics to work with such robotic platforms for development, design and implementation of industrial and mobile robots.

Course Outcomes

On successful completion, students will be able to

- name several existing open-source robotic platforms.
- understand the basic principles of robotic platforms.
- work with existing robotic platforms.
- carry out a robotic project by means of robotic platforms.

Contents

- This course illustrates robotic platforms and their usage within robotics projects.

Literature

Compulsory Reading

Further Reading

- Cacace, J./Joseph, L. (2018): Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System. 2nd ed., Packt Publishing, Birmingham.
- Koubaa, A. (ed.) (2018): Robot operating system (ROS): the complete reference. Volume 1. Springer, Cham.
- Quigley, M./Gerkey, B./Smart, W. D. (2015): Programming robots with ROS. O’Reilly, Sebastopol, CL.

Study Format myStudies

Study Format	Course Type
myStudies	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

DLBROPARRP01_E

Control Engineering

Module Code: DLBWINWRT_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

N.N. (Signals and Systems) / N.N. (Control Systems Engineering)

Contributing Courses to Module

- Signals and Systems (DLBROSS01_E)
- Control Systems Engineering (DLBROCSE01_E)

Module Exam Type	
Module Exam	**Split Exam** Signals and Systems • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Control Systems Engineering • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

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Module Contents

Signals and Systems

- 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

Control Systems Engineering

- 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

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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.

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.

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Links to other Modules within the Study Program

This module is similar to other modules in the field of Engineering

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Links to other Study Programs of the University

All Bachelor Programs in the IT & Technology fields

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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

- Alkin, O. (2014): Signals and systems: a MATLAB integrated approach. CRC Press, Boca Raton, FL.
- Lathi, B. P. (2009): Principles of Linear Systems and Signals. 2nd ed., Oxford University Press, New Delhi.
- Rao, K. D. (2018): Signals and Systems. Springer International Publishing, Cham.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods

☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

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

- Nise, N. S. (2019): Control systems engineering. 8th ed., John Wiley & Sons, Hoboken, NJ.
- Doyle, J. C./Francis, B. A./Tannenbaum, A. R. (2009): Feedback Control Theory. Dover Publications Inc, Mineola, NY.
- Franklin, G. F./Powell, J. D./Emami-Naeini, A. (2019): Feedback control of dynamic systems. 8th ed., Pearson, London.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Microcontroller

Module Code: DLBWINWMC_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	▪ none ▪ DLBAETDIT01_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

Prof. Dr. Marian Benner-Wickner (Digital and Information Technology) / Prof. Dr. Marian Benner-Wickner (Project: Microcontrollers and Logical Circuits)

Contributing Courses to Module

- Digital and Information Technology (DLBAETDIT01_E)
- Project: Microcontrollers and Logical Circuits (DLBAETPMLS01_E)

Module Exam Type	
Module Exam	**Split Exam** Digital and Information Technology • 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

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

Project: Microcontrollers and Logical Circuits

The students should work independently through the complete flowof 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

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.

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

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

3. Combinational Logic
   3.1 Logic Gate
   3.2 Connection of Logic Gaes
   3.3 Substitution by NOR / NAND Gates

4. Sequential Logic
   4.1 Latches and Flipflops
   4.2 Counter and Frequency Divider
   4.3 Shift Register and Memory

5. State Machines
   5.1 Foundations
   5.2 Models for State Machines
   5.3 Representation of State Machines
   5.4 Event-driven / Clock-driven State Machines
   5.5 Synchronization of Parallel State Machines

6. Arithmatic Circuits
   6.1 Adders
   6.2 Subtractor Circuits
   6.3 Multiplication Circuits

7. Introduction to Programmable Logic
   7.1 Programmable Cell Logic and Programmable Logic Array
   7.2 Complex Programmable Logic Devices (CPLD)
   7.3 FPGAs
   7.4 Introduction to VHDL

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	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ 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 Distance Learning	Course Type Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Object-oriented Programing

Module Code: IOBP_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. Damir Ismailovic (Object-oriented Programming with Java) / Prof. Dr. Damir Ismailovic (Data Structures and Java Class Library)

Contributing Courses to Module

- Object-oriented Programming with Java (DLBCSOOPJ01)
- Data Structures and Java Class Library (DLBCSDSJCL01)

Module Exam Type	
Module Exam	**Split Exam** <u>Object-oriented Programming with Java</u> • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes <u>Data Structures and Java Class Library</u> • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents

Object-oriented Programming with Java

- Introduction to the Java language
- Java language constructs
- Introduction to object-oriented system developement
- Inheritance
- Object-oriented concepts
- Exception handling
- Interfaces

Data Structures and Java Class Library

- Programming style
- Working with objects
- External packages and libraries
- Data structures
- Strings and calendar
- File system and data streams

Learning Outcomes

Object-oriented Programming with Java

On successful completion, students will be able to

- describe the basic concepts of object-oriented modeling and programming, distinguishing them from one another.
- describe the basic concepts and elements of the Java programming language and have some experience in their use.
- independently create Java programs to solve concrete problems.

Data Structures and Java Class Library

On successful completion, students will be able to

- understand typical data structures and distinguish them from each other.
- independently create solutions in the Java programming language using the data structures.
- understand scenarios and strategies for comparing objects and implement them in Java.
- describe the possible uses and functions of character strings and calendar objects in Java and have experience using them.
- describe the possible uses and functions of streams in Java and have experience using them.

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 Programmes in the IT & Technology fields

Object-oriented Programming with Java

Course Code: DLBCSOOPJ01

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

Course Description

Operational information systems are usually planned and programmed to be object-oriented. Therefore, this course teaches the basic skills of object-oriented programming. Theoretical concepts are presented and practiced directly with the programming language Java.

Course Outcomes

On successful completion, students will be able to

- describe the basic concepts of object-oriented modeling and programming, distinguishing them from one another.
- describe the basic concepts and elements of the Java programming language and have some experience in their use.
- independently create Java programs to solve concrete problems.

Contents

1. Introduction to Object-Oriented System Development
   - 1.1 Object Orientation as a Way of Looking at Complex Systems
   - 1.2 The Object as a Basic Concept of Object Orientation
   - 1.3 Phases in the Object-Oriented Development Process
   - 1.4 Basic Principle of Object-Oriented System Development

2. Introduction to Object-Oriented Modeling
   - 2.1 Structuring Problems With Classes
   - 2.2 Identifying Classes
   - 2.3 Attributes as Properties of Classes
   - 2.4 Methods as Functions of Classes
   - 2.5 Associations between Classes
   - 2.6 Unified Modeling Language (UML)

3. Programming Classes in Java
    - 3.1 Introduction to the Java Programming Language
    - 3.2 Basic Elements of a Class in Java
    - 3.3 Attributes in Java
    - 3.4 Methods in Java
    - 3.5 Main Method: Starting Point of a Java Program

4. Java Language Constructs
    - 4.1 Primitive Data Types
    - 4.2 Variables
    - 4.3 Operators and Expressions
    - 4.4 Control Structures
    - 4.5 Packages and Visibility Modifiers .

5. Inheritance
    - 5.1 Modeling and Inheritance in the Class Diagram
    - 5.2 Programming Inheritance in Java

6. Important Object-Oriented Concepts
    - 6.1 Abstract Classes
    - 6.2 Polymorphism
    - 6.3 Static Attributes and Methods

7. Constructors for Generating Objects
    - 7.1 The Standard Constructor
    - 7.2 Overloading Constructors
    - 7.3 Constructors and Inheritance

8. Handling Exceptions with Exceptions
    - 8.1 Typical Scenarios of Exception Handling
    - 8.2 Standard Exceptions in Java
    - 8.3 Defining Your Own Exceptions

9. Programming Interfaces with Interfaces
    - 9.1 Typical Scenarios of Programming Interfaces
    - 9.2 Interfaces as Programming Interfaces in Java

Literature
Compulsory Reading
Further Reading • Freeman, E., Robson, E., Bates, B., & Sierra, K. (2014). Head first design patterns (A brain friendly guide). O'Reilly Media. • Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1995). Design patterns: Elements of re-usable object-oriented software. Addison-Wesley. • Liang, Y. D. (2018). Introduction to Java programming and data structures. Pearson Education. • Liguiori, L. & Liguori, P. (2008). Java pocket guide: Instant help for Java. O'Reilly Media. • Oracle (2017). The Java tutorials. Available online. • Samoylov, N. (2019). Learn Java 12 programming: A step-by-step guide to learning essential concepts in Java SE 10, 11, and 12. Packt Publishing. • Weisfeld M. (2019). The object-oriented thought process (5th ed.). Addison-Wesley.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Data Structures and Java Class Library

Course Code: DLBCSDSJCL01

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

Course Description

Based on the contents of the course "Basics of object-oriented programming with Java", this course deepens the knowledge of object-oriented programming. In particular, data structures, their use cases, and their implementation in the Java language are considered. In addition, strategies and scenarios of object comparisons, the use of functions of the "String" data type, the use of calendar objects, and the use of streams are taught.

Course Outcomes

On successful completion, students will be able to

- understand typical data structures and distinguish them from each other.
- independently create solutions in the Java programming language using the data structures.
- understand scenarios and strategies for comparing objects and implement them in Java.
- describe the possible uses and functions of character strings and calendar objects in Java and have experience using them.
- describe the possible uses and functions of streams in Java and have experience using them.

Contents

1. Programming Style
   - 1.1 Code Documentation
   - 1.2 Code Annotations
   - 1.3 Code Conventions

2. Working with Objects
   - 2.1 String Representation of Objects
   - 2.2 Compare with ==
   - 2.3 Compare with Equals()
   - 2.4 Compare by HashCode()
   - 2.5 CompareTo()
   - 2.6 Cloning Objects

3. External Packages and Libraries
    - 3.1 Importing Packages
    - 3.2 The Java Class Library

4. Data Structures
    - 4.1 Arrays
    - 4.2 Collections
    - 4.3 Working with Collections
    - 4.4 Lists
    - 4.5 Quantities (Sets)
    - 4.6 Associative Memory (Maps)
    - 4.7 Stacks (Basement)
    - 4.8 Queues (Snakes)

5. Strings and Calendar
    - 5.1 Strings
    - 5.2 StringBuffer
    - 5.3 Splitting Character Strings
    - 5.4 Date and time
    - 5.5 Calendar

6. File System and Data Streams
    - 6.1 Working with the File System
    - 6.2 Working with Files

Literature

Compulsory Reading

Further Reading

- Bloch, J. (2017). Effective Java (3rd ed.). Addison-Wesley.
- Oracle. (2018a). Java platform standard edition 10 API specification. (Available online).
- Oracle. (2018b). String (Java platform SE 10). (Available online).
- Oracle. (2018c). Date (Java platform SE 10). (Available online).
- Oracle. (2018d). java.io (Java platform SE 10). (Available online).
- Oracle. (2019). The Java language specification: Java SE 11 edition. (Available online).
- Seidl, M. (2015). UML@Classroom: An introduction to object-oriented modeling. Springer.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Practice Project: Industrial Engineering 4.0

Module Code: DLBWINWPWIN_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	at least 90 ECTS, DLBINGET01-01_E, DLBINGDT01_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

Prof. Dr. Marian Benner-Wickner (Practice Project: Industrial Engineering 4.0)

Contributing Courses to Module

- Practice Project: Industrial Engineering 4.0 (DLBWINWPWIN01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Internship Reflection Paper (passed / not passed)	

Weight of Module

see curriculum

Module Contents

The Practical Project: Industrial Engineering 4.0 offers students the opportunity to gain practical experience in the field of industrial engineering, based on the subject-specific study components in industrial engineering. For this purpose, a tangible or digital result is to be created in collaboration with a company, for example a product prototype, a tool or software. The result should be able to solve an existing practical problem of the company.

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

Learning Outcomes

Practice Project: Industrial Engineering 4.0

On successful completion, students will be able to

- identify relevant problems from the professional environment of an industrial engineer in a company and explain them to an interested audience,
- apply established procedures to find a (prototypical) solution to the problem,
- find relevant concepts or technologies for the solution and integrate them appropriately,
- evaluate the result in terms of its suitability for solving the practical problem,present the problem, the solution and the way to get there in a comprehensible and descriptive way.

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Links to other Modules within the Study Program

This module is similar to other modules in the field of Engineering

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Links to other Study Programs of the University

All Bachelor Programs in the IT & Technology fields

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</table>

Practice Project: Industrial Engineering 4.0

Course Code: DLBWINWPWIN01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		10	at least 90 ECTS, DLBINGET01-01_E, DLBINGDT01_E

Course Description

In the course of the study program, a variety of different concepts, methods and techniques were introduced that are relevant to the professional practice of an industrial engineer. The practical project offers the opportunity to use the accumulated knowledge and skills to solve a relevant problem of a company independently and on one's own responsibility. The result should be the creation of hardware or software (or a combination of both) that can demonstrate, at least in the sense of a proof-of-concept or a prototype, how the practical problem can be solved.

Course Outcomes

On successful completion, students will be able to

- identify relevant problems from the professional environment of an industrial engineer in a company and explain them to an interested audience,
- apply established procedures to find a (prototypical) solution to the problem,
- find relevant concepts or technologies for the solution and integrate them appropriately,
- evaluate the result in terms of its suitability for solving the practical problem,present the problem, the solution and the way to get there in a comprehensible and descriptive way.

Contents

- At the beginning of the practical project, the students look for a company that agrees to cooperate accordingly (in all formal matters such as confidentiality agreements or blocking notes, the students are advised in the tutorial and by the examination office). In consultation with the company and the tutor, the students select a concrete task that (a) can be derived from a company-specific problem, (b) can be processed with the available time and technical resources. Possible problems and use cases can be found, for example, in the areas of sustainability, smart factory, robotics, smart home, electromobility, autonomous driving, human-machine interaction, data analytics, robotic process automation, or digital business models. The students ideally work on the task in a working environment provided by the company. To complete the task, the students apply the concepts, methods and tools taught throughout the curriculum. They write down their result in the form of a simple practical reflection. The result is evaluated in terms of its suitability for solving the previously selected problem. Aspects such as complexity, creativity and practical relevance play a role.

Literature
Compulsory Reading
Further Reading - Bangemann, Thomas; Riedl, Matthias; Thron, Mario; Diedrich, Christian (2016): Integration of Classical Components Into Industrial Cyber–Physical Systems. In: Proc. IEEE 104 (5), S. 947–959. - Harrison, Robert; Vera, Daniel; Ahmad, Bilal (2016): Engineering Methods and Tools for Cyber–Physical Automation Systems. In: Proc. IEEE 104 (5), S. 973–985. - Kelley, T./ Kelley, D. (2013): Creative Confidence: Unleashing the Creative Potential Within Us All. Crown Publishing, New York. - Meinel, C.; Weinberg, U.; Krohn, T. (Eds.) (2015): Design Thinking Live. How to develop ideas and solve problems. Murmann Publishers, Hamburg.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Internship Reflection Paper (passed / not passed)

Student Workload					
Self Study	**Contact Hours**	**Tutorial**	**Self Test**	**Independent Study**	**Hours Total**
0 h	0 h	0 h	0 h	300 h	300 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Project: Hackathon

Module Code: DLBWINWPH_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	at least 90 ECTS, DLBINGET01-01_E, DLBINGDT01_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

Prof. Dr. Marian Benner-Wickner (Project: Hackathon)

Contributing Courses to Module

- Project: Hackathon (DLBWINWPH01_E)

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

Module Contents

The Project: Hackathon offers students the opportunity to gain practical experience in the field of industrial engineering based on the subject-specific study components in industrial engineering. For this purpose, a tangible or digital result is to be created, for example a product prototype, a tool or a software. The result should be able to solve an existing problem from practice.

Learning Outcomes	
Project: Hackathon On successful completion, students will be able to ▪ identify relevant problems from the professional environment of an industrial engineer and explain it to an interested audience, ▪ apply established procedures to find a (prototypical) solution to the problem, ▪ find relevant concepts or technologies for the solution and integrate them appropriately, ▪ evaluate the result with respect to its suitability for solving the practical problem, ▪ present the problem, the solution and the way to get there in a comprehensible and descriptive way.	
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

Project: Hackathon

Course Code: DLBWINWPH01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		10	at least 90 ECTS, DLBINGET01-01_E, DLBINGDT01_E

Course Description

In the course of the study program, a variety of different concepts, methods and techniques were introduced that are relevant to the professional practice of an industrial engineer. The Hackathon offers the opportunity to use the accumulated knowledge and skills to solve a relevant practical problem independently and on one's own responsibility. The result should be the creation of hardware or software (or a combination of both) that can demonstrate, at least in terms of a proof-of-concept or prototype, how the practical problem can be solved. The problem and the result are to be made available to other students on a platform provided for this purpose.

Course Outcomes

On successful completion, students will be able to

- identify relevant problems from the professional environment of an industrial engineer and explain it to an interested audience,
- apply established procedures to find a (prototypical) solution to the problem,
- find relevant concepts or technologies for the solution and integrate them appropriately,
- evaluate the result with respect to its suitability for solving the practical problem,
- present the problem, the solution and the way to get there in a comprehensible and descriptive way.

Contents

- At the beginning of the Hackathon the students choose a concrete task in coordination with the tutor. The task shall be derived from a relevant practical problem. Possible problems and use cases can be found, for example, in the areas of sustainability, smart factory, robotics, smart home, electromobility, autonomous driving, human-machine interaction, data analytics, robotic process automation or digital business models. Students work on the task with the help of a prototyping environment that fits the subject of the task. The environments can be hardware (e.g. prototyping boards such as the Arduino) or software (e.g. technology-specific development environments such as Matlab or Eclipse IDE). To complete the task, students apply the concepts, methods and tools taught throughout the curriculum. They present their result in the form of a project presentation. In addition, the students are asked to publish the result together with the underlying problem and the chosen solution on a platform so that it is visible to other students. The result is evaluated in terms of its suitability to solve the previously selected problem. Aspects such as complexity, creativity and practical relevance play a role.

Literature
Compulsory Reading
Further Reading ▪ Anderson, C. (2013): Makers - The Internet of Things: The next industrial revolution. Carl Hanser, Munich. ▪ Kelley, T./ Kelley, D. (2013): Creative Confidence: Unleashing the Creative Potential Within Us All. Crown Publishing, New York. ▪ Meinel, C./ Weinberg, U./ Krohn, T. (eds.) (2015): Design Thinking Live. How to create ideas develops and solves problems. Murmann Publishers, Hamburg. ▪ Monk, S, (2018): Programming Arduino Next Steps: Going Further with Sketches, Second Edition. McGraw-Hill Education TAB

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

Student Workload					
Self Study	**Contact Hours**	**Tutorial**	**Self Test**	**Independent Study**	**Hours Total**
240 h	0 h	60 h	0 h	0 h	300 h

Instructional Methods

☐ Learning Sprints®
☐ Course Book
☐ Vodcast
☐ Shortcast
☐ Audio
☐ Exam Template
☐ Review Book
☐ Creative Lab
☑ Guideline
☐ Live Tutorium/Course Feed
☑ Slides

DLBWINWPH01_E

6. Semester

Smart Devices

Module Code: DLBINGSD_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
N.N. (Smart Devices I) / N.N. (Smart Devices II)

Contributing Courses to Module
• Smart Devices I (DLBINGSD01_E) • Smart Devices II (DLBINGSD02_E)

Module Exam Type	
Module Exam	**Split Exam** Smart Devices I • Study Format "Fernstudium": Exam, 90 Minutes Smart Devices II • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents

Smart Devices I

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

Smart Devices II

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

Learning Outcomes

Smart Devices I

On successful completion, students will be able to

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

Smart Devices II

On successful completion, students will be able to

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

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 Devices I

Course Code: DLBINGSD01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

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

Literature
Compulsory Reading
Further Reading • Fortino, G./Trunfio, P. (2014): Internet of Things Based on Smart Objects. Technology, Middleware and Applications. Springer International Publishing, Cham. • López, Tomás Sánchez et al. (2011): Taxonomy, Technology and Applications of Smart Bbjects. In: Information Systems Frontiers, No. 13, Issue 2, p. 281–300. • McTear, M./Callejas, Z./Griol, D. (2016): The Conversational Interface. Talking to Smart Devices. Springer International Publishing, Cham. • Nihtianov, S./Luque, A. (2014): Smart Sensors and MEMS. Intelligent Devices and Microsystems for Industrial Applications. Woodhead, Burlington. • Poslad, S. (2009): Ubiquitous Computing. Smart Devices, Environments and Interactions. 2nd edition, Wiley, Hoboken, NJ. • Sendler, U. (Ed.) (2018): The Internet of Things – Industrie 4.0 Unleashed. Springer, Berlin. • Vinoy, K. J. et al. (Ed.) (2014): Micro and Smart Devices and Systems. Springer India, New Delhi.

Study Format Fernstudium

Study Format	Course Type
Fernstudium	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Smart Devices II

Course Code: DLBINGSD02_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

Literature

Compulsory Reading

Further Reading

Study Format Distance Learning

Study Format Distance Learning	Course Type Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Smart Factory

Module Code: DLBDSESF

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. Mario Boßlau (Smart Factory I) / Prof. Dr. Mario Boßlau (Smart Factory II)

Contributing Courses to Module
• Smart Factory I (DLBDSESF01) • Smart Factory II (DLBDSESF02)

Module Exam Type	
Module Exam	**Split Exam** Smart Factory I • Study Format "Distance Learning": Exam, 90 Minutes Smart Factory II • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents

Smart Factory I

- Motivation and Definition of Terms
- Development of Automation
- Technological Basics and Standards
- Basic concepts of a Smart Factory
- Reference Architectures
- Smart Factory Engineering
- Safety and Security

Smart Factory II

A catalogue with the currently provided tasks is provided on the online platform of the module. It provides the content basis of the module and can be supplemented or updated by the seminar leader.

Learning Outcomes

Smart Factory I

On successful completion, students will be able to

- understand the term Smart Factory in the context of Industry 4.0.
- be able to trace the development of automation to a fully autonomous, non-centrally organized production plant.
- understand the basic technologies and standards used to design and operate a Smart Factory.
- understand the essential concepts of a Smart Factory.
- identify and differentiate between the individual elements of a Smart Factory using different reference architectures.
- understand the special engineering challenges in the Smart Energy context.
- understand the special safety risks of digitized and networked production plants and assign concrete recommendations for action.

Smart Factory II

On successful completion, students will be able to

- have a deeper understanding of the technologies and standards in the context of Smart Factory.
- apply technologies in the context of Smart Factory to a simple practical example.
- design a hardware or software prototype for a selected task.
- document, design, and develop activities in the form of a project report.

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 Programmes in the IT & Technology fields

Smart Factory I

Course Code: DLBDSESF01

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

Course Description

In this course, students will gain a deeper insight into the networking and digitization of production facilities by examining a Smart Factory. For this purpose, they will be familiarized with the basic goals of a Smart Factory in the context of the research complex Industry 4.0. After a brief introduction to the history of automation, students will learn the technical basics and standards required to design and operate a Smart Factory. Building on this, they will learn how these individual technologies are used to implement the central concepts of a Smart Factory. In order to understand which components a Smart Factory consists of, different reference architectures are presented and compared. The course concludes with the special engineering challenges of an autonomously acting and decentralized production plant. Above all, this includes IT security, which is particularly relevant due to the digital networking of production facilities and products.

Course Outcomes

On successful completion, students will be able to

- understand the term Smart Factory in the context of Industry 4.0.
- be able to trace the development of automation to a fully autonomous, non-centrally organized production plant.
- understand the basic technologies and standards used to design and operate a Smart Factory.
- understand the essential concepts of a Smart Factory.
- identify and differentiate between the individual elements of a Smart Factory using different reference architectures.
- understand the special engineering challenges in the Smart Energy context.
- understand the special safety risks of digitized and networked production plants and assign concrete recommendations for action.

Contents

1. Motivation and Definition of Terms
   - 1.1 Goals of Smart Factory
   - 1.2 Internet of Things
   - 1.3 Cyber-Physical Systems
   - 1.4 Cyber-Physical Production Systems
   - 1.5 Smart Factory as a Cyber-Physical (Production) System

Literature
Compulsory Reading
Further Reading • Butun, I. (2020). Industrial IoT: Challenges, design principles, applications, and security. Springer. • Drossel, W. G., Ihlenfeldt, S., Lanzger, T., & Dumitrescu, R. (2019). Cyber-physical systems. In R. Neugebauer (Ed.), Digital transformation (pp. 189–213). Springer. • Durakbasa, N. M., & Gençyılmaz, M. G. (Eds.). (2021). Digital conversion on the way to Industry 4.0. Springer. • Ustundag, A., & Cevikcan, E. (2018). Industry 4.0: Managing the digital transformation. Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Smart Factory II

Course Code: DLBDSESF02

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

Course Description

In this course, students select a concrete task from the catalog of topics provided in consultation with the seminar leader. They will work on the task in a prototyping environment suited to the task, which can be either a hardware (e.g., prototyping boards) or software (e.g., technology-specific development environments) environment. To complete the task, students apply the concepts, methods, and tools taught in the Smart Factory I course. They document their results with a project report.

Course Outcomes

On successful completion, students will be able to

- have a deeper understanding of the technologies and standards in the context of Smart Factory.
- apply technologies in the context of Smart Factory to a simple practical example.
- design a hardware or software prototype for a selected task.
- document, design, and develop activities in the form of a project report.

Contents

- A catalogue with the currently provided tasks is provided on the online platform of the module. It provides the content basis of the module and can be supplemented or updated by the seminar leader.

Literature
Compulsory Reading
Further Reading

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Smart Mobility

Module Code: DLBINGSM_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

N.N. (Smart Mobility I) / N.N. (Smart Mobility II)

Contributing Courses to Module

- Smart Mobility I (DLBINGSM01_E)
- Smart Mobility II (DLBINGSM02_E)

Module Exam Type	
Module Exam	**Split Exam** Smart Mobility I • Study Format "Distance Learning": Exam, 90 Minutes Smart Mobility II • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

Module Contents	
Smart Mobility I - Introduction and Definitions - Overview over traditional mobility infrastructure approaches - Alternative approaches to mobility - Services for smart mobility - Overview over relevant technologies and standards - Car2X Communication - Examples and use-cases **Smart Mobility II** In-depth analysis of a specific topic in the context of Smart Mobility in form of a prototype report.	
Learning Outcomes **Smart Mobility I** On successful completion, students will be able to - remember several types of mobility. - understand distinct reasons for designing intelligent mobility systems. - analyze diverse types of mobility infrastructure regarding their properties and access requirements. - understand various alternative mobility approaches. - remember a range of services that relevant for Smart Mobility. - understand the relevant technologies and standards for connecting infrastructure elements and services. - understand use cases for Car2X communication and the relevant standards and technologies. - remember example projects in the context of Smart Mobility. **Smart Mobility II** On successful completion, students will be able to - have an in-depth understanding of the technologies and standards in the context of Smart Mobility. - apply technologies in the context of Smart Mobility using a simple practical example. - design a hardware or software prototype for a selected task. - document design choices and development tasks in the form of a project report.	
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

Smart Mobility I

Course Code: DLBINGSM01_E

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

Course Description

This course gives an introduction and overview into the future of mobility. Starting from an understanding of traditional and current mobility infrastructure, alternative approaches are introduced. The course discusses a range of services that are typical for smart mobility solutions. The course includes a detailed discussion on technologies and standards relevant for smart mobility, in particular in Car2X communication. A range of projects and examples are discussed to illustrate the application of smart mobility approaches in a real-life context.

Course Outcomes

On successful completion, students will be able to

- remember several types of mobility.
- understand distinct reasons for designing intelligent mobility systems.
- analyze diverse types of mobility infrastructure regarding their properties and access requirements.
- understand various alternative mobility approaches.
- remember a range of services that relevant for Smart Mobility.
- understand the relevant technologies and standards for connecting infrastructure elements and services.
- understand use cases for Car2X communication and the relevant standards and technologies.
- remember example projects in the context of Smart Mobility.

Contents

1. Introduction and Definitions
   - 1.1 Types of Mobility
   - 1.2 Smart Mobility and Smart City
   - 1.3 Efficient use of energy
   - 1.4 Emissions
   - 1.5 Security
   - 1.6 Comfort
   - 1.7 Cost Effectiveness

2. Overview over traditional mobility infrastructure approaches
   - 2.1 Properties and Access Requirements
   - 2.2 Infrastructure Planning
   - 2.3 Disadvantages of Isolated Infrastructures

3. Alternative approaches to mobility
   - 3.1 Park and Ride
   - 3.2 Car-Sharing
   - 3.3 Rent A Bike
   - 3.4 Carpooling

4. Services for smart mobility
   - 4.1 Authorization
   - 4.2 Payment
   - 4.3 Booking
   - 4.4 Navigation
   - 4.5 Security
   - 4.6 Hybrid Services

5. Overview over relevant technologies and standards
   - 5.1 Mobile Devices
   - 5.2 Mobile Networks and Wireless LAN
   - 5.3 NFC and RFID
   - 5.4 Outdoor and Indoor Localization
   - 5.5 Technologies for Traffic Monitoring

6. Car2X Communication
   - 6.1 Use Cases
   - 6.2 Elements of a Car2X System
   - 6.3 Technologies and Standards
   - 6.4 Sample Implementations

7. Examples and use-cases
   - 7.1 Octopus (Hong Kong)
   - 7.2 Amsterdam Practical Trial
   - 7.3 Mobincity

Literature
Compulsory Reading
Further Reading • Fluegge, B. (2017): Smart Mobility – Connecting Everyone: Trends, Concepts and Best Practices Paperback. Springer/Vierweg, Wiesbaden. • Handke, V./Jonuschat, H. (2013): Flexible Ridesharing. New Opportunities and Service Concepts for Sustainable Mobility. Springer, Berlin/Heidelberg. • Inderwildi, O./King, D. (Eds.) (2012): Energy, Transport, & the Environment. Addressing the Sustainable Mobility Paradigm. Springer, London. • Nathanail, E./Karakikes, I. (2018): Data Analytics: Paving the Way to Sustainable Urban Mobility: Proceedings of 4th Conference on Sustainable Urban Mobility (CSUM2018). Springer, London. • Papa, R./Fistola, R./Gargiulo, C. (2018): Smart Planning: Sustainability and Mobility in the Age of Change (Green Energy and Technology). Springer, London. • Planing, P. et al (2020): Innovations for Metropolitan Areas: Intelligent Solutions for Mobility, Logistics and Infrastructure designed for Citizens. Springer, London. • Sashinskaya, M. (2015): Smart Cities in Europe. Open Data in a Smart Mobility Context. Createspace Independent Publishing Platform.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Smart Mobility II

Course Code: DLBINGSM02_E

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

Course Description

In the course Smart Mobility II, students are asked to choose an assignment provided by the course tutor to apply the concepts and methods covered in Smart Mobility I in a specific use case or application area. The students will develop a prototype focused on a specific topic related to smart mobility. The prototype can be developed either as a hardware setup or a software solution. The students 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 Mobility.
- apply technologies in the context of Smart Mobility using a simple practical example.
- design a hardware or software prototype for a selected task.
- document design choices and development tasks in the form of a project report.

Contents

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

Literature

Compulsory Reading

Further Reading

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

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
N.N. (Smart Services I) / N.N. (Smart Services II)

Contributing Courses to Module
• Smart Services I (DLBINGSS01_E) • Smart Services II (DLBINGSS02_E)

Module Exam Type	
Module Exam	**Split Exam** Smart Services I • Study Format "Distance Learning": Exam, 90 Minutes Smart Services II • 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

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Microcontroller

Module Code: DLBWINWMC_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	• none • DLBAETDIT01_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

Prof. Dr. Marian Benner-Wickner (Digital and Information Technology) / Prof. Dr. Marian Benner-Wickner (Project: Microcontrollers and Logical Circuits)

Contributing Courses to Module

- Digital and Information Technology (DLBAETDIT01_E)
- Project: Microcontrollers and Logical Circuits (DLBAETPMLS01_E)

Module Exam Type

Module Exam	Split Exam
	Digital and Information Technology • 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

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

Project: Microcontrollers and Logical Circuits

The students should work independently through the complete flowof 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

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.

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

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

3. Combinational Logic
   - 3.1 Logic Gate
   - 3.2 Connection of Logic Gaes
   - 3.3 Substitution by NOR / NAND Gates

4. Sequential Logic
   - 4.1 Latches and Flipflops
   - 4.2 Counter and Frequency Divider
   - 4.3 Shift Register and Memory

5. State Machines
   - 5.1 Foundations
   - 5.2 Models for State Machines
   - 5.3 Representation of State Machines
   - 5.4 Event-driven / Clock-driven State Machines
   - 5.5 Synchronization of Parallel State Machines

6. Arithmatic Circuits
   - 6.1 Adders
   - 6.2 Subtractor Circuits
   - 6.3 Multiplication Circuits

7. Introduction to Programmable Logic
   - 7.1 Programmable Cell Logic and Programmable Logic Array
   - 7.2 Complex Programmable Logic Devices (CPLD)
   - 7.3 FPGAs
   - 7.4 Introduction to VHDL

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	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ 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 Distance Learning	**Course Type** Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Service Robotics

Module Code: DLBROESR_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

N.N. (Mobile Robotics) / N.N. (Soft Robotics)

Contributing Courses to Module

- Mobile Robotics (DLBROESR01_E)
- Soft Robotics (DLBROESR02_E)

Module Exam Type

Module Exam	Split Exam
	<u>Mobile Robotics</u> • Study Format "Distance Learning": Module Exam (50) <u>Soft Robotics</u> • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents	
Mobile Robotics - Locomotion - Kinematics and dynamics - Perception - Mobile manipulators - Path motion and task planning - Localization and mapping **Soft Robotics** - Soft robotics - Actuators for soft robots - Sensors for soft robots - Applications of soft robots	
Learning Outcomes	
Mobile Robotics On successful completion, students will be able to - understand mobile robot locomotion, kinematics, and dynamics. - model and simulate a wheeled, legged, or aerial mobile robot. - understand common approaches for localization and mapping. - apply and simulate path, motion, and task planning algorithms. - simulate and understand mobile manipulators. **Soft Robotics** On successful completion, students will be able to - know the basics behind soft robots. - understand and analyze common structures of soft robots. - choose the best soft robot 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

Mobile Robotics

Course Code: DLBROESR01_E

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

Course Description

Modern robots are mobile robots, able to move in spaces and perform tasks autonomously. This is for instance what is done by household robots, or by robots working in warehouses. In the last years, such robots have been improved by the implementation of advanced localization and task planning algorithms, which are based on the fundamentals of mobile robot kinematics and dynamics. This course starts with an introduction to the main concepts of robot locomotion, presenting the three main categories of mobile robots, namely legged, wheeled and aerial (often called drones). As second focus lies on the necessary mathematical foundation. This course, thus, discusses kinematics and dynamics of mobile robots. The topic of how a mobile robot can perceive the surrounding world is treated in detail in a third part of this course, where sensors for mobile robots are introduced together with an introduction on advanced topics such as robot vision and image processing. The last part of this course describes the main approaches for localization, mapping and motion and task planning. A brief overview on combination of mobile robots and manipulators, i.e., mobile manipulators, is also given.

Course Outcomes

On successful completion, students will be able to

- understand mobile robot locomotion, kinematics, and dynamics.
- model and simulate a wheeled, legged, or aerial mobile robot.
- understand common approaches for localization and mapping.
- apply and simulate path, motion, and task planning algorithms.
- simulate and understand mobile manipulators.

Contents

1. Locomotion
   - 1.1 Basics
   - 1.2 Legged Mobile Robots
   - 1.3 Wheeled Mobile Robots
   - 1.4 Aerial Mobile Robots

2. Kinematics
    2.1 Basics
    2.2 Kinematic Models and Constraints
    2.3 Mobile Robot Maneuverability
    2.4 Mobile Robot Workspace
    2.5 Applications

3. Dynamics
    3.1 Basics
    3.2 Dynamic Modeling
    3.3 Examples

4. Perception
    4.1 Sensors for Mobile Robots
    4.2 Position and Velocity Sensors
    4.3 Accelerometers
    4.4 Inertial Measurement Unit
    4.5 Distance Sensors
    4.6 Vision Sensors
    4.7 Robot Vision and Image Processing
    4.8 Global Positioning System

5. Mobile Manipulators
    5.1 Basics
    5.2 Modeling
    5.3 Examples

6. Path, Motion and Task Planning
    6.1 Basics
    6.2 Path Planning
    6.3 Motion Planning
    6.4 Task Planning

7. Localization and Mapping
   - 7.1 Sensor Imperfections
   - 7.2 Relative Localization
   - 7.3 Absolute Localization
   - 7.4 Localization, Calibration and Sensor Fusion
   - 7.5 Simultaneous Localization and Mapping
   - 7.6 Examples

Literature

Compulsory Reading

Further Reading

- Corke, P. (2017): Robotics, Vision and Control: Fundamental Algorithms In MATLAB. 2nd ed., Springer International Publishing, Cham.
- Siciliano, B./Khatib, O. (eds.) (2016): Springer Handbook of Robotics. Springer International Publishing, Cham.
- Siegwart, R./Nourbakhsh, I. R./Scaramuzza, D. (2011): Introduction to Autonomous Mobile Robots. The MIT Press, Cambridge, MS.
- Tzafestas, S. G. (2013): Introduction to Mobile Robot Control. Elsevier Inc, Amsterdam.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Module Exam

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Soft Robotics

Course Code: DLBROESR02_E

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

Course Description

Classic robots are made of rigid links and structures. In the last years, the field of robotics has been strongly influenced and inspired by biological processes. Instead of rigid structures, soft structures, materials, and surfaces are characterizing innovative, soft robots. This new generation of robots can be used in several applications where highly dynamic tasks must be performed in unsafe or rough environments, and especially where the interaction with humans is necessary. This course provides the basics in the fast-changing field of soft robotics, starting with an overview of materials and technologies for soft actuators, proceeding with an overview on innovative sensors, and concluding with an overview on modeling approaches for soft robots. The last part summarizes some relevant state-of-the-art applications.

Course Outcomes

On successful completion, students will be able to

- know the basics behind soft robots.
- understand and analyze common structures of soft robots.
- choose the best soft robot technology for a given application.

Contents

1. Introduction
   - 1.1 Soft Robots
   - 1.2 Challenges
   - 1.3 Trends
   - 1.4 Applications
2. Actuators
   - 2.1 Materials and Properties of Soft Actuators
   - 2.2 Thermo-driven Soft Actuators
   - 2.3 Electro-driven Soft Actuators
   - 2.4 Light-driven Soft Actuators
   - 2.5 Magneto-driven Soft Actuators
   - 2.6 Pneumatic Actuators
   - 2.7 Examples

3. Sensors
    - 3.1 Basics
    - 3.2 Proximity Sensing
    - 3.3 Mechano-sensing
    - 3.4 Examples

4. Modeling
    - 4.1 Artificial Muscles
    - 4.2 Interactions
    - 4.3 Compliance Control
    - 4.4 Variable-stiffness Actuators

5. Applications
    - 5.1 Soft Bionic Hands
    - 5.2 Healthcare and Surgery
    - 5.3 Underwater and Aquatic Propulsion
    - 5.4 Bio-inspired Aerial Robots

Literature

Compulsory Reading

Further Reading

- Asaka, K./Okuzaki, H. (eds.) (2019): Soft actuators: materials, modeling, applications, and future perspectives. Springer, Singapore.
- Kim, J. (2017): Microscale Soft Robotics. Springer International Publishing, Cham.
- Siciliano, B./Khatib, O. (eds.) (2016): Springer Handbook of Robotics. Springer International Publishing, Cham.
- Verl, A., et al (eds.) (2015): Soft Robotics: Transferring Theory to Application. Soft Robotics. Springer, Berlin.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Introduction to Cognitive Robotics

Module Code: DLBROEICR_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

N.N. (Digital Signal Processing) / N.N. (Fundamentals of NLP and Computer Vision)

Contributing Courses to Module

- Digital Signal Processing (DLBROEICR01_E)
- Fundamentals of NLP and Computer Vision (DLBROEICR02_E)

Module Exam Type	
Module Exam	**Split Exam** Digital Signal Processing • Study Format "Distance Learning": Exam, 90 Minutes (50) Fundamentals of NLP and Computer Vision • Study Format "Distance Learning": Exam, 90 Minutes (50)
Weight of Module see curriculum	

Module Contents

Digital Signal Processing

- Signal sampling and quantization
- Digital signals and systems
- Discrete Fourier Transform
- z-Transform
- Digital signal processing and filters

Fundamentals of NLP and Computer Vision

- Introduction to Natural Language Processing
- Introduction to Computer Vision
- Applications to Robotics

Learning Outcomes

Digital Signal Processing

On successful completion, students will be able to

- analyze discrete time systems.
- apply analysis tools such as the Discrete Fourier Transform.
- apply the z-Transform.
- analyze properties of discrete systems.
- design finite and infinite impulse response filters.
- implement filters in hardware and software.

Fundamentals of NLP and Computer Vision

On successful completion, students will be able to

- name central problems and challenges in natural language processing and computer vision.
- understand common methods used in natural language processing and computer vision.
- name common use-case scenarios in which NLP and computer vision techniques are applied.
- design basic language processing and computer vision solutions for use in robotics.

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

Digital Signal Processing

Course Code: DLBROEICR01_E

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

Course Description

Digital signal processing enables digital audio and video extraction, as well as extraction of important features from any other kind of signal, for instance medial imagery or diagnostic tools. This course provides the students with expertise on the theory and practice of digital signal processing. In the first part, theoretical concepts are introduced, presenting the main tools for analysis of digital, i.e., sampled or discrete-time systems. The core of digital signal processing resides in the design of a digital filter. The second part of the course focuses on different filter-design approaches, i.e. a discussion on finite impulse response and infinite impulse response filters. The last part gives important insights into the hardware and software implementation of digital signal processing, bridging theory with applied practice.

Course Outcomes

On successful completion, students will be able to

- analyze discrete time systems.
- apply analysis tools such as the Discrete Fourier Transform.
- apply the z-Transform.
- analyze properties of discrete systems.
- design finite and infinite impulse response filters.
- implement filters in hardware and software.

Contents

1. Introduction
   - 1.1 Basic Concepts
   - 1.2 Applications

2. Signal Sampling and Quantization
   - 2.1 Sampling
   - 2.2 Signal reconstruction
   - 2.3 Analog-to-digital Conversion
   - 2.4 Digital-to-Analog Conversion
   - 2.5 Quantization

3. Digital Signals and Systems
   - 3.1 Digital Signals
   - 3.2 Difference Equations and Impulse Responses
   - 3.3 BIBO-Stability
   - 3.4 Digital Convolution

4. Discrete Fourier Transform
   - 4.1 Discrete Fourier Transform
   - 4.2 Amplitude and Power Spectrum
   - 4.3 Spectral Estimation

5. The z-Transform
   - 5.1 Definition
   - 5.2 Properties
   - 5.3 Inverse z-Transform
   - 5.4 Solution of Difference Equations

6. Digital Signal Processing Systems and Filters
   - 6.1 Difference Equation and Transfer Function
   - 6.2 Poles, Zeros and Stability
   - 6.3 Digital Filter Frequency Response
   - 6.4 Basic Filtering
   - 6.5 Realization of Digital Filters
   - 6.6 Applications

7. Finite Impulse Response Filter Design
   - 7.1 Basics
   - 7.2 Fourier Transform Design
   - 7.3 Window Method
   - 7.4 Frequency Sampling Design Method
   - 7.5 Optimal Design Method
   - 7.6 Applications

8. Infinite Impulse Response Filter Design
    - 8.1 Basics
    - 8.2 Bilinear Transformation Design Method
    - 8.3 Butterworth and Chebyschev Filter Designs
    - 8.4 Higher-Order Infinite Impulse Response Filter Design
    - 8.5 Pole-Zero Placement for Simple Filters
    - 8.6 Applications

9. Hardware and Software for Digital Signal Processing
    - 9.1 Digital Signal Processor Architecture
    - 9.2 Digital Signal Processor Hardware Units
    - 9.3 Fixed-Point and Floating-Point Formats
    - 9.4 Implementation of FIR and IIR Filters in Fixed-Point
    - 9.5 DSP Programming Examples

Literature

Compulsory Reading

Further Reading

- Manolakis, D. G./Ingle, V. K. (2011): Applied digital signal processing: theory and practice. Cambridge University Press, Cambridge.
- Tan, L./Jiang, J. (2013): Digital signal processing: fundamentals and applications. 2nd ed., Academic Press, Cambridge, MS.
- Vetterli, M./Kovačević, J./Goyal, V. K. (2014): Foundations of signal processing. 2nd ed., Cambridge University Press, Cambridge.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Fundamentals of NLP and Computer Vision

Course Code: DLBROEICR02_E

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

Course Description

Innovative robots, belonging to the so-called generation 3.0, need to sense and understand the environment in many ways, for instance using vision and language understanding and processing. This course introduces the topics of natural language processing (NLP) and computer vision, discussing the main techniques of both fields as well as their application in the field of robotics.

Course Outcomes

On successful completion, students will be able to

- name central problems and challenges in natural language processing and computer vision.
- understand common methods used in natural language processing and computer vision.
- name common use-case scenarios in which NLP and computer vision techniques are applied.
- design basic language processing and computer vision solutions for use in robotics.

Contents

1. Introduction to NLP
   - 1.1 History
   - 1.2 Basics Concepts of NLP
   - 1.3 Feature Extraction Methods
2. Applications of NLP
   - 2.1 Topic Modeling
   - 2.2 Text Summarization and Generation
   - 2.3 Sentiment Analysis
   - 2.4 Translation
   - 2.5 Chatbots

3. Introduction to Computer Vision
   - 3.1 Light and Color
   - 3.2 Image Formation
   - 3.3 Image Processing
   - 3.4 Image Feature Extraction
   - 3.5 Stereo Vision

4. Applications of Computer Vision
   - 4.1 Image Classification, Motion Tracking
   - 4.2 Semantic Segmentation
   - 4.3 Object Identification and Tracking
   - 4.4 Eigenfaces and Facial Recognition

5. NLP and Computer Vision in Robotics
   - 5.1 Camera Calibration
   - 5.2 Pose Estimation
   - 5.3 Visual Servoing
   - 5.4 Human-Robot Interaction
   - 5.5 Privacy Issues

Literature

Compulsory Reading

Further Reading

- Bird S., Klein, E./Loper, E. (2009): Natural language processing with Python. 2nd ed., O‘Reilly, Sebastopol, CA.
- Fisher, R. B., et al (2016) : Dictionary of computer vision and image processing. John Wiley & Sons, Chichester.
- Jurafsky, D./Martin, J. H. (2008): Speech and language processing. Prentice Hall, Upper Saddle River, NJ.
- Szelski, R. (2011): Computer vision: Algorithms and applications. 2nd ed., Springer VS, Wiesbaden.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

DLBROEICR02_E

Programming of Robotic Systems

Module Code: DLBROEPRS_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. Emanuele Grasso (Programming with C/C++) / N.N. (Programming PLCs)

Contributing Courses to Module

- Programming with C/C++ (DLBROEPRS01_E)
- Programming PLCs (DLBROEPRS02_E)

Module Exam Type	
Module Exam	**Split Exam** Programming with C/C++ • Study Format "myStudies": Portfolio • Study Format "Distance Learning": Portfolio Programming PLCs • Study Format "Fernstudium": Oral Assignment
Weight of Module see curriculum	

Module Contents

Programming with C/C++

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

Programming PLCs

- Architectures of programmable logic controllers
- Ladder and Functional Block Programming
- IL, SFC and ST Programming Methods
- Elements of PLC programming
- Applications of PLC programming

Learning Outcomes

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.

Programming PLCs

On successful completion, students will be able to

- understand the architecture of PLC systems.
- program PLC devices.
- apply PLC programming methods for control of simple processes.

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 Programmes in the IT & Technology fields

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	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Programming PLCs

Course Code: DLBROEPRS02_E

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

Course Description

Programmable logic controllers (PLCs) are used extensively for industrial automation in modern factories and smart houses, either as compact controllers, modular controllers or distributed controllers. PLC algorithms are developed using specific programming languages created for the particular PLC. This course introduces the purpose, architecture, and programming methods of modern PLC systems for use in industrial automation and robotics.

Course Outcomes

On successful completion, students will be able to

- understand the architecture of PLC systems.
- program PLC devices.
- apply PLC programming methods for control of simple processes.

Contents

1. Introduction
   - 1.1 Programmable Logic Controllers
   - 1.2 Hardware
   - 1.3 PLC Architecture
   - 1.4 PLC Systems
   - 1.5 Trends

2. Digital Systems
   - 2.1 The Binary, Octal and Hexadecimal Systems
   - 2.2 Binary Arithmetic
   - 2.3 PLC Data Types
   - 2.4 Combinational and Sequential Logic

3. I/O Processing
   - 3.1 Input/Output Units
   - 3.2 Signal Conditioning
   - 3.3 Remote Connections
   - 3.4 Networks
   - 3.5 I/O addresses

4. Ladder and Functional Block Programming
   - 4.1 Ladder Diagrams
   - 4.2 Logic Functions
   - 4.3 Latching
   - 4.4 Multiple Outputs
   - 4.5 Entering Programs
   - 4.6 Function Blocks
   - 4.7 Examples

5. IL, SFC and ST Programming Methods
   - 5.1 Instruction List
   - 5.2 Sequential Function Charts
   - 5.3 Structured Text
   - 5.4 Examples

6. Elements of PLC Programming
   - 6.1 Internal Relays
   - 6.2 Jump and Call
   - 6.3 Timers
   - 6.4 Counters
   - 6.5 Shift Registers
   - 6.6 Data Handling

7. Applications
   - 7.1 PLC and Safety
   - 7.2 Testing Software and Fault Finding
   - 7.3 Examples of Process Control

Literature
Compulsory Reading
Further Reading • Barkalov, A./Titarenko, L./Mazurkiewicz, M. (2019): Foundations of Embedded Systems. Springer International Publishing, Cham. • Bolton, W. (2015): Programmable logic controllers. 6th ed., Newnes/Elsevier, Amsterdam. • Petruzella, F. D. (2016): Programmable logic controllers. 5th ed., McGraw-Hill Education, New York City, NY.

Study Format Fernstudium

Study Format	Course Type
Fernstudium	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

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
N.N. (Self-Driving Vehicles) / N.N. (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** <u>Self-Driving Vehicles</u> • Study Format "Distance Learning": Exam, 90 Minutes <u>Seminar: Current Topics and Trends in Self-Driving Technology</u> • Study Format "Distance Learning": 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 calibaration
   - 1.4 Application scenarios
2. Sensor Fusion
   - 2.1 Elaborating data from sensors
   - 2.2 Kalman filter
   - 2.3 Object tracking

3. Computer Vision
   - 3.1 Pixels and filters
   - 3.2 Feature detection
   - 3.3 Distortions and calibration
   - 3.4 Semantic segmentation

4. Localization & Motion
   - 4.1 Motion models
   - 4.2 Odometry
   - 4.3 Triangulation
   - 4.4 Satellite-based localization

5. Motion planning
   - 5.1 Path planning
   - 5.2 Motion prediction
   - 5.3 Trajectory generation

6. Safety Standards
   - 6.1 Functional Safety
   - 6.2 IT Security Standards
   - 6.3 Safety development approaches

Literature

Compulsory Reading

Further Reading

- Ben-Ari, M./Mondada, F. (2018): Elements of robotics. Springer, Cham.
- European Union. (2001).:Directive 2001/95/EG. (URL: https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A32001L0095 [Retrieved: 28.02.2020])
- Fisher, R. B., et al. (2016): Dictionary of computer vision and image processing. John Wiley & Sons, Chichester.
- International Electrotechnical Commission. (2015): IEC 61508. (URL: https://www.iec.ch/functionalsafety/ [Retrieved: 28.02.2020])
- International Organization for Standardization. (2009): ISO 15408. (URL: https://www.iso.org/standard/50341.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 25119. (URL: https://www.iso.org/standard/69026.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 26262. (URL: https://www.iso.org/standard/68383.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (n.d.): ISO 21434. (URL: https://www.iso.org/standard/70918.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO/IEC 27001. (URL: https://www.iso.org/isoiec-27001-information-security.html [Retrieved: 28.02.2020])
- Rausand, M. (2014): Reliability of safety-critical systems: Theory and applications. Wiley, Hoboken, NJ.
- 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. (URL: https://www.sae.org/standards/content/j3061/ [Retrieved: 28.02.2020])
- Szelski, R. (2011): 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	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ 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. (URL: https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A32001L0095 [Retrieved: 28.02.2020])
- Fisher, R. B., et al. (2016): Dictionary of computer vision and image processing. John Wiley & Sons, Chichester.
- International Electrotechnical Commission. (2015): IEC 61508. (URL: https://www.iec.ch/functionalsafety/ [Retrieved: 28.02.2020])
- International Organization for Standardization. (2009): ISO 15408. (URL: https://www.iso.org/standard/50341.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 25119. (URL: https://www.iso.org/standard/69026.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 26262. (URL: https://www.iso.org/standard/68383.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (n.d.): ISO 21434. (URL: https://www.iso.org/standard/70918.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO/IEC 27001. (URL: https://www.iso.org/isoiec-27001-information-security.html [Retrieved: 28.02.2020])
- Marchthaler, R./Dingler, S. (2017): Kalman-Filter. Springer, Wiesbaden.
- Rausand, M. (2014): Reliability of safety-critical systems: Theory and applications. Wiley, Hoboken, NJ.
- 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. (URL: https://www.sae.org/standards/content/j3061/ [Retrieved: 28.02.2020])
- Szelski, R. (2011): 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	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Applied Sales

Module Code: DLBDSEAS

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. Patrick Geus (Applied Sales I) / Prof. Dr. Patrick Geus (Applied Sales II)

Contributing Courses to Module
• Applied Sales I (DLBDSEAS01) • Applied Sales II (DLBDSEAS02)

Module Exam Type	
Module Exam	**Split Exam** Applied Sales I • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes Applied Sales II • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents

Applied Sales I

- Fundamentals of Applied Sales
- The Distribution System
- Personal Sales
- Sales Plans
- New Customer Acquisition
- A Sales Visit
- Conversational Tactics
- Conducting Negotiations
- Other Sales Channels

Applied Sales II

- Marketing and Sales
- Customer Satisfaction as a Success Factor
- Personalities in Sales
- Customer-Oriented Communication
- Presentation and Rhetoric
- Customer Loyalty
- Networking
- Case Study

Learning Outcomes

Applied Sales I

On successful completion, students will be able to

- understand the fundamentals of applied sales and place them in the context of the company.
- understand the interaction of the individual facets of applied sales.
- differentiate between and evaluate individual sales systems.
- describe current sales types and sales characteristics.
- oversee and classify the entire sales process from customer acquisition to customer retention.
- understand the basics of sales and negotiation management and apply them.
- name the usual sales instruments, recognize their advantages and disadvantages, and reflect on essential fields of application and possibilities.

Applied Sales II

On successful completion, students will be able to

- understand the interaction and the respective areas of responsibility of marketing and sales.
- reflect on and classify the goals and measures within the framework of the applied sales system.
- assess the relevance of customer satisfaction and retention. In addition, the students will be familiar with the central design elements of CRM.
- reflect on and assess alternative approaches to customer loyalty and relationship management and apply them in business practice.
- understand the meaning of the terms customer life cycle and customer value, and develop approaches to manage them in the sense of the respective sales targets.
- use descriptive presentation techniques in order to convince customers and other sales partners.
- understand the relevance of networking and develop strategies to broaden the contact base.
- develop and evaluate their own market analyses and sales concepts on the basis of practical experience within the framework of the case study.

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 Marketing & Sales	All Bachelor Programmes in the Marketing & Communication fields

Applied Sales I

Course Code: DLBDSEAS01

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

Course Description

The demands on sales thinking are growing every day. Globalized demand combined with high competition is making it increasingly difficult for companies to compete for customers. At the same time, customers are becoming better informed, while traditional supply markets are saturated and at overcapacity. In order to be successful in such an environment, sales thinking and action are required along with a new type of salesperson. Within the course Applied Sales I (Introduction), the participants are familiarized with the basic concepts of applied sales. You will learn about sales organization, dealing with alternative sales channels, and get to know the dedicated sales planning process. The contents of the module are complemented by the successful acquisition of new customers, whereby particular attention is paid to the organization and implementation of customer visits and the conduct of discussions and negotiations.

Course Outcomes

On successful completion, students will be able to

- understand the fundamentals of applied sales and place them in the context of the company.
- understand the interaction of the individual facets of applied sales.
- differentiate between and evaluate individual sales systems.
- describe current sales types and sales characteristics.
- oversee and classify the entire sales process from customer acquisition to customer retention.
- understand the basics of sales and negotiation management and apply them.
- name the usual sales instruments, recognize their advantages and disadvantages, and reflect on essential fields of application and possibilities.

Contents

1. Fundamentals of Applied Sales and Distribution
   1.1 Tasks and Forms of Applied Distribution
   1.2 Marketing as the Basis of Sales
   1.3 Distribution, Sales, and Other Terms
   1.4 Sales in Different Economic Sectors

8. Conducting Negotiations
    - 8.1 Psychology of Negotiation
    - 8.2 Negotiation Structure
    - 8.3 Objection Handling
    - 8.4 Price Negotiations

9. Other Sales Channels
    - 9.1 Telemarketing
    - 9.2 Catalogue and Brochure Sales
    - 9.3 Internet and E-Commerce

Literature

Compulsory Reading

Further Reading

- Bloomfield, J. (2020). NeuroSelling: Mastering the customer conversation using the surprising science of decision making. Axon Publishing.
- Jobber, D., Lancaster, G., & Le Meunier-FitzHugh, K. (2019). Selling and sales management (10th ed.). Pearson.
- Peppers, D., & Rogers, M. (2016). Managing customer experience and relationships: A strategic framework (3rd ed.). Wiley.
- Pink, D. H. (2012). To sell is human: The surprising truth about moving others. Riverhead Books.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format myStudies	Course Type Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Applied Sales II

Course Code: DLBDSEAS02

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

Course Description

The course Applied Sales II builds on the basics taught in the course "Applied Sales I" and broadens and deepens them. First, the tension between marketing and sales is examined in more detail. Based on this, essential backgrounds and central target figures for successful sales management (e.g., customer satisfaction and loyalty as well as the customer life cycle) are derived and operationalized in order to create the basis for efficient and effective customer relationship management. As the process progresses, attention will also be paid to mental processes and consumer behavior in general. In addition, strategies and paths to successful negotiation are deepened and supplemented by convincing communication techniques. The course concludes with a case study in the course of which the students have the opportunity to apply what they have learned in a practice-oriented manner.

Course Outcomes

On successful completion, students will be able to

- understand the interaction and the respective areas of responsibility of marketing and sales.
- reflect on and classify the goals and measures within the framework of the applied sales system.
- assess the relevance of customer satisfaction and retention. In addition, the students will be familiar with the central design elements of CRM.
- reflect on and assess alternative approaches to customer loyalty and relationship management and apply them in business practice.
- understand the meaning of the terms customer life cycle and customer value, and develop approaches to manage them in the sense of the respective sales targets.
- use descriptive presentation techniques in order to convince customers and other sales partners.
- understand the relevance of networking and develop strategies to broaden the contact base.
- develop and evaluate their own market analyses and sales concepts on the basis of practical experience within the framework of the case study.

Contents

Literature

Compulsory Reading

Further Reading

- Jobber, D./Lancaster, G./Le Meunier-Fitzhugh, K. (2019): Selling and Sales Management, 11th Ed.; Pearson
- Johnston, M.W./Marshall (2021): Sales Force Management: Leadership, Innovation, Technology; Routledge
- Jordan, J./Vazzana, M. (2011): Cracking the Sales Management Code: The Secrets to Measuring and Managing Sales Performance; 13th Ed.; McGraw Hill
- Kumar, V./Reinartz, W. (2018): Customer Relationship Management: Concept, Strategy, and Tools; 3rd Ed.; Springer Texts in Business and Economics
- Marcos, J./Davies, M. (2019): Implementing Key Account Management: Designing Customer-Centric Processes for Mutual Growth; KoganPage
- Peppers, D./Rogers, M. (2011): Managing Customer Relationships : A Strategic Framework; 2nd Ed.; Wiley

Study Format Distance Learning

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

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	**Course Type**
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Applied Robotics

Module Code: DLBWINWAR_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
N.N. (Embedded Systems) / N.N. (Project: Applied Robotics with Robotic Platforms)

Contributing Courses to Module
• Embedded Systems (DLBROES01_E) • Project: Applied Robotics with Robotic Platforms (DLBROPARRP01_E)

Module Exam Type	
Module Exam	**Split Exam** Embedded Systems • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Project: Applied Robotics with Robotic Platforms • Study Format "myStudies": Oral Project Report • Study Format "Distance Learning": Oral Project Report
Weight of Module see curriculum	

Module Contents	
Embedded Systems - Embedded systems architecture - Embedded hardware - Embedded software - Distributed systems and IoT architecture - Embedded operating systems **Project: Applied Robotics with Robotic Platforms** This module provides students with the basic competence to use existing robotic software and hardware platforms to design, create and implement 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. **Project: Applied Robotics with Robotic Platforms** On successful completion, students will be able to - name several existing open-source robotic platforms. - understand the basic principles of robotic platforms. - work with existing robotic platforms. - carry out a robotic project by means of robotic platforms.	
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 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
   - 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

- Barkalov, A./Titarenko, L./Mazurkiewicz, M. (2019): Foundations of Embedded Systems. In: Kacprzyk, J.: Studies in Systems, Decision and Control, Volume 195, Springer Nature, Chams.
- Lacamera, D. (2018): Embedded systems architecture: explore architectural concepts, pragmatic design patterns, and best practices to produce robust systems. Packt Publishing, Birmingham.
- Noergaard, T. (2013): Embedded Systems Architecture. Elsevier Inc, Amsterdam.
- Siegesmund, M. (2014): Embedded C Programming. Elsevier Inc, Amsterdam.
- Simon, D. E. (1999): An embedded software primer. Addison Wesley, Boston, MS.
- White, E. (2011): Making Embedded Systems. O'Reilly, Sebastopol, CL.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Project: Applied Robotics with Robotic Platforms

Course Code: DLBROPARRP01_E

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

Course Description

In the last years several robotic software and hardware platforms have been developed. The existing diverse robotic systems provide an affordable and reliable basis to build next generation robots. Some of those systems are open source and constantly developed by the community of roboticists. Of course, such systems require a minimal understanding of robotics as well as of other robotics-related issues which are important in today’s technical community, such as internet of things and communication interfaces. This course provides the basics to work with such robotic platforms for development, design and implementation of industrial and mobile robots.

Course Outcomes

On successful completion, students will be able to

- name several existing open-source robotic platforms.
- understand the basic principles of robotic platforms.
- work with existing robotic platforms.
- carry out a robotic project by means of robotic platforms.

Contents

- This course illustrates robotic platforms and their usage within robotics projects.

Literature

Compulsory Reading

Further Reading

- Cacace, J./Joseph, L. (2018): Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System. 2nd ed., Packt Publishing, Birmingham.
- Koubaa, A. (ed.) (2018): Robot operating system (ROS): the complete reference. Volume 1. Springer, Cham.
- Quigley, M./Gerkey, B./Smart, W. D. (2015): Programming robots with ROS. O’Reilly, Sebastopol, CL.

Study Format myStudies

Study Format	Course Type
myStudies	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format Distance Learning	**Course Type** Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Control Engineering

Module Code: DLBWINWRT_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

N.N. (Signals and Systems) / N.N. (Control Systems Engineering)

Contributing Courses to Module

- Signals and Systems (DLBROSS01_E)
- Control Systems Engineering (DLBROCSE01_E)

Module Exam Type

Module Exam	Split Exam
	Signals and Systems • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Control Systems Engineering • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents	
Signals and Systems • 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 **Control Systems Engineering** • 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	
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. **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

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

- Alkin, O. (2014): Signals and systems: a MATLAB integrated approach. CRC Press, Boca Raton, FL.
- Lathi, B. P. (2009): Principles of Linear Systems and Signals. 2nd ed., Oxford University Press, New Delhi.
- Rao, K. D. (2018): Signals and Systems. Springer International Publishing, Cham.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format Distance Learning	Course Type Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

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

- Nise, N. S. (2019): Control systems engineering. 8th ed., John Wiley & Sons, Hoboken, NJ.
- Doyle, J. C./Francis, B. A./Tannenbaum, A. R. (2009): Feedback Control Theory. Dover Publications Inc, Mineola, NY.
- Franklin, G. F./Powell, J. D./Emami-Naeini, A. (2019): Feedback control of dynamic systems. 8th ed., Pearson, London.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

DLBROCSE01_E

Object-oriented Programing

Module Code: IOBP_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. Damir Ismailovic (Object-oriented Programming with Java) / Prof. Dr. Damir Ismailovic (Data Structures and Java Class Library)

Contributing Courses to Module

- Object-oriented Programming with Java (DLBCSOOPJ01)
- Data Structures and Java Class Library (DLBCSDSJCL01)

Module Exam Type

Module Exam	Split Exam
	Object-oriented Programming with Java • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Data Structures and Java Class Library • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents
Object-oriented Programming with Java ▪ Introduction to the Java language ▪ Java language constructs ▪ Introduction to object-oriented system developement ▪ Inheritance ▪ Object-oriented concepts ▪ Exception handling ▪ Interfaces **Data Structures and Java Class Library** ▪ Programming style ▪ Working with objects ▪ External packages and libraries ▪ Data structures ▪ Strings and calendar ▪ File system and data streams

Learning Outcomes
Object-oriented Programming with Java On successful completion, students will be able to ▪ describe the basic concepts of object-oriented modeling and programming, distinguishing them from one another. ▪ describe the basic concepts and elements of the Java programming language and have some experience in their use. ▪ independently create Java programs to solve concrete problems. **Data Structures and Java Class Library** On successful completion, students will be able to ▪ understand typical data structures and distinguish them from each other. ▪ independently create solutions in the Java programming language using the data structures. ▪ understand scenarios and strategies for comparing objects and implement them in Java. ▪ describe the possible uses and functions of character strings and calendar objects in Java and have experience using them. ▪ describe the possible uses and functions of streams in Java and have experience using them.

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 Programmes in the IT & Technology fields

Object-oriented Programming with Java

Course Code: DLBCSOOPJ01

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

Course Description

Operational information systems are usually planned and programmed to be object-oriented. Therefore, this course teaches the basic skills of object-oriented programming. Theoretical concepts are presented and practiced directly with the programming language Java.

Course Outcomes

On successful completion, students will be able to

- describe the basic concepts of object-oriented modeling and programming, distinguishing them from one another.
- describe the basic concepts and elements of the Java programming language and have some experience in their use.
- independently create Java programs to solve concrete problems.

Contents

1. Introduction to Object-Oriented System Development
   - 1.1 Object Orientation as a Way of Looking at Complex Systems
   - 1.2 The Object as a Basic Concept of Object Orientation
   - 1.3 Phases in the Object-Oriented Development Process
   - 1.4 Basic Principle of Object-Oriented System Development

2. Introduction to Object-Oriented Modeling
   - 2.1 Structuring Problems With Classes
   - 2.2 Identifying Classes
   - 2.3 Attributes as Properties of Classes
   - 2.4 Methods as Functions of Classes
   - 2.5 Associations between Classes
   - 2.6 Unified Modeling Language (UML)

3. Programming Classes in Java
   - 3.1 Introduction to the Java Programming Language
   - 3.2 Basic Elements of a Class in Java
   - 3.3 Attributes in Java
   - 3.4 Methods in Java
   - 3.5 Main Method: Starting Point of a Java Program

4. Java Language Constructs
   - 4.1 Primitive Data Types
   - 4.2 Variables
   - 4.3 Operators and Expressions
   - 4.4 Control Structures
   - 4.5 Packages and Visibility Modifiers .

5. Inheritance
   - 5.1 Modeling and Inheritance in the Class Diagram
   - 5.2 Programming Inheritance in Java

6. Important Object-Oriented Concepts
   - 6.1 Abstract Classes
   - 6.2 Polymorphism
   - 6.3 Static Attributes and Methods

7. Constructors for Generating Objects
   - 7.1 The Standard Constructor
   - 7.2 Overloading Constructors
   - 7.3 Constructors and Inheritance

8. Handling Exceptions with Exceptions
   - 8.1 Typical Scenarios of Exception Handling
   - 8.2 Standard Exceptions in Java
   - 8.3 Defining Your Own Exceptions

9. Programming Interfaces with Interfaces
   - 9.1 Typical Scenarios of Programming Interfaces
   - 9.2 Interfaces as Programming Interfaces in Java

Literature

Compulsory Reading

Further Reading

- Freeman, E., Robson, E., Bates, B., & Sierra, K. (2014). Head first design patterns (A brain friendly guide). O'Reilly Media.
- Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1995). Design patterns: Elements of re-usable object-oriented software. Addison-Wesley.
- Liang, Y. D. (2018). Introduction to Java programming and data structures. Pearson Education.
- Liguiori, L. & Liguori, P. (2008). Java pocket guide: Instant help for Java. O'Reilly Media.
- Oracle (2017). The Java tutorials. Available online.
- Samoylov, N. (2019). Learn Java 12 programming: A step-by-step guide to learning essential concepts in Java SE 10, 11, and 12. Packt Publishing.
- Weisfeld M. (2019). The object-oriented thought process (5th ed.). Addison-Wesley.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Data Structures and Java Class Library

Course Code: DLBCSDSJCL01

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

Course Description

Based on the contents of the course "Basics of object-oriented programming with Java", this course deepens the knowledge of object-oriented programming. In particular, data structures, their use cases, and their implementation in the Java language are considered. In addition, strategies and scenarios of object comparisons, the use of functions of the "String" data type, the use of calendar objects, and the use of streams are taught.

Course Outcomes

On successful completion, students will be able to

- understand typical data structures and distinguish them from each other.
- independently create solutions in the Java programming language using the data structures.
- understand scenarios and strategies for comparing objects and implement them in Java.
- describe the possible uses and functions of character strings and calendar objects in Java and have experience using them.
- describe the possible uses and functions of streams in Java and have experience using them.

Contents

1. Programming Style
   - 1.1 Code Documentation
   - 1.2 Code Annotations
   - 1.3 Code Conventions
2. Working with Objects
   - 2.1 String Representation of Objects
   - 2.2 Compare with ==
   - 2.3 Compare with Equals()
   - 2.4 Compare by HashCode()
   - 2.5 CompareTo()
   - 2.6 Cloning Objects

3. External Packages and Libraries
    - 3.1 Importing Packages
    - 3.2 The Java Class Library

4. Data Structures
    - 4.1 Arrays
    - 4.2 Collections
    - 4.3 Working with Collections
    - 4.4 Lists
    - 4.5 Quantities (Sets)
    - 4.6 Associative Memory (Maps)
    - 4.7 Stacks (Basement)
    - 4.8 Queues (Snakes)

5. Strings and Calendar
    - 5.1 Strings
    - 5.2 StringBuffer
    - 5.3 Splitting Character Strings
    - 5.4 Date and time
    - 5.5 Calendar

6. File System and Data Streams
    - 6.1 Working with the File System
    - 6.2 Working with Files

Literature

Compulsory Reading

Further Reading

- Bloch, J. (2017). Effective Java (3rd ed.). Addison-Wesley.
- Oracle. (2018a). Java platform standard edition 10 API specification. (Available online).
- Oracle. (2018b). String (Java platform SE 10). (Available online).
- Oracle. (2018c). Date (Java platform SE 10). (Available online).
- Oracle. (2018d). java.io (Java platform SE 10). (Available online).
- Oracle. (2019). The Java language specification: Java SE 11 edition. (Available online).
- Seidl, M. (2015). UML@Classroom: An introduction to object-oriented modeling. Springer.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Practice Project: Industrial Engineering 4.0

Module Code: DLBWINWPWIN_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	at least 90 ECTS, DLBINGET01-01_E, DLBINGDT01_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

Prof. Dr. Marian Benner-Wickner (Practice Project: Industrial Engineering 4.0)

Contributing Courses to Module

- Practice Project: Industrial Engineering 4.0 (DLBWINWPWIN01_E)

Module Exam Type	
Module Exam Study Format: Distance Learning Internship Reflection Paper (passed / not passed)	**Split Exam**
Weight of Module see curriculum	

Module Contents

The Practical Project: Industrial Engineering 4.0 offers students the opportunity to gain practical experience in the field of industrial engineering, based on the subject-specific study components in industrial engineering. For this purpose, a tangible or digital result is to be created in collaboration with a company, for example a product prototype, a tool or software. The result should be able to solve an existing practical problem of the company.

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

Practice Project: Industrial Engineering 4.0

On successful completion, students will be able to
▪ identify relevant problems from the professional environment of an industrial engineer in a company and explain them to an interested audience,
▪ apply established procedures to find a (prototypical) solution to the problem,
▪ find relevant concepts or technologies for the solution and integrate them appropriately,
▪ evaluate the result in terms of its suitability for solving the practical problem,present the problem, the solution and the way to get there in a comprehensible and descriptive way.</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 fields</td></tr>
</table>

Practice Project: Industrial Engineering 4.0

Course Code: DLBWINWPWIN01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		10	at least 90 ECTS, DLBINGET01-01_E, DLBINGDT01_E

Course Description

In the course of the study program, a variety of different concepts, methods and techniques were introduced that are relevant to the professional practice of an industrial engineer. The practical project offers the opportunity to use the accumulated knowledge and skills to solve a relevant problem of a company independently and on one's own responsibility. The result should be the creation of hardware or software (or a combination of both) that can demonstrate, at least in the sense of a proof-of-concept or a prototype, how the practical problem can be solved.

Course Outcomes

On successful completion, students will be able to

- identify relevant problems from the professional environment of an industrial engineer in a company and explain them to an interested audience,
- apply established procedures to find a (prototypical) solution to the problem,
- find relevant concepts or technologies for the solution and integrate them appropriately,
- evaluate the result in terms of its suitability for solving the practical problem,present the problem, the solution and the way to get there in a comprehensible and descriptive way.

Contents

- At the beginning of the practical project, the students look for a company that agrees to cooperate accordingly (in all formal matters such as confidentiality agreements or blocking notes, the students are advised in the tutorial and by the examination office). In consultation with the company and the tutor, the students select a concrete task that (a) can be derived from a company-specific problem, (b) can be processed with the available time and technical resources. Possible problems and use cases can be found, for example, in the areas of sustainability, smart factory, robotics, smart home, electromobility, autonomous driving, human-machine interaction, data analytics, robotic process automation, or digital business models. The students ideally work on the task in a working environment provided by the company. To complete the task, the students apply the concepts, methods and tools taught throughout the curriculum. They write down their result in the form of a simple practical reflection. The result is evaluated in terms of its suitability for solving the previously selected problem. Aspects such as complexity, creativity and practical relevance play a role.

Literature
Compulsory Reading
Further Reading - Bangemann, Thomas; Riedl, Matthias; Thron, Mario; Diedrich, Christian (2016): Integration of Classical Components Into Industrial Cyber–Physical Systems. In: Proc. IEEE 104 (5), S. 947–959. - Harrison, Robert; Vera, Daniel; Ahmad, Bilal (2016): Engineering Methods and Tools for Cyber–Physical Automation Systems. In: Proc. IEEE 104 (5), S. 973–985. - Kelley, T./ Kelley, D. (2013): Creative Confidence: Unleashing the Creative Potential Within Us All. Crown Publishing, New York. - Meinel, C.; Weinberg, U.; Krohn, T. (Eds.) (2015): Design Thinking Live. How to develop ideas and solve problems. Murmann Publishers, Hamburg.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Internship Reflection Paper (passed / not passed)

Student Workload					
Self Study	**Contact Hours**	**Tutorial**	**Self Test**	**Independent Study**	**Hours Total**
0 h	0 h	0 h	0 h	300 h	300 h

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Project: Hackathon

Module Code: DLBWINWPH_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	at least 90 ECTS, DLBINGET01-01_E, DLBINGDT01_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

Prof. Dr. Marian Benner-Wickner (Project: Hackathon)

Contributing Courses to Module

- Project: Hackathon (DLBWINWPH01_E)

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

Module Contents

The Project: Hackathon offers students the opportunity to gain practical experience in the field of industrial engineering based on the subject-specific study components in industrial engineering. For this purpose, a tangible or digital result is to be created, for example a product prototype, a tool or a software. The result should be able to solve an existing problem from practice.

Learning Outcomes	
Project: Hackathon On successful completion, students will be able to • identify relevant problems from the professional environment of an industrial engineer and explain it to an interested audience, • apply established procedures to find a (prototypical) solution to the problem, • find relevant concepts or technologies for the solution and integrate them appropriately, • evaluate the result with respect to its suitability for solving the practical problem,• • present the problem, the solution and the way to get there in a comprehensible and descriptive way.	
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

Project: Hackathon

Course Code: DLBWINWPH01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		10	at least 90 ECTS, DLBINGET01-01_E, DLBINGDT01_E

Course Description

In the course of the study program, a variety of different concepts, methods and techniques were introduced that are relevant to the professional practice of an industrial engineer. The Hackathon offers the opportunity to use the accumulated knowledge and skills to solve a relevant practical problem independently and on one's own responsibility. The result should be the creation of hardware or software (or a combination of both) that can demonstrate, at least in terms of a proof-of-concept or prototype, how the practical problem can be solved. The problem and the result are to be made available to other students on a platform provided for this purpose.

Course Outcomes

On successful completion, students will be able to

- identify relevant problems from the professional environment of an industrial engineer and explain it to an interested audience,
- apply established procedures to find a (prototypical) solution to the problem,
- find relevant concepts or technologies for the solution and integrate them appropriately,
- evaluate the result with respect to its suitability for solving the practical problem,
- present the problem, the solution and the way to get there in a comprehensible and descriptive way.

Contents

- At the beginning of the Hackathon the students choose a concrete task in coordination with the tutor. The task shall be derived from a relevant practical problem. Possible problems and use cases can be found, for example, in the areas of sustainability, smart factory, robotics, smart home, electromobility, autonomous driving, human-machine interaction, data analytics, robotic process automation or digital business models. Students work on the task with the help of a prototyping environment that fits the subject of the task. The environments can be hardware (e.g. prototyping boards such as the Arduino) or software (e.g. technology-specific development environments such as Matlab or Eclipse IDE). To complete the task, students apply the concepts, methods and tools taught throughout the curriculum. They present their result in the form of a project presentation. In addition, the students are asked to publish the result together with the underlying problem and the chosen solution on a platform so that it is visible to other students. The result is evaluated in terms of its suitability to solve the previously selected problem. Aspects such as complexity, creativity and practical relevance play a role.

Literature
Compulsory Reading
Further Reading

Further Reading

- Anderson, C. (2013): Makers - The Internet of Things: The next industrial revolution. Carl Hanser, Munich.
- Kelley, T./ Kelley, D. (2013): Creative Confidence: Unleashing the Creative Potential Within Us All. Crown Publishing, New York.
- Meinel, C./ Weinberg, U./ Krohn, T. (eds.) (2015): Design Thinking Live. How to create ideas develops and solves problems. Murmann Publishers, Hamburg.
- Monk, S, (2018): Programming Arduino Next Steps: Going Further with Sketches, Second Edition. McGraw-Hill Education TAB

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

Student Workload					
Self Study	**Contact Hours**	**Tutorial**	**Self Test**	**Independent Study**	**Hours Total**
240 h	0 h	60 h	0 h	0 h	300 h

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Smart Devices

Module Code: DLBINGSD_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

N.N. (Smart Devices I) / N.N. (Smart Devices II)

Contributing Courses to Module

- Smart Devices I (DLBINGSD01_E)
- Smart Devices II (DLBINGSD02_E)

Module Exam Type	
Module Exam	**Split Exam** Smart Devices I • Study Format "Fernstudium": Exam, 90 Minutes Smart Devices II • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents

Smart Devices I

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

Smart Devices II

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

Learning Outcomes

Smart Devices I

On successful completion, students will be able to

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

Smart Devices II

On successful completion, students will be able to

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

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 Devices I

Course Code: DLBINGSD01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

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

Literature
Compulsory Reading
Further Reading - Fortino, G./Trunfio, P. (2014): Internet of Things Based on Smart Objects. Technology, Middleware and Applications. Springer International Publishing, Cham. - López, Tomás Sánchez et al. (2011): Taxonomy, Technology and Applications of Smart Bbjects. In: Information Systems Frontiers, No. 13, Issue 2, p. 281–300. - McTear, M./Callejas, Z./Griol, D. (2016): The Conversational Interface. Talking to Smart Devices. Springer International Publishing, Cham. - Nihtianov, S./Luque, A. (2014): Smart Sensors and MEMS. Intelligent Devices and Microsystems for Industrial Applications. Woodhead, Burlington. - Poslad, S. (2009): Ubiquitous Computing. Smart Devices, Environments and Interactions. 2nd edition, Wiley, Hoboken, NJ. - Sendler, U. (Ed.) (2018): The Internet of Things – Industrie 4.0 Unleashed. Springer, Berlin. - Vinoy, K. J. et al. (Ed.) (2014): Micro and Smart Devices and Systems. Springer India, New Delhi.

Study Format Fernstudium

Study Format	Course Type
Fernstudium	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Smart Devices II

Course Code: DLBINGSD02_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

Literature

Compulsory Reading

Further Reading

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Smart Factory

Module Code: DLBDSESF

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. Mario Boßlau (Smart Factory I) / Prof. Dr. Mario Boßlau (Smart Factory II)

Contributing Courses to Module

- Smart Factory I (DLBDSESF01)
- Smart Factory II (DLBDSESF02)

Module Exam Type

Module Exam	Split Exam
	Smart Factory I • Study Format "Distance Learning": Exam, 90 Minutes Smart Factory II • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

Module Contents

Smart Factory I

- Motivation and Definition of Terms
- Development of Automation
- Technological Basics and Standards
- Basic concepts of a Smart Factory
- Reference Architectures
- Smart Factory Engineering
- Safety and Security

Smart Factory II

A catalogue with the currently provided tasks is provided on the online platform of the module. It provides the content basis of the module and can be supplemented or updated by the seminar leader.

Learning Outcomes

Smart Factory I

On successful completion, students will be able to

- understand the term Smart Factory in the context of Industry 4.0.
- be able to trace the development of automation to a fully autonomous, non-centrally organized production plant.
- understand the basic technologies and standards used to design and operate a Smart Factory.
- understand the essential concepts of a Smart Factory.
- identify and differentiate between the individual elements of a Smart Factory using different reference architectures.
- understand the special engineering challenges in the Smart Energy context.
- understand the special safety risks of digitized and networked production plants and assign concrete recommendations for action.

Smart Factory II

On successful completion, students will be able to

- have a deeper understanding of the technologies and standards in the context of Smart Factory.
- apply technologies in the context of Smart Factory to a simple practical example.
- design a hardware or software prototype for a selected task.
- document, design, and develop activities in the form of a project report.

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 Programmes in the IT & Technology fields

Smart Factory I

Course Code: DLBDSESF01

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

Course Description

In this course, students will gain a deeper insight into the networking and digitization of production facilities by examining a Smart Factory. For this purpose, they will be familiarized with the basic goals of a Smart Factory in the context of the research complex Industry 4.0. After a brief introduction to the history of automation, students will learn the technical basics and standards required to design and operate a Smart Factory. Building on this, they will learn how these individual technologies are used to implement the central concepts of a Smart Factory. In order to understand which components a Smart Factory consists of, different reference architectures are presented and compared. The course concludes with the special engineering challenges of an autonomously acting and decentralized production plant. Above all, this includes IT security, which is particularly relevant due to the digital networking of production facilities and products.

Course Outcomes

On successful completion, students will be able to

- understand the term Smart Factory in the context of Industry 4.0.
- be able to trace the development of automation to a fully autonomous, non-centrally organized production plant.
- understand the basic technologies and standards used to design and operate a Smart Factory.
- understand the essential concepts of a Smart Factory.
- identify and differentiate between the individual elements of a Smart Factory using different reference architectures.
- understand the special engineering challenges in the Smart Energy context.
- understand the special safety risks of digitized and networked production plants and assign concrete recommendations for action.

Contents

1. Motivation and Definition of Terms
   - 1.1 Goals of Smart Factory
   - 1.2 Internet of Things
   - 1.3 Cyber-Physical Systems
   - 1.4 Cyber-Physical Production Systems
   - 1.5 Smart Factory as a Cyber-Physical (Production) System

2. Development of Automation
   - 2.1 Automation Pyramid
   - 2.2 Networked, Decentralized Organization of Production
   - 2.3 Future Challenges

3. Technological Basics and Standards
   - 3.1 Identification of Physical Objects
   - 3.2 Formal Description Languages and Ontologies
   - 3.3 Digital Object Memory
   - 3.4 Physical Situation Recognition
   - 3.5 (Partially) Autonomous Action and Cooperation
   - 3.6 Human-Machine Interaction
   - 3.7 Machine to Machine Communication

4. Basic Concepts of a Smart Factory
   - 4.1 Order-Controlled Production
   - 4.2 Bundling of Machine and Production Data
   - 4.3 Supporting People in Production
   - 4.4 Intelligent Products and Resources
   - 4.5 Smart Services

5. Reference Architectures
   - 5.1 Purpose and Properties of Reference Architectures
   - 5.2 Overview of Standardization Initiatives
   - 5.3 CyProS Reference Architecture
   - 5.4 RAMI 4.0 (DIN SPEC 91345)

6. Smart Factory Engineering
   - 6.1 Classification of Different Engineering Tools
   - 6.2 Virtual Engineering
   - 6.3 User-Centered Design
   - 6.4 Requirements Engineering
   - 6.5 Modelling
   - 6.6 Integration of Classic and Smart Components

Literature
Compulsory Reading
Further Reading • Butun, I. (2020). Industrial IoT: Challenges, design principles, applications, and security. Springer. • Drossel, W. G., Ihlenfeldt, S., Lanzger, T., & Dumitrescu, R. (2019). Cyber-physical systems. In R. Neugebauer (Ed.), Digital transformation (pp. 189—213). Springer. • Durakbasa, N. M., & Gençyılmaz, M. G. (Eds.). (2021). Digital conversion on the way to Industry 4.0. Springer. • Ustundag, A., & Cevikcan, E. (2018). Industry 4.0: Managing the digital transformation. Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Smart Factory II

Course Code: DLBDSESF02

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

Course Description

In this course, students select a concrete task from the catalog of topics provided in consultation with the seminar leader. They will work on the task in a prototyping environment suited to the task, which can be either a hardware (e.g., prototyping boards) or software (e.g., technology-specific development environments) environment. To complete the task, students apply the concepts, methods, and tools taught in the Smart Factory I course. They document their results with a project report.

Course Outcomes

On successful completion, students will be able to

- have a deeper understanding of the technologies and standards in the context of Smart Factory.
- apply technologies in the context of Smart Factory to a simple practical example.
- design a hardware or software prototype for a selected task.
- document, design, and develop activities in the form of a project report.

Contents

- A catalogue with the currently provided tasks is provided on the online platform of the module. It provides the content basis of the module and can be supplemented or updated by the seminar leader.

Literature

Compulsory Reading

Further Reading

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☑ Slides

Smart Mobility

Module Code: DLBINGSM_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

N.N. (Smart Mobility I) / N.N. (Smart Mobility II)

Contributing Courses to Module

- Smart Mobility I (DLBINGSM01_E)
- Smart Mobility II (DLBINGSM02_E)

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

Weight of Module

see curriculum

Module Contents

Smart Mobility I

- Introduction and Definitions
- Overview over traditional mobility infrastructure approaches
- Alternative approaches to mobility
- Services for smart mobility
- Overview over relevant technologies and standards
- Car2X Communication
- Examples and use-cases

Smart Mobility II

In-depth analysis of a specific topic in the context of Smart Mobility in form of a prototype report.

Learning Outcomes

Smart Mobility I

On successful completion, students will be able to

- remember several types of mobility.
- understand distinct reasons for designing intelligent mobility systems.
- analyze diverse types of mobility infrastructure regarding their properties and access requirements.
- understand various alternative mobility approaches.
- remember a range of services that relevant for Smart Mobility.
- understand the relevant technologies and standards for connecting infrastructure elements and services.
- understand use cases for Car2X communication and the relevant standards and technologies.
- remember example projects in the context of Smart Mobility.

Smart Mobility II

On successful completion, students will be able to

- have an in-depth understanding of the technologies and standards in the context of Smart Mobility.
- apply technologies in the context of Smart Mobility using a simple practical example.
- design a hardware or software prototype for a selected task.
- document design choices and development tasks 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 Mobility I

Course Code: DLBINGSM01_E

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

Course Description

This course gives an introduction and overview into the future of mobility. Starting from an understanding of traditional and current mobility infrastructure, alternative approaches are introduced. The course discusses a range of services that are typical for smart mobility solutions. The course includes a detailed discussion on technologies and standards relevant for smart mobility, in particular in Car2X communication. A range of projects and examples are discussed to illustrate the application of smart mobility approaches in a real-life context.

Course Outcomes

On successful completion, students will be able to

- remember several types of mobility.
- understand distinct reasons for designing intelligent mobility systems.
- analyze diverse types of mobility infrastructure regarding their properties and access requirements.
- understand various alternative mobility approaches.
- remember a range of services that relevant for Smart Mobility.
- understand the relevant technologies and standards for connecting infrastructure elements and services.
- understand use cases for Car2X communication and the relevant standards and technologies.
- remember example projects in the context of Smart Mobility.

Contents

1. Introduction and Definitions
   - 1.1 Types of Mobility
   - 1.2 Smart Mobility and Smart City
   - 1.3 Efficient use of energy
   - 1.4 Emissions
   - 1.5 Security
   - 1.6 Comfort
   - 1.7 Cost Effectiveness

2. Overview over traditional mobility infrastructure approaches
   - 2.1 Properties and Access Requirements
   - 2.2 Infrastructure Planning
   - 2.3 Disadvantages of Isolated Infrastructures

3. Alternative approaches to mobility
   - 3.1 Park and Ride
   - 3.2 Car-Sharing
   - 3.3 Rent A Bike
   - 3.4 Carpooling

4. Services for smart mobility
   - 4.1 Authorization
   - 4.2 Payment
   - 4.3 Booking
   - 4.4 Navigation
   - 4.5 Security
   - 4.6 Hybrid Services

5. Overview over relevant technologies and standards
   - 5.1 Mobile Devices
   - 5.2 Mobile Networks and Wireless LAN
   - 5.3 NFC and RFID
   - 5.4 Outdoor and Indoor Localization
   - 5.5 Technologies for Traffic Monitoring

6. Car2X Communication
   - 6.1 Use Cases
   - 6.2 Elements of a Car2X System
   - 6.3 Technologies and Standards
   - 6.4 Sample Implementations

7. Examples and use-cases
   - 7.1 Octopus (Hong Kong)
   - 7.2 Amsterdam Practical Trial
   - 7.3 Mobincity

Literature
Compulsory Reading
Further Reading - Fluegge, B. (2017): Smart Mobility – Connecting Everyone: Trends, Concepts and Best Practices Paperback. Springer/Vierweg, Wiesbaden. - Handke, V./Jonuschat, H. (2013): Flexible Ridesharing. New Opportunities and Service Concepts for Sustainable Mobility. Springer, Berlin/Heidelberg. - Inderwildi, O./King, D. (Eds.) (2012): Energy, Transport, & the Environment. Addressing the Sustainable Mobility Paradigm. Springer, London. - Nathanail, E./Karakikes, I. (2018): Data Analytics: Paving the Way to Sustainable Urban Mobility: Proceedings of 4th Conference on Sustainable Urban Mobility (CSUM2018). Springer, London. - Papa, R./Fistola, R./Gargiulo, C. (2018): Smart Planning: Sustainability and Mobility in the Age of Change (Green Energy and Technology). Springer, London. - Planing, P. et al (2020): Innovations for Metropolitan Areas: Intelligent Solutions for Mobility, Logistics and Infrastructure designed for Citizens. Springer, London. - Sashinskaya, M. (2015): Smart Cities in Europe. Open Data in a Smart Mobility Context. Createspace Independent Publishing Platform.

Study Format Distance Learning

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

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Smart Mobility II

Course Code: DLBINGSM02_E

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

Course Description

In the course Smart Mobility II, students are asked to choose an assignment provided by the course tutor to apply the concepts and methods covered in Smart Mobility I in a specific use case or application area. The students will develop a prototype focused on a specific topic related to smart mobility. The prototype can be developed either as a hardware setup or a software solution. The students 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 Mobility.
- apply technologies in the context of Smart Mobility using a simple practical example.
- design a hardware or software prototype for a selected task.
- document design choices and development tasks in the form of a project report.

Contents

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

Literature
Compulsory Reading
Further Reading

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

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
N.N. (Smart Services I) / N.N. (Smart Services II)

Contributing Courses to Module
• Smart Services I (DLBINGSS01_E) • Smart Services II (DLBINGSS02_E)

Module Exam Type	
Module Exam	**Split Exam** Smart Services I • Study Format "Distance Learning": Exam, 90 Minutes Smart Services II • 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
   - 2.3 Digital Intermediaries
   - 2.4 Examples of Disruptive Business Models

3. Recognizing Potential for Smart Services
   - 3.1 Business Model Canvas
   - 3.2 Personas
   - 3.3 Customer Journeys
   - 3.4 Domain-Driven Design

4. Development and Specification of Smart Services
   - 4.1 Modelling of the System Context
   - 4.2 Modelling of Business Processes
   - 4.3 Modelling of Technical Interfaces
   - 4.4 Tools for API Specification

5. Service Architectures
   - 5.1 Infrastructure/Platform/Software-as-a-Service
   - 5.2 Everything-as-a-Service
   - 5.3 Service-oriented Architectures
   - 5.4 Micro Services

6. Integration Platforms
   - 6.1 Features and Purpose of Integration Platforms
   - 6.2 Enterprise Integration Patterns
   - 6.3 External Integration with Zapier, IFTTT & Others

7. Technologies for Smart Services
   - 7.1 Formats for Data Exchange
   - 7.2 Internet Communication Protocols
   - 7.3 Semantic Descriptions
   - 7.4 Complex Event Processing
   - 7.5 Security

8. Quality and Operation of Smart Services
   8.1 Quality Characteristics and Maturity of APIs
   8.2 Service Level Agreements
   8.3 Service Level Management

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

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

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Microcontroller

Module Code: DLBWINWMC_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	- none - DLBAETDIT01_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

Prof. Dr. Marian Benner-Wickner (Digital and Information Technology) / Prof. Dr. Marian Benner-Wickner (Project: Microcontrollers and Logical Circuits)

Contributing Courses to Module

- Digital and Information Technology (DLBAETDIT01_E)
- Project: Microcontrollers and Logical Circuits (DLBAETPMLS01_E)

Module Exam Type

Module Exam	Split Exam
	Digital and Information Technology • 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

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

Project: Microcontrollers and Logical Circuits

The students should work independently through the complete flowof 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

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.

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

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

3. Combinational Logic
   - 3.1 Logic Gate
   - 3.2 Connection of Logic Gaes
   - 3.3 Substitution by NOR / NAND Gates

4. Sequential Logic
   - 4.1 Latches and Flipflops
   - 4.2 Counter and Frequency Divider
   - 4.3 Shift Register and Memory

5. State Machines
   - 5.1 Foundations
   - 5.2 Models for State Machines
   - 5.3 Representation of State Machines
   - 5.4 Event-driven / Clock-driven State Machines
   - 5.5 Synchronization of Parallel State Machines

6. Arithmatic Circuits
   - 6.1 Adders
   - 6.2 Subtractor Circuits
   - 6.3 Multiplication Circuits

7. Introduction to Programmable Logic
   - 7.1 Programmable Cell Logic and Programmable Logic Array
   - 7.2 Complex Programmable Logic Devices (CPLD)
   - 7.3 FPGAs
   - 7.4 Introduction to VHDL

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	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ 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	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Service Robotics

Module Code: DLBROESR_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
N.N. (Mobile Robotics) / N.N. (Soft Robotics)

Contributing Courses to Module
• Mobile Robotics (DLBROESR01_E) • Soft Robotics (DLBROESR02_E)

Module Exam Type	
Module Exam	**Split Exam** Mobile Robotics • Study Format "Distance Learning": Module Exam (50) Soft Robotics • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents
Mobile Robotics - Locomotion - Kinematics and dynamics - Perception - Mobile manipulators - Path motion and task planning - Localization and mapping **Soft Robotics** - Soft robotics - Actuators for soft robots - Sensors for soft robots - Applications of soft robots

Learning Outcomes
Mobile Robotics On successful completion, students will be able to - understand mobile robot locomotion, kinematics, and dynamics. - model and simulate a wheeled, legged, or aerial mobile robot. - understand common approaches for localization and mapping. - apply and simulate path, motion, and task planning algorithms. - simulate and understand mobile manipulators. **Soft Robotics** On successful completion, students will be able to - know the basics behind soft robots. - understand and analyze common structures of soft robots. - choose the best soft robot 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

Mobile Robotics

Course Code: DLBROESR01_E

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

Course Description

Modern robots are mobile robots, able to move in spaces and perform tasks autonomously. This is for instance what is done by household robots, or by robots working in warehouses. In the last years, such robots have been improved by the implementation of advanced localization and task planning algorithms, which are based on the fundamentals of mobile robot kinematics and dynamics. This course starts with an introduction to the main concepts of robot locomotion, presenting the three main categories of mobile robots, namely legged, wheeled and aerial (often called drones). As second focus lies on the necessary mathematical foundation. This course, thus, discusses kinematics and dynamics of mobile robots. The topic of how a mobile robot can perceive the surrounding world is treated in detail in a third part of this course, where sensors for mobile robots are introduced together with an introduction on advanced topics such as robot vision and image processing. The last part of this course describes the main approaches for localization, mapping and motion and task planning. A brief overview on combination of mobile robots and manipulators, i.e., mobile manipulators, is also given.

Course Outcomes

On successful completion, students will be able to

- understand mobile robot locomotion, kinematics, and dynamics.
- model and simulate a wheeled, legged, or aerial mobile robot.
- understand common approaches for localization and mapping.
- apply and simulate path, motion, and task planning algorithms.
- simulate and understand mobile manipulators.

Contents

1. Locomotion
   - 1.1 Basics
   - 1.2 Legged Mobile Robots
   - 1.3 Wheeled Mobile Robots
   - 1.4 Aerial Mobile Robots

7. Localization and Mapping
   - 7.1 Sensor Imperfections
   - 7.2 Relative Localization
   - 7.3 Absolute Localization
   - 7.4 Localization, Calibration and Sensor Fusion
   - 7.5 Simultaneous Localization and Mapping
   - 7.6 Examples

Literature

Compulsory Reading

Further Reading

- Corke, P. (2017): Robotics, Vision and Control: Fundamental Algorithms In MATLAB. 2nd ed., Springer International Publishing, Cham.
- Siciliano, B./Khatib, O. (eds.) (2016): Springer Handbook of Robotics. Springer International Publishing, Cham.
- Siegwart, R./Nourbakhsh, I. R./Scaramuzza, D. (2011): Introduction to Autonomous Mobile Robots. The MIT Press, Cambridge, MS.
- Tzafestas, S. G. (2013): Introduction to Mobile Robot Control. Elsevier Inc, Amsterdam.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Module Exam

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Soft Robotics

Course Code: DLBROESR02_E

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

Course Description

Classic robots are made of rigid links and structures. In the last years, the field of robotics has been strongly influenced and inspired by biological processes. Instead of rigid structures, soft structures, materials, and surfaces are characterizing innovative, soft robots. This new generation of robots can be used in several applications where highly dynamic tasks must be performed in unsafe or rough environments, and especially where the interaction with humans is necessary. This course provides the basics in the fast-changing field of soft robotics, starting with an overview of materials and technologies for soft actuators, proceeding with an overview on innovative sensors, and concluding with an overview on modeling approaches for soft robots. The last part summarizes some relevant state-of-the-art applications.

Course Outcomes

On successful completion, students will be able to

- know the basics behind soft robots.
- understand and analyze common structures of soft robots.
- choose the best soft robot technology for a given application.

Contents

1. Introduction
   - 1.1 Soft Robots
   - 1.2 Challenges
   - 1.3 Trends
   - 1.4 Applications

2. Actuators
   - 2.1 Materials and Properties of Soft Actuators
   - 2.2 Thermo-driven Soft Actuators
   - 2.3 Electro-driven Soft Actuators
   - 2.4 Light-driven Soft Actuators
   - 2.5 Magneto-driven Soft Actuators
   - 2.6 Pneumatic Actuators
   - 2.7 Examples

3. Sensors
   - 3.1 Basics
   - 3.2 Proximity Sensing
   - 3.3 Mechano-sensing
   - 3.4 Examples

4. Modeling
   - 4.1 Artificial Muscles
   - 4.2 Interactions
   - 4.3 Compliance Control
   - 4.4 Variable-stiffness Actuators

5. Applications
   - 5.1 Soft Bionic Hands
   - 5.2 Healthcare and Surgery
   - 5.3 Underwater and Aquatic Propulsion
   - 5.4 Bio-inspired Aerial Robots

Literature

Compulsory Reading

Further Reading

- Asaka, K./Okuzaki, H. (eds.) (2019): Soft actuators: materials, modeling, applications, and future perspectives. Springer, Singapore.
- Kim, J. (2017): Microscale Soft Robotics. Springer International Publishing, Cham.
- Siciliano, B./Khatib, O. (eds.) (2016): Springer Handbook of Robotics. Springer International Publishing, Cham.
- Verl, A., et al (eds.) (2015): Soft Robotics: Transferring Theory to Application. Soft Robotics. Springer, Berlin.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

DLBROESR02_E

Introduction to Cognitive Robotics

Module Code: DLBROEICR_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

N.N. (Digital Signal Processing) / N.N. (Fundamentals of NLP and Computer Vision)

Contributing Courses to Module

- Digital Signal Processing (DLBROEICR01_E)
- Fundamentals of NLP and Computer Vision (DLBROEICR02_E)

Module Exam Type	
Module Exam	**Split Exam** Digital Signal Processing • Study Format "Distance Learning": Exam, 90 Minutes (50) Fundamentals of NLP and Computer Vision • Study Format "Distance Learning": Exam, 90 Minutes (50)
Weight of Module see curriculum	

Module Contents
Digital Signal Processing - Signal sampling and quantization - Digital signals and systems - Discrete Fourier Transform - z-Transform - Digital signal processing and filters **Fundamentals of NLP and Computer Vision** - Introduction to Natural Language Processing - Introduction to Computer Vision - Applications to Robotics

Learning Outcomes
Digital Signal Processing On successful completion, students will be able to - analyze discrete time systems. - apply analysis tools such as the Discrete Fourier Transform. - apply the z-Transform. - analyze properties of discrete systems. - design finite and infinite impulse response filters. - implement filters in hardware and software. **Fundamentals of NLP and Computer Vision** On successful completion, students will be able to - name central problems and challenges in natural language processing and computer vision. - understand common methods used in natural language processing and computer vision. - name common use-case scenarios in which NLP and computer vision techniques are applied. - design basic language processing and computer vision solutions for use in robotics.

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

Digital Signal Processing

Course Code: DLBROEICR01_E

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

Course Description

Digital signal processing enables digital audio and video extraction, as well as extraction of important features from any other kind of signal, for instance medial imagery or diagnostic tools. This course provides the students with expertise on the theory and practice of digital signal processing. In the first part, theoretical concepts are introduced, presenting the main tools for analysis of digital, i.e., sampled or discrete-time systems. The core of digital signal processing resides in the design of a digital filter. The second part of the course focuses on different filter-design approaches, i.e. a discussion on finite impulse response and infinite impulse response filters. The last part gives important insights into the hardware and software implementation of digital signal processing, bridging theory with applied practice.

Course Outcomes

On successful completion, students will be able to

- analyze discrete time systems.
- apply analysis tools such as the Discrete Fourier Transform.
- apply the z-Transform.
- analyze properties of discrete systems.
- design finite and infinite impulse response filters.
- implement filters in hardware and software.

Contents

1. Introduction
   - 1.1 Basic Concepts
   - 1.2 Applications

2. Signal Sampling and Quantization
   - 2.1 Sampling
   - 2.2 Signal reconstruction
   - 2.3 Analog-to-digital Conversion
   - 2.4 Digital-to-Analog Conversion
   - 2.5 Quantization

3. Digital Signals and Systems
   - 3.1 Digital Signals
   - 3.2 Difference Equations and Impulse Responses
   - 3.3 BIBO-Stability
   - 3.4 Digital Convolution

4. Discrete Fourier Transform
   - 4.1 Discrete Fourier Transform
   - 4.2 Amplitude and Power Spectrum
   - 4.3 Spectral Estimation

5. The z-Transform
   - 5.1 Definition
   - 5.2 Properties
   - 5.3 Inverse z-Transform
   - 5.4 Solution of Difference Equations

6. Digital Signal Processing Systems and Filters
   - 6.1 Difference Equation and Transfer Function
   - 6.2 Poles, Zeros and Stability
   - 6.3 Digital Filter Frequency Response
   - 6.4 Basic Filtering
   - 6.5 Realization of Digital Filters
   - 6.6 Applications

7. Finite Impulse Response Filter Design
   - 7.1 Basics
   - 7.2 Fourier Transform Design
   - 7.3 Window Method
   - 7.4 Frequency Sampling Design Method
   - 7.5 Optimal Design Method
   - 7.6 Applications

8. Infinite Impulse Response Filter Design
    - 8.1 Basics
    - 8.2 Bilinear Transformation Design Method
    - 8.3 Butterworth and Chebyschev Filter Designs
    - 8.4 Higher-Order Infinite Impulse Response Filter Design
    - 8.5 Pole-Zero Placement for Simple Filters
    - 8.6 Applications

9. Hardware and Software for Digital Signal Processing
    - 9.1 Digital Signal Processor Architecture
    - 9.2 Digital Signal Processor Hardware Units
    - 9.3 Fixed-Point and Floating-Point Formats
    - 9.4 Implementation of FIR and IIR Filters in Fixed-Point
    - 9.5 DSP Programming Examples

Literature

Compulsory Reading

Further Reading

- Manolakis, D. G./Ingle, V. K. (2011): Applied digital signal processing: theory and practice. Cambridge University Press, Cambridge.
- Tan, L./Jiang, J. (2013): Digital signal processing: fundamentals and applications. 2nd ed., Academic Press, Cambridge, MS.
- Vetterli, M./Kovačević, J./Goyal, V. K. (2014): Foundations of signal processing. 2nd ed., Cambridge University Press, Cambridge.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Fundamentals of NLP and Computer Vision

Course Code: DLBROEICR02_E

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

Course Description

Innovative robots, belonging to the so-called generation 3.0, need to sense and understand the environment in many ways, for instance using vision and language understanding and processing. This course introduces the topics of natural language processing (NLP) and computer vision, discussing the main techniques of both fields as well as their application in the field of robotics.

Course Outcomes

On successful completion, students will be able to

- name central problems and challenges in natural language processing and computer vision.
- understand common methods used in natural language processing and computer vision.
- name common use-case scenarios in which NLP and computer vision techniques are applied.
- design basic language processing and computer vision solutions for use in robotics.

Contents

1. Introduction to NLP
    - 1.1 History
    - 1.2 Basics Concepts of NLP
    - 1.3 Feature Extraction Methods
2. Applications of NLP
    - 2.1 Topic Modeling
    - 2.2 Text Summarization and Generation
    - 2.3 Sentiment Analysis
    - 2.4 Translation
    - 2.5 Chatbots

3. Introduction to Computer Vision
   3.1 Light and Color
   3.2 Image Formation
   3.3 Image Processing
   3.4 Image Feature Extraction
   3.5 Stereo Vision

4. Applications of Computer Vision
   4.1 Image Classification, Motion Tracking
   4.2 Semantic Segmentation
   4.3 Object Identification and Tracking
   4.4 Eigenfaces and Facial Recognition

5. NLP and Computer Vision in Robotics
   5.1 Camera Calibration
   5.2 Pose Estimation
   5.3 Visual Servoing
   5.4 Human-Robot Interaction
   5.5 Privacy Issues

Literature

Compulsory Reading

Further Reading

- Bird S., Klein, E./Loper, E. (2009): Natural language processing with Python. 2nd ed., O‘Reilly, Sebastopol, CA.
- Fisher, R. B., et al (2016) : Dictionary of computer vision and image processing. John Wiley & Sons, Chichester.
- Jurafsky, D./Martin, J. H. (2008): Speech and language processing. Prentice Hall, Upper Saddle River, NJ.
- Szelski, R. (2011): Computer vision: Algorithms and applications. 2nd ed., Springer VS, Wiesbaden.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

DLBROEICR02_E

Programming of Robotic Systems

Module Code: DLBROEPRS_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. Emanuele Grasso (Programming with C/C++) / N.N. (Programming PLCs)

Contributing Courses to Module
• Programming with C/C++ (DLBROEPRS01_E) • Programming PLCs (DLBROEPRS02_E)

Module Exam Type	
Module Exam	**Split Exam** <u>Programming with C/C++</u> • Study Format "myStudies": Portfolio • Study Format "Distance Learning": Portfolio <u>Programming PLCs</u> • Study Format "Fernstudium": Oral Assignment
Weight of Module see curriculum	

Module Contents
Programming with C/C++ • C and C++ for programming of applications and robots **Programming PLCs** • Architectures of programmable logic controllers • Ladder and Functional Block Programming • IL, SFC and ST Programming Methods • Elements of PLC programming • Applications of PLC programming
Learning Outcomes
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. **Programming PLCs** On successful completion, students will be able to • understand the architecture of PLC systems. • program PLC devices. • apply PLC programming methods for control of simple processes.

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 Programmes in the IT & Technology fields

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	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Programming PLCs

Course Code: DLBROEPRS02_E

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

Course Description

Programmable logic controllers (PLCs) are used extensively for industrial automation in modern factories and smart houses, either as compact controllers, modular controllers or distributed controllers. PLC algorithms are developed using specific programming languages created for the particular PLC. This course introduces the purpose, architecture, and programming methods of modern PLC systems for use in industrial automation and robotics.

Course Outcomes

On successful completion, students will be able to

- understand the architecture of PLC systems.
- program PLC devices.
- apply PLC programming methods for control of simple processes.

Contents

1. Introduction
   - 1.1 Programmable Logic Controllers
   - 1.2 Hardware
   - 1.3 PLC Architecture
   - 1.4 PLC Systems
   - 1.5 Trends
2. Digital Systems
   - 2.1 The Binary, Octal and Hexadecimal Systems
   - 2.2 Binary Arithmetic
   - 2.3 PLC Data Types
   - 2.4 Combinational and Sequential Logic

3. I/O Processing
   - 3.1 Input/Output Units
   - 3.2 Signal Conditioning
   - 3.3 Remote Connections
   - 3.4 Networks
   - 3.5 I/O addresses

4. Ladder and Functional Block Programming
   - 4.1 Ladder Diagrams
   - 4.2 Logic Functions
   - 4.3 Latching
   - 4.4 Multiple Outputs
   - 4.5 Entering Programs
   - 4.6 Function Blocks
   - 4.7 Examples

5. IL, SFC and ST Programming Methods
   - 5.1 Instruction List
   - 5.2 Sequential Function Charts
   - 5.3 Structured Text
   - 5.4 Examples

6. Elements of PLC Programming
   - 6.1 Internal Relays
   - 6.2 Jump and Call
   - 6.3 Timers
   - 6.4 Counters
   - 6.5 Shift Registers
   - 6.6 Data Handling

7. Applications
   - 7.1 PLC and Safety
   - 7.2 Testing Software and Fault Finding
   - 7.3 Examples of Process Control

Literature
Compulsory Reading
Further Reading • Barkalov, A./Titarenko, L./Mazurkiewicz, M. (2019): Foundations of Embedded Systems. Springer International Publishing, Cham. • Bolton, W. (2015): Programmable logic controllers. 6th ed., Newnes/Elsevier, Amsterdam. • Petruzella, F. D. (2016): Programmable logic controllers. 5th ed., McGraw-Hill Education, New York City, NY.

Study Format Fernstudium

Study Format	Course Type
Fernstudium	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

DLBROEPRS02_E

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

N.N. (Self-Driving Vehicles) / N.N. (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
	<u>Self-Driving Vehicles</u> • Study Format "Distance Learning": Exam, 90 Minutes <u>Seminar: Current Topics and Trends in Self-Driving Technology</u> • Study Format "Distance Learning": 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 calibaration
   - 1.4 Application scenarios

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

3. Computer Vision
   - 3.1 Pixels and filters
   - 3.2 Feature detection
   - 3.3 Distortions and calibration
   - 3.4 Semantic segmentation

4. Localization & Motion
   - 4.1 Motion models
   - 4.2 Odometry
   - 4.3 Triangulation
   - 4.4 Satellite-based localization

5. Motion planning
   - 5.1 Path planning
   - 5.2 Motion prediction
   - 5.3 Trajectory generation

6. Safety Standards
   - 6.1 Functional Safety
   - 6.2 IT Security Standards
   - 6.3 Safety development approaches

Literature
Compulsory Reading

Further Reading

- Ben-Ari, M./Mondada, F. (2018): Elements of robotics. Springer, Cham.
- European Union. (2001).:Directive 2001/95/EG. (URL: https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A32001L0095 [Retrieved: 28.02.2020])
- Fisher, R. B., et al. (2016): Dictionary of computer vision and image processing. John Wiley & Sons, Chichester.
- International Electrotechnical Commission. (2015): IEC 61508. (URL: https://www.iec.ch/functionalsafety/ [Retrieved: 28.02.2020])
- International Organization for Standardization. (2009): ISO 15408. (URL: https://www.iso.org/standard/50341.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 25119. (URL: https://www.iso.org/standard/69026.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 26262. (URL: https://www.iso.org/standard/68383.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (n.d.): ISO 21434. (URL: https://www.iso.org/standard/70918.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO/IEC 27001. (URL: https://www.iso.org/isoiec-27001-information-security.html [Retrieved: 28.02.2020])
- Rausand, M. (2014): Reliability of safety-critical systems: Theory and applications. Wiley, Hoboken, NJ.
- 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. (URL: https://www.sae.org/standards/content/j3061/ [Retrieved: 28.02.2020])
- Szelski, R. (2011): 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	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ 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. (URL: https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A32001L0095 [Retrieved: 28.02.2020])
- Fisher, R. B., et al. (2016): Dictionary of computer vision and image processing. John Wiley & Sons, Chichester.
- International Electrotechnical Commission. (2015): IEC 61508. (URL: https://www.iec.ch/functionalsafety/ [Retrieved: 28.02.2020])
- International Organization for Standardization. (2009): ISO 15408. (URL: https://www.iso.org/standard/50341.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 25119. (URL: https://www.iso.org/standard/69026.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO 26262. (URL: https://www.iso.org/standard/68383.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (n.d.): ISO 21434. (URL: https://www.iso.org/standard/70918.html [Retrieved: 28.02.2020])
- International Organization for Standardization. (2018): ISO/IEC 27001. (URL: https://www.iso.org/isoiec-27001-information-security.html [Retrieved: 28.02.2020])
- Marchthaler, R./Dingler, S. (2017): Kalman-Filter. Springer, Wiesbaden.
- Rausand, M. (2014): Reliability of safety-critical systems: Theory and applications. Wiley, Hoboken, NJ.
- 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. (URL: https://www.sae.org/standards/content/j3061/ [Retrieved: 28.02.2020])
- Szelski, R. (2011): 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	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Applied Sales

Module Code: DLBDSEAS

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. Patrick Geus (Applied Sales I) / Prof. Dr. Patrick Geus (Applied Sales II)

Contributing Courses to Module

- Applied Sales I (DLBDSEAS01)
- Applied Sales II (DLBDSEAS02)

Module Exam Type	
Module Exam	**Split Exam** <u>Applied Sales I</u> • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes <u>Applied Sales II</u> • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents

Applied Sales I

- Fundamentals of Applied Sales
- The Distribution System
- Personal Sales
- Sales Plans
- New Customer Acquisition
- A Sales Visit
- Conversational Tactics
- Conducting Negotiations
- Other Sales Channels

Applied Sales II

- Marketing and Sales
- Customer Satisfaction as a Success Factor
- Personalities in Sales
- Customer-Oriented Communication
- Presentation and Rhetoric
- Customer Loyalty
- Networking
- Case Study

Learning Outcomes

Applied Sales I

On successful completion, students will be able to

- understand the fundamentals of applied sales and place them in the context of the company.
- understand the interaction of the individual facets of applied sales.
- differentiate between and evaluate individual sales systems.
- describe current sales types and sales characteristics.
- oversee and classify the entire sales process from customer acquisition to customer retention.
- understand the basics of sales and negotiation management and apply them.
- name the usual sales instruments, recognize their advantages and disadvantages, and reflect on essential fields of application and possibilities.

Applied Sales II

On successful completion, students will be able to

- understand the interaction and the respective areas of responsibility of marketing and sales.
- reflect on and classify the goals and measures within the framework of the applied sales system.
- assess the relevance of customer satisfaction and retention. In addition, the students will be familiar with the central design elements of CRM.
- reflect on and assess alternative approaches to customer loyalty and relationship management and apply them in business practice.
- understand the meaning of the terms customer life cycle and customer value, and develop approaches to manage them in the sense of the respective sales targets.
- use descriptive presentation techniques in order to convince customers and other sales partners.
- understand the relevance of networking and develop strategies to broaden the contact base.
- develop and evaluate their own market analyses and sales concepts on the basis of practical experience within the framework of the case study.

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 Marketing & Sales	All Bachelor Programmes in the Marketing & Communication fields

Applied Sales I

Course Code: DLBDSEAS01

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

Course Description

The demands on sales thinking are growing every day. Globalized demand combined with high competition is making it increasingly difficult for companies to compete for customers. At the same time, customers are becoming better informed, while traditional supply markets are saturated and at overcapacity. In order to be successful in such an environment, sales thinking and action are required along with a new type of salesperson. Within the course Applied Sales I (Introduction), the participants are familiarized with the basic concepts of applied sales. You will learn about sales organization, dealing with alternative sales channels, and get to know the dedicated sales planning process. The contents of the module are complemented by the successful acquisition of new customers, whereby particular attention is paid to the organization and implementation of customer visits and the conduct of discussions and negotiations.

Course Outcomes

On successful completion, students will be able to

- understand the fundamentals of applied sales and place them in the context of the company.
- understand the interaction of the individual facets of applied sales.
- differentiate between and evaluate individual sales systems.
- describe current sales types and sales characteristics.
- oversee and classify the entire sales process from customer acquisition to customer retention.
- understand the basics of sales and negotiation management and apply them.
- name the usual sales instruments, recognize their advantages and disadvantages, and reflect on essential fields of application and possibilities.

Contents

1. Fundamentals of Applied Sales and Distribution
   - 1.1 Tasks and Forms of Applied Distribution
   - 1.2 Marketing as the Basis of Sales
   - 1.3 Distribution, Sales, and Other Terms
   - 1.4 Sales in Different Economic Sectors

8. Conducting Negotiations
   - 8.1 Psychology of Negotiation
   - 8.2 Negotiation Structure
   - 8.3 Objection Handling
   - 8.4 Price Negotiations

9. Other Sales Channels
   - 9.1 Telemarketing
   - 9.2 Catalogue and Brochure Sales
   - 9.3 Internet and E-Commerce

Literature

Compulsory Reading

Further Reading

- Bloomfield, J. (2020). NeuroSelling: Mastering the customer conversation using the surprising science of decision making. Axon Publishing.
- Jobber, D., Lancaster, G., & Le Meunier-FitzHugh, K. (2019). Selling and sales management (10th ed.). Pearson.
- Peppers, D., & Rogers, M. (2016). Managing customer experience and relationships: A strategic framework (3rd ed.). Wiley.
- Pink, D. H. (2012). To sell is human: The surprising truth about moving others. Riverhead Books.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Applied Sales II

Course Code: DLBDSEAS02

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

Course Description

The course Applied Sales II builds on the basics taught in the course "Applied Sales I" and broadens and deepens them. First, the tension between marketing and sales is examined in more detail. Based on this, essential backgrounds and central target figures for successful sales management (e.g., customer satisfaction and loyalty as well as the customer life cycle) are derived and operationalized in order to create the basis for efficient and effective customer relationship management. As the process progresses, attention will also be paid to mental processes and consumer behavior in general. In addition, strategies and paths to successful negotiation are deepened and supplemented by convincing communication techniques. The course concludes with a case study in the course of which the students have the opportunity to apply what they have learned in a practice-oriented manner.

Course Outcomes

On successful completion, students will be able to

- understand the interaction and the respective areas of responsibility of marketing and sales.
- reflect on and classify the goals and measures within the framework of the applied sales system.
- assess the relevance of customer satisfaction and retention. In addition, the students will be familiar with the central design elements of CRM.
- reflect on and assess alternative approaches to customer loyalty and relationship management and apply them in business practice.
- understand the meaning of the terms customer life cycle and customer value, and develop approaches to manage them in the sense of the respective sales targets.
- use descriptive presentation techniques in order to convince customers and other sales partners.
- understand the relevance of networking and develop strategies to broaden the contact base.
- develop and evaluate their own market analyses and sales concepts on the basis of practical experience within the framework of the case study.

Contents

Literature

Compulsory Reading

Further Reading

- Jobber, D./Lancaster, G./Le Meunier-Fitzhugh, K. (2019): Selling and Sales Management, 11th Ed.; Pearson
- Johnston, M.W./Marshall (2021): Sales Force Management: Leadership, Innovation, Technology; Routledge
- Jordan, J./Vazzana, M. (2011): Cracking the Sales Management Code: The Secrets to Measuring and Managing Sales Performance; 13th Ed.; McGraw Hill
- Kumar, V./Reinartz, W. (2018): Customer Relationship Management: Concept, Strategy, and Tools; 3rd Ed.; Springer Texts in Business and Economics
- Marcos, J./Davies, M. (2019): Implementing Key Account Management: Designing Customer-Centric Processes for Mutual Growth; KoganPage
- Peppers, D./Rogers, M. (2011): Managing Customer Relationships : A Strategic Framework; 2nd Ed.; Wiley

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Applied Robotics

Module Code: DLBWINWAR_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

N.N. (Embedded Systems) / N.N. (Project: Applied Robotics with Robotic Platforms)

Contributing Courses to Module

- Embedded Systems (DLBROES01_E)
- Project: Applied Robotics with Robotic Platforms (DLBROPARRP01_E)

Module Exam Type	
Module Exam	**Split Exam** Embedded Systems • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Project: Applied Robotics with Robotic Platforms • Study Format "myStudies": Oral Project Report • Study Format "Distance Learning": Oral Project Report

Weight of Module

see curriculum

Module Contents

Embedded Systems

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

Project: Applied Robotics with Robotic Platforms

This module provides students with the basic competence to use existing robotic software and hardware platforms to design, create and implement 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.

Project: Applied Robotics with Robotic Platforms

On successful completion, students will be able to

- name several existing open-source robotic platforms.
- understand the basic principles of robotic platforms.
- work with existing robotic platforms.
- carry out a robotic project by means of robotic platforms.

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

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

Literature

Compulsory Reading

Further Reading

- Barkalov, A./Titarenko, L./Mazurkiewicz, M. (2019): Foundations of Embedded Systems. In: Kacprzyk, J.: Studies in Systems, Decision and Control, Volume 195, Springer Nature, Chams.
- Lacamera, D. (2018): Embedded systems architecture: explore architectural concepts, pragmatic design patterns, and best practices to produce robust systems. Packt Publishing, Birmingham.
- Noergaard, T. (2013): Embedded Systems Architecture. Elsevier Inc, Amsterdam.
- Siegesmund, M. (2014): Embedded C Programming. Elsevier Inc, Amsterdam.
- Simon, D. E. (1999): An embedded software primer. Addison Wesley, Boston, MS.
- White, E. (2011): Making Embedded Systems. O'Reilly, Sebastopol, CL.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Project: Applied Robotics with Robotic Platforms

Course Code: DLBROPARRP01_E

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

Course Description

In the last years several robotic software and hardware platforms have been developed. The existing diverse robotic systems provide an affordable and reliable basis to build next generation robots. Some of those systems are open source and constantly developed by the community of roboticists. Of course, such systems require a minimal understanding of robotics as well as of other robotics-related issues which are important in today's technical community, such as internet of things and communication interfaces. This course provides the basics to work with such robotic platforms for development, design and implementation of industrial and mobile robots.

Course Outcomes

On successful completion, students will be able to

- name several existing open-source robotic platforms.
- understand the basic principles of robotic platforms.
- work with existing robotic platforms.
- carry out a robotic project by means of robotic platforms.

Contents

- This course illustrates robotic platforms and their usage within robotics projects.

Literature

Compulsory Reading

Further Reading

- Cacace, J./Joseph, L. (2018): Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System. 2nd ed., Packt Publishing, Birmingham.
- Koubaa, A. (ed.) (2018): Robot operating system (ROS): the complete reference. Volume 1. Springer, Cham.
- Quigley, M./Gerkey, B./Smart, W. D. (2015): Programming robots with ROS. O'Reilly, Sebastopol, CL.

Study Format myStudies

Study Format	Course Type
myStudies	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format Distance Learning	Course Type Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

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

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☐ Live Tutorium/Course Feed ☐ Reader ☑ Slides

DLBROPARRP01_E

Control Engineering

Module Code: DLBWINWRT_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

N.N. (Signals and Systems) / N.N. (Control Systems Engineering)

Contributing Courses to Module

- Signals and Systems (DLBROSS01_E)
- Control Systems Engineering (DLBROCSE01_E)

Module Exam Type	
Module Exam	**Split Exam** Signals and Systems • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Control Systems Engineering • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents

Signals and Systems

- 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

Control Systems Engineering

- 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

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.

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

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

- Alkin, O. (2014): Signals and systems: a MATLAB integrated approach. CRC Press, Boca Raton, FL.
- Lathi, B. P. (2009): Principles of Linear Systems and Signals. 2nd ed., Oxford University Press, New Delhi.
- Rao, K. D. (2018): Signals and Systems. Springer International Publishing, Cham.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

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

- Nise, N. S. (2019): Control systems engineering. 8th ed., John Wiley & Sons, Hoboken, NJ.
- Doyle, J. C./Francis, B. A./Tannenbaum, A. R. (2009): Feedback Control Theory. Dover Publications Inc, Mineola, NY.
- Franklin, G. F./Powell, J. D./Emami-Naeini, A. (2019): Feedback control of dynamic systems. 8th ed., Pearson, London.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

DLBROCSE01_E

Object-oriented Programing

Module Code: IOBP_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. Damir Ismailovic (Object-oriented Programming with Java) / Prof. Dr. Damir Ismailovic (Data Structures and Java Class Library)

Contributing Courses to Module
• Object-oriented Programming with Java (DLBCSOOPJ01) • Data Structures and Java Class Library (DLBCSDSJCL01)

Module Exam Type	
Module Exam	**Split Exam** <u>Object-oriented Programming with Java</u> • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes <u>Data Structures and Java Class Library</u> • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes
Weight of Module see curriculum	

Module Contents

Object-oriented Programming with Java

- Introduction to the Java language
- Java language constructs
- Introduction to object-oriented system developement
- Inheritance
- Object-oriented concepts
- Exception handling
- Interfaces

Data Structures and Java Class Library

- Programming style
- Working with objects
- External packages and libraries
- Data structures
- Strings and calendar
- File system and data streams

Learning Outcomes

Object-oriented Programming with Java

On successful completion, students will be able to

- describe the basic concepts of object-oriented modeling and programming, distinguishing them from one another.
- describe the basic concepts and elements of the Java programming language and have some experience in their use.
- independently create Java programs to solve concrete problems.

Data Structures and Java Class Library

On successful completion, students will be able to

- understand typical data structures and distinguish them from each other.
- independently create solutions in the Java programming language using the data structures.
- understand scenarios and strategies for comparing objects and implement them in Java.
- describe the possible uses and functions of character strings and calendar objects in Java and have experience using them.
- describe the possible uses and functions of streams in Java and have experience using them.

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 Programmes in the IT & Technology fields

Object-oriented Programming with Java

Course Code: DLBCSOOPJ01

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

Course Description

Operational information systems are usually planned and programmed to be object-oriented. Therefore, this course teaches the basic skills of object-oriented programming. Theoretical concepts are presented and practiced directly with the programming language Java.

Course Outcomes

On successful completion, students will be able to

- describe the basic concepts of object-oriented modeling and programming, distinguishing them from one another.
- describe the basic concepts and elements of the Java programming language and have some experience in their use.
- independently create Java programs to solve concrete problems.

Contents

1. Introduction to Object-Oriented System Development
   - 1.1 Object Orientation as a Way of Looking at Complex Systems
   - 1.2 The Object as a Basic Concept of Object Orientation
   - 1.3 Phases in the Object-Oriented Development Process
   - 1.4 Basic Principle of Object-Oriented System Development

2. Introduction to Object-Oriented Modeling
   - 2.1 Structuring Problems With Classes
   - 2.2 Identifying Classes
   - 2.3 Attributes as Properties of Classes
   - 2.4 Methods as Functions of Classes
   - 2.5 Associations between Classes
   - 2.6 Unified Modeling Language (UML)

3. Programming Classes in Java
   - 3.1 Introduction to the Java Programming Language
   - 3.2 Basic Elements of a Class in Java
   - 3.3 Attributes in Java
   - 3.4 Methods in Java
   - 3.5 Main Method: Starting Point of a Java Program

4. Java Language Constructs
   - 4.1 Primitive Data Types
   - 4.2 Variables
   - 4.3 Operators and Expressions
   - 4.4 Control Structures
   - 4.5 Packages and Visibility Modifiers .

5. Inheritance
   - 5.1 Modeling and Inheritance in the Class Diagram
   - 5.2 Programming Inheritance in Java

6. Important Object-Oriented Concepts
   - 6.1 Abstract Classes
   - 6.2 Polymorphism
   - 6.3 Static Attributes and Methods

7. Constructors for Generating Objects
   - 7.1 The Standard Constructor
   - 7.2 Overloading Constructors
   - 7.3 Constructors and Inheritance

8. Handling Exceptions with Exceptions
   - 8.1 Typical Scenarios of Exception Handling
   - 8.2 Standard Exceptions in Java
   - 8.3 Defining Your Own Exceptions

9. Programming Interfaces with Interfaces
   - 9.1 Typical Scenarios of Programming Interfaces
   - 9.2 Interfaces as Programming Interfaces in Java

Literature
Compulsory Reading
Further Reading

- Freeman, E., Robson, E., Bates, B., & Sierra, K. (2014). Head first design patterns (A brain friendly guide). O'Reilly Media.
- Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1995). Design patterns: Elements of re-usable object-oriented software. Addison-Wesley.
- Liang, Y. D. (2018). Introduction to Java programming and data structures. Pearson Education.
- Liguiori, L. & Liguori, P. (2008). Java pocket guide: Instant help for Java. O'Reilly Media.
- Oracle (2017). The Java tutorials. Available online.
- Samoylov, N. (2019). Learn Java 12 programming: A step-by-step guide to learning essential concepts in Java SE 10, 11, and 12. Packt Publishing.
- Weisfeld M. (2019). The object-oriented thought process (5th ed.). Addison-Wesley.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Data Structures and Java Class Library

Course Code: DLBCSDSJCL01

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

Course Description

Based on the contents of the course "Basics of object-oriented programming with Java", this course deepens the knowledge of object-oriented programming. In particular, data structures, their use cases, and their implementation in the Java language are considered. In addition, strategies and scenarios of object comparisons, the use of functions of the "String" data type, the use of calendar objects, and the use of streams are taught.

Course Outcomes

On successful completion, students will be able to

- understand typical data structures and distinguish them from each other.
- independently create solutions in the Java programming language using the data structures.
- understand scenarios and strategies for comparing objects and implement them in Java.
- describe the possible uses and functions of character strings and calendar objects in Java and have experience using them.
- describe the possible uses and functions of streams in Java and have experience using them.

Contents

1. Programming Style
   - 1.1 Code Documentation
   - 1.2 Code Annotations
   - 1.3 Code Conventions

2. Working with Objects
   - 2.1 String Representation of Objects
   - 2.2 Compare with ==
   - 2.3 Compare with Equals()
   - 2.4 Compare by HashCode()
   - 2.5 CompareTo()
   - 2.6 Cloning Objects

3. External Packages and Libraries
   - 3.1 Importing Packages
   - 3.2 The Java Class Library

4. Data Structures
   - 4.1 Arrays
   - 4.2 Collections
   - 4.3 Working with Collections
   - 4.4 Lists
   - 4.5 Quantities (Sets)
   - 4.6 Associative Memory (Maps)
   - 4.7 Stacks (Basement)
   - 4.8 Queues (Snakes)

5. Strings and Calendar
   - 5.1 Strings
   - 5.2 StringBuffer
   - 5.3 Splitting Character Strings
   - 5.4 Date and time
   - 5.5 Calendar

6. File System and Data Streams
   - 6.1 Working with the File System
   - 6.2 Working with Files

Literature

Compulsory Reading

Further Reading

- Bloch, J. (2017). Effective Java (3rd ed.). Addison-Wesley.
- Oracle. (2018a). Java platform standard edition 10 API specification. (Available online).
- Oracle. (2018b). String (Java platform SE 10). (Available online).
- Oracle. (2018c). Date (Java platform SE 10). (Available online).
- Oracle. (2018d). java.io (Java platform SE 10). (Available online).
- Oracle. (2019). The Java language specification: Java SE 11 edition. (Available online).
- Seidl, M. (2015). UML@Classroom: An introduction to object-oriented modeling. Springer.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☑ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Internship

Module Code: OPTINTER1

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	On campus offer only		10	300 h

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

Module Coordinator

see MyCampus (Internship)

Contributing Courses to Module

- Internship (OPTINTER110)

Module Exam Type	
Module Exam Study Format: On Campus Reflection (of Practical Work) / Group Reflection	**Split Exam**
Weight of Module see curriculum	

Module Contents

Internship according to the “Internship Regulations” of the IU.

Learning Outcomes	
Internship On successful completion, students will be able to • apply skills and knowledge they have obtained during the first three semesters of the programme in an entrepreneurial environment. • develop his / her practical and analytical skills in order to improve his / her employability. • have practical knowledge and learn to work within an organization. • acquire a first deep insight into organisational structures and communication procedures. • apply comminication skills, socials skills, problem solving, time and project management which will shape their general management skills. • shape their personality with the help of the interdisciplinary nature of the course especially in the area of the key qualifications like interpersonal skills or intercultural skills.	
Links to other Modules within the Study Program Builds on modules of the chosen degree program	**Links to other Study Programs of the University** All on campus offered programs

Internship

Course Code: OPTINTER110

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
	English		10	On campus offer only

Course Description

This module consists of three parts:preparation tutorials. During these tutorials, students will learn about the intention of the internship and about the intellectual as well as social requirements of the working environment.the internship itself, andWorkshops that accompany the internship by presentations and give an insight into different companies and working environments by the students.

Course Outcomes

On successful completion, students will be able to

- apply skills and knowledge they have obtained during the first three semesters of the programme in an entrepreneurial environment.
- develop his / her practical and analytical skills in order to improve his / her employability.
- have practical knowledge and learn to work within an organization.
- acquire a first deep insight into organisational structures and communication procedures.
- apply comminication skills, socials skills, problem solving, time and project management which will shape their general management skills.
- shape their personality with the help of the interdisciplinary nature of the course especially in the area of the key qualifications like interpersonal skills or intercultural skills.

Contents

- Internship according to the “Internship Regulation” of the IU.

Literature

Compulsory Reading

- Sweitzer, F. H. & King, M. A. (2009). The Successful Internship: Personal, Professional, and Civic Development. 3rd ed.. Cengage. ISBN: 0-495-59642-6.
- Kaser, K., Brooks, J. R. & Brooks, K. (2007). Making the Most of your Internship. Thomson. ISBN: 0-538-44432-0.
- Myers Kiser, P. (2008). The Human Services Internship: Getting the Most from your Experience. 2nd ed.. Cengage. ISBN: 0-495-09226-6.

Further Reading

Study Format On Campus

Study Format	Course Type
On Campus	Practical work

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Reflection (of Practical Work) / Group Reflection

Student Workload					
Self Study	**Contact Hours**	**Tutorial**	**Self Test**	**Independent Study**	**Hours Total**
13 h	0 h	7 h	0 h	280 h	300 h

Instructional Methods
In order to prepare students for their internship, a preparatory lecturing seminar will be held. During their internship, students will report about their progress by writing reports (start up report or mid-term report).

Studium Generale

Module Code: DLBSG_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

N.N. (Studium Generale I) / N.N. (Studium Generale II)

Contributing Courses to Module

- Studium Generale I (DLBSG01_E)
- Studium Generale II (DLBSG02_E)

Module Exam Type	
Module Exam	**Split Exam** Studium Generale I • Study Format "Distance Learning": See Selected Course Studium Generale II • Study Format "Distance Learning": See Selected Course
Weight of Module see curriculum	

Module Contents

Studium Generale I

In principle, all IU bachelor courses can be selected as courses for the "Studium Generale", so that the content can be chosen from the entire breadth of the IU distance learning program.

Studium Generale II

In principle, all IU bachelor courses can be selected as courses for the "Studium Generale", so that the content can be chosen from the entire breadth of the IU distance learning program.

Learning Outcomes

Studium Generale I

On successful completion, students will be able to

- apply acquired key competencies to issues in their field of study and/or in their professional environment.
- to deepen one's own skills and abilities in a self-directed manner.
- to look beyond the boundaries of their own area of expertise.

Studium Generale II

On successful completion, students will be able to

- apply acquired key competencies to issues in their field of study and/or in their professional environment.
- to deepen one's own skills and abilities in a self-directed manner.
- to look beyond the boundaries of their own area of expertise.

Links to other Modules within the Study Program	Links to other Study Programs of the University
It is a stand-alone offering with possible references to various required and elective modules	All IU Distance Learning Bachelor Programs

Studium Generale I

Course Code: DLBSG01_E

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

Course Description
In the course "Studium Generale I", students deepen their knowledge in a self-selected subject area by completing an IU course outside their applicable curriculum. This gives them the opportunity to look beyond their own subject area and acquire further competencies. The associated option enables students to self-determine their study content to focus even more on issues relevant to them and/or to strengthen or develop selected competencies.

Course Outcomes

On successful completion, students will be able to

- apply acquired key competencies to issues in their field of study and/or in their professional environment.
- to deepen one's own skills and abilities in a self-directed manner.
- to look beyond the boundaries of their own area of expertise.

Contents

- The course "Studium Generale I" offers students the opportunity to take courses outside of their curriculum and the result can be credited as an elective subject. In principle, all IU bachelor courses that fulfill the following requirements can be chosen for this purpose:
  - They are not part of an integral part of the applicable mandatory curriculum.
  - They do not have admission requirements or students can prove that they have met the admission requirement.
- The examination of the selected courses must be taken in full and finally passed in order to be credited as part of the 'Studium Generale' .

Literature

Compulsory Reading

Further Reading

- See course description of the selected course

Study Format Distance Learning

Study Format Distance Learning	**Course Type** See Selected Course

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	See Selected Course

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

Instructional Methods
See Selected Course

Studium Generale II

Course Code: DLBSG02_E

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

Course Description

In the course "Studium Generale II", students deepen their knowledge in a self-selected subject area by completing an IU course outside their applicable curriculum. This gives them the opportunity to look beyond their own subject area and acquire further competencies. The associated option enables students to self-determine their study content to focus even more on issues relevant to them and/or to strengthen or develop selected competencies.

Course Outcomes

On successful completion, students will be able to

- apply acquired key competencies to issues in their field of study and/or in their professional environment.
- to deepen one's own skills and abilities in a self-directed manner.
- to look beyond the boundaries of their own area of expertise.

Contents

- The course "Studium Generale II" offers students the opportunity to take courses outside of their curriculum and the result can be credited as an elective subject. In principle, all IU bachelor courses that fulfill the following requirements can be chosen for this purpose:
  - They are not part of an integral part of the applicable mandatory curriculum.
  - They do not have admission requirements or students can prove that they have met the admission requirement.
- The examination of the selected courses must be taken in full and finally passed in order to be credited as part of the 'Studium Generale' .

Literature

Compulsory Reading

Further Reading

- See course description of the selected course

Study Format Distance Learning

Study Format	Course Type
Distance Learning	See Selected Course

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	See Selected Course

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

Instructional Methods
See Selected Course

Digital Business Models

Module Code: DLBLODB_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. Mario Boßlau (Digital Business Models)

Contributing Courses to Module

- Digital Business Models (DLBLODB01_E)

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

- Meaning, origin and definition of the term "digital business model"
- Basic concepts for the description of business models
- Tools for the description of business models
- Patterns of digital business models
- Digital business models and business plans

Learning Outcomes	
Digital Business Models On successful completion, students will be able to - understand what a business model is and how to describe it systematically. - outline the basic features of the historical development of business models. - describe key digital business models and evaluate their advantages and disadvantages. - establish the relationship between a business model and a business plan to independently derive and analyse the positioning of a company.	
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 Business Administration and Management fields	All Bachelor Programmes in the Business & Management fields

Digital Business Models

Course Code: DLBLODB01_E

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

Course Description

A business model contains the depiction of the logic of how a company generates, delivers and secures value. The progressing digitalization of many processes, products and services has made possible a large number of innovations in the area of business models in recent years. The subject of this course rounds up the presentation, the underlying patterns and the main factors that influence these digital business models.Starting from a general definition of the concept of a business model, a system is developed to describe the essential factors of a business model. An overview of the historical development of important business models and in particular the influence of digitization on newer business models allows a classification of the concept and an understanding of the framework.Then the most important alternative digital business models of recent years are systematically presented, analyzed and evaluated with regard to their respective strengths and weaknesses.Finally, the role of business models in the creation process of a business plan is described. Students learn the central approaches to developing an independent corporate positioning and are enabled to examine and evaluate the central factors influencing corporate success in digital business.

Course Outcomes

On successful completion, students will be able to

- understand what a business model is and how to describe it systematically.
- outline the basic features of the historical development of business models.
- describe key digital business models and evaluate their advantages and disadvantages.
- establish the relationship between a business model and a business plan to independently derive and analyse the positioning of a company.

Contents

1. Meaning, Origin and Definition of the Term "Digital Business Model
   - 1.1 Goals and Functions of Digital Business Models
   - 1.2 Business Model - Origin of the Term and its Meaning in the Digital Economy
   - 1.3 Definition of the terms Business Model and Digital Business Model
   - 1.4 Differentiation from Other Terminologies of the Digital Economy

2. Basic Concepts for the Description of Business Models
   - 2.1 Value Chain by Porter
   - 2.2 Value-added Chain
   - 2.3 Dominant Logic
   - 2.4 Revenue Model
   - 2.5 Unique Selling Proposition
   - 2.6 Transaction
   - 2.7 Product or Service Range

3. Tools for the Description of Business Models
   - 3.1 Business Model Canvas
   - 3.2 St. Gallen Business Model Navigator
   - 3.3 MIT Framework

4. Patterns of Digital Business Models
   - 4.1 Long Tail
   - 4.2 Multi-Sided Pattern
   - 4.3 Free and Freemium
   - 4.4 OPEN API Pattern

5. Digital Business Models and Business Plans
   - 5.1 Integration of the Business Model into the Business Plan
   - 5.2 Company Positioning and the Digital Business Model
   - 5.3 Digital Business Models as Innovation Drivers for the Development of New Businesses

Literature

Compulsory Reading

Further Reading

- Brynjolfsson, E./Hu, Yu J./Smith, M. D. (2006): From Niches to Riches. Anatomy of the Long Tail. In: MIT Sloan Management Review, volume 47, Magazine 4, p. 67–71.
- Osterwalder, A./Pigneur, Y. (2010): Business Modell Generation. Wiley, Hoboken (NJ).

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☑ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Principles of Management

Module Code: DLBBAPM_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. Markus Prandini (Principles of Management)

Contributing Courses to Module

- Principles of Management (DLBBAPM01_E)

Module Exam Type

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

Weight of Module

see curriculum

Module Contents

- Management Functions
- Managerial Decision-Making
- Planning and Goal-Setting
- Strategic Planning
- Organizing
- Leading
- Controlling

Learning Outcomes	
Principles of Management On successful completion, students will be able to - understand the functions, roles and influencing-factors of management. - explain the decision-making process. - discuss basic corporate und competitive strategies. - analyze organizational structures and designs. - transfer knowledge about basic principles of management to real-world cases.	
Links to other Modules within the Study Program This module is similar to other modules in the fields of Business Administration & Management	**Links to other Study Programs of the University** All Bachelor Programmes in the Business & Management fields

Principles of Management

Course Code: DLBBAPM01_E

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

Course Description

In the fast-changing and complex environment of today's business world the economic survival and success of an organization depends highly on its management. For future managers it is indispensable to be familiar with the fundamental principles of management as the basis for the development of further managerial knowledge and skills. This course introduces necessary functions, roles and skills for managers and their decision-making process. Furthermore, it discusses the basic managerial functions of planning, organizing, leading and controlling in detail.

Course Outcomes

On successful completion, students will be able to

- understand the functions, roles and influencing-factors of management.
- explain the decision-making process.
- discuss basic corporate und competitive strategies.
- analyze organizational structures and designs.
- transfer knowledge about basic principles of management to real-world cases.

Contents

1. Introduction to Management
   - 1.1 Functions, Roles and Skills of Managers
   - 1.2 Influencing Factors on Managers' Tasks
   - 1.3 History of Management

2. Managerial Decision-Making
   - 2.1 Decision-Making Process
   - 2.2 Approaches to Decision Making
   - 2.3 Types of Decisions and Decision-Making Conditions

3. Planning and Goal-Setting
   - 3.1 The Role of Planning
   - 3.2 Goals and Plans
   - 3.3 Setting Goals and Developing Plans

4. Strategic Planning
    4.1 Strategic Management
    4.2 The Strategic Management Process
    4.3 Corporate Strategies
    4.4 Competitive Strategies

5. Organizing
    5.1 Organizational Structures and Design
    5.2 Organizational Change
    5.3 Managing Change

6. Leading
    6.1 Interpersonal and Organizational Communication
    6.2 Organizational Behavior
    6.3 Leadership

7. Controlling
    7.1 The Control Process
    7.2 Tools for Measuring Organizational Performance

Literature

Compulsory Reading

Further Reading

- Bright, D. S., Cortes, A. H., Hartmann, E., Parboteeah, K. P., Pierce, J. L., Reece, M., Shah, A., Terjesen, S., Weiss, J., White, M. A., Gardner, D. G., Lambert, J., Leduc, L. M., Leopold, J., Muldoon, J., & O´Rourke, J. S. (2019). Principles of management. OpenStax.
- Robbins, S. P., & Coulter, M. (2018). Management (global ed., 14th ed.). Pearson.

Study Format myStudies

Study Format myStudies	Course Type Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

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

Instructional Methods	
☐ Learning Sprints® ☑ Course Book ☐ Vodcast ☑ Shortcast ☑ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☑ Guideline ☑ Live Tutorium/Course Feed ☐ Reader ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

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

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
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☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

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** <u>Bachelor Thesis</u> • Study Format "myStudies": Written Assessment: Bachelor Thesis • Study Format "Distance Learning": Written Assessment: Bachelor Thesis <u>Colloquium</u> • Study Format "myStudies": Presentation: Colloquium • Study Format "Distance Learning": Presentation: 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 - Turabian, K. L. (2013). A Manual for Writers of Research Papers, theses, and dissertations (8th ed.). University of Chicago Press. - 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. - Selection of literature according to topic

Study Format myStudies

Study Format	Course Type
myStudies	Thesis

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Bachelor Thesis

Student Workload					
Self Study	**Contact Hours**	**Tutorial**	**Self Test**	**Independent Study**	**Hours Total**
270 h	0 h	0 h	0 h	0 h	270 h

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Thesis

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Bachelor Thesis

Student Workload					
Self Study	**Contact Hours**	**Tutorial**	**Self Test**	**Independent Study**	**Hours Total**
270 h	0 h	0 h	0 h	0 h	270 h

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☑ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Colloquium

Course Code: DLBBT02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		1	none

Course Description

The colloquium will take place after the submission of the bachelor's thesis. This is done at the invitation of the experts. During the colloquium, students must prove that they have independently produced the content and results of the written work. The content of the colloquium is a presentation of the most important work contents and research results by the student as well as the answering of questions by experts.

Course Outcomes

On successful completion, students will be able to

- present a problem from their field of study using academic presentation and communication techniques.
- reflect on the scientific and methodological approach chosen in their bachelor's thesis.
- demonstrate that they can actively answer subject-related questions from the subject experts (reviewers of the bachelor's thesis).

Contents

- The colloquium includes a presentation of the most important results of the bachelor's thesis, followed by the student answering the reviewers' technical questions.

Literature

Compulsory Reading

Further Reading

- Subject specific literature chosen by the student

Study Format myStudies

Study Format	Course Type
myStudies	Thesis Defense

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Presentation: Colloquium

Student Workload					
Self Study	**Contact Hours**	**Tutorial**	**Self Test**	**Independent Study**	**Hours Total**
30 h	0 h	0 h	0 h	0 h	30 h

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Thesis Defense

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Presentation: Colloquium

Student Workload					
Self Study	**Contact Hours**	**Tutorial**	**Self Test**	**Independent Study**	**Hours Total**
30 h	0 h	0 h	0 h	0 h	30 h

Instructional Methods	
☐ Learning Sprints® ☐ Course Book ☐ Vodcast ☐ Shortcast ☐ Audio ☐ Exam Template	☐ Review Book ☐ Creative Lab ☐ Guideline ☐ Live Tutorium/Course Feed ☑ Slides