MODULE HANDBOOK

Bachelor of Engineering

Bachelor Industrial Engineering and Management (CSE-WINGE)

180 CP

Campus Studies

As of April 1st, 2026

INTERNATIONAL
UNIVERSITY OF
APPLIED SCIENCES

Classification: Undergraduate

Contents

Business 101

Module Code: CSEBBAB-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. Andreas Herrmann (Business 101)

Contributing Courses to Module

- Business 101 (CSEBBAB01-01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies Exam, 90 Minutes	**Split Exam**
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

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

</td></tr>
<tr>
<td>Links to other Modules within the Study Program
This module is similar to other modules in the field of Business Administration & Management</td>
<td>Links to other Study Programs of the University
All Bachelor Programmes in the Business field</td>
</tr>
</table>

Business 101

Course Code: CSEBBAB01-01_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

- Covey, S. R. (2013). *The 7 habits of highly effective people: powerful lessons in personal change* (25th anniversary edition). Simon & Schuster.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Introduction to Academic Work for IT and Technology

Module Code: CSEBIAWITT

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 Christof Hemmer (Introduction to Academic Work for IT and Technology)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Introduction to Academic Work for IT and Technology (CSEBIAWITT01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Written Assessment: Case Study	

Weight of Module

see curriculum

Module Contents

- Everyday Knowledge vs. Academic Work
- Academic Work
- Working with Sources and Literature
- Research Design
- Writing an Academic Paper
- Academic Work in IT and Technology in Practice

<table>
<tr><td colspan="2">Learning Outcomes
Introduction to Academic Work for IT and Technology
On successful completion, students will be able to
▪ explain what science is and why science is needed (including in practice-based studies and professional practice).
▪ name and apply theories, methods, and models in IT and technology.
▪ find, analyze, and classify academic literature and types of sources.
▪ prepare academic papers independently.</td></tr>
<tr><td>Links to other Modules within the Study Program
This module is similar to other modules in the field of Methods</td><td>Links to other Study Programs of the University
All Bachelor Programs in the Business field</td></tr>
</table>

Introduction to Academic Work for IT and Technology

Course Code: CSEBIAWITT01

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

Course Description

As researchers and students, we do not want to take arguments for true simply because they sound interesting but to get to the bottom of them systematically. For this, we must think scientifically. But what exactly is science? The course teaches the basics of scientific thinking and working and uses concrete examples from IT and technology to show which standards academic papers must meet and how they are structured. Students learn important aspects of academic work, such as handling sources, basic formats for papers in IT and technology, and the methods and techniques necessary to write their academic papers.

Course Outcomes

On successful completion, students will be able to

- explain what science is and why science is needed (including in practice-based studies and professional practice).
- name and apply theories, methods, and models in IT and technology.
- find, analyze, and classify academic literature and types of sources.
- prepare academic papers independently.

Contents

1. Everyday Knowledge vs. Academic Work
   - 1.1 What is True?
   - 1.2 What are Trustworthy Sources?
   - 1.3 Critical Use of Primary and Secondary Sources
   - 1.4 Developing and Arguing Your Point of View
   - 1.5 Aspects of Academic Work

2. Academic Work
   - 2.1 Finding a Topic
   - 2.2 Formats of Academic Works
   - 2.3 Example: The Structure of an Academic Work
   - 2.4 Standards in IT and Technology

3. Working with Sources and Literature

3.1 Acquire Information: Search for, Find, and Evaluate Sources and Literature
3.2 Literature Management
3.3 Reading Academic Texts
3.4 Citation
3.5 Avoiding Plagiarism

4. Research Design
   4.1 Important Formats
   4.2 Methods: Quantitative or Qualitative?
   4.3 Data Collection Methods
   4.4 Data Evaluation Methods
   4.5 Choosing a Research Design

5. Writing an Academic Paper
   5.1 Project Plan and Schedule
   5.2 Structure
   5.3 Format and Style
   5.4 Developing an Academic Argument

6. Academic Work in IT and Technology in Practice
   6.1 Becoming a Billionaire Through Research: Brin & Page, 1998
   6.2 A Systematic Literature Review: Jansen-Preilowski et al., 2020
   6.3 Design Science Research: Kunzmann, 2022

Literature

Compulsory Reading

Further Reading

- Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed., Int. Student Ed.). Sage Publications.
- Hemmer, M. C., & Fröhlich, T. (2023). The art of thesis writing: A comprehensive guide to authoring graduate theses with foundations of research. Hemmer Fröhlich Publishing.
- Paul, J., & Criado, A. R. (2020). The art of writing literature review: What do we know and what do we need to know? Elsevier Ltd.
- Pears, R., & Shields, G. J. (2022). Cite them right: The essential referencing guide (12th ed.). Bloomsbury Publishing.
- Silvia, P. J. (2019). How to write a lot: A practical guide to productive academic writing (2nd ed.). APA LifeTools.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
94 h	36 h	0 h	20 h	0 h	150 h

Collaborative Work

Module Code: CSEBCSCW-01

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

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

Module Coordinator

Prof. Dr. Karin Halbritter (Collaborative Work)

Contributing Courses to Module

- Collaborative Work (CSEBCSCW01-01)

Module Exam Type	
Module Exam Study Format: Campus Studies Exam, 90 Minutes	**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 field

Collaborative Work

Course Code: CSEBCSCW01-01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

1. Learning for a Networked World, in a Networked World
    - 1.1 Requirements and Opportunities in the “VUCA” World
    - 1.2 Learning, Knowing and Not-Knowing
    - 1.3 The 4C Model: Collective, Collaborative, Continuous, and Connected
    - 1.4 Monitoring Learning Behaviour

2. Networking & Cooperation
   - 2.1 Cooperation Partners
   - 2.2 Sustainable Relationships: Digital Interaction and Trust Building
   - 2.3 Organizing Collaboration
   - 2.4 Social Learning

3. Performance in (Online) Teams
   - 3.1 Goals, Roles, Organization and Performance Measurement
   - 3.2 Team Building and Team Flow
   - 3.3 Agile Project Management with Scrum
   - 3.4 Other Agile Methods

4. Communicating and Convincing
   - 4.1 Communication as Social Interaction
   - 4.2 Language, Images, Metaphors, and Stories
   - 4.3 Attitude: Open, Empathetic, and Appreciative Communication
   - 4.4 Active Listening
   - 4.5 Analyze Your Conversational and Argumentative Skills

5. Recognizing Conflict Potential — Managing Conflicts — Negotiating Effectively
   - 5.1 Respecting Diversity and Seizing Opportunities
   - 5.2 Empathy
   - 5.3 Systemic Solution Process Work
   - 5.4 Constructive Negotiation

6. Achieving Your Goals
   - 6.1 Effective Goal Setting
   - 6.2 The Agile Use of Time
   - 6.3 (Self-)Coaching Methods
   - 6.4 Self-Management and Motivation Strategies

7. Mobilizing Resources
   - 7.1 Recognizing Resources
   - 7.2 Reflection and Innovation
   - 7.3 Transfer Strength and Willpower

Literature
Compulsory Reading
Further Reading ▪ Baber, A., Waymon, L., Alphonso, A., & Wylde, J. (2015). Strategic connections: The new face of networking in a collaborative world. AMACOM. ▪ Kaats, E., & Opheij, W. (2014). Creating conditions for promising collaboration: Alliances, networks, chains, strategic partnerships. Springer. ▪ Martin, S. J., Goldstein, N. J., & Cialdini, R. B. (2014). The small BIG: Small changes that spark BIG influence. Profile Books. ▪ Oettingen, G. (2014). Rethinking positive thinking: Inside the new science of motivation. Current.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Course Book	☑ Online Tests
☑ Video	☑ Practice Exam
☑ Slides	

Introduction to the Internet of Things

Module Code: CSEBINGEIT_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 (CSEBINGEIT01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies 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 field of Computer Science & Software	**Links to other Study Programs of the University** All Bachelor Programmes in the IT & Technology field

Introduction to the Internet of Things

Course Code: CSEBINGEIT01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

1. Internet of Things Fundamentals
   - 1.1 The Internet of Things - Basics and Motivation
   - 1.2 Evolution of the Internet - Web 1.0 to Web 4.0
2. Social and Economic Significance
   - 2.1 Innovations for Consumers and Industry
   - 2.2 Implications on People and the World of Work
   - 2.3 Data Protection and Data Security
3. Communication Standards and Technologies
   - 3.1 Network Topologies
   - 3.2 Network Protocols
   - 3.3 Technologies
4. Data Storage and Processing

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Fundamentals of Physics

Module Code: CSEBWINGP-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. Christian Magnus (Fundamentals of Physics)

Contributing Courses to Module

- Fundamentals of Physics (CSEBWINGP01-01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies Exam, 90 Minutes	**Split Exam**
Weight of Module see curriculum	

Module Contents

- Mechanics
- Thermodynamics
- Electricity and Magnetism
- Oscillations and Waves
- Optics & Acoustics
- Introduction to Particle Physics

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

Fundamentals of Physics

On successful completion, students will be able to
▪ explain the basic concepts of mechanics and calculate the quantities of mechanics.
▪ explain the basic concepts of thermodynamics and calculate the quantities of thermodynamics.
▪ apply the physical laws of electricity to electrostatic and magnetic fields.
▪ explain free and forced oscillations and reproduce applications.
▪ explain phenomena of geometrical optics and wave optics.
▪ understand basic concepts of particle physics.</td></tr>
<tr><td>Links to other Modules within the Study Program

This module is similar to other modules in the field of Engineering</td><td>Links to other Study Programs of the University

All Bachelor Programs in the IT & Technology field</td></tr>
</table>

Fundamentals of Physics

Course Code: CSEBWINGP01-01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

6. Optics & Acoustics
    - 6.1 Basic Terms
    - 6.2 Reflection and Refraction
    - 6.3 Ray Optics and Imaging Errors
    - 6.4 Wave Optics - Interference and Polarization
    - 6.5 Sound Waves - Fundamentals of Acoustics

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

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

Study Format Campus Studies

Study Format	**Course Type**
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Course Book	☑ Practice Exam
☑ Video	☑ Review Book
☑ Slides	☑ Online Tests

Mathematics II

Module Code: CSEBCSM2

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
Dr. Annika Denkert (Mathematics II)

Contributing Courses to Module
▪ Mathematics II (CSEBCSM201)

Module Exam Type	
Module Exam Study Format: Campus Studies Exam, 90 Minutes	**Split Exam**
Weight of Module see curriculum	

Module Contents

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

<table>
<tr><td colspan="2">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.</td></tr>
<tr><td>Links to other Modules within the Study Program
This module is similar to other modules in the field of Methods</td><td>Links to other Study Programs of the University
All Bachelor Programs in the Business & Management field</td></tr>
</table>

Mathematics II

Course Code: CSEBCSM201

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 Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Introduction to Robotics

Module Code: CSEBROIR-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. Matthias Eifler (Introduction to Robotics)

Contributing Courses to Module

- Introduction to Robotics (CSEBROIR01-01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Exam, 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 field

Introduction to Robotics

Course Code: CSEBROIR01-01_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 Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	Contact Hours	Tutorial/Tutorial Support	Self Test	Independent Study	Hours Total
84 h	36 h	0 h	30 h	0 h	150 h

International Marketing

Module Code: CSEBDSEIMB1

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. Josephine Zhou-Brock (International Marketing)

Contributing Courses to Module

- International Marketing (CSEBDSEIMB01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Exam, 90 Minutes	

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	**Links to other Study Programs of the University**
This module is similar to other modules in the field of Marketing & Sales	All Bachelor Programs in the Marketing & Communication field

International Marketing

Course Code: CSEBDSEIMB01

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

Literature
Compulsory Reading
Further Reading ▪ Armstrong, G., Kotler, P., & Opresnik, M. O. (2019). Marketing: An introduction (14th 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.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Managerial Economics

Module Code: CSEBBWME_E

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

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

Module Coordinator

Dr. Tolga Ülkü (Managerial Economics)

Contributing Courses to Module

- Managerial Economics (CSEBBWME01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies 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	**Links to other Study Programs of the University**
This module is similar to other modules in the field of Economics	All Bachelor Programs in the Business field

Managerial Economics

Course Code: CSEBBWME01_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 ▪ Acemoglu, D., Laibson, D., & List, J. A. (2018). Microeconomics (Global edition, 2nd ed.). Pearson. ▪ Case, K. E., Fair, R. C., & Osten, S. M. (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. Morgan & Claypool. ▪ Parkin, M. (2019). Economics (13th ed.). Harlow. ▪ Pindyck, R. S., & Rubinfeld, D. L. (2017). Microeconomics (9th ed.). Pearson.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Electrical Engineering

Module Code: CSEBINGET-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
Aiko Walte (Electrical Engineering)

Contributing Courses to Module
▪ Electrical Engineering (CSEBINGET01-01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies 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	**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 field

Electrical Engineering

Course Code: CSEBINGET01-01_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

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

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	Contact Hours	Tutorial/Tutorial Support	Self Test	Independent Study	Hours Total
84 h	36 h	0 h	30 h	0 h	150 h

Production Engineering Industry 4.0

Module Code: CSEBDSEAR1

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

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

Module Coordinator

Prof. Dr. Hans Kerwat (Production Engineering Industry 4.0)

Contributing Courses to Module

- Production Engineering Industry 4.0 (CSEBDSEAR01)

Module Exam Type	
Module Exam Study Format: Campus Studies 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 Industry 4.0 On successful completion, students will be able to ▪ understand the basic concepts and interrelationships of production engineering. ▪ understand current changes in manufacturing technology due to technologies such as additive manufacturing and megatrends such as cyber physical systems. ▪ assign different manufacturing processes to the main manufacturing groups according to DIN 8580. ▪ understand the basic principle of additive manufacturing processes. ▪ distinguish between different additive manufacturing processes. ▪ understand the terms Rapid Prototyping, Rapid Tooling, and Direct Manufacturing and name individual processes and application examples. ▪ understand the elements and properties of cyber-physical production plants.	
Links to other Modules within the Study Program This module is similar to other modules in the field of Computer Science & Software Development	**Links to other Study Programs of the University** All Bachelor Programs in the IT & Technology field

Production Engineering Industry 4.0

Course Code: CSEBDSEAR01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

2.5 Coating
2.6 Changing the Properties of Substances

3. Additive Manufacturing Processes
   3.1 Basic Principles and Legal Aspects
   3.2 Stereolithography (STL)
   3.3 Selective Laser Sintering and Selective Beam Melting With Laser or Electron Beam
   3.4 Fused Deposition Modeling (FDM)
   3.5 Multi-Jet Modeling (MJM) and Poly-Jet Process (PJM)
   3.6 3D Printing Process (3DP)
   3.7 Laminating Processes
   3.8 Mask Sintering

4. Rapid Prototyping
   4.1 Definition
   4.2 Strategic and Operational Aspects
   4.3 Application Areas and Examples

5. Rapid Tooling
   5.1 Definition, Strategic, and Operational Aspects
   5.2 Indirect and Direct Procedures

6. Direct/Rapid Manufacturing
   6.1 Potentials and Requirements for Procedures
   6.2 Implementation, Application Areas, and Examples

7. Cyber-Physical Production Plants
   7.1 Derivation of the Terms Industry 4.0 and Cyber-Physical Systems
   7.2 Megatrend Cyber Physical Systems (CPS)
   7.3 Definition Cyber-Physical Production Plant
   7.4 Effects on Planning and Operation of Production Facilities
   7.5 Dynamic Reconfiguration and Migration of Production Facilities

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

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	Contact Hours	Tutorial/Tutorial Support	Self Test	Independent Study	Hours Total
84 h	36 h	0 h	30 h	0 h	150 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Course Book	☑ Practice Exam
☑ Video	☑ Online Tests
☑ Slides	

Sensor Technology

Module Code: CSEBROST_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 (CSEBROST01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies Exam, 90 Minutes	**Split Exam**
Weight of Module see curriculum	

Module Contents

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

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

Sensor Technology

Course Code: CSEBROST01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

3. Resistive Sensors
   - 3.1 Resistivity and Resistance

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

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Course Book	☑ Practice Exam
☑ Video	☑ Online Tests
☑ Slides	

Management Accounting

Module Code: CSEBMAE-01

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

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

Module Coordinator

Prof. Dr. Zeljko Sevic (Management Accounting)

Contributing Courses to Module

- Management Accounting (CSEBMAE01-01)

Module Exam Type	
Module Exam Study Format: Campus Studies Exam, 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

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

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.

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

Links to other Modules within the Study Program

This module is similar to other modules in the field of Finance & Tax Accounting

</td><td>

Links to other Study Programs of the University

All Bachelor Programs in the Business field

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

Management Accounting

Course Code: CSEBMAE01-01

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

3. Simplistic Methods of Cost Allocation

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 Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30h	0 h	150 h

Automation Technology

Module Code: CSEBROEIRA2_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
Ha Ngo (Automation Technology)

Contributing Courses to Module
▪ Automation Technology (CSEBROEIRA02_E)

Module Exam Type	
Module Exam Study Format: Campus Studies 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 field

Automation Technology

Course Code: CSEBROEIRA02_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

1. Introduction
   - 1.1 Evolution of Automation
   - 1.2 Industrial Revolutions
   - 1.3 Modern Automation Systems
   - 1.4 Challenges and Trends
2. An Introduction to Programmable Logic Controllers
   - 2.1 Hardware
   - 2.2 Internal Architecture
   - 2.3 I/O
   - 2.4 Ladder and Functional Block Programming
   - 2.5 Programming Methods
3. Batch Automation
   - 3.1 Basics

3.2 Applications

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

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Technical Drawing

Module Code: CSEBROTD_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 (CSEBROTD01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies 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: CSEBROTD01_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 Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Corporate Finance and Investment

Module Code: CSEBCFIE

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 (CSEBCFIE01)

Module Exam Type	
Module Exam Study Format: Campus Studies 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: CSEBCFIE01

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 Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
94 h	36 h	0 h	20 h	0 h	150 h

Supply Chain Management I

Module Code: CSEBDSESCM1

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. Alex Leberling (Supply Chain Management I)

Contributing Courses to Module

- Supply Chain Management I (CSEBDSESCM01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies 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

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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.

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Links to other Modules within the Study Program

This module is similar to other modules in the field of Transportation & Logistics

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Links to other Study Programs of the University

All Bachelor Programs in the Transport & Logistics field

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Supply Chain Management I

Course Code: CSEBDSESCM01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Instructional Methods	
Learning Material ☑ Course Book ☑ Video ☑ Slides	**Exam Preparation** ☑ Practice Exam ☑ Online Tests

Mechatronic Systems

Module Code: CSEBROMSY_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. Torsten Bruns (Mechatronic Systems)

Contributing Courses to Module

- Mechatronic Systems (CSEBROMSY01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

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

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.	
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

Mechatronic Systems

Course Code: CSEBROMSY01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

1. Introduction
   - 1.1 Mechatronic Systems
   - 1.2 Examples

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

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Entrepreneurship and Innovation

Module Code: CSEBBAEI-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

Diana Murtgah-Böhm (Entrepreneurship and Innovation)

Contributing Courses to Module

- Entrepreneurship and Innovation (CSEBBAEI01-01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies Exam, 90 Minutes	**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 field

Entrepreneurship and Innovation

Course Code: CSEBBAEI01-01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

3.2 Venture Creation
3.3 Creativity Management and Time Pressure

4. Innovation
4.1 Defining Innovation
4.2 Innovation Lifecycle
4.3 Sources of Innovation
4.4 Encouraging Entrepreneurship and Innovation

5. Planning, Business Models and Strategy
5.1 Business Plan
5.2 Designing a Business Model
5.3 Developing a Business Strategy

Literature

Compulsory Reading

Further Reading

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

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Course Book	☑ Practice Exam
☑ Video	☑ Online Tests
☑ Slides	

Project: Design Thinking

Module Code: CSEBINGDT_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. Inga Schlömer (Project: Design Thinking)

Contributing Courses to Module

- Project: Design Thinking (CSEBINGDT01_E)

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

Module Contents

- Basic principles of Design Thinking
- The Design Thinking micro process
- 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 field

Project: Design Thinking

Course Code: CSEBINGDT01_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. Harvard Business Review, June, 84–95. ▪ Brown, T., & Kātz, B. (2019). Change by design: How design thinking transforms organizations and inspires innovation (Revised and updated edition). Harper Business. ▪ IDEO. (2015). The field guide to human-centered design: Design kit (1st ed.). IDEO. ▪ Lewrick, M., Patrick, L., & Leifer, L. (2018). The design thinking playbook: Mindful digital transformation of teams, products, services, businesses and ecosystems. John Wiley & Sons. ▪ Lewrick, M., Patrick, L., & Leifer, L. (2020). Design Thinking Toolbook. John Wiley & Sons.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assessment: Project Report

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
114 h	36 h	0 h	0 h	0 h	150 h

Data Analytics and Big Data

Module Code: CSEBINGDABD_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. Jan Rüterbories (Data Analytics and Big Data)

Contributing Courses to Module

- Data Analytics and Big Data (CSEBINGDABD01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies 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 field

Data Analytics and Big Data

Course Code: CSEBINGDABD01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

1. Introduction to Data Analysis
   - 1.1 Decisions, Information, Data
   - 1.2 Historical Development of Data Storage and Evaluation
   - 1.3 Big Data: Features and Examples
   - 1.4 Data Analysis

Literature
Compulsory Reading
Further Reading ▪ Akerkar, R., & Srinivas Sajja, P. (2016). Intelligent Techniques for Data Science. Springer. ▪ Curry, E., Auer, S., Berre, A., J., Metzger, A., Perez, M., S., & Zillner, S. (2022). Technologies and Applications for big data value. Springer. Pages 1–15 & 321–344. ▪ Hoeren, T., & Kolany-Raiser, B., (Eds.). (2018). Big data in context – Legal, social and technological insights. Springer Nature. ▪ Illowsky, B., & Dean, S. (2018). Introductory statistics. OpenStax CNX. Chapters 2 & 8. ▪ Jurafsky, D., & Martin, J. H. (2013). Speech and language processing: an introduction to natural language processing, computational linguistics, and speech recognition (2. ed.). Pearson Prentice Hall.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
94 h	36 h	0 h	20 h	0 h	150 h

Seminar: Human-Robot Interaction

Module Code: CSEBROSHRI_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. Amir Al-Munajjed (Seminar: Human-Robot Interaction)

Contributing Courses to Module

- Seminar: Human-Robot Interaction (CSEBROSHRI01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Written Assessment: Research Essay	

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).

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.	
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 field

Seminar: Human-Robot Interaction

Course Code: CSEBROSHRI01_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 Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	Contact Hours	Tutorial/Tutorial Support	Self Test	Independent Study	Hours Total
114 h	36 h	0 h	0 h	0 h	150 h

Project: Agile Project Management

Module Code: CSEBCSAPM

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 (Project: Agile Project Management)

Contributing Courses to Module
▪ Project: Agile Project Management (CSEBCSAPM01)

Module Exam Type	
Module Exam Study Format: Campus Studies 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	
Project: 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 field of Computer Science & Software Development	All Bachelor Programs in the IT & Technology field

Project: Agile Project Management

Course Code: CSEBCSAPM01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assessment: Project Report

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
114 h	36 h	0 h	0 h	0 h	150 h

Intercultural and Ethical Decision-Making

Module Code: CSEBCSIDM

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. Zeljko Sevic (Intercultural and Ethical Decision-Making)

Contributing Courses to Module

- Intercultural and Ethical Decision-Making (CSEBCSIDM01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Written Assessment: Case Study	

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 field of Business Administration & Management	All Bachelor Programs in the Business field

Intercultural and Ethical Decision-Making

Course Code: CSEBCSIDM01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

3. Culture and Ethics
    3.1 Ethics - Basic Terms and Concepts
    3.2 Interdependence of Culture and Ethics
    3.3 Ethical Concepts in Different Regions of the World
4. Current Topics in the Area of Interculturality, Ethics, and Diversity
    4.1 Digital Ethics
    4.2 Equality and Equal Opportunities
    4.3 Social Diversity
5. Intercultural Learning and Working
    5.1 Acculturation
    5.2 Learning and Working in Intercultural Groups
    5.3 Strategies for Dealing with Cultural Conflicts
6. Case Studies for Cultural and Ethical Conflicts
    6.1 Case Study: Interculturality
    6.2 Case Study: Diversity
    6.3 Case Study: Interculturality and Ethics

Literature

Compulsory Reading

Further Reading

- Al-Ali, E., & Masmoudi, M. (2023). Leadership and Workplace Culture in the Digital Era. Business Science Reference.
- Barmeyer, C., Bausch, M., & Mayrhofer, U. (2021). Constructive Intercultural Management.
- Berrones-Flemmig, N., Contreras, F., & Dornberger, U. (2022). Business in the 21st century: A sustainable approach (1st ed.). Emerald Publishing Limited.
- Rossouw, J., & Van Vuuren, L. (2017). Business ethics (6th ed.). Oxford University Press Southern Africa.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
94 h	36 h	0 h	20 h	0 h	150 h

Product Development in Industry 4.0

Module Code: CSEBINGPE_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. Dorian Mora (Product Development in Industry 4.0)

Contributing Courses to Module

- Product Development in Industry 4.0 (CSEBINGPE01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies Exam, 90 Minutes	**Split Exam**
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: CSEBINGPE01_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

2. Fundamentals of Product Development

Literature
Compulsory Reading
Further Reading ▪ Kull, H. (2015): Mass Customization. Opportunities, Methods, and Challenges for Manufacturers. Apress, Berkeley/New York. ▪ Olsen, D. (2015): The Lean product playbook: How to innovate with minimum viable products and rapid customer feedback. Wiley, Hoboken, NJ. ▪ Stark, J. (2022): Product Lifecycle Management (Volume 1): 21st Century Paradigm for Product Realisation (Decision Engineering) (English Edition). Fifth Edition. Springer.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	Contact Hours	Tutorial/Tutorial Support	Self Test	Independent Study	Hours Total
84 h	36 h	0 h	30 h	0 h	150 h

Instructional Methods	
Learning Material	Exam Preparation
☑ Course Book	☑ Practice Exam
☑ Video	☑ Online Tests
☑ Slides	

Project: Smart Product Solutions

Module Code: CSEBIEPSPS01-01

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

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

Module Coordinator

Dr. Hajck Karapetjan (Project: Smart Product Solutions)

Contributing Courses to Module

- Project: Smart Product Solutions (CSEBIEPSPS01-01)

Module Exam Type	
Module Exam Study Format: Campus Studies Written Assessment: 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	Links to other Study Programs of the University
This module is similar to other modules in the field of Computer Science & Software Development	All Bachelor Programs in the IT & Technology field

Project: Smart Product Solutions

Course Code: CSEBIEPSPS01-01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

and the dynamic modelling of the mechanics of the smart product solutions and their business models, students learn the basics for effective decision support in practice, which ensures continuous learning in a digital world with growing dynamic complexity.

Literature

Compulsory Reading

Further Reading

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

Study Format Campus Studies

Study Format Campus Studies	Course Type Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Written Assessment: Project Report

Student Workload					
Self Study 114 h	Contact Hours 36 h	Tutorial/Tutorial Support 0 h	Self Test 0 h	Independent Study 0 h	Hours Total 150 h

Instructional Methods	
Learning Material ☑ Slides	Exam Preparation ☑ Guideline

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
Sheik Radiah Ravim Rivu (Smart Devices) / Tamer Abdalrahman (Project: Smart Devices)

Contributing Courses to Module
▪ Smart Devices (DLBINGSD01_E) ▪ Project: Smart Devices (DLBINGSD02_E)

Module Exam Type	
Module Exam	**Split Exam** <u>Smart Devices</u> • Study Format "Distance Learning": Exam, 90 Minutes <u>Project: Smart Devices</u> • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents
Smart Devices ▪ Overview and introduction ▪ Smart devices ▪ Technological features ▪ Communication and networking ▪ User interfaces ▪ Ubiquitous computing **Project: Smart Devices** In-depth study of a selected topic in the field of smart devices and work on a practical task in a prototyping environment.

Learning Outcomes
Smart Devices 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. **Project: Smart Devices** 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

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

Study Format Distance Learning

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

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

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

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

Project: Smart Devices

Course Code: DLBINGSD02_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

Literature

Compulsory Reading

Further Reading

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

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
Sahar Qaadan (Smart Factory) / Dr. Sahar Qaadan (Project: Smart Factory)

Contributing Courses to Module
▪ Smart Factory (DLBDSESF01) ▪ Project: Smart Factory (DLBDSESF02)

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

Module Contents

Smart Factory

- 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

Project: Smart Factory

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

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.

Project: Smart Factory

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 field

Smart Factory

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 Distance Learning	**Course Type** Theory Course

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

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

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

Project: Smart Factory

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 ▪ Arey, D., Le, C. H. & Gao, J. (2021). Lean industry 4.0: a digital value stream approach to process improvement. Procedia Manufacturing, 54, 19–24. ▪ Hartmann, L., Meudt, T., Seifermann, S. & Metternich, J. (2018). Value stream method 4.0: holistic method to analyse and design value streams in the digital age. Procedia CIRP, 78, 249–254. ▪ Luscinski, S. & Ivanov, V. (2020). A Simulation Study of Industry 4.0 Factories based on the Ontology on Flexibility with using FlexSim Software. Management and Production Engineering Review (volume 11, number 3), S. 74–83. ▪ Meroni, G., Baresi, L., Montali, M. & Plebani, P. (2017). Multi-party business process compliance monitoring through IoT-enabled artifacts. Information Systems, 73, 61-78. ▪ OMG (2014). Business Process Model and Notation (BPMN). Version 2.0.2

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

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
Prof. Dr. Dorian Mora (Smart Mobility) / Prof. Dr. Dorian Mora (Project: Smart Mobility)

Contributing Courses to Module
▪ Smart Mobility (DLBINGSM01_E) ▪ Project: Smart Mobility (DLBINGSM02_E)

Module Exam Type	
Module Exam	**Split Exam** <u>Smart Mobility</u> • Study Format "Distance Learning": Exam, 90 Minutes <u>Project: Smart Mobility</u> • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents
Smart Mobility ▪ 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 **Project: Smart Mobility** In-depth analysis of a specific topic in the context of Smart Mobility in form of a prototype report.

Learning Outcomes
Smart Mobility 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. **Project: Smart Mobility** 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

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

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	Theory Course

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

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

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

Project: Smart Mobility

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	**Online Tests:** no
Type of Exam	Written Assessment: Project Report

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

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

Smart Services

Module Code: DLBINGSS_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	BA	10	300 h

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

Module Coordinator

Prof. Dr. Holger Klus (Smart Services) / Prof. Dr. Holger Klus (Project: Smart Services)

Contributing Courses to Module

- Smart Services (DLBINGSS01_E)
- Project: Smart Services (DLBINGSS02_E)

Module Exam Type

Module Exam	Split Exam
	Smart Services • Study Format "Distance Learning": Exam, 90 Minutes Project: Smart Services • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

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

Learning Outcomes
Smart Services 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. **Project: Smart Services** 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 field of Computer Science & Software Development	All Bachelor Programs in the IT & Technology field

Smart Services

Course Code: DLBINGSS01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

Study Format Distance Learning

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

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

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

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

Project: Smart Services

Course Code: DLBINGSS02_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

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
Dr. Florian Simroth (Mobile Robotics) / Dr. Florian Simroth (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": Written Assessment: Case Study Soft Robotics • Study Format "Distance Learning": Written Assessment: Written Assignment
Weight of Module see curriculum	

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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

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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.

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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 Programmes in the IT & Technology fields

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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

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	Theory Course

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

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

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

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 Soft Actuators and Their Classification
   - 2.2 Materials and Properties of Soft Actuators
   - 2.3 Thermo-Driven Soft Actuators
   - 2.4 Electro-Driven Soft Actuators
   - 2.5 Light-Driven Soft Actuators
   - 2.6 Magneto-Driven Soft Actuators
   - 2.7 Pneumatic Soft Actuators

3. Sensors
   - 3.1 Basics
   - 3.2 Types of Sensors (With Examples)
   - 3.3 Sensing Technologies

4. Modeling and Control
   - 4.1 Basics
   - 4.2 Modeling of Soft Robots (With Examples)
   - 4.3 Control of Soft Robots (With Examples)

5. Concluding Remarks
   - 5.1 Applications
   - 5.2 Challenges and Opportunities
   - 5.3 Useful Research and Projects on Soft Robotics

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	Theory Course

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

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

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

Cognitive Robotics

Module Code: DLBROECR

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. Matthias Eifler (Digital Signal Processing) / Dr. Sheikh Radiah Rahim Rivu (Introduction to Computer Vision)

Contributing Courses to Module

- Digital Signal Processing (DLBROEICR01_E)
- Introduction to Computer Vision (DLBAIICV01)

Module Exam Type

Module Exam	Split Exam
	<u>Digital Signal Processing</u> • Study Format "Distance Learning": Exam, 90 Minutes (50) <u>Introduction to Computer Vision</u> • Study Format "Distance Learning": Exam, 90 Minutes (100)

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 **Introduction to Computer Vision** ▪ Vision Fundamentals ▪ Image Filtering ▪ Low-Level Vision ▪ High-Level Vision ▪ Video

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. **Introduction to Computer Vision** On successful completion, students will be able to ▪ remember important facts about image acquisition both in humans as well as technical systems. ▪ describe the importance of filtering in image processing and its practical application. ▪ know about the role and function of lower-level features such as edges or salient points in vision processing. ▪ explain how Deep Learning methods are successfully applied in high-level vision tasks. ▪ understand the particularities of video processing and know how to solve common problems related to the interpretation of video material.

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 Programs in the IT & Technology field

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	Theory Course

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

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

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

Introduction to Computer Vision

Course Code: DLBAIICV01

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

Course Description

This course aims at laying the foundation in the understanding of Computer Vision. To this end, it starts with an introduction of the image acquisition process both from a biological as well as a technical perspective. Building upon that, the importance of filtering in image processing is explained and the necessary conceptual background is laid out. This enables the subsequent presentation of how crucial low-level features are generated from the raw image material. From there, the exposition moves on to describing current approaches to relevant high-level vision problems such as object recognition or image classification. Finally, the processing of video information is treated together with an exposition on modern approaches to solving salient Computer Vision tasks in this setting.

Course Outcomes

On successful completion, students will be able to

- remember important facts about image acquisition both in humans as well as technical systems.
- describe the importance of filtering in image processing and its practical application.
- know about the role and function of lower-level features such as edges or salient points in vision processing.
- explain how Deep Learning methods are successfully applied in high-level vision tasks.
- understand the particularities of video processing and know how to solve common problems related to the interpretation of video material.

Contents

1. Vision Fundamentals
   - 1.1 The Human Visual System
   - 1.2 Pinhole and Lens Cameras
   - 1.3 Image Sensors

2. Image Filtering
   - 2.1 Linear Shift Invariant Systems, Convolutions and the Point Spread Function
   - 2.2 Fourier Transform and Spatial Frequency
   - 2.3 Common Image Filters (Gaussian Smoothing, Median, Mode Filters, Rank Order)

3. Low-Level Vision
   3.1 Blobs
   3.2 Edges and Lines
   3.3 Corners and Points of Interest

4. High Level Vision
   4.1 Deep Learning
   4.2 Image Classification
   4.3 Semantic Segmentation
   4.4 Object Recognition

5. Video
   5.1 Fundamentals of Video Data, Motion and Optical Flow
   5.2 Object Tracking
   5.3 Action Classification

Literature
Compulsory Reading
Further Reading

- Davies E. R. (2018). Computer Vision (5th ed.). Academic Press.
- Forsyth, D. & Ponce, J. (2011). Computer vision: A modern approach. Pearson.
- Szeliski R. (2022). Computer Vision - Algorithms and Applications (2nd ed.). Springer.

Study Format Distance Learning

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

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

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

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Practice Exam
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Online Tests
☑ Recorded Live Sessions	☑ Audio	
	☑ 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
Ha Ngo (Self-Driving Vehicles) / Ha Ngo (Seminar: Current Topics and Trends in Self-Driving Technology)

Contributing Courses to Module
▪ Self-Driving Vehicles (DLBDSEAD01) ▪ Seminar: Current Topics and Trends in Self-Driving Technology (DLBDSEAD02)

Module Exam Type	
Module Exam	**Split Exam** <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 field

Self-Driving Vehicles

Course Code: DLBDSEAD01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

3. Computer Vision
   - 3.1 Pixels and filters

3.2 Feature detection
3.3 Semantic segmentation

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Practice Exam
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Online Tests
☑ Recorded Live Sessions	☑ 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.
- European Union. (2001). Directive 2001/95/EC.
- Fisher, R. B., Breckon, T. P., Dawson-Howe, K., Fitzgibbon, A., Robertson, C., Trucco, E., & Williams, C. K. I. (2016). Dictionary of computer vision and image processing. John Wiley & Sons.
- Smith, D. J., & Simpson, K. (2016). The safety critical systems handbook (4th ed.). Elsevier.
- Smith, D. J. (2017). Reliability, maintainability, and risk (9th ed.). Elsevier.
- Society of Automobile Engineers International. (2012). SAE J3061.
- Szeliski, R. (2022). Computer vision: Algorithms and applications (2nd ed.). Springer.
- Wang, P. K.-C. (2015). Visibility-based optimal path and motion planning (Vol. 568). Springer.

Study Format Distance Learning

Study Format Distance Learning	**Course Type** Seminar

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

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

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

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
Tanja Moehler (Applied Sales I) / Tanja Moehler (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 Applied Sales II • Study Format "Distance Learning": Exam or Advanced Workbook, 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

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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.

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Links to other Modules within the Study Program

This module is similar to other modules in the fields of Marketing & Sales

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Links to other Study Programs of the University

All Bachelor Programmes in the Marketing & Communication fields

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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

2. The Distribution System

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	Theory Course

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

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

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

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

1. Marketing and Sales
   - 1.1 Marketing and Business Philosophy
   - 1.2 Sales Marketing in Different Economic Sectors
   - 1.3 Relationship Marketing

Literature
Compulsory Reading
Further Reading ▪ Homburg, C., Schäfer, H., & Schneider, J. (2012). Sales excellence: Systematic sales management. Springer Science & Business Media. ▪ Ingram, T. N., Schwepker, C. H., Williams, M. R., Avila, R. A., & LaForge, R. W. (2020). Salesmanagement: Analysis and decision making (10th ed.). Routledge, Taylor & Francis Group. ▪ Kotler, P., & Keller, K. L. (2021). Marketing management (16th, global ed.). Pearson Education.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Jacko Nudzor (Embedded Systems) / Dr. Florian Simroth (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 "Distance Learning": Exam, 90 Minutes Project: Applied Robotics with Robotic Platforms • Study Format "Distance Learning": Oral Project Report
Weight of Module see curriculum	

<table>
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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.

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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.

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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 Programmes in the IT & Technology fields

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Embedded Systems

Course Code: DLBROES01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

3. Programming a Microcontroller

3.1 Bone Structure of a Microcontroller Software
3.2 Low-Level Programming
3.3 Usage of Middle-Level Libraries
3.4 Common IDEs and Tools

4. Embedded Operating Systems
4.1 Task Management
4.2 Scheduler
4.3 Examples of Embedded Operating Systems

5. Distributed Systems and IoT Architecture
5.1 Network Interfaces
5.2 The Internet Protocol
5.3 Examples of Distributed Systems

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Study Format	Course Type
Distance Learning	Project

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

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

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

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

Andrej Keksel (Signals and Systems) / Prof. Dr. Matthias Eifler (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 "Distance Learning": Exam, 90 Minutes Control Systems Engineering • 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 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

Signals and Systems

Course Code: DLBROSS01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Microcontroller

Module Code: DLBWINWMC_E

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

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

Module Coordinator

Pazir Ahmad Ahmad (Digital and Information Technology) / Kamran Mahmood (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 Distance Learning	**Course Type** Theory Course

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

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

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

Project: Microcontrollers and Logical Circuits

Course Code: DLBAETPMLS01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

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. Sebastian Lempert (Object-oriented Programming with Java) / Prof. Dr. Sebastian Lempert (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 "Distance Learning": Exam, 90 Minutes Data Structures and Java Class Library • 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

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 Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

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 Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Practical Project: Industrial Engineering

Module Code: DLBWINWPWIN_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. Dorian Mora (Practical Project: Industrial Engineering)

Contributing Courses to Module
▪ Practical Project: Industrial Engineering (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.

Learning Outcomes	
Practical Project: Industrial Engineering 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.	
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

Practical Project: Industrial Engineering

Course Code: DLBWINWPWIN01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		10	none

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	**Online Tests:** no
Type of Exam	Internship Reflection Paper (passed / not passed)

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

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

Project: Hackathon

Module Code: DLBWINWPH_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. Dorian Mora (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	none

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	**Online Tests:** no
Type of Exam	Oral Project Report

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

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

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

Sheik Radiah Ravim Rivu (Smart Devices) / Tamer Abdalrahman (Project: Smart Devices)

Contributing Courses to Module

- Smart Devices (DLBINGSD01_E)
- Project: Smart Devices (DLBINGSD02_E)

Module Exam Type

Module Exam	Split Exam
	Smart Devices • Study Format "Distance Learning": Exam, 90 Minutes Project: Smart Devices • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

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Module Contents

Smart Devices

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

Project: Smart Devices

In-depth study of a selected topic in the field of smart devices and work on a practical task in a prototyping environment.

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Learning Outcomes

Smart Devices

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.

Project: Smart Devices

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.

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Links to other Modules within the Study Program

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

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Links to other Study Programs of the University

All Bachelor Programs in the IT & Technology fields

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Smart Devices

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

Study Format Distance Learning

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

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

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

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

Project: Smart Devices

Course Code: DLBINGSD02_E

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

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

Literature
Compulsory Reading
Further Reading

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

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

Sahar Qaadan (Smart Factory) / Dr. Sahar Qaadan (Project: Smart Factory)

Contributing Courses to Module

- Smart Factory (DLBDSESF01)
- Project: Smart Factory (DLBDSESF02)

Module Exam Type

Module Exam	Split Exam
	Smart Factory • Study Format "Distance Learning": Exam, 90 Minutes Project: Smart Factory • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

Module Contents

Smart Factory

- 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

Project: Smart Factory

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

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.

Project: Smart Factory

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 field

Smart Factory

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	Theory Course

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

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

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

Project: Smart Factory

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 ▪ Arey, D., Le, C. H. & Gao, J. (2021). Lean industry 4.0: a digital value stream approach to process improvement. Procedia Manufacturing, 54, 19–24. ▪ Hartmann, L., Meudt, T., Seifermann, S. & Metternich, J. (2018). Value stream method 4.0: holistic method to analyse and design value streams in the digital age. Procedia CIRP, 78, 249–254. ▪ Luscinski, S. & Ivanov, V. (2020). A Simulation Study of Industry 4.0 Factories based on the Ontology on Flexibility with using FlexSim Software. Management and Production Engineering Review (volume 11, number 3), S. 74–83. ▪ Meroni, G., Baresi, L., Montali, M. & Plebani, P. (2017). Multi-party business process compliance monitoring through IoT-enabled artifacts. Information Systems, 73, 61-78. ▪ OMG (2014). Business Process Model and Notation (BPMN). Version 2.0.2

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

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
Prof. Dr. Dorian Mora (Smart Mobility) / Prof. Dr. Dorian Mora (Project: Smart Mobility)

Contributing Courses to Module
▪ Smart Mobility (DLBINGSM01_E) ▪ Project: Smart Mobility (DLBINGSM02_E)

Module Exam Type	
Module Exam	**Split Exam** <u>Smart Mobility</u> • Study Format "Distance Learning": Exam, 90 Minutes <u>Project: Smart Mobility</u> • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents

Smart Mobility

- 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

Project: Smart Mobility

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

Learning Outcomes

Smart Mobility

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.

Project: Smart Mobility

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

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	Theory Course

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

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

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

Project: Smart Mobility

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 Distance Learning	**Course Type** Project

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

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

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

Smart Services

Module Code: DLBINGSS_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	BA	10	300 h

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

Module Coordinator
Prof. Dr. Holger Klus (Smart Services) / Prof. Dr. Holger Klus (Project: Smart Services)

Contributing Courses to Module
▪ Smart Services (DLBINGSS01_E) ▪ Project: Smart Services (DLBINGSS02_E)

Module Exam Type	
Module Exam	**Split Exam** <u>Smart Services</u> • Study Format "Distance Learning": Exam, 90 Minutes <u>Project: Smart Services</u> • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents

Smart Services

- 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

Project: Smart Services

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

Learning Outcomes

Smart Services

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.

Project: Smart Services

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

Smart Services

Course Code: DLBINGSS01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Project: Smart Services

Course Code: DLBINGSS02_E

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

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Microcontroller

Module Code: DLBWINWMC_E

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

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

Module Coordinator

Pazir Ahmad Ahmad (Digital and Information Technology) / Kamran Mahmood (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	Theory Course

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

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

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

Project: Microcontrollers and Logical Circuits

Course Code: DLBAETPMLS01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

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

Dr. Florian Simroth (Mobile Robotics) / Dr. Florian Simroth (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": Written Assessment: Case Study <u>Soft Robotics</u> • Study Format "Distance Learning": Written Assessment: Written Assignment
Weight of Module see curriculum	

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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

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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.

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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 Programmes in the IT & Technology fields

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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

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	Theory Course

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

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

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Guideline
☑ Recorded Live Sessions	☑ Audio	
	☑ 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 Soft Actuators and Their Classification
   - 2.2 Materials and Properties of Soft Actuators
   - 2.3 Thermo-Driven Soft Actuators
   - 2.4 Electro-Driven Soft Actuators
   - 2.5 Light-Driven Soft Actuators
   - 2.6 Magneto-Driven Soft Actuators
   - 2.7 Pneumatic Soft Actuators

3. Sensors
    - 3.1 Basics
    - 3.2 Types of Sensors (With Examples)
    - 3.3 Sensing Technologies

4. Modeling and Control
    - 4.1 Basics
    - 4.2 Modeling of Soft Robots (With Examples)
    - 4.3 Control of Soft Robots (With Examples)

5. Concluding Remarks
    - 5.1 Applications
    - 5.2 Challenges and Opportunities
    - 5.3 Useful Research and Projects on Soft Robotics

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	Theory Course

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

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

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

Cognitive Robotics

Module Code: DLBROECR

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. Matthias Eifler (Digital Signal Processing) / Dr. Sheikh Radiah Rahim Rivu (Introduction to Computer Vision)

Contributing Courses to Module

- Digital Signal Processing (DLBROEICR01_E)
- Introduction to Computer Vision (DLBAIICV01)

Module Exam Type

Module Exam	Split Exam
	Digital Signal Processing • Study Format "Distance Learning": Exam, 90 Minutes (50) Introduction to Computer Vision • Study Format "Distance Learning": Exam, 90 Minutes (100)

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 **Introduction to Computer Vision** ▪ Vision Fundamentals ▪ Image Filtering ▪ Low-Level Vision ▪ High-Level Vision ▪ Video

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. **Introduction to Computer Vision** On successful completion, students will be able to ▪ remember important facts about image acquisition both in humans as well as technical systems. ▪ describe the importance of filtering in image processing and its practical application. ▪ know about the role and function of lower-level features such as edges or salient points in vision processing. ▪ explain how Deep Learning methods are successfully applied in high-level vision tasks. ▪ understand the particularities of video processing and know how to solve common problems related to the interpretation of video material.

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 Programs in the IT & Technology field

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

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	Theory Course

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

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

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

Introduction to Computer Vision

Course Code: DLBAIICV01

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

Course Description

This course aims at laying the foundation in the understanding of Computer Vision. To this end, it starts with an introduction of the image acquisition process both from a biological as well as a technical perspective. Building upon that, the importance of filtering in image processing is explained and the necessary conceptual background is laid out. This enables the subsequent presentation of how crucial low-level features are generated from the raw image material. From there, the exposition moves on to describing current approaches to relevant high-level vision problems such as object recognition or image classification. Finally, the processing of video information is treated together with an exposition on modern approaches to solving salient Computer Vision tasks in this setting.

Course Outcomes

On successful completion, students will be able to

- remember important facts about image acquisition both in humans as well as technical systems.
- describe the importance of filtering in image processing and its practical application.
- know about the role and function of lower-level features such as edges or salient points in vision processing.
- explain how Deep Learning methods are successfully applied in high-level vision tasks.
- understand the particularities of video processing and know how to solve common problems related to the interpretation of video material.

Contents

1. Vision Fundamentals
   - 1.1 The Human Visual System
   - 1.2 Pinhole and Lens Cameras
   - 1.3 Image Sensors

2. Image Filtering
   - 2.1 Linear Shift Invariant Systems, Convolutions and the Point Spread Function
   - 2.2 Fourier Transform and Spatial Frequency
   - 2.3 Common Image Filters (Gaussian Smoothing, Median, Mode Filters, Rank Order)

3. Low-Level Vision
   - 3.1 Blobs
   - 3.2 Edges and Lines
   - 3.3 Corners and Points of Interest

4. High Level Vision
   - 4.1 Deep Learning
   - 4.2 Image Classification
   - 4.3 Semantic Segmentation
   - 4.4 Object Recognition

5. Video
   - 5.1 Fundamentals of Video Data, Motion and Optical Flow
   - 5.2 Object Tracking
   - 5.3 Action Classification

Literature

Compulsory Reading

Further Reading

- Davies E. R. (2018). Computer Vision (5th ed.). Academic Press.
- Forsyth, D. & Ponce, J. (2011). Computer vision: A modern approach. Pearson.
- Szeliski R. (2022). Computer Vision - Algorithms and Applications (2nd ed.). Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Autonomous Driving

Module Code: DLBDSEAD

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

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

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

Contributing Courses to Module
▪ Self-Driving Vehicles (DLBDSEAD01) ▪ Seminar: Current Topics and Trends in Self-Driving Technology (DLBDSEAD02)

Module Exam Type	
Module Exam	**Split Exam** <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 field

Self-Driving Vehicles

Course Code: DLBDSEAD01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

1. Sensors
   - 1.1 Physical principles of sensors
   - 1.2 Types of sensors
   - 1.3 Sensor calibration
   - 1.4 Application scenarios
2. Sensor Fusion
   - 2.1 Elaborating data from sensors
   - 2.2 The Kalman filter
   - 2.3 Object tracking
3. Computer Vision
   - 3.1 Pixels and filters

3.2 Feature detection
3.3 Semantic segmentation

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

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

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

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

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

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.
- European Union. (2001). Directive 2001/95/EC.
- Fisher, R. B., Breckon, T. P., Dawson-Howe, K., Fitzgibbon, A., Robertson, C., Trucco, E., & Williams, C. K. I. (2016). Dictionary of computer vision and image processing. John Wiley & Sons.
- Smith, D. J., & Simpson, K. (2016). The safety critical systems handbook (4th ed.). Elsevier.
- Smith, D. J. (2017). Reliability, maintainability, and risk (9th ed.). Elsevier.
- Society of Automobile Engineers International. (2012). SAE J3061.
- Szeliski, R. (2022). Computer vision: Algorithms and applications (2nd ed.). Springer.
- Wang, P. K.-C. (2015). Visibility-based optimal path and motion planning (Vol. 568). Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Seminar

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

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

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

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

Tanja Moehler (Applied Sales I) / Tanja Moehler (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 Applied Sales II • Study Format "Distance Learning": Exam or Advanced Workbook, 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 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

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

2. The Distribution System

2.1 Forms of Sales
2.2 Sales Organisation
2.3 Key Account Management
2.4 Multi-Channel Distribution

3. Personal Sales
3.1 The "New Sellers"
3.2 Requirements for Sales Personalities
3.3 The Key Account Manager
3.4 Task of Sales Managers

4. Sales Plan
4.1 Tasks and Objectives of Sales Management
4.2 Observation of Competition in the Context of Sales Management
4.3 Potential Analyses and Sales Planning
4.4 Sales Control and Visit Strategies

5. New Customer Acquisition
5.1 Identification of New Customer Potential
5.2 Customer Relationship Management and Customer Acquisition
5.3 Trade Fairs and Events
5.4 Networking

6. The Sales Visit
6.1 Frequency and Preparation of Visits
6.2 Conduct of a Visit
6.3 Visit Reports and Follow-Up
6.4 Aftercare and Follow-Up

7. Conversational Tactics
7.1 Structured Conversation Preparation
7.2 Goal-Oriented Conversation: The D.A.L.A.S Model
7.3 Questioning Techniques

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

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	Theory Course

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

Student Workload

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

Instructional Methods

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

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

1. Marketing and Sales
    - 1.1 Marketing and Business Philosophy
    - 1.2 Sales Marketing in Different Economic Sectors
    - 1.3 Relationship Marketing

1.4 (International) Marketing and Sales Integration

2. Customer Satisfaction as a Success Factor
   - 2.1 Customer Relationship Management (CRM)
   - 2.2 Customer Orientation Success Chain
   - 2.3 Customer Relationship Strategies

3. Customer Retention
   - 3.1 Customer Retention Management
   - 3.2 Customer Retention Tools
   - 3.3 Complaints Management

4. Customer-Oriented Communications
   - 4.1 Communication and Sales Promotion by Sales Staff
   - 4.2 Sales Promotion by Sales Team
   - 4.3 Sales Promotion by the Company

5. Personalities in Sales
   - 5.1 Sales Personalities
   - 5.2 Selling in Teams
   - 5.3 Negotiating with Committees

6. Presentation and Rhetoric
   - 6.1 Rhetoric in Sales
   - 6.2 Presentation Techniques
   - 6.3 Nonverbal Communication

7. Networking
   - 7.1 Organizational Networks and Networking
   - 7.2 Building and Shaping Relationships
   - 7.3 Networking via Social Media

8. Case Study—Multi-Vendor Customer Loyalty Programs
   - 8.1 German Consumer Goods Market & Drugstore Industry Situation
   - 8.2 PAYBACK—A German Synonym for Loyalty Cards

Literature
Compulsory Reading
Further Reading ▪ Homburg, C., Schäfer, H., & Schneider, J. (2012). Sales excellence: Systematic sales management. Springer Science & Business Media. ▪ Ingram, T. N., Schwepker, C. H., Williams, M. R., Avila, R. A., & LaForge, R. W. (2020). Salesmanagement: Analysis and decision making (10th ed.). Routledge, Taylor & Francis Group. ▪ Kotler, P., & Keller, K. L. (2021). Marketing management (16th, global ed.). Pearson Education.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

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

Jacko Nudzor (Embedded Systems) / Dr. Florian Simroth (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 "Distance Learning": Exam, 90 Minutes Project: Applied Robotics with Robotic Platforms • Study Format "Distance Learning": Oral Project Report

Weight of Module

see curriculum

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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.

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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.

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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 Programmes in the IT & Technology fields

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Embedded Systems

Course Code: DLBROES01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

3. Programming a Microcontroller

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

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

Study Format Distance Learning

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

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

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

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

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 Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

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

Andrej Keksel (Signals and Systems) / Prof. Dr. Matthias Eifler (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 "Distance Learning": Exam, 90 Minutes Control Systems Engineering • 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 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

Signals and Systems

Course Code: DLBROSS01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

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

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Practice Exam
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Review Book
☑ Recorded Live Sessions	☑ Audio	☑ Online Tests
	☑ 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. Sebastian Lempert (Object-oriented Programming with Java) / Prof. Dr. Sebastian Lempert (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 "Distance Learning": Exam, 90 Minutes Data Structures and Java Class Library • 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

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 Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

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 Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Studium Generale I and II

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** <u>Studium Generale I</u> • Study Format "Distance Learning": See Selected Course <u>Studium Generale II</u> • 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 It is a stand-alone offering with possible references to various required and elective modules	**Links to other Study Programs of the University** 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 are creditable 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	**Online Tests:** no
Type of Exam	See Selected Course

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
0 h	0 h	0 h	0 h	0 h	0 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		5	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	**Online Tests:** no
Type of Exam	See Selected Course

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

Instructional Methods
See Selected Course

Career Development

Module Code: DLBKAENT_E

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

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

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

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

Module Exam Type	
Module Exam	**Split Exam** <u>Personal Career Plan</u> • Study Format "Distance Learning": Advanced Workbook <u>Personal Elevator Pitch</u> • Study Format "Distance Learning": Concept Presentation

Weight of Module
see curriculum

Module Contents

Personal Career Plan

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

Personal Elevator Pitch

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

Learning Outcomes

Personal Career Plan

On successful completion, students will be able to

- understand, apply, and reflect presented career theory and models with regard to their personal situation to arrive at a concept or pictore of a desired career.
- understand and critically reflect the concept of career and career planning.
- understand the relevance of a strategically oriented career planning.
- understand the importance of and conduct a personal assessment to identify one's personality, values, motivation, strengths, competencies, skills, and interests.
- understand the necessity of building and maintaining their own personal brand.
- understand differing job search processes across national/international contexts, and to create context-sensitive job applications accordingly.
- understand the principles of global careers and how to effectively act in international environments.

Personal Elevator Pitch

On successful completion, students will be able to

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

Links to other Modules within the Study Program	Links to other Study Programs of the University
This module is similar to other modules in the field of Human Resources	All Bachelor Programs in the Human Resources field

Personal Career Plan

Course Code: DLBKAENT01_E

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

Course Description
In today's complex and ever-changing environment, the forms of careers vary depending on the context, understanding of values, and market dynamics. The 'classic career ladder' that one is climbing being the only predominant form of career is long outdated, and individuals are being confronted with a great number of opportunities regarding industry or job choice and working arrangements.Considering the great variety of options especially for well-educated individuals, has become more important than ever to make informed decisions. This course is designed to support students maneauvering themselves through these complexities of their personal career plan, whereby self-awareness, self-reflection, and goal-setting are important elements of this process. Guided by central elements of career theory, career models, and research outcomes, students will be given tools and reflection exercises to arrive at a solid, directly applicable strategy to further steet their professional progress and career steps.

Course Outcomes

On successful completion, students will be able to

- understand, apply, and reflect presented career theory and models with regard to their personal situation to arrive at a concept or pictore of a desired career.
- understand and critically reflect the concept of career and career planning.
- understand the relevance of a strategically oriented career planning.
- understand the importance of and conduct a personal assessment to identify one's personality, values, motivation, strengths, competencies, skills, and interests.
- understand the necessity of building and maintaining their own personal brand.
- understand differing job search processes across national/international contexts, and to create context-sensitive job applications accordingly.
- understand the principles of global careers and how to effectively act in international environments.

Contents

1. Career Theories and Approaches
   - 1.1 Traditional Career Theories and Models
   - 1.2 Protean Career Orientation
   - 1.3 Career Learning Cycle

2. Career Development

2.1 Career Motives
2.2 Career Roles
2.3 Career Performance

3. Career Planning
   3.1 Essentials of Career Planning
   3.2 The Career Planning Process
   3.3 Contingencies of Career Planning

4. Personal Assessment
   4.1 Personality
   4.2 Values and Motivation
   4.3 Competencies, Skills, Strengths, and Fields of Interest

5. Career Choice
   5.1 Possible Career Paths
   5.2 Forms of Careers
   5.3 Employability
   5.4 Career Identity

6. Develop a Career Strategy and Manage your Career
   6.1 Career Capital
   6.2 Career Goals
   6.3 Career Success
   6.4 Personal Reflection
   6.5 Personal Branding

7. Global Careers
   7.1 Forms of Global Careers
   7.2 Individual Characteristics of Global Leaders
   7.3 Role of Interculturality
   7.4 Diversity and Inclusion

8. Search for Employment in Germany and Abroad
   8.1 Job Search Databases
   8.2 Networks and Platforms
   8.3 Shaping Resume and Cover Letter
   8.4 Written and Video Application
   8.5 Selection Procedures

Literature
Compulsory Reading
Further Reading ▪ Baruch, Y. (2022). Managing Careers and Employability. SAGE. ▪ Greenhaus, J.H., Callanan, G.A., & Godshalk, V.M. (2018). Career Management for Life (5th edition). College of Business & Public Management Faculty Books. ▪ Hoeckstra, H. (2011). A career roles model of career development. Journal of Vocational Behavior, 78(2), 159-173. ▪ Ibarra, H. (2004). Working Identity: Unconventional Strategies for Reinventing Your Career. Harvard Business School Press. ▪ Kingsley, T. (2022). Personal Branding. Independently published. ▪ Ng, T.W.H., Eby, L.T., Sorensen, K.L., & Feldman, D.C. (2005). Predictors of objective and subjective career success: A meta-analysis. Personnel psychology, 58(2), 367-408. ▪ Ng, T.W.H., & Feldman, D.C. (2014). Subjective career success: A meta-analytic review. Journal of Vocational Behavior, 85(2), 169-179.

Study Format Distance Learning

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

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Advanced Workbook

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

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

Personal Elevator Pitch

Course Code: DLBKAENT02_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Mastering Prompts

Module Code: DLBWMP_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	BA	10	300 h

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

Module Coordinator

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

Contributing Courses to Module

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

Module Exam Type

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

Weight of Module
see curriculum

Module Contents

Artificial Intelligence

Project: AI Excellence with Creative Prompting Techniques

Learning Outcomes

Artificial Intelligence

On successful completion, students will be able to

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

Project: AI Excellence with Creative Prompting Techniques

On successful completion, students will be able to

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

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

Artificial Intelligence

Course Code: DLBDSEAIS01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

	3.3 Time-Difference and Q Learning
4.	Natural Language Processing (NLP)
	4.1 Introduction to NLP and Application Areas
	4.2 Basic NLP Techniques
	4.3 Vectorizing Data
5.	Computer Vision
	5.1 Introduction to Computer Vision
	5.2 Image Representation and Geometry
	5.3 Feature Detection
	5.4 Semantic Segmentation

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

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

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

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

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

Project: AI Excellence with Creative Prompting Techniques

Course Code: DLBPKIEKPT01_E

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

AWS Cloud Specialization

Module Code: DLBAWSCLSP

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

Georgi Dimchev (Project: AWS - Cloud Essentials) / Prof. Dr. Tianxiang Lu (Project: AWS - Cloud Advanced)

Contributing Courses to Module

- Project: AWS - Cloud Essentials (DLBPAWSCLES01)
- Project: AWS - Cloud Advanced (DLBPAWSCLAD01)

Module Exam Type	
Module Exam	**Split Exam** Project: AWS - Cloud Essentials • Study Format "Distance Learning": Written Assessment: Project Report Project: AWS - Cloud Advanced • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module
see curriculum

Module Contents

Project: AWS - Cloud Essentials

Students will learn the foundational concepts and services of Amazon Web Services (AWS), covering its core infrastructure services including computing, storage, and networking through practical experience. Emphasis is placed on practical skills for deploying Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) solutions.

Project: AWS - Cloud Advanced

This course offers advanced understanding of AWS, with a particular emphasis on specialized areas such as Solutions Architecture, Compliance & Security, and AI & Machine Learning. Students will acquire hands-on expertise in these areas, with the goal of enabling them to deploy laaS, Paas, or SaaS workloads using AWS, effectively tackle real-life interdisciplinary challenges, and confidently handle service configurations within the AWS cloud console.

Learning Outcomes

Project: AWS - Cloud Essentials

On successful completion, students will be able to

- understand the core services of AWS including compute, network, databases, and storage, deployment models (on-premises, hybrid, and vpc).
- explain the shared responsibility model, describe the basic global infrastructure and core security services.
- describe the AWS Well-Architected Framework and the basics of AWS Cloud Migration.
- get familiar with the terminology and concepts related to AWS Services, the AWS Management Console, AWS security measures, IAM and AWS networking services.
- apply and manage core service settings within the AWS cloud console effectively.
- assess data storage services in AWS to meet various application needs.
- plan and implement a scenario-based serverless service for small or medium-sized companies.
- configure basic network security using Amazon CloudWatch monitoring features for simple use cases in AWS, ensuring secure cloud operations.
- critically examine the core billing, account management, and pricing models and explain how to use pricing tools to make cost-effective choices for AWS services.

Project: AWS - Cloud Advanced

On successful completion, students will be able to

- understand and articulate the core services provided by AWS within chosen specialization tracks, including Solutions Architect, Compliance & Security, and AI & Machine Learning.
- critically examine the pros and cons of developing and deploying real-world scenarios using AWS IaaS, PaaS, vs. SaaS and public, private or hybrid deployment demonstrating a clear grasp of the necessary service and deployment intricacies.
- manage and configure profound service settings within the AWS cloud console, showing depth in technical proficiency and operational capabilities.
- critically assess, test and monitor the effect of different AWS deployment features, addressing interdisciplinary challenges through the appropriate use of AWS cloud services in realistic use cases.
- assess and critically reflect on AWS-based solutions, considering industry compliance and security requirements, ensuring a robust understanding of the legal and regulatory framework.
- apply and implement machine learning and artificial intelligence concepts using AWS to solve real-world problems, demonstrating innovative thinking and practical application of theoretical knowledge.

Links to other Modules within the Study Program	**Links to other Study Programs of the University**
This module is similar to other modules in the field of Computer Science & Software Development	All Bachelor Programs in the IT & Technology field

Project: AWS - Cloud Essentials

Course Code: DLBPAWSCLES01

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

Course Description

Amazon Web Services (AWS) is a comprehensive cloud computing platform provided by Amazon that offers scalable computing power, storage, and various other functionalities to help businesses and individuals deploy applications and manage data efficiently. It reduces the need for physical hardware, thus lowering costs and increasing flexibility by allowing users to access services and resources on-demand from anywhere in the world. This service is highly relevant for daily life and business as it supports a wide range of applications and services, from hosting websites to supporting IoT devices and big data analytics, ultimately facilitating innovation, scalability, and global operations.This course prepares students for the AWS Cloud Practitioner Certificate, providing a foundational understanding of AWS core services. Students will learn to articulate the benefits and use cases of AWS IaaS, PaaS, and SaaS, and grasp the basics of public, private, and hybrid cloud deployments. The course emphasizes practical skills in managing and configuring AWS services, ensuring students can effectively navigate the AWS cloud console. It lays the groundwork for critical assessments of AWS deployment features, addressing compliance and security requirements, and preparing students for more advanced AWS certifications and applications

Course Outcomes

On successful completion, students will be able to

- understand the core services of AWS including compute, network, databases, and storage, deployment models (on-premises, hybrid, and vpc).
- explain the shared responsibility model, describe the basic global infrastructure and core security services.
- describe the AWS Well-Architected Framework and the basics of AWS Cloud Migration.
- get familiar with the terminology and concepts related to AWS Services, the AWS Management Console, AWS security measures, IAM and AWS networking services.
- apply and manage core service settings within the AWS cloud console effectively.
- assess data storage services in AWS to meet various application needs.
- plan and implement a scenario-based serverless service for small or medium-sized companies.
- configure basic network security using Amazon CloudWatch monitoring features for simple use cases in AWS, ensuring secure cloud operations.
- critically examine the core billing, account management, and pricing models and explain how to use pricing tools to make cost-effective choices for AWS services.

Contents

- This course offers a comprehensive exploration of Amazon Web Services (AWS), focusing on its core services such as computing, networking, databases, and storage solutions. Students will delve into the AWS shared responsibility model, understand the global infrastructure, and learn about the integral security services provided. This also covers the AWS Well-Architected Framework and an introduction of the fundamentals for cloud migration strategies. Through hands-on exercises, students will gain proficiency in managing AWS environments using the AWS Management Console and implement security measures via AWS Identity and Access Management (IAM) and network services. Additionally, the course emphasizes the importance of cost management, enabling students to critically analyze AWS pricing models to make informed financial decisions for cloud-based solutions.

Literature

Compulsory Reading

Further Reading

- AWS Training and Certification Skill Builder. (2024). AWS Cloud Practitioner Essentials (7 hours).
- AWS Training and Certification Skill Builder. (2024). AWS Cloud Quest: Cloud Practitioner.
- AWS Training and Certification Skill Builder. (2024). AWS Technical Essentials (4 hours).
- AWS Training and Certification Skill Builder. (2024). Serverless – Knowledge Badge Readiness Path (13 hours).
- AWS Training and Certification Skill Builder. (2024). Standard Exam Prep Plan: AWS Certified Cloud Practitioner (CLF-C02) (18 hours).

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Project: AWS - Cloud Advanced

Course Code: DLBPAWSCLAD01

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

Course Description

AWS (Amazon Web Services) is a comprehensive cloud computing platform provided by Amazon that offers scalable computing power, storage, and various other functionalities to help businesses and individuals deploy applications and manage data efficiently. It reduces the need for physical hardware, thus lowering costs and increasing flexibility by allowing users to access services and resources on-demand from anywhere in the world. This service is highly relevant for daily life and business as it supports a wide range of applications and services, from hosting websites to supporting IoT devices, big data analytics and machine learning, ultimately facilitating innovation, scalability, and global operations. The course prepares students for the AWS Cloud Solution Architect Professional Certificate. It dives deeper into AWS core services, focusing on sophisticated deployment and management techniques. Students will critically examine and apply real-world scenarios using AWS IaaS, PaaS, and SaaS, and navigate complex deployment models. They will gain technical proficiency in managing advanced service settings within the AWS cloud console and address interdisciplinary challenges through hands-on practice. Additionally, the course covers assessing AWS solutions for compliance and security, ensuring robust understanding of legal frameworks. Students will also implement machine learning and AI concepts to solve real-world problems, fostering innovative thinking and practical application, and preparing them for the dynamic demands of the tech industry.

Course Outcomes

On successful completion, students will be able to

- understand and articulate the core services provided by AWS within chosen specialization tracks, including Solutions Architect, Compliance & Security, and AI & Machine Learning.
- critically examine the pros and cons of developing and deploying real-world scenarios using AWS IaaS, PaaS, vs. SaaS and public, private or hybrid deployment demonstrating a clear grasp of the necessary service and deployment intricacies.
- manage and configure profound service settings within the AWS cloud console, showing depth in technical proficiency and operational capabilities.
- critically assess, test and monitor the effect of different AWS deployment features, addressing interdisciplinary challenges through the appropriate use of AWS cloud services in realistic use cases.
- assess and critically reflect on AWS-based solutions, considering industry compliance and security requirements, ensuring a robust understanding of the legal and regulatory framework.
- apply and implement machine learning and artificial intelligence concepts using AWS to solve real-world problems, demonstrating innovative thinking and practical application of theoretical knowledge.

Contents

- This course ensures students gain a comprehensive understanding of AWS, specializing in Solutions Architect, Compliance & Security, and AI & Machine Learning. They will articulate core AWS services and critically examine the pros and cons of deploying real-world scenarios using AWS IaaS, PaaS, SaaS, and different deployment models (public, private, hybrid).
- Students will manage and configure service settings within the AWS cloud console, demonstrating technical proficiency. They will assess, test, and monitor AWS deployment features, addressing interdisciplinary challenges using realistic use cases. Additionally, students will evaluate AWS-based solutions for industry compliance and security, understanding the legal and regulatory frameworks.
- The course also covers applying machine learning and AI concepts using AWS to solve real-world problems, encouraging innovative thinking and practical application. This approach prepares students to excel in cloud architecture, compliance protocols, security measures, and AI-driven problem-solving, ensuring readiness for the tech industry's dynamic demands.

Literature
Compulsory Reading
Further Reading ▪ AWS Training and Certification Skill Builder. (2024). AWS Solutions Architect – Knowledge Badge Readiness Path (51 hours). ▪ AWS Training and Certification Skill Builder. (2024). Generative AI Learning Plan for Developers (12 hours). ▪ AWS Training and Certification Skill Builder. (2024). Online Course Supplement: Practical Data Science with Amazon SageMaker (1 day).

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Project

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

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

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

Internship

Module Code: FSINTER

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	None		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. Andreas Simon (Internship)

Contributing Courses to Module

- Internship (FSINTER01)

Module Exam Type	
Module Exam Study Format: Distance Learning Internship Reflection Paper (passed / not passed)	**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 previously during their study program 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 organizational 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 myStudies programs

Internship

Course Code: FSINTER01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
	English		10	None

Course Description

This module consists of two parts: (1) preparation tutorials and (2) the internship itself. During the preparation tutorials, students will learn about the intention of the internship and about the intellectual as well as social requirements of the working environment.

Course Outcomes

On successful completion, students will be able to

- apply skills and knowledge they have obtained previously during their study program 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 organizational 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 Regulations of the IU.

Literature

Compulsory Reading

Further 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.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	

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

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

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

Digital Business Models

Module Code: CSEBLODB-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. Muhammad Ashfaq (Digital Business Models)

Contributing Courses to Module
▪ Digital Business Models (CSEBLODB01-01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies Exam, 90 Minutes	**Split Exam**
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 This module is similar to other modules in the Business Administration and Management field	**Links to other Study Programs of the University** All Bachelor Programmes in the Business field

Digital Business Models

Course Code: CSEBLODB01-01_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

Literature

Compulsory Reading

Further Reading

- Gassmann, O., Frankenberger, K., & Choudury, M. (2020). The business model navigator: The strategies behind the most successful companies (Second edition). FT Financial Times publishing. Pearson Education, Limited.
- Weil, P., & Woerner, S. L. (2018). What's your digital business model? Six questions to help you to build the next-generation enterprise. Harvard Business Review Press.
- Wirtz, B. W. (2019). Digital Business Models: Concepts, Models, and the Alphabet Case Study (1st edition 2019). Progress in IS. Springer International Publishing.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	Contact Hours	Tutorial/Tutorial Support	Self Test	Independent Study	Hours Total
84 h	36 h	0 h	30 h	0 h	150 h

Principles of Management

Module Code: CSEBBAPM_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 Herrmann (Principles of Management)

Contributing Courses to Module
▪ Principles of Management (CSEBBAPM01_E)

Module Exam Type	
Module Exam Study Format: Campus Studies Written Assessment: Case Study	**Split Exam**
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 field

Principles of Management

Course Code: CSEBBAPM01_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 Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
94 h	36 h	0 h	20 h	0 h	150 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Course Book	☑ Online Tests
☑ Video	☑ Guideline
☑ 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
	Bachelor Thesis • Study Format "Distance Learning": Bachelor Thesis Colloquium • Study Format "Distance Learning": Colloquium

Weight of Module

see curriculum

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Module Contents

Bachelor Thesis

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

Colloquium

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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).

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Links to other Modules within the Study Program

All modules in the Bachelor program

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Links to other Study Programs of the University

All Bachelor Programs in distance learning

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Bachelor Thesis

Course Code: DLBBT01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
BA	English		9	none

Course Description
The aim and purpose of the bachelor's thesis is to successfully apply the subject-specific and methodological competencies acquired during the course of study in the form of an academic dissertation with a thematic reference to the major field of study. The content of the bachelor's thesis can be a practical-empirical or theoretical-scientific problem. Students should prove that they can independently analyze a selected problem with scientific methods, critically evaluate it, and work out proposed solutions under the subject-methodological guidance of an academic supervisor. The topic chosen by the student from their respective field of study should meet the acquired scientific competences, deepening their academic knowledge and skills in order to meet the future needs of the field.

Course Outcomes

On successful completion, students will be able to

- work on a problem from their major field of study by applying the specialist and methodological skills they have acquired during their studies.
- independently analyze selected tasks with scientific methods, critically evaluate them, and develop appropriate solutions under the guidance of an academic supervisor.
- record and analyze existing (research) literature appropriate to the topic of their bachelor's thesis.
- prepare a detailed written elaboration in compliance with scientific methods.

Contents

- The bachelor's thesis must be written on a topic that relates to the content of the respective major field of study. In the context of the bachelor's thesis, the problem, as well as the scientific research goal, must be clearly emphasized. The work must reflect the current state of knowledge of the topic to be examined by means of an appropriate literature analysis. The student must prove their ability to use the acquired knowledge theoretically and/or empirically in the form of an independent and problem-solution-oriented application.

Literature
Compulsory Reading
Further Reading ▪ Lipson, C. (2018). How to write a BA thesis. A practical guide from your first ideas to your finished paper (2nd ed.). University of Chicago Press. ▪ Turabian, K. L. (2013). A Manual for Writers of Research Papers, theses, and dissertations (8th ed.). University of Chicago Press. ▪ Selection of literature according to topic

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Thesis Course

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

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
270 h	0 h	0 h	0 h	0 h	270 h

Instructional Methods

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 Distance Learning

Study Format	Course Type
Distance Learning	Thesis Course

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

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

Instructional Methods