Hochschule Bochum
Bochum University
of Applied Sciences

Campus
Velbert/Heiligenhaus

Modulhandbuch des Masterstudiengangs Mechatronics am Campus Velbert/Heiligenhaus:

mit dem Abschluss

Master of Science (M.Sc.)

Stand: 02/2026

Inhaltsverzeichnis

German as a foreign Language

Deutsch als Fremdsprache

ID number	Workload	Credits	Semester	Duration
CVH-MA-GL	360 h	12	winter and summer semester	2 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Lecture	2 SWS / 60 h	240 h	100
	Exercise	2 SWS / 60 h		30

2 Learning outcomes / competences

After completing this module, students will be able to communicate effectively in basic everyday and university-related situations. They will understand and respond to simple questions, express needs and facts in short sentences, and engage in basic social interactions both orally and in writing.

Students can describe their daily routines, explain their academic background, and talk about their living conditions. They are capable of handling routine tasks such as shopping or making medical appointments. Furthermore, they can compose and respond to short, simple emails in German.

In addition to linguistic skills, students will have developed an awareness of cultural differences between their home countries and Germany. They are able to articulate these differences and reflect on them. Moreover, they have acquired basic knowledge of the German political system and are familiar with commonly used terms and job titles in the professional context.

Students know the keys to active participation in German society, in particular membership in various clubs such as sports, carnival or shooting clubs and involvement in voluntary work, e.g. with the volunteer fire brigade or the THW (Federal Agency for Technical Relief). Therefore they have insight into German society, have an idea how to integrate and participate, facilitate personal development and how to ultimately settle in.

After completing the module students are enabled to reach at least level A2 of the Common European Framework of Reference for Languages (CEFR).

3 Contents

- Development of all four language skills: listening, reading, speaking, and writing
- Emphasis on spoken communication in everyday contexts
- Basic up to expanded grammar structures and sentence formation
- Vocabulary related to daily life, socialising, university, housing, workplace and professional life (job titles, routines)
- Exercises in oral interaction and short writing tasks (e.g. personal emails)
- Introduction to cultural norms and social practices in Germany
- Practical communication in professional settings (e.g. job interviews, appointments)
- Insights into the German political system and social structures
- Comparative reflection on cultural values and societal expectations

4 Teaching methods

Seminaristic lessons with exercises

5 Content requirements for participation

6	**Form of examination** Assignment (10-20 pages) with presentation and with oral examination (10-30 min)
7	**Requirements for the award of credit points** Regular active participation (at least 22 recorded attendance dates, which are collected continuously) & adequate exam performance
8	**Use of the module in other study programs**
9	**Importance of the grade for the final grade** No influence on the final grade
10	**Module coordinator and full-time lecturer, representative**
11	**Further information**

Vehicle Dynamics

Fahrzeugdynamik

ID number	Workload	Credits	Semester	Duration
CVH-MA-VD	180 h	6	annually in winter semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Lecture	2 SWS / 30 h	120 h	100
	Exercise	2 SWS / 30 h		

2 Learning outcomes / competences

Students understand the dynamic behavior of motor vehicles and know methods to predict behavior.

They have learnt relevant technical terms and are able to make quantitative statements about vehicle-specific parameters

3 Contents

- Force generation on tire
- Longitudinal dynamics: driving resistance, drive map, Torque and speed conversion, driving performance, driving limits
- Lateral dynamics: bicycle model, self-steering gradient, driving behavior
- Vertical dynamics: wheel loads, types of vehicle excitation, transfer functions, elements for influencing vehicle vibrations

4 Teaching methods

Seminaristic lessons with exercises

5 Content requirements for participation

Technical mechanics

6 Form of examination

Examination (written, 120 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient”

8 Use of the module in other study programs

9 Importance of the grade for the final grade

1/20

10 Module coordinator and full-time lecturer, representative

Prof. Dr.-Ing. Stefan Breuer

11 Further information / literature

- Gillespie,T.: Fundamentals of Vehicle Dynamics, ISBN-10 1560911999
- Reimpell, J., Betzler, J.: Fahrwerkstechnik: Grundlagen, Vogel Verlag, Würzburg, 2005
- Mitschke, M., Wallentowitz, H.: Dynamik der Kraftfahrzeuge, Springer Verlag, Wiesbaden, 2014
- Breuer, S.; Rohrbach-Kerl, A: Fahrzeugdynamik, Springer Verlag, Wiesbaden, 2015

Sensors and mobile robots

Sensoren und mobile Roboter

ID number	Workload	Credits	Semester	Duration
CVH-MA-SMR	180 h	6	annually in winter semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Workshop	3 SWS / 45 h	120 h	30
	Practise	1SWS / 15 h		

2 Learning outcomes / competences

- Students will understand the principles and functionality of various sensor technologies and learn how to integrate and filter sensor data effectively.
- Students will be able to apply localisation, mapping, and navigation techniques to enable autonomous robot movement and obstacle avoidance.
- Students will develop skills in robotic vision systems, including processing RGB and depth camera data, implementing stereo vision, and utilising computer vision for object detection and environmental perception.
- Students will gain proficiency in using robotic software frameworks like ROS, applying them to integrate sensors, test systems in simulation tools, and analyse real-world robotic applications..

3 Contents

- Introduction to Mobile Robotics
- Sensor Fundamentals
- Localisation and Mapping
- Vision Systems for Robotics
- Environmental Perception
- Mobile Robot Kinematics
- Communication Systems for Mobile Robots
- Robotic Software Frameworks
- Case Studies and Applications

4 Teaching methods

Seminar-style teaching with integrated practical elements

5 Content requirements for participation

6 Form of examination

Written assignment (15-35 pages) with presentation or with oral examination (10-30 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient” and successfully completed Testat

8 Use of the module in other study programs

9 Importance of the grade for the final grade

1/20

10	**Module coordinator and full-time lecturer, representative** Prof. Dr. Michael Danner
11	**Further information / literature** CORKE, Peter. Robotics, Vision and Control: fundamental algorithms in Python. Springer Nature, 2023. ISBN 978-3031064692

Electromagnetism

Elektromagnetismus

ID number	Workload	Credits	Semester	Duration
CVH-MA-ELM	180 h	6	annually in winter semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Lecture	3 SWS / 45 h	120 h	100
	Exercise	1 SWS / 15 h		30

2 Learning outcomes / competences

The students are familiar with the mathematical foundation of field theory and can evaluate corresponding electromagnetic problems using the methods of vector calculus. They understand the concept of expressing circuits in terms of effort and flow. They can derive appropriate magnetic circuits from a given technical situation, and can interpret these in terms of differential-algebraic systems of equations (DAEs). They are familiar with technically relevant properties of such circuits and can solve the DAEs accordingly.

3 Contents

- field theory
  - differential operators
  - Gauß's, Stokes' and Green's theorem
  - differential equations
- electro- and magnetostatics
  - Maxwell's equations
  - potentials and gauge transformation
  - multipole expansion
- electrodynamics
  - plane waves and equations of telegraphy
  - electric and magnetic circuits
  - oscillatory circuts and wave guides

4 Teaching methods

Lectures and discussion sessions

5 Content requirements for participation

Understanding of mathematics equivalent to two semesters of university level calculus and one semester of university level linear algebra

Understanding of electromagnetism equivalent to two semesters of university level electrical engineering.

6 Form of examination

Examination (written, 120 min)

7 Requirements for the award of credit points

Examination graded with at least "sufficient"

8 Use of the module in other study programs

9	**Importance of the grade for the final grade** 1/20
10	**Module coordinator and full-time lecturer, representative** Prof. Dr. Herbert Schmidt
11	**Further information** ./.

Software for mechatronic systems

Software für mechatronische Systeme

ID number	Workload	Credits	Semester	Duration
CVH-MA-SMS	180 h	6	annually in winter semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Lecture	3 SWS / 45 h	120 h	100
	Exercise	1 SWS / 15 h		40

2 Learning outcomes / competences

The students have a deep understanding of the impact of software in mechatronic systems.

They can apply their knowledge of computer science, including programming languages, frameworks, and development tools, to conceptualise and to develop software for mechatronic systems and to analyse, to maintain, and to advance existing systems.

3 Contents

- review of fundamentals of computer science: numbering systems, computer memory, pointers, control structures, functions, parameters, storage classes of variables
- state machines, object-oriented programming, events
- basic algorithms and data structures
- micro-controller programming in C: cross development, bit manipulation, I/O ports, interrupts
- introduction to the Python programming language
- further development tools, version control systems
- introduction to the Robot Operating System (ROS): hardware abstraction, device drivers, event system, packaging, distributed computing

4 Teaching methods

Lectures and discussion sessions

5 Content requirements for participation

6 Form of examination

Examination (written, 120 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient”

8 Use of the module in other study programs

9 Importance of the grade for the final grade

1/20

10 Module coordinator and full-time lecturer, representative

Prof. Dr. rer. nat. Peter Gerwinski

11 Further information

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Advanced Computer-Aided Engineering

CAE Advanced

ID number	Workload	Credits	Semester	Duration
CVH-MA-ACAE	180 h	6	annually in summer semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Lecture	3 SWS / 45 h	120 h	100
	Exercise	1 SWS / 15 h		30

2 Learning outcomes / competences

Students can understand and evaluate computer-aided development processes. They are able to use computer-aided tools and assess their performance capabilities and limitations. Students can work on tasks independently using various computer-aided tools. They will be able to use techniques such as Finite Element Method (FEM) and rapid prototyping in the development processes and analyze their results.

3 Contents

- Computer-aided Engineering (CAE) in the development process
- Computer-aided Design (CAD)
- Applied Finite Element Method (FEM)
- Dimensioning of machine elements
- Application of 3D printing, rapid prototyping

4 Teaching methods

Seminar-style teaching, project work, group work

5 Content requirements for participation

Experience in a CAD system is desired.

6 Form of examination

Examination (written, 120 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient”

8 Use of the module in other study programs

9 Importance of the grade for the final grade

1/20

10 Module coordinator and full-time lecturer, representative

Prof. Dr.-Ing Gregor Steinberger

11 Further information / literature

Signals and Controls

Signale und Regelungssysteme

ID number	Workload	Credits	Semester	Duration
CVH-MA-SC	180 h	6	annually in summer semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Lecture	3 SWS / 45 h	120 h	100
	Exercise	1 SWS / 15 h		40

2 Learning outcomes / competences

The students are familiar with a variety of technically relevant aspects of control theory. They can summarize the respective concepts and ideas what to use it for. They know examples for control theory in practical use and can argue based on underlying principles and properties why these examples are useful for a given technical situation.

3 Contents

- Tasks, Objectives and Application of Control Engineering
- Mathematical modelling of technical systems via differential equations
- Behaviour and Analysis of LTI Systems
- Selective Topics of Filters, State Space, Observers, Discrete Systems and Computer Aided Control System Design (e.g. by using Matlab)
- Control design (e.g. PID, compensation controller in time-, frequency or Laplace-Domain, State Space Control)
- Analysis and Design of Controlled Systems
- Simulation and Application of Controlled Systems

4 Teaching methods

Lectures and discussion sessions

5 Content requirements for participation

The students are familiar with the mathematical foundation of Linear Algebra, Analysis and Differential Equations.
They understand basic concepts Physics, Electric / electronic Systems, Mechanical Systems and Mechatronics.

6 Form of examination

Examination (written, 120 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient”

8 Use of the module in other study programs

9 Importance of the grade for the final grade

1/20

10 Module coordinator and full-time lecturer, representative

Prof. Dr.-Ing Markus Lemmen

11	**Further information / literature** Feedback Control of Dynamic Systems (Franklin, Powell et al) CTMS – Control Tutorials for Matlab & Simulink (Carnegie Mellon University https://ctms.engin.umich.edu/CTMS)

Electric Drives

Elektrische Antriebe

ID number	Workload	Credits	Semester	Duration
CVH-MA-ELD	180 h	6	annually in summer semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Lecture	3 SWS / 45 h	120 h	100
	Exercise	1 SWS / 15 h		30

2 Learning outcomes / competences

- The students have a substantial knowledge of the fundamental concepts of electro-mechanical systems, that they can apply to understand the operation and analyse the static and dynamic behaviour of electric machines needed to develop and evaluate drive system solutions to be deployed in industrial and traction applications.
- Applying the concepts and methods learnt in this module, they are proficient in selecting the appropriate motors in order to devise and design solutions for electric drive system.

3 Contents

- Review of essential concepts of electromechanical systems
- Asynchronous and synchronous machine in electric drives
- Selected drive concepts

4 Teaching methods

Seminar-style teaching with integrated practical elements

5 Content requirements for participation

Understanding of mathematics equivalent to two semesters of university level calculus and one semester of university level linear algebra. Understanding of basic electrical engineering equivalent to two semesters of university level engineering. Understanding of the module CVH-MA-AEM and basic mechanics.

6 Form of examination

Examination (written, 150 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient”

8 Use of the module in other study programs

9 Importance of the grade for the final grade

1/20

10 Module coordinator and full-time lecturer, representative

Prof. Dr.-Ing Mohammad Ashfaq

11 Further information / literature

Lab Project

Laborprojekt

ID number	Workload	Credits	Semester	Duration
CVH-MA-LP	360 h	12	Every semester	2 semesters

1	Type of Course	Contact time	Self-study	Planned group size
	Workshop	1 SWS / 30 h	330 h	1-6

2 Learning outcomes / competences

- Students are able to put scientific/technical methods from the Master's program into practice
- They know how to transfer theoretical knowledge into practice.
- They are able to work independently in scientific and technical fields in Industry and Society.
- Students have strengthened their teamwork skills and can organize themselves in a team.
- They are practiced in time and resource management.
- Students can give presentations using presentation techniques.
- Students can scientifically analyse and reflect on the tasks, possible solutions, the selection of solution approaches, the success of their implementation, and their relevance for the field of application, industry, and society.

3 Contents

- Students work on a project alone or in small groups.
- The project can be carried out either in a laboratory on the Velbert/Heiligenhaus campus or in a cooperating company.
- The objective is to address a practical problem related to the field of the degree program. The project must be thematically linked to methods or knowledge from one or more courses of the Master's program.
- The field of application may be freely chosen e.g. within mechatronics or other thematically related areas such as industrial automation, healthcare technologies, medical engineering, or other society-related applications.

4 Teaching methods

Project work

5 Content requirements for participation

6 Form of examination

Written assignment (20-70 pages) with presentation or with oral examination (10-30 min)

7 Requirements for the award of credit points

Examination graded with at least "sufficient"

8 Use of the module in other study programs

9	**Importance of the grade for the final grade** 1/10
10	**Module coordinator and full-time lecturer, representative** Every professor involved in the program
11	**Further information / literature**

Functional Materials

Funktionsmaterialien

ID number	Workload	Credits	Semester	Duration
CVH-MA-FM	180 h	6	annually in winter semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Lecture	3 SWS / 45 h	120 h	100
	Exercise	1 SWS / 15 h		30

2 Learning outcomes / competences

The students are familiar with a variety of technically relevant classes of functional and multifunctional materials.
They can summarize the respective concepts and ideas that make either of these useful. They know examples for materials in practial use and can argue based on underlying principles and properties why these examples are useful for a given technical situation.

3 Contents

- materials with particular thermal properties
  - thermoelectric effects
  - thermal shape memory effect
- materials with particular electric properties
  - electrostriction and piezoelectricity
  - electroactive polymers
- materials with particular magnetic properties
  - micromagnetism
  - soft magnetic materials
  - hard magnetic materials
  - magnetostrictive materials
  - magnetic shape memory alloys

4 Teaching methods

Lectures and discussion sessions

5 Content requirements for participation

Understanding of basic concepts of condensed matter physics including fundamental ideas of quantum mechancis, formation of solids and phase diagrams.

Understanding of basic concepts of electromagnetism.

6 Form of examination

Examination (written, 120 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient”

8 Use of the module in other study programs

9 Importance of the grade for the final grade

1/20

10	**Module coordinator and full-time lecturer, representative** Prof. Dr. Herbert Schmidt
11	**Further information** ./.

Automated Driving

Automatisiertes Fahren

ID number	Workload	Credits	Semester	Duration
CVH-MA-AD	180 h	6	annually in summer semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Workshop	4 SWS / 60 h	120 h	30

2 Learning outcomes / competences

Students understand fundamental principles of automated driving. They can describe selective processes, name necessary prerequisites and framework conditions of legal, social and technical nature and know examples of solution approaches from relevant literature. Based on the knowledge acquired they will be able to describe and solve selected tasks from the field of automated driving.

3 Contents

- Introduction to Automated Driving
- Technical, legal and social framework conditions
- Sensors and actuators, signal conditioning, processing and filtering / filter methods
- Modelling, system structuring and system integration
- Development processes and development tools

4 Teaching methods

Seminar-style teaching with integrated practical elements

5 Content requirements for participation

Understanding Signals & Controls, Sensors & Mobile Robots,
Fundamentals of Vehicle Dynamics, Software for Mechatronic Systems

6 Form of examination

Written assignment (15-35 pages) with presentation or with oral examination (10-30 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient”

8 Use of the module in other study programs

9 Importance of the grade for the final grade

1/20

10 Module coordinator and full-time lecturer, representative

Prof. Dr.-Ing Markus Lemmen

11 Further information / literature

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Digital Image Processing

Digitale Bildverarbeitung

ID number	Workload	Credits	Semester	Duration
CVH-MA-DIP	180 h	6	annually in summer semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Workshop	4 SWS / 60 h	120 h	100

2 Learning outcomes / competences

- Students understand the basic methods of digital image processing.
- They know methods for describing and characterising images. They can evaluate, select and use them.
- They know methods for recognizing structures in images and are thus able to pre-process images for subsequent pattern recognition.
- Students learn the basics of feature calculation and classification in relation to image data.
- They can apply the methods they have learned with common image processing tools (Matlab, OpenCV, Python).

3 Contents

- Importance of digital image processing in technical applications
- Basics of image acquisition and calibration of camera systems
- Linear and non-linear filter operations, morphological filters
- Processing, detection and measurement of geometric objects (edges, corners, textures)
- Processing and detection of edges and contours (Hough transformation etc.)
- Spectral techniques (Discrete Fourier Transformation, Discrete Cosine Transformation)
- Features and classification methods in image object recognition

4 Teaching methods

Seminar-style teaching with integrated practical elements

5 Content requirements for participation

Knowledge of higher mathematics (e.g. matrix calculation, convolution, statistics, integral transformations)

6 Form of examination

Written assignment (15-35 pages) with presentation or with oral examination (10-30 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient”

8 Use of the module in other study programs

9 Importance of the grade for the final grade

	1/20
10	**Module coordinator and full-time lecturer, representative** Prof. Dr.-Ing Dietmar Gerhardt
11	**Further information / literature**

Control of electric drives

Regelung elektrischer Antriebe

ID number	Workload	Credits	Semester	Duration
CVH-MA-CED	180 h	6	annually in winter semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
	Lecture	2 SWS / 30 h	120 h	100
	Exercise	1 SWS / 15 h		30
	Practise	1 SWS / 15 h		30

2 Learning outcomes / competences

- The students can analyse and develop drive control systems based on the dynamic behaviour of the electric machines, mechanical components and inverters.
- They can apply the commonly used control methods including field-oriented control learnt in the module to analyse and develop solutions for industrial and traction applications of appropriate complexity.

3 Contents

- Common electric drive system structures
- Common methods of speed and position control
- Drive inverters and their modulation techniques

4 Teaching methods

Seminar-style teaching with integrated practical elements

5 Content requirements for participation

Thorough understanding of the concepts learnt in the modules CVH-MA-SC, CVH-MA-AEM and CVH-MA-ELD

6 Form of examination

Examination (written, 150 min)

7 Requirements for the award of credit points

Examination graded with at least “sufficient” and successfully completed Testat

8 Use of the module in other study programs

9 Importance of the grade for the final grade

1/20

10 Module coordinator and full-time lecturer, representative

Prof. Dr.-Ing Mohammad Ashfaq

11 Further information / literature

Masterthesis with Colloquim

Masterarbeit with Kolloquium

ID number	Workload	Credits	Semester	Duration
CVH-MA-MT	750 h (MT) 150 h (C)	25 (MT) 5 (C)	every semester	1 Semester

1	Type of Course	Contact time	Self-study	Planned group size
			900 h	1

2 Learning outcomes / competences

In the Master's thesis students prove that they are able to

- work on a topic of application-oriented research and development within a specified period of time,
- use and evaluate subject-related primary and secondary literature as a basis for their work,
- present the results of their own work in a comprehensible form and
- Students can scientifically analyse and reflect on the tasks, possible solutions, the selection of solution approaches, the success of their implementation, and their relevance for the field of application, industry, and society.

3 Contents

Based on the knowledge gained from one or more modules of the Master's degree program, a topic from the field of application-oriented research and development is agreed between the student and the supervisor. A suitable selection of the technical and scientific methods to be used in the work is made jointly.

The field of application may be freely chosen e.g. within mechatronics or other thematically related areas such as industrial automation, healthcare technologies, medical engineering, or other society-related applications.

4 Teaching methods

Self-study under supervision (preparation of the Master's thesis), colloquium (possibly in the form of a public lecture)

5 Content requirements for participation

After submitting a written application to the examination board, candidates who have passed or completed all examinations and certificates of the Master's program except for the final thesis and the colloquium will be admitted to the Masterthesis.

6 Form of examination

Written Master's thesis (25 ECTS) with Colloquium (5 ECTS)

7 Requirements for the award of credit points

Completion of the Master's thesis within 5 months in English.

- Submission of the Master's thesis in triplicate to the Examination Office by the deadline.
- Written assurance that the thesis was written independently and that no sources and aids other than those specified were used.
- Public presentation by the student with discussion of the Master's thesis

	• The module must be graded at least 4.0.
8	**Use of the module in other study programs**
9	**Importance of the grade for the final grade** 5/20
10	**Module coordinator and full-time lecturer, representative** Chairman of the Examination Board; all professors of the Velbert/Heiligenhaus campus
11	**Further information / literature**