Technische Hochschule Ingolstadt

Module Handbook

M.Eng. INTERNATIONAL AUTOMOTIVE ENGINEERING

Faculty of

Electrical Engineering and Information Technology

Study and examination regulation WS 25/26

As of: 13.03.2026

Content

1 Introduction

1.1 Overview

In the field of automotive development, strong efforts should be made on national and international level to adequately prepare students for coping with the technical exigencies of future automobiles. Engineers with interdisciplinary knowledge in mechanics, electronics and computer science are particularly wanted. The Master-programme "International Automotive Engineering" (IAE) wants to impart dedicated engineering approaches for the development of automotive mechatronic systems and to give instructions for solving specific problems of developing automotive electronic systems in general as well as for vehicle safety systems specifically.

The programme takes four semesters. Semester 1 prepares students that have been graduated from different engineering disciplines for the subsequent modules. The following two semesters are dedicated to lectures, seminars and projects. The third semester is reserved for the Master's thesis. The curriculum of the Master's programme has been tailored towards the intermediation of expertise that is required to work on problems in development of electronic systems in automobiles. It mediates the special of the engineer-scientific approach. It explains the means of language and symbols to be used in automobile projects. However, scientific oriented work in a master programme means that students learn independently and solely responsible.

Multi-disciplinary modules structure the programme. The subjects of the modules emanate from mechanical engineering, electrical engineering, mathematics and engineering methodology.

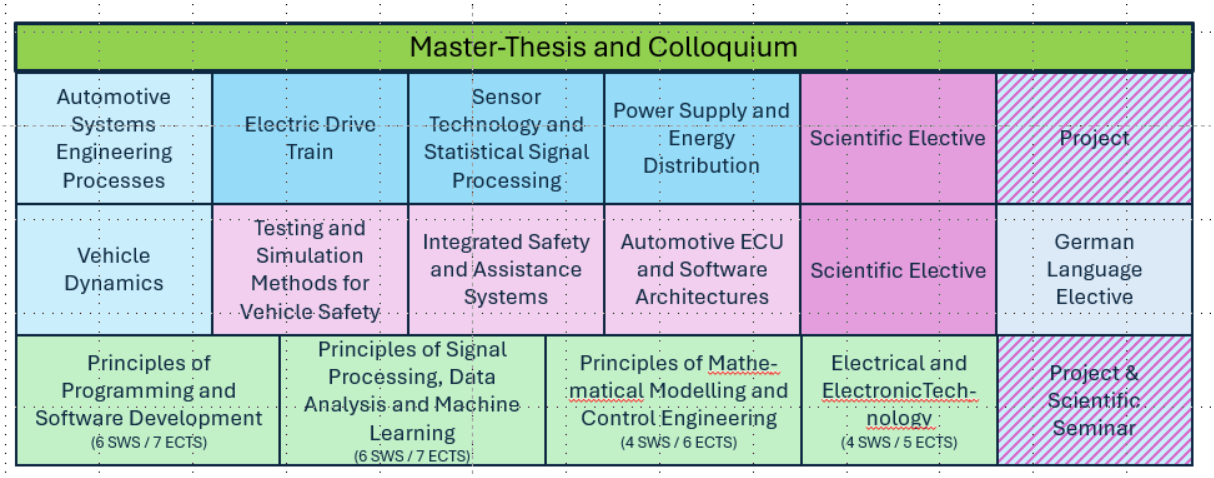

Figure 1: General Programme structure

Compulsory modules aim at transfer of knowledge an automotive engineer must have. The compulsory module Project enables students to incorporate into a new complex task and - based on a division of labor - to work on this task interdisciplinary in a team using suitable scientific methods.

Legal Basis

This module handbook describes the curriculum of the Master's degree program in International Automotive Engineering and its courses in accordance with the General Examination Regulations of the Technical University of Ingolstadt (APO THI) dated July 17, 2023. The curriculum is described in an appendix that applies to all students who have enrolled in M.Eng. International Automotive Engineering at TH Ingolstadt since winter term 2025/26.

In particular, the module handbook specifies the study objectives and content of the individual compulsory modules as well as the division of the semester hours per week per module and semester. It also contains more detailed provisions on course-related performance and attendance assessments. In the event of ambiguities, the higher-level study and examination regulations take precedence.

The list of compulsory and elective courses offered in a specific semester are documented in the study guide for the respective semester. The study guide is published in the Moodle course room dedicated to this degree program.

1.2 Graduation

The Technische Hochschule Ingolstadt awards the academic degree

Master of Engineering (M.Eng.)

1.3 Advisor and Programme Coordinator

For subject-oriented questions and problems, the course advisor is available. Questions related to the organization will be answered by the programme coordinator. Advisor and coordinator is

Prof. Dr. Armin Arnold, building A, room 123, phone 0841 / 9348-7980

The consultation hours that apply during the semester are announced via Moodle.

2 Basic Structure of the Programme

The Master's programme starts every summer and winter semester. Due to the modular structure of the degree programme it is possible to complete all subjects both at the beginning in the summer and at the beginning in the winter semester. Therefore, not every subject is offered every semester. The following two tables represent the curriculum for a study start in the winter semester or in the summer semester.

2.1 Compulsories

Start in winter

SPO-No.	Module	Semester 1		Semester 2		Semester 3		Semester 4	
		SWS/ ECTS	Exam	SWS/ ECTS	Exam	SWS/ ECTS	Exam	SWS/ ECTS	Exam
1	Principles of Programming and Software Development	6 / 7	PF						
2	Principles of Signal Processing, Data Analysis and Machine Learning	6 / 7	PF						
3	Principles of Mathematical Modelling and Control Engineering	4 / 6	schrP						
4	Automotive Electrical and Electronic Technology	4 / 5	schrP						
14	Engineering Project	2 / 2.5	Proj						
15	Research Methods	2 / 2.5	SA						
6	Vehicle Dynamics			4 / 5	schrP				
9	Automotive ECU and Software Architectures			4 / 5	PF				
12	Integrated Safety and Assistance Systems			4 / 5	schrP				
13	Testing and Simulation Methods for Vehicle Safety			4 / 5	schrP				
17	Scientific Elective			4 / 5	LN				
5	German Language Elective			4 / 5	LN				
7	Power Supply and Energy Distribution					4 / 5	schrP		
8	Sensor Technology and Statistical Signal Processing					4 / 5	schrP		
10	Automotive Systems Engineering Processes					4 / 5	mdlP		
11	Electric Drive Train					4 / 5	schrP		
16	Team Project					2 / 5	Proj		
17	Scientific Elective					4 / 5	LN		
18	Master Thesis							0 /30	
18.1	Master Thesis								MA
18.2	Master Thesis Colloquium								Koll
	Sum	24/30		24/30		22/30		0/30	

schrP written exam
Proj project work
SA seminar paper
mdlP oral exam
LN subject-defined exam
PF portfolio exam
MA Master Thesis
Koll Colloquium

Start in summer

SPO-No.	Module	Semester 1		Semester 2		Semester 3		Semester 4	
		SWS/ ECTS	Exam	SWS/ ECTS	Exam	SWS/ ECTS	Exam	SWS/ ECTS	Exam
1	Principles of Programming and Software Development	6 / 7	PF						
2	Principles of Signal Processing, Data Analysis and Machine Learning	6 / 7	PF						
3	Principles of Mathematical Modelling and Control Engineering	4 / 6	schrP						
4	Automotive Electrical and Electronic Technology	4 / 5	schrP						
14	Engineering Project	2 / 2.5	Proj						
15	Research Methods	2 / 2.5	SA						
7	Power Supply and Energy Distribution			4 / 5	schrP				
8	Sensor Technology and Statistical Signal Processing			4 / 5	schrP				
10	Automotive Systems Engineering Processes			4 / 5	mdlP				
11	Electric Drive Train			4 / 5	schrP				
17	Scientific Elective			4 / 5	LN				
5	German Language Elective			4 / 5	LN				
6	Vehicle Dynamics					4 / 5	schrP		
9	Automotive ECUs and Software Architectures					4 / 5	PF		
12	Integrated Safety and Assistance Systems					4 / 5	schrP		
13	Testing and Simulation Methods for Vehicle Safety					4 / 5	schrP		
16	Team Project					2 / 5	Proj		
17	Scientific Elective					4 / 5	LN		
18	Master Thesis							0 /30	
18.1	Master Thesis								MA
18.2	Master Thesis Colloquium								Koll
	Sum	24/30		24/30		22/30		0/30	

schrP written exam
Proj project work
SA seminar paper
mdlP oral exam
LN subject-defined exam
PF portfolio exam
MA Master Thesis
Koll Colloquium

2.2 Electives

Scientific Electives

Required scientific elective modules are modules offered to students as part of the degree programme. Each student must complete a total of two elective modules according to the study and examination regulations. The selected modules are handled like compulsory modules. A claim that all scientific elective modules envisaged in a specific semester are offered, does not exist. Likewise, there is no claim that the associated teaching events are carried out if the number of participants is insufficient. Which modules are offered in the respective semester can be found in the study guide of the semester.

German Language Elective

From the catalogue of compulsory German language modules offered, modules worth 5 ECTS or modules worth 2.5 ECTS can be selected and included. If compulsory German language modules worth 2.5 ECTS are taken, the number of performance assessments to be completed increases accordingly. A performance assessment must be completed in each module. The performance assessment is graded with the designation “passed” or “failed”. The modules are included in the transcript with the module designation.

3 Description of Modules

3.1 Compulsory Modules

Principles of Programming and Software Development			
Module abbreviation	IAE_ProgSW	**Reg.-Nr.**	1
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	1
Module frequency	winter and summer term	**Module duration**	1 semester

Responsible for module	Hagerer, Andreas		
Lecturer(s)	Hagerer, Andreas		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	7 ECTS / 6 SWS		
Workload	Contact hours		70 h
	Self-study		105 h
	Total		175 h
Subjects of the module	Principles of Programming and Software Development		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

PF - Portfolio Exam (with exams during the examination period)

Additional explanations regarding examinations

The portfolio exam aims to assess your ability to apply fundamental programming and software development skills in real-world and problem-solving contexts. It consists of three individual examinations

- a practical examination (written test, 30 minutes, (10%, participation required to pass, mid of April))
- a practical examination (programming project) to be submitted online with an interview about code produced (20%, submission and participation required to pass, end of May)
- a computer based written exam (90 minutes, closed book) asking with programming and software development concepts comprehension and writing of short code pieces (70%, examination period)

If an individual examination is not attended, the overall grade will be “not attended” (in German: nicht teilgenommen). The module is passed if about 50% of the marks have been achieved in each part.

Prerequisites according examination regulation

None

Recommended prerequisites

Basic mathematical understanding (logic, functions, variables); basic knowledge of computer science and programming is advantageous: concepts such as algorithms, data types, control structures; ability to learn independently, solve problems and debug

Objectives

After successfully completing the master's thesis, students are able to

- know how to use basic data structures and control statements in Python programs.
- design and implement programs to solve real-world problems in Python.

- apply object-oriented concepts.
- know the concepts of the scientific Python ecosystem.
- create, manipulate and use NumPy arrays efficiently to solve linear algebra problems.
- be familiar with software development concepts like software lifecycle, software specification and process models, software project management, and quality standards.
- apply methods used to plan, develop and engineer software solutions.

Content

- information representation and manipulation by means of variables, data structures, statements and control structures
- structuring programs by means of functions and modules
- introduction to object-oriented programming
- modules and concepts of the scientific Python ecosystem: NumPy, Matplotlib, Scikit-Learn
- phases and characteristics of software processes: requirements engineering, software modeling, design and implementation
- software processes: V-model and MISRA development guideline, process assessment (CMMI, automotive SPICE), model-based development (Matlab/Simulink/Stateflow), supporting processes (e.g. versioning with git, requirements tracing)

Literature

- MATTHES, Eric, 2023. *Python crash course: a hands-on, project-based introduction to programming*. San Francisco: No Starch Press. ISBN 978-1-7185-0270-3
- GUTTAG, John, 2021. *Introduction to computation and programming using Python: with application to computational modeling and understanding data*. Cambridge, MA: The MIT Press. ISBN 978-0-262-36343-3
- PINE, David J., 2019. *Introduction to Python for science and engineering* [online]. Boca Raton ; London ; New York: CRC Press PDF e-Book. ISBN 978-0-429-01425-3, 978-0-429-50641-3. Verfügbar unter: https://doi.org/10.1201/9780429506413.
- LANGTANGEN, Hans Petter, 2016. *A primer on scientific programming with Python* [online]. Berlin: Springer PDF e-Book. ISBN 978-3-662-49887-3. Verfügbar unter: https://doi.org/10.1007/978-3-662-49887-3.

Additional remarks

None

Principles of Signal Processing, Data Analysis and Machine Learning			
Module abbreviation	IAE_SigML	**Reg.-Nr.**	2
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	1
Module frequency	winter and summer term	**Module duration**	1 semester

Responsible for module	Botsch, Michael		
Lecturer(s)	Botsch, Michael; Elter, Tim		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	7 ECTS / 6 SWS		
Workload	Contact hours		70 h
	Self-study		105 h
	Total		175 h
Subjects of the module	Principles of Signal Processing, Data Analysis and Machine Learning		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

PF - Portfolio Exam (with exams during the examination period)

Additional explanations regarding examinations

The examination consists of two individual exams:

- a 45-minute written exam before the examination period (33% overall weight, held in week 12 of the semester),
- a 90-minute written exam during the examination period (67% overall weight).

If an individual examination is not attended, the overall grade will be recorded as “not attended” (in German: nicht teilgenommen). The overall exam is considered passed if more than 50% of the weighted points are achieved.

Prerequisites according examination regulation

None

Recommended prerequisites

A thorough understanding of complex variables and mathematical analysis is required.

Objectives

After successfully completing the master's thesis, students are able to

- describe and analyse the properties of signals and discrete-time linear systems in the time and frequency domain using discrete-time transforms.
- design linear discrete-time filters with prescribed properties.
- determine the limitations and impact of sampling and quantisation on the conversion of analogue to digital signals.
- apply (fast) Fourier-Transforms to analyse and realise discrete-time signal processing systems.
- understand statistical machine learning (ML).
- identify ML potential and limitations in application domains.
- choose appropriate ML methods, models, and algorithms for a given problem.
- analyze properties of ML models and algorithms.

Content

1. fundamentals of discrete-time signals and systems
2. system analysis and transform techniques
3. sampling theory
4. digital filter design and filter implementation
5. classification tasks and basic learning algorithms
6. model architectures and learning techniques
7. models for sequential data
8. unsupervised learning

Literature

- OPPENHEIM, Alan V. und Ronald W. SCHAFER, 2014. *Discrete-time signal processing*. Harlow: Pearson. ISBN 978-1-292-03815-5
- VAIDYANATHAN, P. P., 2024. *Signals, systems, and signal processing*. Cambridge: Cambridge University Press. ISBN 978-1-00-941229-2
- MURPHY, Kevin P., 2022. *Probabilistic machine learning: an introduction*. Cambridge, Massachusetts: The MIT Press. ISBN 978-0-262-36930-5
- VAN DER PLAS, Jake. *Python Data Science Handbook* [online]. PDF e-Book. Verfügbar unter: https://jakevdp.github.io/PythonDataScienceHandbook/.

Additional remarks

None

Principles of Mathematical Modelling and Control Engineering			
Module abbreviation	IAE_MathCtrlEng	**Reg.-Nr.**	3
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	1
Module frequency	winter and summer term	**Module duration**	1 semester

Responsible for module	Kefferpütz, Klaus		
Lecturer(s)	Kefferpütz, Klaus		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	6 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		103 h
	Total		150 h
Subjects of the module	Principles of Mathematical Modelling and Control Engineering		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

schrP90 - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

Mathematical foundations, in particular:
- Differential and integral calculus.
- Linear differential equations with constant coefficients.
- Complex numbers and functions.
- Partial fraction decomposition of rational functions.
- Laplace transform.

Objectives

After successfully completing the module, students are able to

- investigate real technical systems, to structure them into appropriate subsystems and derive suitable differential equations or systems of differential equations.
- analyze control systems and create models in the time and frequency domain.
- analyze systems with regards to dynamics, oscillatory behavior and stability.
- understand the system specifications which a closed-loop circuit must fulfill.
- evaluate and select suitable controller structures in accordance to the specifications.
- apply different methods to parameterize the controller structures and analyze the results in simulations.

Content
• methodological approaches to derive ordinary differential equations from simple electrical and mechanical systems • different methods to implement linear and non-linear differential equations in Matlab/Simulink (transfer functions, state space representation, ...) • Laplace-transformation and its fields of application (implementation and analysis of LTI-systems) • system description and representation in the time and frequency domain • elementary control loop elements • control loops: requirements, behavior, design • controller synthesis: root locus / Bode diagram / empirical approach
Literature
• SUN, Jing, 2018. *Control engineering: fundamentals* [online]. Berlin: De Gruyter PDF e-Book. ISBN 978-3-11-057327-5. Verfügbar unter: https://doi.org/10.1515/9783110573275. • BOLTON, William, 2010. *Control engineering*. Harlow u.a.: Prentice Hall. ISBN 978-0-582-32773-3 • DORF, Richard C. und Robert H. BISHOP, 2022. *Modern control systems*. Harlow, United Kingdom: Pearson. ISBN 978-1-292-42235-0
Additional remarks
None

Automotive Electrical and Electronic Technology

Module abbreviation	IAE_ElecTechn	**Reg.-Nr.**	4
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	1
Module frequency	winter and summer term	**Module duration**	1 semester

Responsible for module	Arnold, Armin		
Lecturer(s)	Arnold, Armin		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Automotive Electrical and Electronic Technology		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

schrP90 - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the master's thesis, students are able to

- have acquainted the special characteristics and specifications of electronic systems in vehicles.
- understand the specific characteristics of the most important sensors and actuators and are able to select the appropriate components for any given problem.
- know the electric architecture of automotive control units and applied integrated circuits.
- know about different vehicle networks and can explain the communication principles of the corresponding electronic components.

Content

- basics of electrical and electronic engineering
- introduction to sensor and actuator technology
- basic functionalities of different bus systems
- control unit circuits for input and sensor signal conditioning, output drivers and controlling actuators, power supply
- physical layer of automotive communication networks and onboard communication
- introduction to automotive electric standards

Literature
• ZAMAN, Najamuz, 2015. *Automotive electronics design fundamentals* [online]. Cham [u.a.]: Springer PDF e-Book. ISBN 978-3-319-17584-3. Verfügbar unter: https://doi.org/10.1007/978-3-319-17584-3. • IDA, Nathan, 2021. *Engineering Electromagnetics* [online]. Cham: Springer International Publishing PDF e-Book. ISBN 978-3-030-15557-5. Verfügbar unter: https://doi.org/10.1007/978-3-030-15557-5. • ROBERT BOSCH GMBH (ED.), 2014. *Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive* [online]. PDF e-Book. ISBN 978-3-658-01784-2. Verfügbar unter: https://doi.org/10.1007/978-3-658-01784-2.
Additional remarks
None

Vehicle Dynamics			
Module abbreviation	IAE_VDS	**Reg.-Nr.**	6
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	2, 3
Module frequency	only summer term	**Module duration**	1 semester

Responsible for module	Arnold, Armin		
Lecturer(s)	Arnold, Armin		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Vehicle Dynamics		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

schrP90 - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

ability to apply the physical rules of mechanical systems, especially Newton's laws; basic knowledge of electrics/electronics

Objectives

After successfully completing the master's thesis, students are able to

- explain and judge all tire properties that are important for vehicle dynamics.
- calculate according to some simplified vehicle models.
- analyse how drivetrain, brakes and other chassis components work together, e.g. like control arms, spring rates, position of center of gravity, differentials including limited slip differentials, torque-vectoring-differentials.
- explain the operational principles of ABS-control.
- explain vehicle stability control systems.
- deduct the additional possibilities given by four-wheel-steering, torque-vectoring and active suspensions.

Content

- tire and tire properties under different conditions (camber, normal force, combinations of longitudinal and/or lateral slip
- Kamm's circle and its application to different scenarios
- properties of rubber and brush model of tire
- vehicle models (single track model steady state and dynamically, application to cornering, banked road, sidewind, physical and effective sideslip stiffness)

- influencing driving behaviour by means of suspension:
  - roll- und instant center, (elasto)-kinematics
  - spring stiffnesses
  - distribution of driving- and braking torques
- drive train influences: behavior of open differentials, limited slip differentials (viscous and clutch type, 4WD)
- ABS algorithm
- traction control and vehicle stability control
- torque vectoring

Literature

- REIMPELL, Jörnsen, Jürgen W. BETZLER und Helmut STOLL, 2001. *The automotive chassis: engineering principles: chassis and vehicle overall, wheel suspensions and types of drive, axle kinematics and elastokinematics, steering - springing - tyres, construction and calculations advice*. Oxford [u.a.]: Butterworth-Heinemann. ISBN 0-7506-5054-0
- MILLIKEN, William F. und Douglas L. MILLIKEN, 1995. *Race car vehicle dynamics*. Warrendale, PA: SAE International. ISBN 1-56091-526-9, 978-1-56091-526-3
- GENTA, Giancarlo und Lorenzo MORELLO, . *The automotive chassis*. [Dordrecht]: Springer Netherland.
- HANEY, Paul, 2012. *The racing & high-performance tire: using the tires to tune for grip and balance*. Dallas, Tex. [u.a.]: InfoTire [u.a.]. ISBN 0-9646414-2-9, 978-0-7680-12415

Additional remarks

None

Power Supply and Energy Distribution			
Module abbreviation	IAE_PSED	**Reg.-Nr.**	7
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	2, 3
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Pforr, Johannes		
Lecturer(s)	Pforr, Johannes		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Power Supply and Energy Distribution		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

schrP90 - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

Basic knowledge of electronics

Objectives

After successfully completing the master's thesis, students are able to

- have good knowledge in the field of modern energy distribution systems in cars and of the components used in the automotive energy nets.
- understand why energy management systems are important for the operation of electric energy nets in cars.
- understand the operation principle of power electronic converters for automotive applications.
- understand and to use methods to develop steady-state and dynamic models of power electronic converters for given type of problems.
- understand the operation principle of modern electric machines for electric and hybrid electric vehicles including the control of the electric machines.
- derive models of given automotive energy nets and the components and to perform simulations for optimization purposes

Content

Introduction, background and design of vehicular electrical energy distribution networks and power electronic systems and devices:

- power devices and converter topologies
- 14V / 48V power supply and energy distribution

- generation of electric power in vehicles
- energy management Systems
- high voltage electric energy distribution for hybrid vehicles
- electric motor drives and motion control
- simulation of power devices and energy distribution

Literature

- VELTMAN, André, PULLE, Duco W. J., DE DONCKER, Rik W., 2016. *Fundamentals of Electrical Drives* [online]. Cham: Springer International Publishing PDF e-Book. ISBN 978-3-319-29409-4, 978-3-319-29408-7. Verfügbar unter: https://doi.org/10.1007/978-3-319-29409-4.
- ERICKSON, Robert W. und Dragan MAKSIMOVIĆ, 2004. *Fundamentals of power electronics*. Dordrecht: Kluwer. ISBN 0-7923-7270-0, 978-0-7923-7270-7
- LEONHARD, Werner, 2001. *Control of electrical drives*. Berlin [u.a.]: Springer. ISBN 3-540-41820-2
- EHSANI, Mehrdad, Yimin GAO und Ali EMADI, 2010. *Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory, and design*. Boca Raton, FL [u.a.]: CRC Press, Taylor & Francis Group. ISBN 978-1-4200-5400-2, 978-1-4200-5398-2

Additional remarks

No remarks.

Sensor Technology and Statistical Signal Processing			
Module abbreviation	IAE_ST&SP	**Reg.-Nr.**	8
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	General Elective Subject	2, 3
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Botsch, Michael		
Lecturer(s)	Botsch, Michael		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Sensor Technology and Statistical Signal Processing		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

schrP90 - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the master's thesis, students are able to

- describe major trends in the automotive sensor market.
- categorize automotive sensors with respect to the underlying physical effects.
- analyze sensor signals in the time- and frequency-domain.
- apply statistical signal processing algorithms (e. g., Kalman filter) to automotive sensor data.
- evaluate algorithms for sensor data fusion.
- design and apply simple machine learning algorithms.
- implement statistical signal processing algorithms in Matlab.

Content

- introduction to automotive sensors
  - automotive sensor market
  - sensor technologies
  - sensor types and characteristics
  - multi-modal sensor systems
- statistical signal processing
  - signal types and characteristics

- basics of statistical signal processing
- pattern recognition
- Kalman filter

- sensor data fusion
  - data association
  - track-to-track fusion
- analog and digital processing of signals
  - analog filters, amplifiers and A/D-converters
  - Fourier-series and -transform, Laplace- and z-transform
  - digital filters

Literature

- SEVERAL AUTHORS, . Current publications from IEEE Symposium on Intelligent Vehicle and from IEEE International Conference on Intelligent Transportation Systems. In: , IEEE, Hrsg.*IEEE Intelligent Vehicles Symposium / IEEE International Conference on Intelligent Transportation Systems*.
- BOTSCH, Michael und Wolfgang UTSCHICK, 2020. *Fahrzeugsicherheit und automatisiertes Fahren: Methoden der Signalverarbeitung und des maschinellen Lernens* . ISBN 978-3-446-45326-5
- WINNER, Hermann, DIETMAYER, Klaus C J., ECKSTEIN, Lutz, JIPP, Meike, MAURER, Markus, STILLER, Christoph, 2024. *Handbuch Assistiertes und Automatisiertes Fahren: Grundlagen, Komponenten und Systeme für assistiertes und automatisiertes Fahren* [online]. Wiesbaden: Springer Fachmedien Wiesbaden PDF e-Book. ISBN 978-3-658-38486-9. Verfügbar unter: https://doi.org/10.1007/978-3-658-38486-9.
- BAR-SHALOM, Yaakov, LI, Xiao-Rong, KIRUBARAJAN, Thiagalingam, 2001. *Estimation with applications to tracking and navigation* [online]. New York: Wiley PDF e-Book. ISBN 0-471-46521-6, 978-0-471-46521-8. Verfügbar unter: http://onlinelibrary.wiley.com/book/10.1002/0471221279.
- REIF, Konrad, 2016. *Sensoren im Kraftfahrzeug* [online]. Wiesbaden: Springer Vieweg PDF e-Book. ISBN 978-3-658-11211-0, 978-3-658-11210-3. Verfügbar unter: https://doi.org/10.1007/978-3-658-11211-0.

Additional remarks

None

Automotive ECUs and Software Architectures			
Module abbreviation	IAE_EcuArch	**Reg.-Nr.**	9
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	2, 3
Module frequency	only summer term	**Module duration**	1 semester

Responsible for module	Margull, Ulrich		
Lecturer(s)	Margull, Ulrich		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Automotive ECUs and Software Architectures		
Lecture types	SU/Ü/PR - seminar based teaching/Exercise course/laboratory		

Examinations

PF - Portfolio Exam (with exams during the examination period)

Additional explanations regarding examinations

The portfolio exam consists of 4 partial exams: 3 midterms and 1 final exam. Each midterm exam contributes 16% to the total grade. The midterms will cover the following contents:

- Midterm 1 (written exam): ECU Hardware: Sensors, CPU, memory, virtual memory, PWM; 23.4.2026
- Midterm 2 (written exam): SW Development+Architecture: numbers (integer, fix-point, floating), SW architecture, real-time systems; 11.6.2026
- Midterm 3 (practical exercise): SW development with git; 30.6.2026
- Final exam (oral, 15 minutes) contributes 52% to the final grade. It covers the SW development processes and AUTOSAR as well as all previous content. The exam will take place 20. - 24.7.2026.

The final grade is the sum of all partial exams. Passing grade is 50%.

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the master's thesis, students are able to

- explain the main components of vehicle electronic/electrical systems.
- recognize key operational blocks within a typical automotive ECU.
- explain operating principles of ECU microcontrollers/microprocessors and peripherals.
- identify software/firmware control blocks and the interaction with hardware.
- develop and design software for embedded, automotive, real-time systems using AUTOSAR.
- explain concepts of server-zone architecture with central HPC and architectural concepts of software defined vehicles.

Content

- ECU fundamentals and hardware architecture
- embedded software and fail-safe software implementation
- architecture of automotive software: modularity, software layers, real-time systems (tasks, scheduling), resource management (deadlocks, semaphores, priority inversion), interrupts and timers
- AUTOSAR development process for classic (Virtual Function Bus, Application Components, RTE, BSW, AUTOSAR OS) and adaptive AUTOSAR
- currently used protocols and communication patterns for automotive architectures based on the service-oriented architecture (SOA) paradigm
- essentials and building blocks of software defined vehicles

Literature

- MARWEDEL, Peter, 2021. *Embedded system design: embedded systems foundations of cyber-physical systems, and the internet of things*. Cham, Switzerland: Springer. ISBN 978-3-030-60909-2, 978-3-030-60912-2
- LEE, Edward A. und Sanjit Arunkumar SESHIA, 2019. *Introduction to embedded systems: a cyber-physical systems approach*. Dehli: PHI Learning. ISBN 978-93-88028-40-0
- SCHÄUFFELE, Jörg und Thomas ZURAWKA, 2016. *Automotive software engineering: principles, processes, methods, and tools*. Warrendale, Pennsylvania, USA: SAE International. ISBN 978-0-7680-7992-0
- PANDIAN, Sivakumar, KUMAR, B. Vinoth, DEVI, R. S. Sandhya, 2022. *Software engineering for automotive systems: principles and applications* [online]. Boca Raton ; London ; New York: CRC Press PDF e-Book. ISBN 978-1-003-26990-8, 9781003269908. Verfügbar unter: https://doi.org/10.1201/9781003269908.
- BLOKDYK, Gerardus, 2021. *AUTOSAR: a complete guide ; practical tools for self-assessment*. 2020. Auflage. [Erscheinungsort nicht ermittelbar]: 5starcooks. ISBN 978-0-6559-1480-8

Additional remarks

None

Automotive Systems Engineering Processes			
Module abbreviation	IAE_SysEng	**Reg.-Nr.**	10
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	2, 3
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Giesler, Björn		
Lecturer(s)			
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Automotive Systems Engineering Processes		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

mdlP - oral exam, 20 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the master's thesis, students are able to

- understand methods and processes for systems requirements engineering, system architecture and system testing for the modern automotive industry.
- have acquired knowledge on the design, development, and integration of complex vehicle systems, ensuring functionality, safety, and efficiency.
- are familiar with different systematic approaches that encompasses various engineering disciplines like mechanical, electrical, software, and control systems, to manage the increasing complexity of modern vehicles.

Content

Key aspects of automotive systems engineering

- interdisciplinary approach
- system-level thinking
- requirements Management
- architectural design
- integration and verification

Processes and methodologies

- vehicle development projects
- product strategy
- phases of the product evolution process
- V-model, agile development, and model based systems engineering (MBSE)
- E/E-system development

Literature

- MAURER, Markus, 2013. *Automotive systems engineering* [online]. Berlin [u.a.]: Springer PDF e-Book. ISBN 978-3-642-36455-6. Verfügbar unter: https://doi.org/10.1007/978-3-642-36455-6.
- BORKY, John M., BRADLEY, Thomas H., 2019. *Effective Model-Based Systems Engineering* [online]. Cham: Springer International Publishing PDF e-Book. ISBN 978-3-319-95669-5. Verfügbar unter: https://doi.org/10.1007/978-3-319-95669-5.
- WEBER, Julian, 2009. *Automotive development processes: Processes for successful customer oriented vehicle development* [online]. Berlin: Springer PDF e-Book. ISBN 3-642-01252-3, 978-3-642-01252-5. Verfügbar unter: https://doi.org/10.1007/978-3-642-01253-2.
- BHISE, Vivek D., 2017. *Automotive product development: a systems engineering implementation*. Boca Raton ; London ; New York: CRC Press. ISBN 978-1-351-64581-2

Additional remarks

None

Electric Drive Train			
Module abbreviation	IAE_ElectDT	**Reg.-Nr.**	11
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	2, 3
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Schiele, Thomas		
Lecturer(s)			
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Electric Drive Train		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

schrP90 - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

none

Recommended prerequisites

basic knowledge of physics (Work, Power, Forces, Torques, ...), engineering mathematics (differential and integral calculus), electrical engineering fundamentals, engineering mechanics

Objectives

After successfully completing the master's thesis, students are able to

- have detailled knowledge of electric and hybrid drivetrain components (e-motor, power-electronics, energy-storage systems, basics of IC engines).
- understand advantages and disadvantages of different drivetrain concepts according to driving performance and energy consumption.
- know basic principles of operational strategies and energy management in electric and hybrid vehicles.
- explain the principles of different charging systems.
- know details about vehicle storage systems and their advantages and disadvantages.
- set up models and evaluate results from dynamic drivetrain simulations focussing on the impact of operation principles on factors like driving performance and efficiency.

Content

- basics of vehicle movement, driving resistances and energy consumption
- electric machines for electric and hybrid vehcles
- power-electronics for electric motors
- drivetrain concepts for electric vehicels
- hybrid drivetrain concepts and operational strategies

- energy storage systems for vehicle applications
- charging systems for electric vehicles
- modelling and simulation of different drivetrain concepts
- intelligent strategies for energy management

Literature

- PATEL, Nil, BHOI, Akash Kumar, PADMANABAN, Sanjeevikumar, HOLM-NIELSEN, Jens Bo, 2021. *Electric vehicles: modern technologies and trends* [online]. Singapore: Springer PDF e-Book. ISBN 978-981-159-251-5. Verfügbar unter: https://doi.org/10.1007/978-981-15-9251-5.
- ELGOWAINY, Amgad, 2021. *Electric, Hybrid, and Fuel Cell Vehicles* [online]. New York, NY: Springer New York PDF e-Book. ISBN 978-1-07-161492-1. Verfügbar unter: https://doi.org/10.1007/978-1-0716-1492-1.
- DOPPELBAUER, Martin, 2025. *Grundlagen der Elektromobilität: Technik, Praxis, Energie und Umwelt* [online]. Wiesbaden: Springer Fachmedien Wiesbaden PDF e-Book. ISBN 978-3-658-44828-8. Verfügbar unter: https://doi.org/10.1007/978-3-658-44828-8.
- KAMPKER, Achim, HEIMES, Heiner Hans, 2024. *Elektromobilität: Grundlagen einer Fortschrittstechnologie* [online]. Berlin, Germany: Springer Vieweg PDF e-Book. ISBN 978-3-662-65812-3. Verfügbar unter: https://doi.org/10.1007/978-3-662-65812-3.

Additional remarks

None

Integrated Safety and Assistance Systems			
Module abbreviation	IAE_ISAS	**Reg.-Nr.**	12
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	General Elective Subject	2, 3
Module frequency	only summer term	**Module duration**	1 semester

Responsible for module	Botsch, Michael		
Lecturer(s)	Botsch, Michael; Dirndorfer, Tobias		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Integrated Safety and Assistance Systems		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

schrP90 - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

Mathematics for Engineers

Recommended prerequisites

None

Objectives

After successfully completing the master's thesis, students are able to

- to explain basic vehicle components that are required for driver assistance systems and for vehicle integrated safety functions.
- to analyze and evaluate state of the art driver assistance systems.
- to describe testing procedures that are used for vehicle active safety functions.
- to explain mathematically the concepts for motion planning that are used in algorithms for driver assistance systems and integrated safety functions.
- to implement basic trajectory planning algorithms in Matlab.

Content

- introduction to IS & DAS
- examples of driver assistance and integrated vehicle safety systems: parking systems, adaptive cruise control, autonomous emergency braking
- position and orientation: pose, representing pose in 2-D and in 3-D
- time and motion: generation of trajectories, rate of change and inverse problem
- vehicle motion models: decoupled X- and Y-dynamics, constant velocity model, constant steering angle and velocity model, constant turn rate and acceleration model, one-track model, two-track model
- navigation and localization

Literature
• KELLY, Alonzo, 2013. *Mobile robotics: mathematics, models, and methods*. New York, NY: Cambrige Univ. Press. ISBN 978-1-107-03115-9 • HEISSING, Bernd, ERSOY, Metin, 2016. *Chassis handbook: fundamentals, driving dynamics, components, mechatronics, perspectives* [online]. Wiesbaden: Vieweg+Teubner PDF e-Book. ISBN 978-3663205197. • WINNER, Hermann, HAKULI, Stephan, LOTZ, Felix, SINGER, Christina, 2019-. *Handbook of Driver Assistance Systems: Basic Information, Components and Systems for Active Safety and Comfort* [online]. Cham: Springer International Publishing PDF e-Book. ISBN 978-3-319-09840-1. Verfügbar unter: https://doi.org/10.1007/978-3-319-09840-1. • BOTSCH, Michael, UTSCHICK, Wolfgang, 2020. *Fahrzeugsicherheit und automatisiertes Fahren: Methoden der Signalverarbeitung und des maschinellen Lernens* [online]. PDF e-Book. ISBN 978-3-446-46804-7.
Additional remarks
No remarks.

Testing and Simulation Methods for Vehicle Safety

Module abbreviation	IAE_TSMS	**Reg.-Nr.**	13
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	2, 3
Module frequency	only summer term	**Module duration**	1 semester

Responsible for module	Vaculin, Ondrej		
Lecturer(s)	Vaculin, Ondrej		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Testing and Simulation Methods for Vehicle Safety		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

schrP90 - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the master's thesis, students are able to

- know how to test automotive safety systems and control units while its development process.
- understand different testing methods and their usage for different types of control units and different criticalities.
- know when and how to use simulation as an improvement of the testing process, which types of simulation can be used and their pros and cons.

Content

- vehicle approval process, consumer testing
- testing as part of the development process (ISO 26262/ V-model)
- testing methods and testing metrics
  - electrical safety
  - passive safety
  - active safety
  - automated driving
- application of simulation-based methods
- components of simulation

• different model types
Literature
• ARJUNRAJ, P., 2024. *Functional Safety in Modern Mobility: ISO 26262 and Beyond: ISO 26262 and Beyond*. ISBN 979-8894753379 • THE ART SERVICE, 2020. *ISO 26262 A Complete Guide*. ISBN 978-1867441762 • SOKOLOVSKIJ, Edgar, ŽURAULIS, Vidas, 2024. *Advances in vehicle dynamics and road safety: technologies, simulations and applications* [online]. Basel: MDPI PDF e-Book. ISBN 978-3-7258-1182-3. Verfügbar unter: https://doi.org/10.3390/books978-3-7258-1182-3.
Additional remarks
None

Engineering Project			
Module abbreviation	IAE_EngProj	**Reg.-Nr.**	14
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Einsetzungstext ist leer!	2
Module frequency	winter and summer term	**Module duration**	1 semester

Responsible for module	Arnold, Armin		
Lecturer(s)	Zimmer, Alessandro		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	2.5 ECTS / 2 SWS		
Workload	Contact hours		23 h
	Self-study		40 h
	Total		63 h
Subjects of the module	Engineering Project		
Lecture types	Proj - project		

Examinations

Project report and oral presentation 15 min.

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the master's thesis, students are able to

- have gained a deeper understanding of the complexity and challenges of engineering project work in a small team.
- understand the benefits of soft skills such as communication, moderation, forward-looking project planning and team-based task distribution.
- change behaviours and patterns that prevent from reaching full potential.
- have applied engineering knowledge to a project and learned methods to enable interdisciplinary collaboration and to organize cooperation at interfaces and smooth workflows across disciplines.
- know the necessity of working to deadlines and have practiced meeting milestone targets in an engineering work environment.

Content

The module combines the practical application of engineering knowledge and methods with interdisciplinary key skills such as project management and team skills, in particular communication and conflict resolution skills.

Groups of up to 8 students are formed, who work during the semester on a project offered by the supervisors and participating chairs. Through a combination of theoretical training and supervised team/project work, in which students make decisions largely independently, they learn to work interactively across disciplines as part of a team. By jointly planning the approach to the project and dealing with challenging implementation problems, students gain knowledge about project work and the necessary key qualifications in addition to specialist skills.
Literature
Will be specified at the beginning
Additional remarks
None

Research Methods			
Module abbreviation	IAE_ResSem	**Reg.-Nr.**	15
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Compulsory Subject	1
Module frequency	winter and summer term	**Module duration**	1 semester

Responsible for module	Vaculin, Ondrej		
Lecturer(s)	Gadhavi, Raviraj; Knorr, Alexander; Schlamp, Anna-Lena; Turnwald, Alen		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	2.5 ECTS / 2 SWS		
Workload	Contact hours		23 h
	Self-study		40 h
	Total		63 h
Subjects of the module	Research Methods		
Lecture types	S - seminar		

Examinations

SA - Seminar paper with oral examination (15min) and written elaboration (8-15 pages)

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the master's thesis, students are able to

- acquire knowledge in a technical field by means of independent literature research and analysis.
- summarise and explain a technical content in the form of a brief written elaboration following scientific referencing guidelines.
- present this knowledge comprehensibly within the framework of an oral presentation using suitable supportive media.
- understand a presentation and to critically and professionally discuss the contents with the speaker.
- apply enhanced interdisciplinary knowledge and communicative skills in relevant contexts.

Content

The respective lecturer compiles a collection of publications from the technical literature. In the course of the seminar, each student is required to present a paper/topic that was assigned by either lot or choice at the beginning of the semester. In the preparation phase, each student must conduct an independent literature research on the topic and aggregate the results.

The student will give an oral presentation on the topic lasting about 25 minutes followed by a discussion with peers. Participation in the discussions is contributing to the final grade. In addition to an oral presentation, the student is required to prepare a written paper on the topic of the presentation. This paper should summarise the main contents. The respective instructor will communicate detailed information on topics, deadlines and expectations regarding the presentation as well as the written elaboration at the beginning of the semester.
Literature
Will be specified at the beginning
Additional remarks
None

Master Thesis

Module abbreviation	IAE_THESIS	**Reg.-Nr.**	18
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Pflichtfach	4
Module frequency	winter and summer term	**Module duration**	1 semester

Responsible for module	Arnold, Armin		
Lecturer(s)	All lecturers (IAE_THESIS)		
Language of instruction	Deutsch/Englisch	**Language of exams**	Deutsch/Englisch
Credit points / SWS	30 ECTS / 0 SWS		
Workload	Contact hours		0 h
	Self-study		750 h
	Total		750 h
Subjects of the module	18.1: Master Thesis 18.2: Seminar for Master's thesis		
Lecture types	18.1: MA - Masterarbeit 18.2: S - Seminar		

Examinations

18.1: Master-Abschlussarbeit
18.2: Koll - Kolloquium

Additional explanations regarding examinations

In general, students look for a topic for their thesis on their own. Topics are either offered internally by university lecturers in notices (also online) or result from the cooperation of the student with a company. In the case of an externally provided topic, the student must convince a university lecturer of his or her topic so that the lecturer assumes the role of the first examiner. For this purpose, it is advisable to outline the topic and the planned approach in a short paper. This exposé serves to convince the lecturer desired as the first examiner.

In the course of the master thesis seminar, students must participate in regular meetings with the supervising professor/lecturer (first examiner).

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the master's thesis, students are able to

- to work on a complex engineering problem from the subject area of the study program within a limited period of time and a possibly given budget according to scientific methods in a qualified and independent manner
- systematically and creatively develop solutions for similar problems
- determine and evaluate the limits of the solution presented

- to prepare the problem definition, its classification in an overall context as well as a presentation and discussion of the problem solution and the results in compliance with the rules for scientific texts (stringency, transparency, etc.) and formal criteria
- follow good scientific practice and apply scientific working methods

The students are able to present the contents of their scientific-technical work as well as the strategy of problem solving and the solution methods in a structured way and to represent them convincingly in a subsequent questioning and discussion according to scientific standards.

Content

The master's thesis is a graduation thesis in engineering specific to the course of study. The topic of the master's thesis is set, supervised and accompanied in terms of content by a professor from the participating universities. The topic can be worked on in practice, e.g. in a company, or in research at the THI.

- scientific analysis of a complex problem specific to the course of study against the background of the state of the art in science and technology.
- literature research, especially considering current international publications in scientific journals
- development of a creative solution concept appropriate to the context of the problem, taking into account current scientific, technical and operational aspects
- comprehensive evaluation of alternative solution concepts and selection of the best solution concept (technical, economic evaluation)
- implementation of the selected solution concept of the complex problem specific to the course of study
- critical and comprehensive analysis of the obtained results using appropriate engineering methods
- project management (especially time and, if necessary, budget management)
- comprehensible and formally correct presentation and documentation of the solution and results
- good scientific practice and scientific working methods
- familiarization with the scientific-technical problem of the task for the master thesis
- analysis and evaluation of the relevant scientific preliminary work
- development and evaluation of own approaches to the solution
- implementation of the solution
- scientific presentation of the methodology and the solution in written form
- presentation of methodology and results in a lecture as well as their scientific representation in a subsequent survey with discussion.

Literature

Own research, depending on the subject of work.

Additional remarks

Important Notes: Keep your supervisors and primary examiners regularly informed of your progress. In particular, clarify their expectations regarding the content of the thesis. A whole semester is estimated for working on the Master's thesis (30 credit points), whereas only 12 credit points are estimated for working on the Bachelor's thesis. This shows that the requirements for the scope and content of a Master's thesis are much higher than for a Bachelor's thesis. In particular, the scientific character should be emphasized more strongly in a Master's thesis:

- statements should, wherever possible, be placed in the context of relevant technical literature.
- in addition to conventional technical literature, sources from current research (e.g., dissertations and conference papers) should be substantially included.
- the graduate's working methods should be purposeful, methodical, and systematic, and should be explicitly documented in the thesis
- quantitative statements, such as measurements, should be investigated and documented using the tools of mathematical statistics.

3.2 Electives

Artificial Intelligence and Automotive Systems			
Module abbreviation	IAE_AIAS	**Reg.-Nr.**	17
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Specialised Elective Subject	2
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Lopes da Silva, Joed		
Lecturer(s)	Lopes da Silva, Joed; Zimmer, Alessandro		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Artificial Intelligence and Automotive Systems		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

LN - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the module the students shall be able to

- understand the basic principles that lie behind different Artificial Intelligence techniques that can be used in the context of automotive systems.
- identify the most suitable Artificial Intelligence techniques to be used in a given scenario.
- model a problem of automotive safety using Artificial Intelligence systems.
- implement basic intelligent algorithms in Matlab.

Content

- Introduction to AI. Problems and search space. Knowledge representation and Pattern Recognition.
- AI and Automotive Systems/Automotive Safety Systems.
- Theory, concepts and applications of Neural Networks. Neurodynamics, topology of Neural Networks and learning methods.
- Fuzzy sets and systems. Modelling of Fuzzy System's Applications.
- Concepts of Evolutionary Systems. Genetic Algorithms and optimization problems.

Literature
• RUSSELL, Stuart J. und Peter NORVIG, 2021. *Artificial intelligence: a modern approach*. Hoboken: Pearson. ISBN 978-0-13-461099-3 • MICHELUCCI, Umberto, 2018. *Applied deep learning: a case-based approach to understanding deep neural networks* [online]. Berkeley, CA: Apress PDF e-Book. ISBN 978-1-4842-3790-8. Verfügbar unter: https://doi.org/10.1007/978-1-4842-3790-8. • SINGH, Himanshu, LONE, Yunis Ahmad, 2020. *Deep Neuro-Fuzzy Systems with Python: With Case Studies and Applications from the Industry* [online]. Berkeley, CA: Apress PDF e-Book. ISBN 978-1-4842-5361-8. Verfügbar unter: https://doi.org/10.1007/978-1-4842-5361-8. • BUONTEMPO, Frances und Tammy CORON, January 2019. *Genetic algorithms and machine learning for programmers: create AI models and evolve solutions*. Book version: P 1. Auflage. Raleigh, North Carolina: The Pragmatic Bookshelf. ISBN 978-1-68050-620-4 • ESCALANTE, Hugo Jair, 2018. *Explainable and Interpretable Models in Computer Vision and Machine Learning* [online]. Cham: Springer PDF e-Book. ISBN 978-3-319-98131-4. Verfügbar unter: https://doi.org/10.1007/978-3-319-98131-4.
Additional remarks
None

Automotive Radar Systems

Module abbreviation	IAE_ARS	**Reg.-Nr.**	17
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Specialised Elective Subject	1,2
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Talukder, Prodyut		
Lecturer(s)	Talukder, Prodyut		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Automotive Radar Systems		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

LN - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the module the students are able to

- describe and explain fundamentals, system aspects, digital signal processing techniques as well as hardware components of radar;
- evaluate practical design issues to assess radar parameters;
- evaluate requirements for automotive radar systems;
- design mini radars with the help of MATLAB scripts considering the design boundaries;
- describe vehicle applications that use radar sensors.

Content

- Radar wave propagation
- Radar signals and signal processing techniques, information from radar
- Detection of signals in noise
- Radar clutter: sea, land and weather clutter
- Radar system design considerations
- Automotive radar examples

Literature
• SKOLNIK, Merrill I., 2001. *Introduction to radar systems*. Boston [u.a.]: McGraw-Hill. ISBN 0-07-290980-3, 0-07-118189-X • RICHARDS, Mark A., 2014. *Fundamentals of radar signal processing*. New York [u.a.]: McGraw-Hill. ISBN 978-0-07-179832-7, 0-07-179832-3 • MAHAFZA, Bassem R., 2013. *Radar systems analysis and design using MATLAB*. Boca Raton, FL: CRC Press. ISBN 978-1-4398-8495-9, 978-1-62870-701-4 • LUDLOFF, Albrecht, 2002. *Praxiswissen Radar und Radarsignalverarbeitung* [online]. Wiesbaden: Vieweg+Teubner Verlag PDF e-Book. ISBN 978-3-322-99555-1, 978-3-322-99556-8. Verfügbar unter: https://doi.org/10.1007/978-3-322-99555-1. • WINNER, Hermann, 2015. *Handbuch Fahrerassistenzsysteme: Grundlagen, Komponenten und Systeme für aktive Sicherheit und Komfort* [online]. Wiesbaden: Springer Fachmedien PDF e-Book. ISBN 978-3-658-05734-3, 978-3-658-05733-6. Verfügbar unter: http://dx.doi.org/10.1007/978-3-658-05734-3.
Additional remarks
None

Data Science und KI in intelligenten und nachhaltigen Mobilitätssystemen

Module abbreviation	AUF_INaM	**Reg.-Nr.**	17
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Electives	1,2
Module frequency	nur Wintersemester	**Module duration**	1 Semester

Responsible for module	Schmidtner, Stefanie		
Lecturer(s)	Schmidtner, Stefanie		
Language of instruction	Deutsch	**Language of exams**	Deutsch
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		79 h
	Total		126 h
Subjects of the module	Data Science und KI in intelligenten und nachhaltigen Mobilitätssystemen		
Lecture types	SU - seminaristischer Unterricht		

Examinations

LN - mündliche Prüfung, 20 Minuten

Additional explanations regarding examinations

Keine

Prerequisites according examination regulation

Keine

Recommended prerequisites

Keine

Objectives

Nach erfolgreicher Teilnahme am Modul

- kennen Studierende Grundlagen der Verkehrstheorie und können Konzepte und Mechanismen intelligenter Verkehrssysteme anwenden.
- können Studierende erklären, wie Mobilitätsdaten zur Optimierung von Verkehr und Mobilitätssystemen genutzt werden können und kennen zugrundeliegende Konzepte, Algorithmen und Datenstrukturen.
- können Studierende die Rolle automatisierter Fahrzeuge in intelligenten Verkehrssystemen bewerten.
- sind Studierende mit ausgewählten Forschungsthemen vertraut und in der Lage, wissenschaftliche Arbeiten im behandelten Forschungsbereich zu erläutern.

Content

- Grundlagen der Verkehrstheorie und intelligenter Mobilitätssysteme
- Mobilitätsdaten und Technologien zur Mobilitätsdatenerfassung
- Nutzung von Analytics & KI Anwendungen zur Analyse und Optimierung von Mobilitätssystemen, z. B.
  - Verkehrsprognosen basierend auf statistischen und Deep Learning Methoden
  - Identifikation und Analyse von Mobilitäts- und Fahrmustern
  - Nutzung von Klassifikationsalgorithmen für Mobilitäts- und Fahrverhalten
  - Routing und Verkehr: Zusammenhang und Optimierung

- Optimierung von Lichtsignalanlagen mit Reinforcement Learning
- Einfluss autonomen Verkehrs auf Verkehrsfluss und Verkehrssteuerung
- IT und Infrastrukturanforderungen für intelligente Mobilitätssysteme

Literature

- TREIBER, Martin, KESTING, Arne, 2010. *Verkehrsdynamik und -simulation: Daten, Modelle und Anwendungen der Verkehrsflussdynamik* [online]. Heidelberg [u.a.]: Springer PDF e-Book. ISBN 978-3-642-05227-9, 3-642-05227-4. Verfügbar unter: https://doi.org/10.1007/978-3-642-05228-6.
- CONSTANTINOS, A., L. DIMITRIOU und F. PEREIRA, 2018. *Mobility Patterns, Big Data and Transport Analytics. Tools and Applications for Modeling*.

Additional remarks

Durch die erfolgreiche Durchführung und Abgabe von Übungen haben die Studierenden die Möglichkeit, Bonuspunkte im Umfang von insgesamt 5 Punkten zu erzielen. Der Bonus von 5 Punkten wird nur bei der hinsichtlich der Bewertungskriterien erfolgreichen Bearbeitung und Abgabe von mindestens zwei von drei Übungen erreicht. Die Gesamtpunktzahl der mündlichen Prüfung beträgt 100 Punkte (d. h. die erreichbaren Bonuspunkte entsprechen 5% der erreichbaren Gesamtpunktzahl der Prüfung, 100% sind auch ohne Bonus in der mündlichen Prüfung erreichbar). Aufgabenstellungen, Bewertungskriterien und Abgabezeitpunkte der Übungen werden am Anfang des Semesters in Moodle kommuniziert.

Knowledge Modeling and Machine Learning

Module abbreviation	AUF_WissMod	**Reg.-Nr.**	17
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Electives	
Module frequency	nur Wintersemester	**Module duration**	1 Semester

Responsible for module	Botsch, Michael		
Lecturer(s)	Botsch, Michael		
Language of instruction	Deutsch	**Language of exams**	Deutsch
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		79 h
	Total		126 h
Subjects of the module	Wissensmodellierung und Maschinelles Lernen		
Lecture types	SU/Ü - seminaristischer Unterricht/Übung		

Examinations

schrP90 - schriftliche Prüfung, 90 Minuten

Additional explanations regarding examinations

Keine

Prerequisites according examination regulation

Keine

Recommended prerequisites

Keine

Objectives

Nach erfolgreicher Teilnahme an der Lehrveranstaltung sind die Studierenden in der Lage,

- die mathematischen Grundlagen der statistischen Signalverarbeitung für die Wissensmodellierung und das maschinelle Lernen zu verstehen und anzuwenden.
- klassische Methoden für Klassifikations- und Regressionsmodelle mathematisch zu beschreiben, zu implementieren und anzuwenden.
- fortgeschrittene Methoden des maschinellen Lernens für Klassifikations- und Regressionsmodelle mathematisch zu beschreiben, zu implementieren und anzuwenden.
- generative Modelle zu verstehen.
- Methoden des maschinellen Lernens für Anwendungen beim sicheren, automatisierten Fahren zu nutzen.

Content

- Grundlagen der statistischen Signalverarbeitung (Zufallsvariablen, Maximum-Likelihood und Maximum-A-Posteriori Parameterschätzung, Kernel-Dichteschätzer, Bias-Varianz Zerlegung, Verfahren zur Modellselektion)
- Bayes-Klassifikator und Bayes-Regressionsfunktion
- Lineare Klassifikations- und Regressionsmodelle (Herleitung, Umsetzung, Anwendungen)
- Klassifikation mittels "softmax", k-NN, Nadaraya-Watson Regressionsfunktion (Herleitung, Umsetzung, Anwendungen)

- Gradientenabstiegsverfahren und automatisches Differenzieren im Rückwärtsmodus (Backpropagation)
- Multi-Layer Perzeptron neuronale Netze (Herleitung, Umsetzung, Anwendungen)
- Deep Convolutional Neural Networks (Herleitung, Umsetzung, Anwendungen)
- Radiale Basisfunktionsnetzwerke (Herleitung, Umsetzung, Anwendungen)
- Autoencoder
- Generative Adverserial Neural Networks
- Anwendungen im Bereich des automatisierten Fahrens

Literature

- BOTSCH, Michael, UTSCHICK, Wolfgang, 2020. *Fahrzeugsicherheit und automatisiertes Fahren: Methoden der Signalverarbeitung und des maschinellen Lernens* [online]. München: Hanser PDF e-Book. ISBN 978-3-446-46804-7. Verfügbar unter: https://doi.org/10.3139/9783446468047.
- GOODFELLOW, Ian und andere, 2018. *Deep Learning: das umfassende Handbuch : Grundlagen, aktuelle Verfahren und Algorithmen, neue Forschungsansätze*. Frechen: mitp. ISBN 978-3-95845-701-0
- BISHOP, Christopher M., 2009. *Pattern recognition and machine learning*. New York [u.a.]: Springer. ISBN 0-387-31073-8, 978-1-4939-3843-8
- BISHOP, Christopher M., BISHOP, Hugh, 2024. *Deep Learning: Foundations and Concepts* [online]. Cham: Springer International Publishing PDF e-Book. ISBN 978-3-031-45468-4. Verfügbar unter: https://doi.org/10.1007/978-3-031-45468-4.

Additional remarks

Bewertung der schriftlichen Prüfung durch Drittelnoten.

Machine Perception and Cognition			
Module abbreviation	AI_MachPerception	**Reg.-Nr.**	17
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Einsetzungstext ist leer!	1,2
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Schall, Martin		
Lecturer(s)	Schall, Martin		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	Machine Perception and Cognition		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

LN - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

Upon completion of the module, students will be able to:

- Understand the effects of converting physical signals to digital signals.
- Understand digital cameras and radiometric camera calibration.
- Understand stereo vision, time-of-flight cameras and LiDAR.
- Understand convolutional neural networks (CNNs), recurrent neural networks (RNNs) and their application in computer vision.
- Understand face recognition and handwriting recognition.
- Understand attention networks and transformers.
- Understand large language models (LLMs), vision-language models (VLMs), vision-language-action models (VLAs) and their applications in robotics.
- Understand reinforcement learning and its applications in robotics.

Content

- Sampling, discretization, frequency domain and Nyquist-Shannon theory.
- Pinhole cameras, CCD sensors, radiometric camera calibration and rolling shutter effects.
- Stereo vision, time-of-flight cameras and LiDAR.
- Artificial neural networks, gradient descent and backpropagation.

- Convolutional neural networks (CNNs) and Gabor filters.
- CNNs for object detection, classification and as autoencoders.
- Triplet loss, metric learning and face recognition.
- U-Nets and image segmentation.
- Evaluation metrics for deep neural networks.
- Recurrent neural networks (RNNs) and backpropagation-through-time.
- Handwriting recognition and connectionist temporal classification (CTC).
- Attention networks, transformer and large language models (LLMs).
- Vision-language models (VLMs) and vision-language-action models (VLAs).
- Basics of reinforcement learning.

Literature

Will be specified at the beginning

Additional remarks

None

Model Predictive Control and Applications

Module abbreviation	AI_MPC	**Reg.-Nr.**	17
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Einsetzungstext ist leer!	1,2,3
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Turnwald, Alen		
Lecturer(s)	Turnwald, Alen		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		79 h
	Total		126 h
Subjects of the module	Model Predictive Control and Applications		
Lecture types	SU - lecture		

Examinations

LN - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

After successfully completing the course, students will be able to

- Understand the fundamental principles of discrete-time state-space models as a basis for model predictive control.
- Formulate finite-horizon optimal control problems and explain the structure of MPC cost functions and constraints.
- Apply the core concepts of linear MPC for regulation and tracking tasks in engineering systems.
- Analyse the influence of constraints, horizons and tuning parameters on the closed-loop behaviour.
- Explain the basic numerical and implementation aspects underlying MPC, including the role of quadratic programming.
- Describe advanced MPC concepts such as robustness, nonlinear extensions and data-driven or learning-enhanced approaches at a conceptual level.
- Interpret and evaluate MPC solutions in the context of practical applications in robotics, autonomous systems or aerospace systems.

Content

- Foundations of state-space modelling for control
- Optimal control and finite-horizon formulations
- Linear model predictive control: cost functions, constraints, receding horizon principle

- Stability and feasibility concepts (overview)
- Offset-free tracking and disturbance modelling
- Application-oriented MPC for robotics and autonomous systems
- Practical aspects of MPC implementation, discretisation and solver usage
- Numerical foundations: quadratic programming and algorithmic considerations
- Overview of advanced MPC concepts (robust MPC, nonlinear MPC, learning-based MPC)
- Current developments and applications of MPC in autonomous systems

Literature

- RAWLINGS, James Blake, David Q. MAYNE und Moritz DIEHL, October 2020. *Model predictive control: theory, computation and design*. Santa Barbara, California: Nob Hill Publishing. ISBN 978-0-9759377-5-4
- BORRELLI, Francesco, Alberto BEMPORAD und Manfred MORARI, 2017. *Predictive control for linear and hybrid systems*. Cambridge, United Kingdom: Cambridge University Press. ISBN 978-1-107-01688-0, 978-1-107-65287-3

Additional remarks

None

Optimization Methods for Machine Learning

Module abbreviation	AI_Opt	**Reg.-Nr.**	17
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Einsetzungstext ist leer!	1,2
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Gründinger, Andreas		
Lecturer(s)	Gründinger, Andreas		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		79 h
	Total		126 h
Subjects of the module	Optimization Methods for Machine Learning		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

LN - written exam, 90 minutes

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

- Knowledge of the basics of optimization in theory and practical experiments
- Teaching of technical terms and the ability to read relevant literature on the subject of optimization
- Solving classical optimization problems in exercises accompanying lectures
- Independently classifying optimization approaches and experimenting with different solution approaches in practical experiments
- Presenting, recording, and evaluating experimental results
- Strengthening communication, coordination and teamwork skills

Content

- Classification and feasibility of optimization problems
- Convex functions; linear, affine and convex combinations; convexity preserving transformations
- Unrestricted optimization; (sub-)gradient descent algorithms; stochastic gradient descent algorithms; applications in machine learning (backpropagation); regularization methods
- Restrictions and convex constraint sets; application in support vector machines
- Linear optimization; extremal points of linear sets; simplex method
- Nonlinear constrained optimization; gradient projection algorithms
- Applications

Lab Contents:

- Matlab and Optimization
- Gradient descent methods in machine learning
- Linear regression
- Interior-point solutions vs. gradient projection approaches

Literature

- BOYD, Stephen P. und Lieven VANDENBERGHE, 2014. *Convex optimization*. 16. Auflage. Cambridge [u.a.]: Cambridge Univ. Press. ISBN 978-0-521-83378-3
- SRA, Suvrit, Sebastian NOWOZIN und Stephen J. WRIGHT, 2012. *Optimization for machine learning*. Cambridge, Mass.: MIT Press. ISBN 9780262537766

Additional remarks

None

Projekt Formula Student Electric: Entwicklung, Konstruktion, Bau und Erprobung eines FSE-Rennfahrzeugs

Module abbreviation	EMS-SRE	**Reg.-Nr.**	17
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Electives	1,2,3
Module frequency	nur Wintersemester	**Module duration**	1 Semester

Responsible for module	Birkner, Christian		
Lecturer(s)	Birkner, Christian		
Language of instruction	Deutsch	**Language of exams**	Deutsch
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		79 h
	Total		126 h
Subjects of the module	Projekt Formula Student Electric: Entwicklung, Konstruktion, Bau und Erprobung eines FSE-Rennfahrzeugs		
Lecture types	SU/Ü/PR - Seminaristischer Unterricht/Übung/Praktikum		

Examinations

LN - Seminararbeit (10 Seiten) mit mündl. Präsentation (30 Min.)

Additional explanations regarding examinations

Aktive Teilnahme beim Formula Student Team Schanzer Racing zwingend nötig. Mitgliedschaft bei Schanzer Racing Electric ist Voraussetzung für die Teilnahme an diesem Projekt.

Das jeweilige Thema muss in Zusammenarbeit mit Schanzer Racing definiert und organisiert werden. In der zweiten Semesterwoche findet die Themenvergabe in der Sprechstunde von Prof. Dr. Christian Birkner statt.

Leistungsnachweis erfolgt durch Semesterbegleitenden Arbeit am Projekt, der Projektdokumentation, einer Projektpräsentation und eines Produktes welches im Laufe des Projekts realisiert und am Ende des Semesters präsentiert wird.

Prerequisites according examination regulation

Keine

Recommended prerequisites

Keine

Objectives

Nach erfolgreicher Teilnahme an der Lehrveranstaltung sind die Studierenden in der Lage,

- das jeweils gültige Reglement für das Rennfahrzeug wiederzugeben.
- die komplexen Wechselwirkungen zwischen den Baugruppen, Funktionen und Systemen des Fahrzeugs zu beschreiben.
- wissenschaftliche Methoden aus den Ingenieurswissenschaften oder der Informatik zur Entwicklung und Erprobung von Komponenten Funktionen und Systemen von Fahrzeugen anzuwenden und dies erfolgreich an einem Beispiel zu demonstrieren.

- die erforderlichen Abstimmungsstrukturen innerhalb des Entwicklungsteams, die erforderlichen Formen der interdisziplinären Zusammenarbeit, auch für die erfolgreiche Teamarbeit, anzugeben.
- die im Studium erworbenen Kompetenzen anzuwenden, um eine komplexe fachliche Aufgabenstellung zu analysieren und über ein Semester hinweg in einem Team erfolgreich zu bearbeiten.
- die im Backend eingesetzten IT Systeme zu entwickeln und zu pflegen.
- Projektergebnisse vor Publikum überzeugend zu präsentieren.
- zur konzentrierten, schriftlichen Darstellung von Aufgabenstellung, Analyse, Lösungskonzept, Umsetzung und Verifikation einer komplexen fachlichen Problemstellung.

Content

- Analyse, Modellbildung von elektrotechnischen, mechatronischen und informationstechnischen Komponenten, Funktionen und Systemen von Fahrzeugen
- Entwicklung von elektrotechnischen, mechatronischen und informationstechnischen Komponenten, Funktionen und Systemen von Fahrzeugen
- Erprobung, Verifikation und Dokumentation von elektrotechnischen, mechatronischen und informationstechnischen Komponenten, Funktionen und Systemen von Fahrzeugen
- Grundlagen der vernetzten und interdisziplinären Arbeit
- Grundlagen der Erfolgs- und Fortschrittskontrolle
- Auswahl der Themen erfolgt entsprechend der Kompetenzen aus jeweiligen Studiengängen

Eigenständige Definition des Themengebiets in Zusammenarbeit mit Schanzer Racing und dem betreuenden Professor.

Literature

- Ohne Autor. *Reglement der Formula Student* [online]. [Zugriff am:]. Verfügbar unter: https://www.formulastudent.de/fsg/rules/

Additional remarks

Keine Anmerkungen

Verification of Machine-Learning Algorithms			
Module abbreviation	AI_VerMLAlgo	**Reg.-Nr.**	17
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	Einsetzungstext ist leer!	
Module frequency	only winter term	**Module duration**	1 semester

Responsible for module	Giesler, Björn		
Lecturer(s)	Giesler, Björn		
Language of instruction	English	**Language of exams**	English
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		79 h
	Total		126 h
Subjects of the module	Verification of Machine-Learning Algorithms		
Lecture types	SU/Ü - lecture with integrated exercises		

Examinations

Einsetzungstext ist leer!

Additional explanations regarding examinations

None

Prerequisites according examination regulation

None

Recommended prerequisites

None

Objectives

Upon completion of the module, students will be able to:

- Distinguish between verification and validation of machine-learning (ML) systems.
- Understand the risks and consequences of false decisions by ML algorithms.
- Apply classical and contemporary verification techniques to ML models.
- Reflect critically on the societal and ethical ramifications of ML errors.

Content

- Introduction to ML Verification: The “black-box” nature of modern ML, correctness, robustness, interpretability
- Motivation and Challenges: Lack of formal specifications
- Verification vs. Validation: Definitions and examples, Role of statistical evaluation vs. formal guarantees
- False Decisions in ML Systems: Taxonomy of failures, Root causes: bias in data, model brittleness, distributional drift
- Techniques for Verifying Correctness: Probe points, Large-scale phenomenological testing
- Classical formal methods applied to ML (symbolic execution, model checking, SMT solvers),
- Societal and Ethical Implications: Accountability in algorithmic decisions, fairness, transparency, and justice

Literature
Will be specified at the beginning
Additional remarks
None

3.3 German Language Electives

German A2 intensive			
Module abbreviation	SZ_GERM_INTENS_A2	**Reg.-Nr.**	5
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	German Language Electives	2
Module frequency	Winter- und Sommersemester	**Module duration**	1 Semester

Responsible for module	Ekici, Gülsüm		
Lecturer(s)	Ekici, Gülsüm; Ghasemi, Neda; Seyfferth, Heike; Steinert-Pindrys, Lyubov; Wickern, Barbara		
Language of instruction	Deutsch	**Language of exams**	Deutsch
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours Self-study Total		47 h 78 h 125 h
Subjects of the module	German A2 intensive		
Lecture types	SU/Ü - seminaristischer Unterricht/Übung		

Examinations

LN - schriftliche Prüfung, 90 Minuten

Additional explanations regarding examinations

Prerequisite is the proof of German language basics at Level A1.

Prerequisites according examination regulation

Keine

Recommended prerequisites

Keine

Objectives

Students are able to

- deal with everyday situations in Germany.
- understand factual information (weather, family, how to plan your vacation).
- express and represent their own opinion.
- compare things.
- be polite and hand out advice.

Content

Acquisition of fundamental language concepts allowing students to express themselves simply and coherently on familiar topics of personal interest (about personal experiences, events, dreams, hopes, objectives).

Grammar:

- passive voice
- prepositions (local, modal, temporal)

- modal verbs, separable verbs, subjunctive II
- reflexive verbs (acusative, dative)
- past tense (Perfekt, Präteritum)
- declension of adjectives, adjectives of degree
- prefixes
- adverbs
- infinitive clause, reported questions, subordinate clause, relative clause, conjunctions
- pronouns (possessive, demonstrative)
- cases (genitive, dative, acusative)
- Reading and Listening Comprehensions
- Essay Writing (E-Mail)
- role plays

Literature

- KRENN, Wilfried und Herbert PUCHTA, 2015-. *Motive: Kompaktkurs DaF : Deutsch als Fremdsprache*. München: Hueber Verlag.
- KRENN, Wilfried und Herbert PUCHTA, 2016. *Motive Kompaktkurs DaF A2, Arbeitsbuch, Deutsch als Fremdsprache*. München: Hueber. ISBN 978-3-19-031878-0

Additional remarks

Keine Anmerkungen

German B1 Intensive

Module abbreviation	SZ_GERM_INTENS_B1	**Reg.-Nr.**	5
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	German Language Electives	
Module frequency	Winter- und Sommersemester	**Module duration**	1 Semester

Responsible for module	Ekici, Gülsüm		
Lecturer(s)	Ekici, Gülsüm; Klingenberg, Lothar; Nehir, Mehmet; Seitz, Daniela		
Language of instruction	Deutsch	**Language of exams**	Deutsch
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		78 h
	Total		125 h
Subjects of the module	German B1 Intensive		
Lecture types	SU/Ü - seminaristischer Unterricht/Übung		

Examinations

LN - schriftliche Prüfung, 90 Minuten

Additional explanations regarding examinations

Prerequisite is the proof of German language competence at Level A2.

Prerequisites according examination regulation

Keine

Recommended prerequisites

Keine

Objectives

Nach dem Besuch des Moduls sind die Studierenden in der Lage, in schriftlicher wie mündlicher Form

- über Vergangenes zu berichten
- Sachverhalte zu beschreiben
- über Irreales zu sprechen
- Beschwerden zu formulieren und darauf zu reagieren
- Arbeitsabläufe zu beschreiben und über Fehler zu sprechen
- Vergleiche anzu stellen sowie eine strukturierte Diskussion zu führen

Content

- Veränderungen im Leben, Werbung, Fernweh und Heimat
- Regeln für höfliches Benehmen
- Einbürgerung
- Verkehr der Zukunft
- Grammatik: Konjunktionen, Plusquamperfekt, Konjunktiv II, Passiv, indirekte Fragen, Adjektivdeklination, Relativsätze, Infinitivsätze mit "zu", Vergleichssätze, Futur I

Literature
• KRENN, Wilfried und Herbert PUCHTA, 2016. *Motive: Kompaktkurs DaF : Deutsch als Fremdsprache : Kursbuch, Lektion 1–30 : B1*. München: Hueber Verlag. ISBN 978-3-19-001878-9, 3-19-001878-2 • KRENN, Wilfried und Herbert PUCHTA, 2016. *Motive: Kompaktkurs DaF : Deutsch als Fremdsprache : Arbeitsbuch, Lektion 1–30 : A1, A2, B1*. München: Hueber Verlag. ISBN 978-3-19-031878-0, 3-19-031878-6
Additional remarks
Minimim number of students: 8

German B2 Intensive			
Module abbreviation	SZ_GERM_B2_INTENS	**Reg.-Nr.**	5
Curriculum	**Study Programme**	**Module type**	**Semester**
	International Automotive Engineering	German Language Electives	
Module frequency	nur Wintersemester	**Module duration**	1 Semester

Responsible for module	VHS-Dozent, -		
Lecturer(s)	VHS-Dozent, -		
Language of instruction	Deutsch	**Language of exams**	Deutsch
Credit points / SWS	5 ECTS / 4 SWS		
Workload	Contact hours		47 h
	Self-study		79 h
	Total		126 h
Subjects of the module	German B2 Intensive		
Lecture types	SU/Ü - seminaristischer Unterricht/Übung		

Examinations

LN - schriftliche Prüfung, 90 Minuten

Additional explanations regarding examinations

Keine

Prerequisites according examination regulation

Keine

Recommended prerequisites

Keine

Objectives

Die Studierenden können sich spontan und fließend verständigen und sich zu einem breiten Themenspektrum klar und differenziert äußern, auch in Diskussionen. Sie können die Hauptinhalte komplexer und abstrakter Texte verstehen und klare, detaillierte Texte zu verschiedenen Themen verfassen und dabei Argumente gegeneinander abwägen.

Content

Es werden Themen des studentischen Lebens, aus Familie und Gesellschaft in Deutschland sowie Aspekte der Geschäftskommunikation wie Präsentationen, Korrespondenz und Besprechungen behandelt. Grammatikalische Inhalte: Zweiteilige Konnektoren; Passiv, Mittelfeld im Hauptsatz, Nebensätze, Konjunktiv II, Futur II, indirekte Rede u.a.

Literature

- PERLMANN-BALME, Michaela, Susanne SCHWALB und Magdalena MATUSSEK, 2014. *Sicher! B2 Deutsch als Fremdsprache, Kursbuch*. Ismaning: Hueber. ISBN 978-3-19-001207-7
- PERLMANN-BALME, MICHAELA, SCHWALB, SUSANNE und MATUSSEK, MAGDALENA, 2014. *Sicher! B2 Deutsch als Fremdsprache Arbeitsbuch*. Ismaning: Hueber. ISBN 978-3-19-0011207-4

Additional remarks
Mindestteilnehmerzahl 8 Studierende