TECHNISCHE HOCHSCHULE DEGGENDORF

Module Guide
Automotive Software Engineering

Faculty Computer Science
Examination regulations 24.04.2024
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Table of Contents

ASE-01 Computervision

Module code	ASE-01
Module coordination	Prof. Dr. Marcus Barkowsky
Course number and name	ASE-01 Computervision
Lecturer	Prof. Dr. Marcus Barkowsky
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	project work
Weighting of the grade	5/210
Language of Instruction	English

Module Objective

The aim of this class is to discuss Computer Vision (CV), which allows computers to process visual inputs. We deal every day dozens of times with CV, such as facial recognition, real-time translating camera input or auto-tagging friends in photos. Modern CV algorithms are strongly based on machine learning methods, in particular deep neural networks. Students will acquire knowledge in CV and be able to elaborate it further in the future, for example in projects or further studies. Overall, CV is a cutting-edge eld, with many high-pay opportunities for graduates.

Specifically, students will have achieved the following learning outcomes upon completion of the module:

Subject competency

Students will understand the concepts of the most common methods in computer vision. (2 - Understanding)

Methodological competency
Students will have the ability to develop high-quality programs using computer vision technologies. (3 - Apply)

Personal competency
Students will be able to implement their own algorithms and defend them against competing approaches. (6 - Create)

Social competency
Programming exercises take place as part of the course. Students are thus able to understand, critique, and complement programs of other students. (5 - Assess)

Applicability in this and other Programs

Including, but not limited to, the following modules:

- AI Project
- Deep Learning/Big Data

Entrance Requirements

- Programming, ideally in Python
- Algorithms and data structures
- (Some) mathematics

Learning Content

- Introduction: applications, computational models for vision, perception and prior knowledge, levels of vision, how humans see
- Pixels and filters: digital cameras, image representations, noise, filters, edge detection
- Regions of images and segmentation: segmentation, perceptual grouping, Gestalt theory, segmentation approaches, image compression
- Feature detection: RANSAC, Hough transform, Harris corner detector
- Object recognition: challenges, template matching, histograms, machine learning
- Convolutional neural networks: neural networks, loss functions and optimization, backpropagation, convolutions and pooling, hyperparameters, AutoML, efficient training, selected architectures
- Image sequence processing: motion, tracking image sequences, Kalman filter, correspondence problem, optical flow

- Foundations of mobile robotics: robot motion, sensors, probabilistic robotics, particle filters, SLAM
- Outlook: 3D vision, generative adversarial networks, self-supervised learning, vision transformers

Teaching Methods

- Lectures
- Projects

Recommended Literature

- C. Bishop and H. Bishop, " Deep Learning: Foundations and Concepts ", Springer, 2024.
- R. C. Gonzalez and R. Woods, " Digital Image Processing ", Pearson, 4th edition, 2018.
- I. Goodfellow, Y. Bengio and A. Courville, " Deep Learning ", MIT Press, 2016.
- S. Russell and P. Norvig, " Artificial Intelligence: A Modern Approach ", Pearson, 4th edition, 2021.

ASE-02 Digital Car / Innovation Management & Customer Design

Module code	ASE-02
Module coordination	Prof. Dr. Markus Straßberger
Course number and name	ASE-02 Digital Car / Innovation Management & Customer Design
Lecturer	Prof. Dr. Markus Straßberger
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Portfolio
Weighting of the grade	5/90
Language of Instruction	English

Module Objective

Die Studierenden erhalten einen Einblick in die Herausforderungen und Anforderungen der aktuellen digitalen und vernetzten Automobiltechnik sowie in deren technologischen Ansätze und Lösungen. Darüber hinaus werden die methodischen Grundzüge des Innovationsprozesses in der Automobilindustrie, des nutzerorientierten Designs und des Lean-Development vermittelt.

Die Studierenden erreichen die folgenden Lernziele bzgl. Fach- und Methodenkompetenzen

Die Studierenden sind in der Lage, die Komplexität einer digitalen Fahrzeugfunktion, deren Abhängigkeiten und die wesentlichen Kostenfaktoren sowie die größten Fallstricke bei der Realisierung der jeweiligen Funktionalität im automobilen Umfeld zu verstehen. Sie können sich leicht in jedes digitale Fahrzeugprojekt einarbeiten.

Entrance Requirements

Learning Content

- Grundlagen des digitalen und vernetzten Fahrzeugs
- Abhängigkeiten und Komplexität in der Fahrzeugentwicklung
- Metoden des Innovationsmanagements im Automobilsektor
- Nutzerorientiertes Design und Lean Development im Kontext digitaler Fahrzeuge

Teaching Methods

Lehre in Form von seminaristischem Unterricht und Gastvorträgen aus der Automobilbranche.
Hands-On Gruppenarbeiten mit dem Ziel der Erarbeitung neuer Produktideen uaf Basis nutzenorientierten Desgins.

ASE-02 Digital Car / Innovation Management & Customer Design

Type of Examination

project work

ASE-03 Advanced Driver Assistance Systems

Module code	ASE-03
Module coordination	Prof. Thomas Limbrunner
Course number and name	ASE-03 Advanced Driver Assistance Systems
Lecturer	Prof. Thomas Limbrunner
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Portfolio
Weighting of the grade	5 ECTS
Language of Instruction	English

Module Objective

Students are given a basic overview of the systematics of driver assistance systems and the interaction of the components involved. The aim is to gain an overall system understanding of the topology in the vehicle and to highlight the key aspects of the development and function of driver assistance systems.

Applicability in this and other Programs

Master Automotive Software Engineering, Master Applied Research, Master AI, Bachelor Cybersecurity, B-AI, MT-B, M-AID

Entrance Requirements

Undergraduate studies

Learning Content

- Overview of driver assistance systems (definition, classification of relevant terms, classification, areas of application, legal aspects,
  NCAP, ...)
- System overview of the vehicle from the perspective of driver assistance, understanding the functional chains, K-matrix,
  mapping of signals
- Sensor technology, measurement and functional principle, such as camera (mono, stereo), lidar, radar, ultrasound, EGO data
- Central vehicle computer, domain controller, sensor fusion

Note: The content of the course may change over time and will be continuously adapted to current technological developments

Teaching Methods

Seminar based teaching combined with practical blocks, as well as some group work or research with presentation of results

Recommended Literature

[1] Winner, H.; Hakuli, S.: "Handbuch Fahrerassistenzsysteme"
Springer Vieweg Verlag 2012, 2015, 3. Auflage, ISBN: 978-3-658-05733-6
[2] Reif, K.: "Automobil Elektronik", Vieweg Verlag 2006, 1. Auflage, ISBN 3-528-03985-X
[3] Streichert, T.; Traub, M.: "Elektrik/Elektronik Architekturen im Kraftfahrzeug",
Springer Vieweg Verlag 2012, ISBN: 978-3-642-25478-9
[4] Schäufele, J.; Zurawka, T.: "Automotive Software Engineering",
Vieweg Verlag 2003, ISBN: 3-528-01040-1

ASE-03 Advanced Driver Assistance Systems

Type of Examination

Portfolio

ASE-04 Mobile applications & interaction design in vehicle

Module code	ASE-04
Module coordination	Prof. Dr. Goetz Winterfeldt
Course number and name	ASE-04 Mobile applications & interaction design in vehicle
Lecturer	Prof. Dr. Goetz Winterfeldt
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 90 hours self-study: 60 hours Total: 150 hours
Type of Examination	Portfolio
Language of Instruction	English

Module Objective

ASE-04 Mobile applications & interaction design in vehicle

Type of Examination

Portfolio

ASE-05 Technical Language: German or Other Foreign Language

Module code	ASE-05
Module coordination	Tanja Mertadana
Course number and name	ASE-05 Technical Language: German or Other Foreign Language
Lecturer	Dozierende für AWP und Sprachen
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Postgraduate
Semester periods per week (SWS)	4
ECTS	4
Workload	Time of attendance: 60 hours self-study: 60 hours Total: 120 hours
Type of Examination	See examination schedule AWP and languages
Weighting of the grade	4/90
Language of Instruction	Course dependent
	*Internationale Studierende erhalten ECTS ab der Niveaustufe Deutsch B1/ 1. + 2. Teil. Deutsch-Muttersprachler oder internationale Studierende mit Deutschkenntnissen der Niveaustufe C1 gemäß dem Gemei

Module Objective

The module Technical Language: German or Other Foreign Language aims to equip students with specialised language skills necessary for independent professional activity in the globalised field of automotive software engineering. To this end, students familiarise

themselves with the respective language in order to use it effectively and efficiently as a practical means of communication.
International students receive ECTS as of level German B1/ part 1 + 2. German native speakers or international students with German language skills at level C1 according to the Common European Framework of Reference for Languages can select any two foreign language courses from the catalogue of the Language Centre. Since English level B2 is an admission requirement, English can only be selected at level C1.

Qualification objectives can be found in the corresponding course description on the homepage of the Language Centre:
https://th-deg.de/language-and-electives-centre

Applicability in this and other Programs

Applicable in other degree programmes.

Entrance Requirements

In order to attend advanced language courses, students need to present the required language skills (e.g. by successfully completing of the previous level).

Learning Content

The course content can be found in the corresponding course description on the homepage of the Language Centre:
https://th-deg.de/language-and-electives-centre

Teaching Methods

The teaching methods applied will focus on optimising the four main language skills (listening, speaking, reading and writing). Examples of the applied learning methods include various forms of group, individual and collaborative work, mini-presentations, exercises involving intensive reading and listening, role plays and grammar games, loci method, dictation exercises, translations, peer feedback, working with learning stations, and various writing activities designed to consolidate the content learnt.

Students will be given weekly assignments for self-study.

Remarks

For course-specific details, please refer to the corresponding course description on the homepage of the Language Centre:
https://th-deg.de/language-and-electives-centre

All language courses require a compulsory attendance rate of 75% in order to be allowed to take the examination.

Recommended Literature

Recommended reading can be found in the corresponding course description on the homepage of the Language Centre:
https://th-deg.de/language-and-electives-centre

ASE-05 Technical Language: German or Other Foreign Language

Type of Examination

See examination schedule AWP and languages

ASE-06 Compulsory optional subject 1

Module code	ASE-06
Module coordination	Prof. Dr. Andreas Grzemba
Course number and name	ASE-06 Compulsory optional subject 1
Lecturers	Prof. Dr. Andreas Grzemba Dozierende der ausgewählten Wahlpflichtfächer Lecturer of the chosen Electives
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	elective course
Level	postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 90 hours self-study: 60 hours Total: 150 hours
Type of Examination	Examination form of the chosen module
Weighting of the grade	5/90
Language of Instruction	English

Module Objective

This module allows students to customize their curriculum by choosing an elective out of existing university courses

The main goal is to fill knowledge gaps of the student (individuality), to acquire knowledge in current and different upcoming topics (flexibility) and the students should be able to advance in individual higher-level topics (specialization). In connection with three other electives and two language modules in the curriculum, the module offers a high degree of individuality, flexibility and specialization.

The students achieve the following learning objectives in the module:

Professional skills

The students have closed their previously identified knowledge gaps with regard to the fields of AI, mathematics for AI, data science and software development.

Methodological skills

They can apply knowledge and field-specific methods not covered by regular modules listed in this document. Also, the students collect experience in independent the work on scientific research questions.

Soft skills

The students can give constructive feedback to peers in context of peer-assessed exercises.

Since courses from other programs can be selected for the elective, the respective study and examination regulations must be consulted for module information. Further, student research projects provided by faculty staff are described by the staff once electives have to be chosen for a semester. The descriptions of university courses and projects enhance the description of this module.

Entrance Requirements

Fundamental knowledge in:

- undergraduate mathematics
- undergraduate computer science
- programming languages (Python, R, Java, C, C++, C# etc.)
- literature research and scientific working

Learning Content

In the case of a course chosen as elective, the learning content follows the course content.

The list of electives 1 contains the following modules. A detailed description can be found on the DIT website.

- AIX-M-2 / Datacenter Network Programming / Prof. Kassler / EN /4 SWS / 5 ECTS
- LSI-M / Data Visualization / Prof. Torkler/ Prof. Valdes / EN /4 SWS / 5 ECTS
- HPC-M-7 / HPC/QC Technology / Prof. Liebelt / EN /4 SWS / 5 ECTS
- AIX-M-16 / ChatGPT et al.: Generative AI with Transformers / Prof. Fischer / EN /4 SWS / 5 ECTS

Teaching Methods

Course-based electives involve seminar-style lessons and may contain exercises. Student research projects rely on self-learning by doing literature research, data-science analyses and the development of algorithms or models

Remarks

This course is taught at the Deggendorf Institute of Technology.

The type and duration of examination in this module depends on the chosen elective, such as a course or a student research project. This means that the examination can be a written/oral exam or an examination paper submitted by the student.

Recommended Literature

The fundamental literature of each elective is provided by study and examination regulation and the respective lecturer. However, this also includes literature research done by the student in case of student research projects.

ASE-06 Compulsory optional subject 1

Type of Examination

Examination form of the chosen module

ASE-07 Artificial Intelligence and Software Development

Module code	ASE-07
Module coordination	Prof. Dr. Andreas Grzemba
Course number and name	ASE-07 Artificial Intelligence and Software Development
Lecturer	Prof. Dr. Cezar Ionescu
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Portfolio
Language of Instruction	English

Module Objective

ASE-07 Artificial Intelligence and Software Development

Type of Examination

Portfolio

ASE-08 Automotive Software Engineering

Module code	ASE-08
Module coordination	Prof. Dr. Andreas Wölfl
Course number and name	ASE-08 Automotive Software Engineering
Lecturer	Prof. Dr. Andreas Wölfl
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weighting of the grade	5 ETCS
Language of Instruction	English

Module Objective

Students will aquire knowledge and understanding of the concepts and methods of software engineering in the automotive domain.

Specifically, students will have achieved the following learning outcomes upon completion of the module:

Subject competency

- Students know and understand the fundamental concepts and methods of software engineering
- Students are able to apply fundamentals of project management to automotive software development processes

- Students are able to derive software requirements from high-level system specifications
- Students are able to perform code reviews
- Students know how to transform an embedded software system from proof of concept to production

Methodological competency

- Students are able to define and conduct different test strategies based on requirements
- Students are able to automatically test and deploy software using CI/CD pipelines
- Students are able to work with version control
- Students are able to containerize and deploy software using Docker

Personal competency

- Students work goal-oriented and acquire a high degree of determination
- Using agile methods fosters self-motivation
- Working in a task-oriented way helps to empower a problem-solving way of thinking

Social competency

- Students are able to organize themselves in small groups to conduct a software project
- Students actively participate in team meetings fostering their ability to work in teams

Applicability in this and other Programs

-

Entrance Requirements

Knowledge of the following modules:

- Foundations of Computer Science
- Operating Systems and Networks
- Programming 1
- Programming 2
- Internet Technologies

Learning Content

1 Motivation and Definition
2 Software Engineering Lifecycle
3 Software Process Models

4 Methodology
  - Requirements Engineering
  - Software Design
5 Implementation
  - Coding conventions
  - Design Patterns
  - Static code analysis
  - Code metrics
6 Software Test
  - Testing process
  - Testing methods and strategies
  - Unit-, Integration- and End2End testing
7 Software Quality Assurance
  - Definition
  - Reviews

Teaching Methods

- Interactive lectures
- Practical exercises using CASE tools
- Conducting a small software project in a team

Remarks

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Recommended Literature

- H. Balzert, Lehrbuch der Software-Technik, Spektrum Akademischer Verlag
- I. Sommerville, Software Engineering, Addison Wesley Verlag
- B. Beizer, Black - Box Testing: Techniques for Functional Testing of Software and Systems, Wiley Verlag

ASE-08 Automotive Software Engineering

Type of Examination

written ex. 90 min.

ASE-09 Project

Module code	ASE-09
Module coordination	Prof. Dr. Andreas Grzemba
Course number and name	ASE-09 Project
Lecturer	Prof. Dr. Andreas Grzemba
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	4
ECTS	6
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Portfolio
Language of Instruction	English

Module Objective

ASE-09 Project

Type of Examination

Portfolio

ASE-10 Compulsory optional subject 2

Module code	ASE-10
Module coordination	Prof. Dr. Andreas Grzemba
Course number and name	ASE-10 Compulsory optional subject 2
Lecturer	Prof. Dr. Andreas Grzemba
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	elective course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Examination form of the chosen module
Language of Instruction	English

Module Objective

ASE-10 Compulsory optional subject 2

Type of Examination

Examination form of the chosen module

ASE-11 Wireless and Car2X-Communication

Module code	ASE-11
Module coordination	Prof. Dr. Andreas Kassler
Course number and name	ASE-11 Wireless and Car2X-Communication
Lecturer	Prof. Dr. Andreas Kassler
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Portfolio
Weighting of the grade	
Language of Instruction	English

Module Objective

The module learning objective is to understand the fundamental concepts of vehicular networking. Students understand the following concepts and their application:
- explain the principles and limitations of wireless communication with focus on vehicular networking,
- explain important technical aspects of current wireless and vehicular networking technologies,
- explain the principles of medium access control and routing in the context of vehicular networking,
- summarise key functions and principles behind different architectures for wireless and car-2-X communication systems,

- critically evaluate different properties of a car-2-X communication system using vehicular networking simulations.

Entrance Requirements

Students should have basic understanding of computer networks.

Learning Content

The automotive industry is increasingly relying on computer science and wireless communication. The vision of the car of tomorrow is to be fully connected with the environment. Indeed, connected cars have the capabilities to connect not only to the internet but also to other moving cars and infotainment systems. This lecture teaches important concepts from these domains, starting with wireless networks in general (from wireless signal characteristics to propagation of signals and medium access schemes), to wireless network architectures. The lecture then moves to networks of moving cars (from communication technology and system architectures, to the design of advanced traffic information systems, security and safety). Topics include

- Radio signals and propagation
- Coding, modulation, and multiplexing
- Car-2X communication pattern, use cases and requirements
- UMTS, LTE, 5G and their use for car-2X
- 802.11p and WAVE
- IEEE 1609
- ETSI ITS G5
- Broadcast, Geocast, Routing
- Beaconing and Traffic Information systems
- Simulating Car2X systems

Teaching Methods

- Interactive Lectures
- Interactive Exercise Sessions

Recommended Literature

Vehicular Networking by Christoph Sommer and Falko Dressler, published in December 2014 by Cambridge University Press.

Hannes Hartenstein and Kenneth Laberteaux (Eds.), *VANET - Vehicular Applications and Inter-Networking Technologies* , Intelligent Transport Systems, Chichester, United Kingdom, John Wiley & Sons (Wiley), 2010

ASE-11 Wireless and Car2X-Communication

Type of Examination

Portfolio

ASE-12 Automotive Microcontroller

Module code	ASE-12
Module coordination	Prof. Dr. Andreas Grzemba
Course number and name	ASE-12 Automotive Microcontroller
Lecturer	Prof. Dr. Andreas Grzemba
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Portfolio
Language of Instruction	English

Module Objective

ASE-12 Automotive Microcontroller

Type of Examination

Portfolio

ASE-13 Automotive Communication Architecture (inCar)

Module code	ASE-13
Module coordination	Prof. Dr. Andreas Grzemba
Course number and name	ASE-13 Automotive Communication Architecture (inCar)
Lecturer	Prof. Dr. Andreas Grzemba
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Portfolio
Language of Instruction	English

Module Objective

ASE-13 Automotive Communication Architecture (inCar)

Type of Examination

Portfolio

ASE-14 Master thesis

Module code	ASE-14
Module coordination	Prof. Dr. Andreas Grzemba
Course number and name	Master's colloquium ASE-14 Master thesis
Lecturer	Prof. Dr. Andreas Grzemba
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	2
ECTS	25
Workload	Time of attendance: 0 hours Total: 0 hours
Type of Examination	colloquium, master thesis
Language of Instruction	English

Module Objective

Master's colloquium

Type of Examination

colloquium

ASE-14 Master thesis

Type of Examination

master thesis