



Module handbook

Artificial Intelligence (SPO SS 25)

Faculty of Computer Science

Study and examination regulation: WS 24/25

Status: 2025-06-29

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1 Overview

Name of the study program	Artificial intelligence
Type of study & degree level	Consecutive, M.Sc. (Master of Science), full-time
First start date	Summer semester 2025, start every semester
Standard period of study	3 semesters, 90 ECTS, 46 semester hours per week
Place of study	THI, Ingolstadt
Language/s of instruction	English; individual modules can be offered in German
Cooperation	None; dual studies are possible
Admission requirements	Bachelor's degree in AI, Data Science, Computer Science or comparable with at least 210 ECTS, as well as successful participation in the aptitude test (proof of solid basic skills in the field of AI / Data Science / Machine Learning), see §3 & §4 of the study and examination regulations Artificial Intelligence
Capacity	30 students per academic year
Program Director	Prof. Dr. Sören Gröttrup E-Mail: Soeren.Groettrup@thi.de Phone: +49 (0) 841 / 9348-2332
Student advisor	Prof. Dr. Sören Gröttrup E-Mail: Soeren.Groettrup@thi.de Phone: +49 (0) 841 / 9348-2332

2 Introduction

This module handbook describes the current status of the courses offered in the Master's degree program in Artificial Intelligence in accordance with the Study and Examination Regulations (SPO) WS 2022/23. 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.

2.1 Objective

The Master's degree program in Artificial Intelligence builds on a Bachelor's degree in Artificial Intelligence, Data Science or a related field.

It deepens scientific knowledge and skills with regard to the development and conception of the latest methods and concepts of artificial intelligence. It enables graduates to independently design, implement and apply AI solutions in terms of data management and algorithms for a wide range of practical and research issues and to evaluate these in terms of security aspects. The course enables them to work independently in the field of development and application of artificial intelligence. It also sharpens their awareness of the influence of artificial intelligence on society and the changes it brings. The detailed study objectives are listed in section 3.2 (or in relation to the subject areas in section 3.2.1).

In addition to these subject and topic-related competencies, methodological, social and personal skills typically taught in the above-mentioned Bachelor's degree programs are deepened and expanded.

2.2 Admission requirements

The course-specific admission and qualification requirements are regulated in §3 of the study and examination regulations of the Master's degree course. These are:

- A proof of successful completion of a degree program at a German university with at least 210 ECTS credits or equivalent in the field of artificial intelligence, data science, computer science, mathematics, engineering, computer linguistics or a related field, or an equivalent successful domestic or foreign degree.
- Successful participation in the aptitude test of the degree program, in which subject-specific aptitude (i.e., knowledge of mathematics, statistics, programming, as well as skills in the areas of machine learning, deep learning, computer vision, speech and text understanding and big data technologies), independent scientific work and practical experience in the development of artificial intelligence applications are assessed. The details of the aptitude test are regulated in §3 of the study and examination regulations, and the associated statutes on the aptitude test of the Master's degree program.

Overarching regulations independent of the degree program are laid down in the respective superordinate regulations and statutes of Ingolstadt University of Applied Sciences (general examination regulations, matriculation statutes)¹.

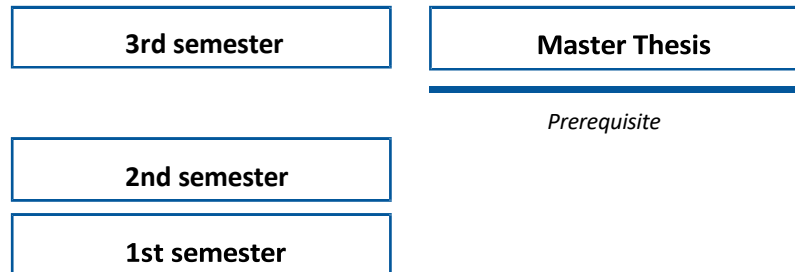
2.3 Target group

This Master's degree program is aimed at Bachelor's graduates in Artificial Intelligence, Data Science or related computer science courses who have a solid background in artificial intelligence, machine learning or data science and want to expand and deepen their skills (acquired in their Bachelor's degree) in the field of artificial intelligence, conception and development, as well as the provision of artificial intelligence solutions in various practical and research contexts. The target group in the narrower sense are, in particular, graduates of the Bachelor's degree programs in Artificial Intelligence, Computer Science and Artificial Intelligence, Computer Science, Business Informatics and Flight and Vehicle Informatics at Ingolstadt University of Applied Sciences.

¹ Available at <https://www.thi.de/en/university/university-profile/university-management/legal-department/general-statutes/>

2.4 Study structure

The standard period of study for the Master's degree course in Artificial Intelligence comprises three semesters, as shown in the following diagram.



The 3rd semester is intended for the creation of the Master's thesis. The contents of the modules of the 1st semester and 2nd semester are independent of each other. They do not build on each other. This ensures that it is possible to start this Master's degree program in both the summer and winter semester. Some of the modules in the first two semesters are defined as subject-specific compulsory elective modules, i.e., the number and scope of these modules is mandatory, while the exact modules can be chosen from a wider range of elective modules. Details on this are listed in the following sections.

2.4.1 Compulsory modules

The following table contains the modules of the first two semesters of the Master's degree course in Artificial Intelligence, including their key dates and semester allocation.

No.	Module	Summer semester		Winter semester	
		SWS	CP	SWS	CP
1	Advanced Computer Vision			4	5
2	Deep Learning Applications			4	5
3	Advanced Speech Technology	4	5		
4	Advanced Big Data Concepts and Technologies			4	5
5	Intelligent Robotics			4	5
6	Social Implications of Artificial Intelligence	4	5		
7	AI in Safety-related Systems	4	5		
8	Elective 1	4	5		
9	Elective 2			4	5
10	Interdisciplinary Elective			4	5
11	Seminar	2	3		
12	Project	4	7		
	Total	22	30	24	30

Legend:

CP Credit Points (ECTS points)

SWS Semester hours per week

2.4.2 Subject-specific elective modules

The first two semesters of the Master's degree course in Artificial Intelligence include a total of three elective modules. These can be selected from the course's elective module catalog. This is determined for each semester and announced in the curriculum for the respective semester.

Compulsory modules from other Master's degree programs, like AI Engineering of Autonomous Systems, Business Information Systems Engineering and Cloud Applications und Security Engineering are offered as elective modules in the Artificial Intelligence degree program, according to their annual offering cycle. These modules give students the opportunity to extend the skills taught in the compulsory modules of their degree program in the direction of other extremely topical and sought-after subject

areas. In addition to these elective modules, further elective modules matching the content profile of the degree program may be offered. Such elective modules can only be offered if there is a sufficient number of participants.

For the interdisciplinary elective module, non-technical modules or modules outside the field of artificial intelligence from other disciplines must be selected. The modules offered for this are typically compulsory or elective modules from other Master's degree programs in other faculties at THI, e.g., the Business School.

The selection of elective modules via online subject registration takes place at the beginning of the semester, usually in the first week of the semester. This serves to determine demand and, if necessary, to ensure an appropriate distribution of demand among the elective modules. There is no entitlement to participate in certain elective modules offered in a semester. The opportunity to participate in the number of elective modules planned per semester is ensured (see semester allocation according to the table in section 2.4.1).

2.5 Dual study program

In cooperation with selected practice partners, the degree course can also be completed in the dual study model ("study with in-depth practice"). Dual students work in the cooperating company during the lecture-free period and can thus supplement the theoretical knowledge they have acquired during their studies with professional practice. An optimal integration of theory and practice is guaranteed by the quality standards of "hochschule dual", the umbrella brand for dual studies in Bavaria (<https://www.hochschule-dual.de/en/>).

The lecture times in the dual study model correspond to the study and lecture times at the THI. The curriculum of the dual study model differs from the non-dual study program concept in the following points:

- **Dual modules:** Elective modules particularly suitable for dual students are offered on a regular basis. These courses are held at the university or at a dual partner. Projects particularly suitable for dual students are also offered. It is possible to receive credit for projects based on skills acquired outside the university from the company as a place of learning. Where possible, individual courses are held by lecturers from the partner companies.
- **Final thesis at the partner company:** In the dual study model, the final thesis is written at the cooperation company, usually on a practice-related topic.

Organizationally, the dual study program model is characterized by the following components:

- **Mentoring:** The central contacts for dual students in the faculty are the respective program directors. They organize an annual mentoring meeting with the dual students of the respective degree course.
- **Quality management:** The evaluations and surveys at THI for quality assurance of the degree programs include separate blocks of questions for the dual study program.

- **"Forum dual"**: Organized by the THI Career Service and Student Advisory Service (CSS), the "Forum dual" takes place once a year. This promotes the professional and organizational exchange between the dual cooperation partners and the faculty and serves to ensure the quality of the dual study programs. All cooperation partners in the dual study program as well as representatives and dual students of the faculty are invited to the event.

Further information on the dual Master's program can be found at

<https://www.thi.de/en/studies/degree-programmes/dual-studies/master-dual/>

Formal legal regulations for dual studies for all degree programs at THI can be found in the APO² (see §§ 17 (3) and 30 (5)) and the matriculation statutes³ (see §§ 8b, 9 and 18).

2.6 Concept

The Master's degree course in Artificial Intelligence was developed as an independent degree course with a clear focus on the increasingly relevant topic of artificial intelligence as part of the further development of the Master's degree courses at the Faculty of Computer Science. The content and orientation of the Artificial Intelligence degree program (see sections 2.1 and 3.2.1) was designed with a view to companies (both regional and supraregional) and scientific institutions, such as the AI research institute Almotion Bavaria, which is affiliated with the THI, highly sought-after competencies, as well as taking into account a competitive analysis of the computer science-related Master's degree programs offered at Bavarian universities of applied sciences.

A Master's degree course in Artificial Intelligence was also urgently requested and demanded by students on the Bachelor's degree course in Artificial Intelligence and other Bachelor's degree courses in the Faculty of Computer Science at THI.

² General Examination Regulations of THI, available at <https://www.thi.de/en/university/university-profile/university-management/legal-department/general-statutes/>

³ Ibid.

3 Qualification profile

3.1 Mission statement

The degree program takes up the mission statement of teaching ("Personalities for a future worth living"⁴) at Ingolstadt University of Applied Sciences in the following way:

"We prepare our students for the challenges of the future":

- The course focuses on the topic of artificial intelligence (see section 2.1), which is of fundamental importance for companies and whose importance will continue to increase in the future due to the constant advance of digitalization and newly emerging applications of artificial intelligence. In the associated modules, the current state of the art established in the field is taught and classified.
- Wherever possible, the modules of the degree course highlight the influences of current or emerging social, economic and research-relevant trends on the topics covered in the degree course, as well as the associated challenges for companies, in order to sensitize students to changes in the framework conditions of their future careers.

"We enable our students to develop solutions to problems on the basis of scientific findings."

- In terms of content and methodology, the modules of the degree program demonstrate the current state of the art in the field and illustrate its practical applicability.
- The application of scientific knowledge to solve problems is taken into account in the design and implementation of the various modules:
 - In the project: The consideration of the current state of scientific and methodological knowledge is an essential aspect in the processing of the task.
 - In the seminar: The classification of the seminar topic to be worked on in the current state of scientific knowledge relevant to the topic is a fundamental step in the well-founded processing of a seminar topic.
 - In the other modules: The integration of suitable tasks and practical exercises promotes the application and transfer of the scientific topics covered in the modules.

⁴ Available at <https://www.thi.de/en/university/university-profile/mission-statement/principles-of-teaching/>

"We open up outstanding regional and international perspectives for our students":

- The project groups offered in the degree program can be carried out by lecturers from companies in the region in addition to research-related professors. This gives students contact with industry and allows them to deal with current tasks from business practice. Lecturers can also be involved in other modules with a high practical relevance.
- Individual modules of the degree program are taught in English, which gives students the opportunity to interact in an international context and gain experience in this regard.
- The elective modules integrated into the curriculum give students the freedom to complete a semester abroad, as modules that are compatible with the profile or objectives of the degree program and that were completed abroad can generally be credited as elective modules.
- The specific subject areas and skills taught on the degree course (see section 3.2.1) are in high demand in almost all companies (regional, national and international) in view of the continuous advance of digitalization, digital transformation and developments in the field of artificial intelligence.

"We teach and learn through personal exchange":

- The lecturers demand and encourage an open and reflective exchange with the students in the context of teaching the module-specific topics and skills.
- Personal exchange is an integral part of the seminar and project modules in particular and plays a central role in these modules, both between the lecturer and the students and between the students themselves.
- In addition to working on a content-related task, modules with practical work and the project serve essentially to gather or deepen experience with regard to the various facets of cooperation in a team: individual work vs. working in (sub)groups of different sizes, coordination / synchronization between subgroups to achieve an overarching work goal, etc.

"We help all students to discover and exploit their individual potential."

- The range of thematic options (topics of the elective modules, project topics or seminar topics) helps students to become explicitly aware of their interests and preferences in terms of content.

- The need to occupy different roles when working on larger, more complex tasks in teams or projects and to work together in these roles encourages students to become aware of their preferred roles and the skills required for these roles.
- The students are actively informed by the course management about the extracurricular, comprehensive offerings of the THI with regard to entrepreneurship and the support and promotion of start-ups in order to initiate corresponding thought processes in this direction.

3.2 Study objectives

3.2.1 Subject-specific competencies of the degree program

The course content was defined according to the needs of companies and research institutions, as well as the qualification framework for German university degrees. Graduates of the Master's degree program in Artificial Intelligence are able to

- independently design and implement the latest artificial intelligence algorithms and apply them to practical and research issues.
- adapt, construct and train deep neural networks of different types to existing tasks and data.
- find and implement artificial intelligence solutions for problems in various applications (including image, speech and text understanding).
- design and set up efficient and scalable database architectures for a wide range of data types and large data volumes.
- develop and analyze AI applications with regard to security aspects.
- reflect on the impact of artificial intelligence on society and the economy, also with regard to ethical issues, and classify the opportunities and risks.

3.2.2 Interdisciplinary competencies of the degree program

In addition to the subject-related skills, the following interdisciplinary skills are taught or strengthened (building on the skills usually taught in a Bachelor's degree course).

Methodological skills:

Graduates of the degree program are able to

- analyze problems, recognize overarching relationships, apply principles and methods to solve problems, evaluate solutions and solution options conceptually and technically, and create decision papers.
- work scientifically.

Social skills:

Graduates of the degree program are able to

- work on complex tasks in a team in a goal-oriented manner (communication and teamwork skills).
- represent work results to third parties in a well-founded and comprehensible manner.
- plan, organize and exercise leadership.
- conduct a scientific discourse.

Self-competencies:

Graduates of the degree program are able to

- organize themselves.
- communicate and present.
- develop complex relationships independently.
- think analytically and solution-oriented.
- work in a goal-oriented and independent manner.
- make well-founded decisions.
- structure and control projects (time management).

3.2.3 Examination concept of the degree program

When developing the degree program, care was taken to ensure that different forms of examination are used and that the forms of examination are suitable or appropriate for the content and skills taught in the modules.

The assignment of the examination forms to the individual modules is listed in the following table (see appendix to the study and examination regulations for the Master program Artificial Intelligence WS 2022/23):

No.	Module	Form of examination
1	Advanced Computer Vision	schrP
2	Deep Learning Applications	prA
3	Advanced Speech Technology	schrP
4	Advanced Big Data Concepts and Technologies	schrP
5	Intelligent Robotics	prA
6	Social Implications of Artificial Intelligence	mdlP
7	AI in Safety-related Systems	schrP
8	Elective 1	LN
9	Elective 2	LN
10	Interdisciplinary Elective	LN
11	Seminar	SA
12	Project	PA
13	Master Thesis	MA

Legend:

schrP	Written examination	The written examination is a written exam lasting 90 minutes unless explicitly stated otherwise.
mdlP	Oral examination	The oral examination is a questioning of 20-30 minutes per person, unless explicitly stated otherwise.
prA	Practical work	Practical work is a concrete task that is carried out in a practical setting. The task may consist of several subtasks. The assignments are to be completed either in a group or individually. In the case of group work, each student must contribute individually. The workload for the individual contribution corresponds to 125 hours. Depending on the type of assignment, the work result must be provided in a suitable form, e.g. source code or documentation. The work result must be explained by the group or the student in an acceptance meeting (scope of the acceptance meeting: 15 to 30 minutes for individual tasks, 30 to 60 minutes for group work,

		whereby in the acceptance meeting each group member must contribute to the parts of the results for which he/she is responsible). Further details can be found in the curriculum.
SA	Seminar paper	The seminar paper is a term paper with an oral presentation. The length of the term paper is approx. 8 to 15 pages (without cover pages, lists and appendices), created with a word processing program. The oral presentation lasts 45 to 75 minutes and can also take place during the semester.
PA	Project work	Project work is group work in which several students work on a joint task as a team over the course of a semester. Each student must contribute individually to the joint task. The workload for the individual contribution of each student corresponds to 175 hours. Depending on the nature of the task, the project result must be provided in a suitable form, e.g. source code or documentation, and the result (or interim results achieved at project milestones) must be presented orally, e.g. in regular project meetings or in a specialist presentation of the results lasting approx. 15 to 30 minutes. Further details can be found in the curriculum.
MA	Master thesis	Written thesis in the Master's program. The scope is approx. 60 to 100 pages (excluding cover sheets, indexes and appendices), created with a word processing program.
LN	Proof of performance	The proof of performance (LN) can be a written examination (schrP), an oral examination (mdlP), a practical thesis (prA) or a seminar paper (SA). The details will be determined by the Faculty Council in the curriculum.

3.2.4 Applied relevance of the degree program

The degree program was developed with a view to the topic of artificial intelligence and the associated skills that are in demand in practice and research (see sections 2.6 and 3.2.1). In addition, social and personal skills that are important for a professional career are also taken into account and deepened (see section 3.2.2). The project deals with typical, realistic tasks from company practice or research-related topics. This is usually supervised by professors from the Almotion AI research institute or lecturers from companies. The Master's thesis can be completed as a scientifically oriented university thesis, in cooperation with the university-affiliated Almotion research institute, but also as an application-oriented thesis in a company.

3.2.5 Contribution of individual modules to the study objectives

The following table lists the modules of the degree program with the degree of their contribution to the subject-related study objectives of Artificial Intelligence (AI) as well as to the interdisciplinary methodological (MC), social (SoC) and personal skills (PeC) (see section 3.2.1 and section 3.2.2).

No.	Module	AI	MC	SoC	PeC
1	Advanced Computer Vision	++	+	+	+
2	Deep Learning Applications	++	+	+	+
3	Advanced Speech Technology	++	+	+	+
4	Advanced Big Data Concepts and Technologies	++	+	0	0
5	Intelligent Robotics	++	+	+	+
6	Social Implications of Artificial Intelligence	++	+	+	+
7	AI in Safety-related Systems	++	+	0	0
8	Elective 1	*	*	*	*
9	Elective 2	*	*	*	*
10	Interdisciplinary Elective	*	*	*	*
11	Seminar	*	++	++	++
12	Project	*	++	++	++
13	Master Thesis	*	++	+	++

Legend:

- ++ High contribution to competence
- +
- 0 Contribution to competence
- No significant contribution to competence
- * For the project or seminar, the contribution to the subject-related competencies depends on the choice of topic. For the elective modules, the contribution to all competencies depends on the content-related topic or focus of the elective module and its design with regard to the interdisciplinary competencies. For the interdisciplinary elective module, it is not possible to make a detailed statement regarding competencies.

3.3 Possible occupational fields

The field of artificial intelligence is becoming increasingly important or already plays a decisive role in many industries and companies with a wide range of applications. Graduates of the degree program can therefore work in companies of various sizes and in different industries. Typical job and role descriptions in companies in this context are:

- Data Scientist
- Machine Learning Engineer
- Deep Learning Engineer
- NLP Engineer
- AI Developer / Architect
- Big Data Engineer/ Architect

Graduates' future fields of activity focus on the following sectors (among others):

- Automotive industry (driver assistance systems, autonomous driving).
- Companies and employers in every industry in which artificial intelligence methods and techniques are developed and used.

Graduates have opportunities to work as self-employed or as employees in companies that primarily deal with the research, development and operation of artificial intelligence.

Graduates of the degree program are qualified to start a scientific career in this field. As an alternative, they can also work at a research institution with a focus on and application of artificial intelligence.

4 Description of Modules

4.1 Compulsory Modules

Advanced Computer Vision			
Module abbreviation:	AIN_AdvCV	SPO-No.:	1
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Subject	2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Schön, Torsten		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	1: Advanced Computer Vision		
Lecture types:	1: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
1: schrP90 - written exam, 90 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
The following basics should be available from the Bachelor's program already completed: Programming language Python, AI frameworks (PyTorch, TensorFlow), machine learning and deep learning, computer vision, convolutional neural networks, architectures for classification, object recognition, semantic segmentation, human pose estimation, generative adversarial networks, pattern recognition.			
Objectives:			
This module introduces students to advanced computer vision methods and deep learning architectures in line with the latest research findings. To this end, students deal with the processing of 2D and 3D image data and their fusion in different application areas. Students further learn how to deal with sequential image data, like videos, and how networks are designed to handle this kind of data. One of the latest concepts in computer vision is the application of attention mechanisms. In this module, students learn the basic concepts of the attention mechanism and transformer networks, and how they can be applied to computer vision problems. After completing this module, students will be able to • reconstruct 3D models from stereo or moving images. • understand different imaging sensor types and what data they deliver. • process and merge sensor data from different models. • process video data and make predictions based on it.			

• register multimodal data. • analyze decision-making processes within the networks. • apply attention and transformer architectures to computer vision problems. • understand and apply foundation models. • understand and apply modern image generation models. • extract, summarize, and reproduce information independently from scientific publications. • work on problems together in learning groups and reflect on their approach.
Content:
• Stereo vision, 3D reconstruction and depth estimation • Processing of sensor data from camera, LiDAR and radar • Early, late and deep fusion • Video processing for tracking and intention recognition • Optical Flow • (visual) SLAM • Registration of multimodal data • Attention / Self-Attention in Computer Vision • Transformer-based models (Introduction to Transformers, Vision Transformers, Anchor-Box-Free Object Detection) • Foundation Models • Generative AI models like Diffusion Models
Literature:
• RUSSELL, Stuart J. and Peter NORVIG, 2022. <i>Artificial intelligence: a modern approach</i>. Harlow, United Kingdom: Pearson. ISBN 978-1-292-40113-3, 1-292-40113-3 • GOODFELLOW, Ian, Yoshua BENGIO and Aaron COURVILLE, 2018. <i>Deep Learning: the comprehensive handbook: basics, current methods and algorithms, new research approaches..</i> Frechen: mitp. ISBN 978-3-95845-700- 3 • ZHANG, Xinyu, LI, Jun, LI, Zhiwei, LIU, Huaping, ZHOU, Mo, WANG, Li, ZOU, Zhenhong, 2023. <i>Multi-sensor Fusion for Autonomous Driving</i> [online]. Singapore: Springer Nature Singapore PDF e-Book. ISBN 978-981-9932-80-1. Available via: https://doi.org/10.1007/978-981-99-3280-1. • SJAFRIE, Hanky, 2020. <i>Introduction to self-driving vehicle technology</i>. Boca Raton ; London ; New York: CRC Press. ISBN 978-1-00-071177-6, 978-0-429-31677-7 • SZELISKI, Richard, 2022. <i>Computer vision: algorithms and applications</i> [online]. Cham, Switzerland: Springer PDF e-Book. ISBN 978-3-030-34372-9. Available via: https://doi.org/10.1007/978-3-030-34372-9.
Additional remarks:
None

Deep Learning Applications			
Module abbreviation:	AIN_DLApp	SPO-No.:	2
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Subject	2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Schön, Torsten		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	2: Deep Learning Applications		
Lecture types:	2: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
2: prA - Practical work incl. oral exam (30 min.) for acceptance			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
The following basics should be available from the Bachelor's program already completed: programming language Python, AI frameworks (PyTorch, TensorFlow), machine learning and deep learning			
Objectives:			
In this module, students learn about the safe application of deep learning methods for solving current research and development questions and apply this knowledge in a practical project and presentation. This module aims to learn the necessary steps of data pre-processing and preparation, targeted parameterization of deep learning networks, and scientific analysis of the training results, and to apply them in practice. To this end, students gain an insight into the latest research fields and results and learn how to process them independently. After completing this module, students will be able to • ideally prepare and augment data for use in deep learning models. • calibrate models ideally and train them in a targeted manner. • monitor and correctly interpret the results and learning progress of the models. • deal with deep reinforcement learning environments. • specifically influence the training of deep learning models. • draw the right conclusions from the training results and adjust the data or models accordingly.			

• deal with MLOps pipelines to ensure a high-quality standard in working with deep learning and to make it comprehensible. • evaluate the results scientifically and present them in written and oral form. • extract, summarize, and reproduce information independently from scientific publications. • work on problems together in learning groups and reflect on their approach.
Content:
• Data pre-processing and augmentation • Dealing with incomplete and inhomogeneous data • Active Learning • Multiple Instance Learning • Model calibration and reliability • Deep reinforcement learning frameworks • Model monitoring (e.g. tensor board) • Machine Learning Operations (MLOps) • Efficient network architectures for application on target hardware • Scientific evaluation and processing of DL results • Independent work on a topic in the form of a seminar paper
Literature:
• GOODFELLOW, Ian, Yoshua BENGIO and Aaron COURVILLE, 2018. <i>Deep Learning: the comprehensive handbook: basics, current methods and algorithms, new research approaches</i>. Frechen: mitp. ISBN 978-3-95845-700-3 • PLAAT, Aske, 2022. <i>Deep Reinforcement Learning</i> [online]. Singapore: Springer PDF e-Book. ISBN 978-981-1906-38-1. Available via: https://doi.org/10.1007/978-981-19-0638-1. • RUSSELL, Stuart J. and Peter NORVIG, 2022. <i>Artificial intelligence: a modern approach</i>. Harlow, United Kingdom: Pearson. ISBN 978-1-292-40113-3, 1-292-40113-3 • BILGIN, Enes, December 2020. <i>Mastering Reinforcement Learning with Python: build next-generation, self-learning models using reinforcement learning techniques and best practices</i>. Birmingham ; Mumbai: Packt. ISBN 978-1-83864-414-7
Additional remarks:
None

Advanced Speech Technology			
Module abbreviation:	AIN_AdvST	SPO-No.:	3
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Subject	1
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only summer term
Responsible for module:	Georges, Munir		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	3: Advanced Speech Technology		
Lecture types:	3: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
3: schrP90 - written exam, 90 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
The following basics should be available from the Bachelor's program already completed: programming language Python, machine learning and deep learning, language models, digital signal processing.			
Objectives:			
After successfully completing the module courses, students will be able to			
• evaluate selected methods in voice assistants. • analyze current developments in this area. • apply methods and carry out experiments independently. • research results in the context of voice assistance systems. • applications and to further develop selected methods. • Use speech/text algorithms to solve problems. • extract information independently from scientific publications, summarize it and present it to groups.			
Content:			
• Voice assistance systems • Speech recognition • Language/text comprehension			

• Knowledge (representation) • Text generation • Speech synthesis • Voice Biometrics (Emotions) • Efficient calculation and storage
Literature:
• EISENSTEIN, Jacob, 2019. <i>Introduction to natural language processing</i>. Cambridge, MA: The MIT Press. ISBN 978-0-262-04284-0 • GOODFELLOW, Ian, Yoshua BENGIO and Aaron COURVILLE, 2016. <i>deep learning</i>. Cambridge, Massachusetts; London, England: The MIT Press. ISBN 978-0-262-03561-3 • JURAFSK, Dan and James H. MARTIN, 2019. <i>speech and language processing</i>. Stanford: Stanford University. ISBN https://web.stanford.edu/~jurafsky/slp3/
Additional remarks:
None

Advanced Big Data Concepts and Technologies			
Module abbreviation:	AIN_BigDataCaT	SPO-No.:	4
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Sub-ject	2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Cato, Patrick		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	4: Advanced Big Data Concepts and Technologies		
Lecture types:	4: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
4: schrP90 - written exam, 90 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
The following basics should be available from the Bachelor's program already completed: Relational data-base systems, SQL, non-relational data management systems.			
Objectives:			
After successfully completing the module, students will be familiar with advanced concepts and technologies for storing and processing large amounts of data, i.e., they are able to			
- describe fundamental architectures and frameworks for distributed storage and processing of large-scale data sets (e.g., Hadoop, batch and stream processing paradigms). - compare and evaluate different storage and data serialization formats and their suitability for big data environments (e.g., columnar storage, optimized formats for versioning). - configure and operate Object Storage systems (e.g. MinIO) within big data environments, understanding their internal mechanisms and operational challenges. - design layered data architectures for ensuring robust data quality, governance, and lifecycle management (e.g., medallion/lakehouse architectures). - apply principles of data versioning and data lineage to ensure reproducibility and traceability in big data workflows (e.g., data versioning tools and metadata management). - explain and apply semantic data modeling concepts, including the use of ontologies and graph-based representations, for expressive and interoperable metadata management (e.g., RDF).			

• assess and critically reflect on the advantages and limitations of various storage, processing, and semantic modeling approaches in response to different big data scenarios.
Content:
• Introduction to Big Data: Definition of big data, selected use cases, data types, data formats and technology overview, modern data stack • Distributed Storage Architectures: Distributed File Systems (e.g., HDFS), Object Storage Systems (e.g., MinIO), Column Family Stores (e.g., HBase) • Optimized and Transactional Data Storage: Advanced table and file formats for big data (e.g., Delta Lake, Apache Iceberg, Parquet, Avro), lakehouse architectures • Data Processing Frameworks: Batch processing concepts (e.g., MapReduce), distributed data processing frameworks (e.g., Apache Spark) • Data Versioning, Lineage, and Governance: Workflow orchestration and pipeline management (e.g., Apache Airflow), metadata management (e.g., Project Nessie) • Semantic Data Modeling and Knowledge Graphs: Foundations of semantic web technologies (e.g., RDF, ontologies), semantic data modeling and integration with modern data architectures (e.g., integration into Retrieval Augmented Generation) and search technologies, construction and querying of knowledge graphs (e.g., SPARQL, property graph databases) • Emerging patterns and architectures (e.g., data mesh)
Literature:
• DEHGHANI, Zhamak, March 2022. <i>Data mesh: delivering data-driven value at scale</i>. Beijing ; Boston ; Farnham ; Sebastopol ; Tokyo: O'Reilly. ISBN 978-1-4920-9236-0 • KLEPPMANN, Martin, 2021-11-12. <i>Designing data-intensive applications: the big ideas behind reliable, scalable, and maintainable systems</i>. Beijing ; Boston ; Farnham ; Sebastopol ; Tokyo: O'Reilly. ISBN 978-1-449-37332-0 • PERKINS, Luc, Eric REDMOND and Jim R. WILSON, 2018. <i>Seven databases in seven weeks: a guide to modern databases and the NoSQL movement</i>. Raleigh, North Carolina: The Pragmatic Bookshelf. ISBN 978-1-68050-597-9 • STRENGTHOLT, Piethein, August 2020. <i>Data management at scale: best practices for enterprise architecture</i>. Beijing ; Boston ; Farnham ; Sebastopol ; Tokyo: O'Reilly. ISBN 149205478X, 978-1-492-05478-8
Additional remarks:
None

Intelligent Robotics			
Module abbreviation:	AIN_IRobot	SPO-No.:	5
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Subject	2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Schweiger, Johann		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	5: Intelligent Robotics		
Lecture types:	5: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
5: prA - Practical work incl. oral exam (30 min.) for acceptance			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
Basics of object-oriented programming			
Objectives:			
After successful completing the module, the students will be able to			
• name the most important sensors and actuators for autonomous mobile robots. • explain which forms of knowledge representation are suitable for intelligent robots. • understand how to program with behavior patterns and master the common methods for map-based locomotion. • use algorithms to record, merge and interpret sensor data and derive specifications for the actuators. • apply the algorithms and concepts they have learned to practical applications in the fields of automobiles, service robotics, automation technology and care robotics. • analyze practical tasks with regard to real-time conditions, safety requirements and the required behavior patterns. • derive a strategic plan for the use of behavioral patterns from a problem. • explain real-time cooperation methods for teams of autonomous mobile robots. • evaluate the different types of algorithms in terms of performance, real-time capability, robustness and flexibility. • work on topics together in small groups and present the results of their work.			

Content:

- Sensors and actuators for intelligent robots
- Software architectures for autonomous mobile robots
- Knowledge-based behavior pattern control
- Environment modeling
- Route and action planning
- Cooperation of autonomous mobile systems
- Practical exercises in the laboratory

Literature:

- VINJAMURI, Ramana, May 2023. *Human-robot interaction: perspectives and applications* [online]. London, United Kingdom: IntechOpen PDF e-Book. ISBN 978-1-80356-412-8, 978-1-80356-411-1. Available via: <https://directory.doabooks.org/handle/20.500.12854/113357>.
- YANG, Huayong, LIU, Honghai, ZOU, Jun, YIN, Zhouping, LIU, Lianqing, YANG, Geng, OUYANG, Xiaoping, WANG, Zhiyong, 2023. *Intelligent robotics and applications: 16th international conference, ICIRA 2023, Hangzhou, China, July 5–7, 2023, proceedings, part II* [online]. Singapore: Springer PDF e-Book. ISBN 978-981-99-6486-4. Available via: <https://doi.org/10.1007/978-981-99-6486-4>.
- HERTZBERG, Joachim, LINGEMANN, Kai, NÜCHTER, Andreas, 2012. *Mobile Roboter: eine Einführung aus Sicht der Informatik* [online]. Berlin [u.a.]: Springer PDF e-Book. ISBN 978-3-642-01726-1. Available via: <https://doi.org/10.1007/978-3-642-01726-1>.
- WHITMORE, Eric D., 2025. *Physical AI: The Revolution of Intelligent Machines*. ISBN 978-1456662431
- HUDA, M. Nazmul, WANG, Mingfeng, KALGANOVA, Tatiana, 2025. *Towards autonomous robotic systems: 25th annual conference, TAROS 2024, London, UK, August 21-23, 2024, proceedings, part I* [online]. Cham, Switzerland: Springer PDF e-Book. ISBN 978-3-031-72059-8. Available via: <https://doi.org/10.1007/978-3-031-72059-8>.
- VILLALBA-DIEZ, Javier, ORDIERES MERÉ, Joaquin, 2022. *JIDOKA. Integration of human and AI within industry 4.0 cyber physical manufacturing systems* [online]. Basel ; Beijing ; Wuhan ; Barcelona ; Belgrade ; Manchester ; Tokyo ; Cluj ; Tianjin: MDPI PDF e-Book. ISBN 978-3-0365-3811-2. Available via: <https://doi.org/10.3390/books978-3-0365-3811-2>.

Additional remarks:

No additional remarks.

Social Implications of Artificial Intelligence			
Module abbreviation:	AIN_SocImplAI	SPO-No.:	6
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Subject	1
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only summer term
Responsible for module:	Richter, Florian		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	6: Social Implications of Artificial Intelligence		
Lecture types:	6: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
6: mdIP - oral exam, 30 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
Foundations of Ethics, Introduction to Economics			
Objectives:			
The module will discuss the impact of the use of artificial intelligence on society. The course is divided into two major topic areas. In the first topic area, the ethical implications of AI are considered and reflected upon against the background of alternative normative theories. The possibilities of ethics through AI (machine ethics) as well as possible influences of AI on human behavior will be discussed. In the second topic area, the economic implications of AI are discussed. Here, in addition to a microeconomic analysis of individual markets, the macroeconomic influence of technology on the national economy is in the foreground. After completing the module, students will be able to • distinguish the categories of ethics and characterize the features of ethical judgments. • describe and criticize the most important normative theories. • elaborate and reflect on specific issues of ethics of technology in general and ethics of AI in particular. • discuss concrete applications of AI against the background of ethical theories. • identify their own research questions on the ethics of AI and outline research designs to address them. • assess the importance of AI for economics and replicate essential stylized data.			

• analyze and exemplify the impact of AI from a microeconomic perspective. • describe the influence of AI on the national economy and critically question forecasts in this area. • elaborate own research questions of an economics of AI and outline research designs to address them.
Content:
• Introduction to ethics • The main normative theories for the social assessment of AI • Conceptions of justice and algorithmic justice • Behavioral ethics of technology, biases and heuristics, and their relevance to the ethics of AI • The importance of empirical methods for the ethics of AI • Ethics and paternalism of things • The distinction between microeconomics and macroeconomics • Microeconomic analysis of the impact of AI on the economy • Consideration of the impact of AI on markets (labor, procurement, sales, financial) • Macroeconomic analysis of the impact of AI on the national economy • The connection between ethics and economics
Literature:
• AGHION, Philippe and others, 2023. <i>The power of creative destruction: economic upheaval and the wealth of nations</i>. Cambridge: The Belknap Press of Harvard University Press. ISBN 9780674292093, 067429209X • AGRAWAL, Ajay, Joshua GANS and Avi GOLDFARB, 2019. <i>The economics of artificial intelligence: an agenda</i>. Chicago and London: <<The>> University of Chicago Press. ISBN 978-0-226-61333-8 • COECKELBERGH, Mark, 2020. <i>AI ethics</i> [online]. Cambridge, Massachusetts ; London, England: The MIT Press PDF e-Book. ISBN 978-0-262-35706-7. Available via: https://doi.org/10.7551/mit-press/12549.001.0001. • LIAO, S. Matthew, 2020. <i>Ethics of artificial intelligence</i>. New York, NY: Oxford University Press. ISBN 978-0-19-090503-3, 978-0-19-090504-0
Additional remarks:
None

AI in safety-related Systems			
Module abbreviation:	AIN_AI SafeRelSyst	SPO-No.:	7
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Subject	1
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only summer term
Responsible for module:	Kugele, Stefan		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	7: AI in safety-related Systems		
Lecture types:	7: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
7: schrP90 - written exam, 90 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After successfully completing the course, students will be able to • understand and classify the requirements for a safety-critical/relevant system. • discuss the risks and opportunities of using AI methods. • be able to reproduce and apply procedures from relevant standards. • determine the dangers and risks of a technical, software-intensive, AI-based system. • Create safety cases using, for example, argumentation patterns. • select and evaluate suitable architectures to achieve reliability goals. • understand and apply formal verification techniques.			
Content:			
• Cyber-physical and safety-critical/relevant systems • Functional safety and key terms • Guidelines and standards for safe systems (e.g. IEC 61508, ISO 26262, ISO/TR 4804:2020) • Hazard analysis and risk assessment (G&R)			

• Determination of Safety Integrity Level (e.g. SIL, ASIL) • Safety analysis techniques • Security cases and argumentation patterns (e.g. GSN) • Security-specific architectures (design patterns: hardware patterns, software patterns) • Analysis techniques for explainability and formal verification (e.g. robustness)
Literature:
• BÖRCSÖK, Josef, 2025. <i>Functional Safety: Basic Principles of Safety-related Systems</i>. Berlin; Offenbach: VDE Verlag GmbH. ISBN 978-3-8007-3337-8 • ISO, 2022. 22989: <i>Information technology - Artificial intelligence - Artificial intelligence concepts and terminology</i>. • ISO/IEC, 2022. 22989: <i>Information technology - Artificial intelligence - Artificial intelligence concepts and terminology</i>. • ROSS, Hans-Leo, 2018. <i>Functional Safety for Road Vehicles: New Challenges and Solutions for E-mobility and Automated Driving</i>. ISBN 978-3319814940
Additional remarks:
None

Seminar			
Module abbreviation:	AIN_Seminar	SPO-No.:	11
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Subject	1
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only summer term
Responsible for module:	Gröttrup, Sören		
Credit points / SWS:	3 ECTS / 2 SWS		
Workload:	Contact hours:	23 h	
	Self study hours:	52 h	
	Total hours:	75 h	
Subjects of the module:	11: Seminar		
Lecture types:	11: S - seminar		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
11: SA - seminar paper and presentation			
Further explanations:			
The examination performance in the seminar is derived from the term paper and the oral presentation (including participation in the academic discourse). The scope of the term paper and the presentation is specified in the appendix to the SPO. Further details on the assessment criteria will be announced by the respective lecturer in the introductory event to the seminar.			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After successfully completing the module, students			
- will have deepened their ability to independently research a specific subject-related topic, to examine it critically and classify it from a scientific point of view, to design an oral presentation and to present it in a way that is comprehensible to the audience using suitable techniques and media. - have deepened their ability to critically follow a scientific presentation, to analyze and question its content and to discuss it with the lecturer. - have strengthened and deepened their interdisciplinary, methodological and communicative skills (e.g. literature work, analytical skills, conclusions, etc.). - can design and prepare a written paper to concisely present or summarize the content of their presentation.			

Content:

Several seminar groups are generally offered per seminar. The subject of the seminar is always a topic from current research and development in the context of the study specializations offered.

The respective lecturer compiles a collection of publications from the specialist literature, which also forms the basic literature for the lectures.

In the course of the seminar, each participant has to write a seminar paper and design a scientific talk on a topic that is assigned to them by lot or choice at the beginning of the semester.

- In the preparation phase, each participant must conduct literature research on their topic and incorporate the results into a presentation.
- This presentation is given orally as part of a double lesson. The duration of the lecture follows the time limit specified in the study and examination regulations of the degree program. The remainder of the seminar is reserved for discussion of the presentation.
- In addition, a written paper must be prepared on the individual topic dealt with. This paper should summarize the essential content of the presentation in prose. The scope of the written elaboration follows the specifications given in the study and examination regulations of the degree program.

The respective lecturer communicates detailed information on deadlines and his/her expectations regarding the design of the presentation and the written paper at the beginning of the semester.

Please note:

Depending on the total number of participants, several seminar groups are usually offered, whereby the individual groups each deal with different seminar topics. Information on the specific topics of the seminar groups will be made available in the Moodle course room of the Artificial Intelligence course (<https://moodle.thi.de/course/view.php?id=8638>) before the start of the semester.

The assignment of participants to the individual seminar groups takes place as part of the subject registration at the beginning of the semester. Further information will be announced via Moodle.

Literature:

- PRUZAN, Peter, 2016. *Research methodology: the aims, practices and ethics of science*. [Cham]: Springer. ISBN 978-3-319-27166-8, 978-3-319-80084-4
- TURNER, Kathy and Christine B. FEAK, 2011. *Essential academic skills*. Oxford: Oxford Univ. Press. ISBN 978-0-19-557605-4, 0-19-557605-5
- SWALES, John and Christine B. FEAK, 2012. *Academic writing for graduate students: essential tasks and skills*. Ann Arbor: Univ. of Michigan Press. ISBN 978-0-472-03475-8

Additional remarks:

Attendance is compulsory in this module.

In addition to the above-mentioned non-topic literature on academic work, writing and presentations, topic-specific literature must be consulted for the Master's thesis, depending on the specific topic.

Project			
Module abbreviation:	AIN_Project	SPO-No.:	12
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Sub-ject	1
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only summer term
Responsible for module:	Gröttrup, Sören		
Credit points / SWS:	7 ECTS / 4 SWS		
Workload:	Contact hours:	46 h	
	Self study hours:	129 h	
	Total hours:	175 h	
Subjects of the module:	12: Project		
Lecture types:	12: P - project		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
12: PA - project report			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
AI models or entire applications are usually developed as part of the project. A solid grounding in the following areas is therefore required: programming (Python, possibly Java), deep learning and deep learning frameworks (PyTorch or Tensorflow), database systems, revision control (Git). Furthermore, knowledge in the field of agile project management (Scrum, Kanban) is required.			
Objectives:			
After attending the module, students			
• have gained further practical experience in the application of project management methods (e.g. agile project management according to Scrum or similar). • can handle tools that are used in the implementation of an IT project. • have developed their ability to deal with technical and non-technical problems that may arise during the implementation of a project lasting several weeks. • have developed their ability to analyze a complex technical task and successfully work on it in a team over the course of a semester, i.e., to analyze, compare and weigh up possible solution alternatives and develop a solution appropriate to the task. • can report on the progress of the project in varying but always appropriate detail in oral and/or written form. • have learned to critically scrutinize the technical and nontechnical (especially entrepreneurial) objectives of the project and to weigh them up in terms of the overall success of the project.			

Content:

In this module, a team works on a complex, practice-oriented task from the subject area of the degree program in the form of a project during the semester.

In general, the projects are carried out in cooperation with external companies or the university's own research center. Alternatively, lecturers can also specify specific project topics to be worked on as part of their teaching or research activities.

The project management and organization are carried out by students. The lecturer/teaching assistant only acts as a coach and/or client. Classic methods or agile methods such as Scrum or Kanban can be used as project management methods. It is up to the project team to decide which method to use.

At the beginning of the project, the lecturer/teaching supervisor clearly communicates his/her expectations regarding the dates, form and proof of individual performance to be provided by all students. The project team agrees with the lecturer/teaching supervisor on the forms of communication and documentation to be observed by all project participants (students, lecturer, client) for the duration of the project.

To be determined:

- Frequency and duration of planning meetings
- Type and conduct of meetings (joint or virtual/electronic)
- Regular meetings (possibly daily in the form of Scrum meetings, etc.)
- Type and scope of deliverables
- Type and scope of individual amounts by students
- Criteria for assessment/grading by the lecturer

Please note:

Depending on the total number of participants, several project groups are usually offered, whereby the individual groups each deal with different project topics. Information on the specific topics of the project groups will be published before the start of the semester in the Moodle course room of the Artificial Intelligence (<https://moodle.thi.de/course/view.php?id=8638>) before the start of the semester.

Participants will be assigned to the individual project groups as part of the subject registration at the beginning of the semester. Further information will be announced via Moodle.

Literature:

Will be specified at the beginning

Additional remarks:

Project groups that are particularly suitable for dual study students are indicated in the topic description of the respective project groups.

Master Thesis			
Module abbreviation:	AIN_MT	SPO-No.:	13
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Compulsory Subject	3
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	winter and summer term
Responsible for module:	Gröttrup, Sören		
Credit points / SWS:	30 ECTS / 0 SWS		
Workload:	Contact hours:	0 h	
	Self study hours:	750 h	
	Total hours:	750 h	
Subjects of the module:	13: Master Thesis		
Lecture types:	13: MA - Master Thesis		
Usability for other study programs:	None		
Examinations:			
13: MA - Master-Thesis			
Further explanations:			
None			
Prerequisites according examination regulation:			
The topic of the Master's thesis is issued at the beginning of the second semester at the earliest. The topic of the Master's thesis can only be issued if at least 30 ECTS credits have been successfully completed.			
Recommended prerequisites:			
None			
Objectives:			
After successfully completing the Master's thesis, students are able to			
- work on a problem independently and using scientific methods. - evaluate requirements, alternative solution approaches and possibly individual developed solutions, and present them in writing in a convincing and comprehensible manner. - complete an extensive task within a given time frame through effective time management.			
Content:			
The Master's thesis is the academic conclusion of a Master's degree program. It should prove that a student is able to independently work on a complex task from the subject area of the degree program using appropriate scientific methods.			
The student works on the task independently. This requires the will and ability to work on and successfully complete a task, as well as creativity in finding and / or designing solutions.			
Writing a Master's thesis requires knowledge and skills in four areas:			

- The relevant specialist knowledge required to work on the topic of the Master's thesis
- Techniques, methods and procedures of scientific work
- Project management (especially time planning and controlling)
- Presentation techniques, if applicable

In general, the student chooses a topic for the Master's thesis independently. Topics are either offered internally by professors or academic staff at the university in notices (also online), or result from the student's cooperation with an external company.

In the case of an external topic, the student must obtain a lecturer from the university as the first examiner. For this purpose, it is advisable to outline the topic and the planned approach in a short exposé. This exposé serves to provide the lecturer who is to be the first examiner with an overview of the topic of the thesis.

Literature:

- PRUZAN, Peter, 2016. *Research methodology: the aims, practices and ethics of science*. [Cham]: Springer. ISBN 978-3-319-27166-8, 978-3-319-80084-4
- TURNER, Kathy, 2011. *Essential academic skills*. Oxford: Oxford Univ. Press. ISBN 978-0-19-557605-4, 0-19-557605-5
- SWALES, John and Christine B. FEAK, 2012. *Academic writing for graduate students: essential tasks and skills*. Ann Arbor: Univ. of Michigan Press. ISBN 978-0-472-03475-8

Additional remarks:

In addition to the above-mentioned non-topic literature on academic work, writing and presentations, topic-specific literature must be consulted for the Master's thesis, depending on the specific topic.

In the dual study model, the thesis is written at the cooperating company, usually on a practical topic related to the focus of the degree program.

4.2 Electives

Avionics and Autonomous Flying			
Module abbreviation:	AIN_AviAutoFly	SPO-No.:	8
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Elective	2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Seidel, Christian		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	8: Avionics and Autonomous Flying		
Lecture types:	8: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examinations:			
8: LN - oral exam, 20 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After active participation in the course, students will be able to			
• draw on knowledge on Aeronautics and Avionics. • understand the demand of more automated systems for aeronautics. • differentiate between the tasks of guidance, navigation and flight control. • recognize the challenges and requirements of Single Pilot Operations. • decide which basic sensors to use for an inertial navigation system. • implement a Kalman filter for an INS. • name the different GNSS systems and potential accuracy improvement methods. • define a setup for an integrated navigation system. • explain Simultaneous Localization and Mapping Algorithms and implement them. • calculate stereo-camera setup for AI based navigation. • understand different ways for telemetry and communication systems for Unmanned Aircraft Systems. • differentiate various types of drones and their use. • name pros and cons for different sensors for UAS.			

• implement reinforcement algorithms for path planning. • understand the bricks required for Autonomous Flight.
Content:
• Introduction to Aeronautics, Avionics definitions and context • Flight accident statistics as motivation • Guidance, navigation and control • Single Pilot Operations for Commercial Aircrafts • Navigation systems (Basic Mathematics, Basic sensors, Kalman Filter, GNSS and enhancements, SLAM, Camera-AI-based) • Telemetry, communication for UAS • Path planning, esp. with Reinforcement Learning • Drones (Types, Perception sensors, Flight controllers) • Autonomous Flight
Literature:
• SUTTON, Richard S. and Andrew BARTO, 2020. <i>Reinforcement learning: an introduction</i>. Cambridge, Massachusetts ; London, England: The MIT Press. • SPITZER, Cary R., Uma FERRELL and Thomas FERRELL, 2017. <i>Digital avionics handbook</i>. Boca Raton ; London ; New York: CRC Press. ISBN 978-1-138-07698-3, 978-1-4398-6861-4 • BARNHART, R. Kurt, Douglas M. MARSHALL and Eric SHAPPEE, 2021. <i>Introduction to Unmanned Aircraft Systems</i>. Milton: Taylor & Francis Group. ISBN 9781000326789, 978-1-00-032686-4
Additional remarks:
None

Computing and Connectivity Technologies			
Module abbreviation:	AI_CompConn	SPO-No.:	9
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Elective	1,2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only summer term
Responsible for module:	Festag, Andreas		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	8: Computing and Connectivity Technologies		
Lecture types:	8: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	None		
Examinations:			
8: LN - oral exam, 15-20 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
Upon completion of the module, students will be able to - describe architecture, organisation and execution concepts of basic and advanced processing technologies (CPU, ISP, GPU, TPU, VPU, NPU) used to handle requirements of various applications of autonomous systems efficiently. - explain the execution of program elements by various processing technologies. - describe concepts of interconnection technologies for processor to memory communication and processor to processor communication. - understand demand for and potential of domain-specific architectures. - describe the requirements, use cases, architectures and communication technologies for exchanging information among autonomous systems. - understand transmission and media access methods, communication protocols of the network, transport and facilities layer as well as data security and system management. - evaluate the advantages and disadvantages of current technological capabilities to deliver uninterrupted connectivity that is interoperable between different kind of mobile units, satellites and command centres and assess future developments.			

Content:
• Organisation and architecture of computing systems: CPU, ISP, GPU, Multi-GPUs, distributed GPUs • Programming concepts for CPUs, ISPs and GPUs • Interconnection structures: crossbar switches, multi-stage networks, CYL, Infiniband, QPI • Domain-specific architectures • Use case: distributed machine learning • Car2X use cases and system architecture • WLAN-V2X and Cellular-V2X • Architecture, channel structure, synchronisation, resource management, scheduling and overload control • IP mobility support and ad hoc networking for Car2X
Literature:
• KUROSE, James F. and Keith W. ROSS, 2022. <i>Computer networking: a top-down approach</i>. Harlow, United Kingdom: Pearson. ISBN 978-1-292-40546-9, 1-292-40546-5 • GEETHA, T V, SENDHILKUMAR, S, 2023. <i>Machine Learning: concepts, techniques and applications</i> [online]. Boca Raton, London, New York: CRC Press, Taylor & Francis Group PDF e-Book. ISBN 978-1-003-29010-0. Available via: https://doi.org/10.1201/9781003290100. • VAIDYA, Bhaumik, September 2018. <i>Hands-on GPU-accelerated computer vision with OpenCV and CUDA: effective techniques for processing complex image data in real time using GPUs</i>. Birmingham ; Mumbai: Packt. ISBN 978-1-78934-368-7 • TROPPENS, Ulf, 2009. <i>Storage networks explained: basics and application of Fibre Channel SAN, NAS, iSCSI, InfiniBand, and FCoE</i>. Hoboken, NJ: John Wiley. ISBN 978-0-470-74143-6 • CHAKRAVARTHI, Veena S., KOTESHWAR, Shivananda R., 2023. <i>System on Chip (SOC) Architecture: A Practical Approach</i> [online]. Cham: Springer Nature Switzerland PDF e-Book. ISBN 978-3-031-36242-2. Available via: https://doi.org/10.1007/978-3-031-36242-2.
Additional remarks:
None

Multimodal, Interactive Systems			
Module abbreviation:	UXDM_MIS	SPO-No.:	9
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Elective	1
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only summer term
Responsible for module:	Nestler, Simon		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	8: Multimodal, Interactive Systems		
Lecture types:	8: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	None		
Examinations:			
8: LN - written exam, 90 minutes			
Further explanations:			
The teaching concept of this course closely connects theoretical foundations and practical applications. Thus, this course is designed workshop-like: The learning contents are presented in relation to concrete areas of application and are deepened by concrete group and single tasks. The active participation of the students is explicitly desired.			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After active participation in the course, students will be able to			
• understand how to use and combine different modalities for the prototyping of interactive systems. • evaluate perception and action modalities with regard to their suitability for the respective application case. • create multimodal user interfaces. • understand in depth how to evaluate the practicality of the applications they develop. • analyze the accessibility of concrete multimodal systems. • improve the accessibility of digital technologies through an appropriate combination of different modalities. • apply the basics of scientific work to the design and evaluation of multimodal interfaces. • communicate professionally at an adequate level of abstraction using appropriate media forms. • work successfully in global teams with their gained experience in intercultural cooperation.			

- work with different forms of team organization, as well as roles in teamwork, and they can assume these roles as needed to successfully lead interdisciplinary teams. - think abstractly and analytically to familiarize themselves independently with new, unfamiliar specialist areas and complex problems and implement solutions.
Content:
- Case Study: Development of a multimodal user interface - Graphic Modalities: Static and dynamic graphic languages, Analogue and non-analogue units, Analogue and dynamic graphics - Acoustic & haptic modalities: Acoustic language with analogue and non-analogue units, analogue static-dynamic acoustics, haptic language with analogue and non-analogue units, analogue static-dynamic haptics - Natural user interfaces: Evolution of HCI, Natural vs. Supernatural, Human Factors in the context of NUI, Ergonomic foundations, Physical ergonomics, multisensory evaluation - Touch gestures: State models, anatomy of gestures, mechanics and dynamics, gesture languages, models for gesture systems, seamlessness, 2D spatial NUIs, thick fingers - In-air gestures: Spatial knowledge, 3D input devices, sensing technologies, hand & finger tracking, radar sensing, 3D spatial NUIs, touch vs. in-air - UX of NUIs: Development frameworks and process, user differentiation, social embedding & context, handling false positives, less is more, providing feedback, self-descriptiveness, in-air gesture languages - Screen-based thinking: App experiences, interface thinking, simplifying interaction processes - From the interface to the experience: The experience, UX vs. UI design, distraction and multitasking - Post-visual interfaces: Processes vs. screens, Ringxiety, Usage Patterns, Back pocket apps & experiences, serving computers, leveraging computers, adaptation, command prompts - Voice user interfaces: Cooperative principle, Turing Test, ELIZA, Mitsuku, Conversational interactions - Conversational design: ChatBots, Visual capabilities & conversational design, setting expectations, dialogs & flows, - Basic VUI concepts: Confirmation, Command & Control, Error handling, Recognition, Adaptivity, Open Speech - Advanced VUI concepts: Help, Optimization, Barge-In, Avatars, Evaluation
Literature:
- PEARL, Cathy, December 2016. <i>Designing voice user interfaces: principles of conversational experiences</i>. Beijing ; Boston ; Farnham ; Sebastopol ; Tokyo: O'Reilly. ISBN 978-1-4919-5538-3 - COHEN, Michael H., James P. GIANGOLA and Jennifer BALOGH, 2004. <i>Voice user interface design</i>. Boston [u.a.]: Addison-Wesley. ISBN 0-321-18576-5 - KRISHNA, Golden, 2015. <i>The best interface is no interface: the simple path to brilliant technology</i>. San Francisco, Calif.: Pearson Education, New Riders. ISBN 978-0-133-89033-4, 0-133-89033-3 - LEE, Henry, 2018. <i>Voice User Interface Projects: Build voice-enabled applications using Dialogflow for Google Home and Alexa Skills Kit for Amazon Echo</i>. Birmingham: Packt Publishing Limited. ISBN 978-1-78847-022-3 - WILLIAMS, Sam, 2018. <i>Hands-On Chatbot Development with Alexa Skills and Amazon Lex: Create custom conversational and voice interfaces for your Amazon Echo devices and web platforms</i>. Birmingham: Packt Publishing Limited. ISBN 978-1-78899-243-5
Additional remarks:
Bonus points are awarded for this course according to APO §8 paragraph (3): Regular participation in the exercises can compensate for missing 5% of the points for the exam. The exact conditions are: The student has decided at the beginning of the semester to participate in the exercises and to acquire exam points. The student has actively participated in at least 6 exercises (4 SWS each).

The student uploads a solution via the learning platform within 48 hours after the exercise that fulfills the requirements described in the exercise sheet.

Security of Modern Networks			
Module abbreviation:	CASE_SMN	SPO-No.:	8
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Elective	2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Jarschel, Michael		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	8: Security of Modern Networks		
Lecture types:	8: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	None		
Examinations:			
8: LN - written exam, 90 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After successful completion of the module, students will be able to			
• name current threats and attacker motivations. • list and explain typical attack scenarios on computer networks. • select and evaluate protective measures, particularly suitable protocols. • select, assess and explain the components of network security architectures. • describe the basic structure of the Internet, the architectural model of communication (TCP/IP layer model) in detail, TCP protocol characteristics and behavior in principle, as well as the fundamentals of routing techniques. • identify the general structure of today's public IP networks with all technology layers and their basic functions, network elements, and security aspects. • reproduce the development, architecture, and function of current wireless networks, particularly the mobile network generations LTE and 5G for voice and data, with special focus on the relevant security functions.			

Content:
• Fundamentals of the Internet and packet switching: architectural model, service and layer concept, packet switching and performance, in-depth study of the TCP transport protocol • Network security: Typical attackers and attacks at the network level • Security architectures: Network security architectures for enterprise networks, their advantages and disadvantages, and components (firewalls, DMZ, IPS/IDS systems) • End-to-end security: Protocols for secure information exchange between communication partners (TLS, IPSec) • Fundamentals and development of WLAN (IEEE 802.11) and its security aspects • Structure and design of GSM & modern mobile networks (LTE, 5G) and their basic procedures for ensuring communication security
Literature:
• STALLINGS, William, 2019. <i>Effective cybersecurity: understanding and using standards and best practices</i>. Upper Saddle River, NJ ; Boston ; San Francisco ; New York ; Toronto ; Montreal ; London ; Munich ; Paris ; Madrid ; Cape Town ; Sydney ; Tokyo ; Singapore ; Mexico City: Addison-Wesley. ISBN 978-0-13-477280-6, 0-13-477280-6 • RAIS, Razi and others, 2024. <i>Zero trust networks: building secure systems in untrusted networks</i>. Beijing ; Boston ; Farnham ; Sebastopol ; Tokyo: O'Reilly. ISBN 978-1-492-09659-7 • NAIR, Pramod, 2022. <i>Securing 5G and evolving architectures</i>. Boston: Addison-Wesley. ISBN 978-0-13-745793-9
Additional remarks:
None

Systems Engineering and Architecting for Edge Computing			
Module abbreviation:	AI_SystemsEng	SPO-No.:	8
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Elective	1,2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Membarth, Richard		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	8: Systems Engineering and Architecting for Edge Computing		
Lecture types:	8: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	None		
Examinations:			
8: LN - written exam, 90 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
Upon completion of the module, students will be able to • understand the characteristics of embedded architectures. • identify optimization potential for algorithms to meet resource constraints. • realize algorithms on embedded systems. • optimise deep learning networks for execution on edge devices. • evaluate the effect of programming alternatives on the execution speed. • explain concepts for performance enhancement in embedded systems and the problems associated with them.			
Content:			
• Embedded architectures • Energy efficiency • Resource constraints and scheduling • Programming for embedded architectures • Deep learning on edge devices (e.g., algorithms for CNNs, network quantization)			

Domain-specific architectures like Google TPU, NVIDIA Jetson, and AMD AI Engine
Literature:
- PATTERSON, David A. and John L. HENNESSY, 2020. <i>Computer Organization and Design: The Hardware Software Interface</i>. Cambridge, MA, USA: Morgan Kaufmann. ISBN 978-0-12-820331-6 - GOODFELLOW, Ian, Yoshua BENGIO and Aaron COURVILLE, 2016. <i>Deep Learning</i>. ISBN 978-0-262-03561-3
Additional remarks:
Bonus points can be earned in this module by completing a programming assignment during the semester. Up to 10% of the points achievable in the examination can be additionally acquired for the programming task. Participation in the bonus system is voluntary. Bonus points will be awarded for: - a correct, working implementation that passes the tests, - resource aspects of the implementation (memory usage), - performance aspects of the implementation (wall runtime). Further details will be provided during the lecture. A clear git development history and documentation of the code development are mandatory for bonus points to be awarded. The programming assignment must undoubtedly be completed independently.

4.3 Interdisciplinary Electives

Entrepreneurship Coaching			
Module abbreviation:	MVM_EC	SPO-No.:	10
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Interdisciplinary Elective	2,3
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	German/English	1 semester	summer & winter term
Responsible for module:	Bader, Martin		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	10: Entrepreneurship Coaching		
Lecture types:	10: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	None		
Examinations:			
10: LN - project report			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After successful participation in the module course, students are able to • analyze customer and market needs on basis of advanced design thinking approaches. • develop and assess a business idea on this basis and apply it to a consistent business model. • identify and analyze key success factors for implementation. • prepare and apply implementation on basis of a minimal viable product approach. • apply the agile business development, prototype testing and lean startup methods and integrate the principles of entrepreneurial thinking in business and leadership. • prepare participation in a business plan competition at graduate level and to meet the specific challenges. • successfully integrate the listed competencies with the content of other modules from their degree program and develop new, overarching approaches.			
Content:			
• Ideation • Value Proposition Design			

- Business Model Canvas
- Business Model Innovation
- Minimal Viable Product & Preto-/Prototyping
- Business Planning

Literature:

- AULET, Bill, Thomas DEMMIG and Marius URSACHE, 2013. *Disciplined entrepreneurship: 24 steps to a successful startup*. Hoboken, NJ: Wiley. ISBN 978-1-118-69228-8, 978-1-118-72088-2
- BayStartUP, 2024. Handbuch Business Planning - Der Weg zum erfolgreichen Unternehmen. [online]. <https://www.baystartup.de/startups/handbuch-business-planning>: BayStartUP GmbH, 9. überarbeitete Auflage [Accessed on: 17.12.2024]. Available via: <https://www.baystartup.de/startups/handbuch-business-planning>
- KAWASAKI, Guy, 2015. *The art of the start 2.0: The time-tested, battle-hardened guide for anyone starting anything*. London: Portfolio Penguin. ISBN 978-0-241-18726-5, 978-1-59184-811-0
- RIES, Eric, 2017. *The lean startup: how today's entrepreneurs use continuous innovation to create radically successful businesses*. New York: Currency. ISBN 978-1-5247-6240-7
- FUEGLISTALLER, Urs, FUST, Alexander, MÜLLER, Christoph, MÜLLER, Susan, ZELLWEGGER, Thomas, 2019. *Entrepreneurship: Modelle – Umsetzung – Perspektiven : Mit Fallbeispielen aus Deutschland, Österreich und der Schweiz* [online]. Wiesbaden: Springer Gabler PDF e-Book. ISBN 978-3-658-26800-8. Available via: <https://doi.org/10.1007/978-3-658-26800-8>.
- GASSMANN, Oliver, Karolin FRANKENBERGER and Michaela CSIK, 2017. *Geschäftsmodelle entwickeln: 55 innovative Konzepte mit dem St. Galler Business Model Navigator*. München: Hanser. ISBN 978-3446451759
- GASSMANN, Oliver, Karolin FRANKENBERGER and Michaela CHOUDURY, 2020. *Business Model Navigator: The Strategies Behind the Most Successful Companies*. Harlow: Pearson. ISBN 978-1292327129
- OSTERWALDER, Alexander and Yves PIGNEUR, 2010. *Business Model Generation: Ein Handbuch für Visionäre, Spielveränderer und Herausforderer*. ISBN 978-3-593-39474-9
- OSTERWALDER, Alexander and Yves PIGNEUR, 2014. *Value Proposition Design: How to Create Products and Services Customers Want*. ISBN 978-1118968055

Additional remarks:

Coaching is carried out (where possible) in cooperation with a business partner as a business mentor. Through this co-operation, each team receives a business mentor in addition to support from the THI lecturer.

Project work:

The aim is, among other things, to use the various media in the further development of business models and for the final presentation.

Global Business and Economics 1			
Module abbreviation:	GBU_GBE1	SPO-No.:	10
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Interdisciplinary Elective	1,2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Gallier, Carlo		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	10: Global Business and Economics 1		
Lecture types:	10: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	None		
Examinations:			
10: LN - written exam, 90 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After successful completion of the module, students will be able to			
- draw on an in-depth knowledge of global economic theories and their application to business decision-making. - understand the impact of globalization on business and the global economy. - analyze complex global business environments using advanced economic and strategic tools. - analyze the competitive environment in global markets. - identify opportunities and challenges presented by emerging markets. - approach complex business problems with critical thinking and creative problem-solving skills. - evaluate corporate social responsibility practices within a global business context. - collaborate effectively in diverse, multicultural teams to achieve common goals.			
Content:			
- Understanding globalization and its impact on business - Theories of international trade and investment			

- Analyzing the competitive environment in global markets
- Global supply chain management and logistics
- Corporate social responsibility in a global context
- Cross-cultural communication and negotiation skills
- Emerging markets and the challenges and opportunities they present
- Emerging issues in global economics, such as climate change and inequality
- The role of culture and social norms in global economics
- Ethical considerations in global economics and business practices

Literature:

- VELASQUEZ, Manuel G., 2013. *Business Ethics: Concepts and Cases*. Harlow: Pearson Education, Limited. ISBN 978-1-292-02281-9, 978-1-292-03601-4
- LÜTGE, Christoph, UHL, Matthias, 2021. *Business Ethics: An Economically Informed Perspective* [online]. Oxford, United Kingdom: Oxford University Press PDF e-Book. ISBN 978-0-19-189685-9. Available via: 20.500.12854/112311.

Additional remarks:

The course is held on-site. However, under special circumstances, it may also take place virtually.

Global Business and Economics 2			
Module abbreviation:	GBU_GBE2	SPO-No.:	10
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Interdisciplinary Elective	1,2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only summer term
Responsible for module:	Rauscher, Alois		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	78 h	
	Total hours:	125 h	
Subjects of the module:	10: Global Business and Economics 2		
Lecture types:	10: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	None		
Examinations:			
10: LN - written exam, 90 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After successful completion of the module, students will be able to			
• understand the role of multinational corporations in the global economy. • explain the determination of exchange rates and the international monetary system. • describe the dynamics of the foreign exchange market. • understand international debt and equity markets. • explain the functions and impacts of international financial institutions, such as the IMF and WTO, on global trade and commerce. • apply foreign exchange risk management techniques. • assess and adapt global financial strategies in response to currency fluctuations and international market trends. • conduct a country risk analysis. • apply concepts related to capital budgeting and cross-border merger & acquisition management of a multinational corporation. • critically evaluate economic data to develop well-founded solutions during case study discussions.			

• approach complex business problems with critical thinking and creative problem-solving skills. • collaborate effectively in multicultural teams to solve complex global business tasks. • demonstrate intercultural communication skills to foster strong professional relationships.
Content:
• The role of multinational corporations in the global economy • Corporate governance from a global perspective • The determination of exchange rates and the international monetary system • The foreign exchange market • Foreign exchange risk management • International debt and equity markets • The impact of economic policies on global business and country risk analysis • Capital budgeting for the multinational corporation • Critical aspects regarding cross-border mergers and acquisitions
Literature:
• EUN, Cheol S. , Bruce G. RESNICK and Tuugi CHULUUN , 2021. <i>International Financial Management</i>. New York: McGraw-Hill. ISBN 978-1-260-57531-6; 1-260-57531-4 • SHAPIRO, Alan C. and Paul HANOUNA , 2020. <i>Multinational Financial Management</i>. 11. edition. Hoboken: Wiley. ISBN 9781119559849
Additional remarks:
None

Innovation Management Methods			
Module abbreviation:	InnoMaMeth_M-GFT	SPO-No.:	10
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Interdisciplinary Elective	2
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Moser, Christina		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	79 h	
	Total hours:	126 h	
Subjects of the module:	10: Innovation Management Methods		
Lecture types:	10: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	None		
Examinations:			
10: LN - written exam, 90 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After successful completing the module, the students will be able to			
• name modern methods for the creation, management and marketing of innovations and can explain them. • propose appropriate innovation models based on industry and company size. • name sources of innovation and know where and how to get inspiration. • design the implementation of workshops for eliciting requirements for product development. • list types of innovation processes and know how to design an innovation process.			
Content:			
• Innovation Management and types of innovation • Component and architectural innovation • Sources of discontinuity • Patterns of innovation and lifecycle models (S-curve, Disruptive innovation, Hype Cycle) • Traditional and modern models of innovation (Technology Push, Market Pull, dominant design, interactive model, coupling model, networking model, Triple-Helix model, Quad-Helix model)			

- Open Innovation
- Frugal Innovation
- Reverse innovation
- Design-driven innovation
- New Service Innovation
- Lean Start-up
- Lean Innovation
- Value Innovation (Value Curve, Strategy Canvas)
- Product-Service-Systems (PSS)
- Market and customer research methods
- Innovation process design (linear Departmental-stage models, phase-review, simultaneous and concurrent process design, Lean Innovation)
- Stage-Gate-Process (Traditional Stage-Gate, Scalable Stage-Gate, next generation agile Stage-Gate)
- Creativity methods and tools for ideation and problem solving: questioning techniques (e.g. 5 Whys), Method of Focal Objects, Brainstorming, Idea Box/Morphological analysis, Six Thinking Hats, Inside-Out process
- Product Concept Generation: Need, Form, Technology, Business model
- Business Model Archetypes
- Sustainable Innovation
- Testing and Validation
- Agile management of innovation processes and projects
- Diffusion and marketing of innovations
- Case studies and industry examples on latest trends and technologies

Literature:

- TROTT, Paul, 2021. *Innovation management and new product development*. Harlow, England: Pearson. ISBN 978-1-292-25152-3
- TIDD, Joseph and John R. BESSANT, 2021. *Managing innovation: integrating technological, market and organizational change*. Hoboken, NJ: Wiley. ISBN 978-1-119-71330-2
- BIAZZO, Stefano, FILIPPINI, Roberto, 2021. *Product Innovation Management: Intelligence, Discovery, Development* [online]. Cham: Springer PDF e-Book. ISBN 978-3-030-75011-4. Available via: <https://doi.org/10.1007/978-3-030-75011-4>.
- KARAOMERLIOGLU, Dilek Cetindamar, Robert PHAAL and David PROBERT, 2016. *Technology management: activities and tools*. New York, NY: Palgrave Macmillan. ISBN 978-1-137-43185-1
- DORF, Richard C., 1999. *The technology management handbook*. Heidelberg: Springer. ISBN 3-540-64814-3
- SCHRAMM, Laurier L., 2018. *Technological innovation: an introduction* [online]. Berlin ; Boston: De Gruyter PDF e-Book. ISBN 978-3-11-042919-0. Available via: <https://doi.org/10.1515/9783110429190>.
- BESSANT, John R. and Joseph TIDD, 2015. *Innovation and entrepreneurship*. Chichester: Wiley. ISBN 978-1-118-99309-5, 978-1-119-08943-8
- SCHILLING, Melissa A., 2020. *Strategic management of technological innovation*. New York, NY: McGraw-Hill Education. ISBN 978-1-260-56579-9
- CHEN, Jin, BREM, Alexander, VIARDOT, Eric, WONG, Poh-Kam, 2019. *The Routledge companion to innovation management* [online]. London ; New York: Routledge PDF e-Book. ISBN 978-1-315-27667-0. Available via: <https://routledgehandbooks.com/doi/10.4324/9781315276670>.

Additional remarks:

A voluntary bonus system is offered: In the course, topics on methods of innovation management are offered for individual processing, which lead to bonus points for the examination performance for each qualitatively processed task. The creditability as well as maximum crediting of bonus points takes place according to the APO.

Lectures contain digital learning elements for self-study, such as learning videos or meetings via web conferences.

The examination can be held in digital form on a PC at the university campus.

Strategic Foresight and Trend Analysis			
Module abbreviation:	StratFor_M-GFT	SPO-No.:	10
Curriculum:	Program	Module type	Semester
	Artificial Intelligence (SPO SS 25)	Interdisciplinary Elective	1
Module attribute:	Language of instruction	Duration of module	Frequency of offer
	English	1 semester	only winter term
Responsible for module:	Schwarz, Jan		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours:	47 h	
	Self study hours:	79 h	
	Total hours:	126 h	
Subjects of the module:	10: Strategic Foresight and Trend Analysis		
Lecture types:	10: SU/Ü - lecture with integrated exercises		
Usability for other study programs:	None		
Examinations:			
10: LN- oral exam, 15 minutes			
Further explanations:			
None			
Prerequisites according examination regulation:			
None			
Recommended prerequisites:			
None			
Objectives:			
After successful completing the module, the students will be able to			
- understand the most important foresight methods and can distinguish and explain them. - apply the methods learned in case studies. - methodically analyse trends and derive future developments. - recognize challenges in future thinking and can address these.			
Content:			
- Customer-, technology-, and competitor-foresight - Trend analysis and strategic early identification - Visioning - Strategic simulation methods - Prognostic crowdsourcing - Delphi method - Scenario technique			

• Trendreceiver method • Analysis of Science Fiction
Literature:
• ELLER, E., HOFMANN, R., SCHWARZ, J.O., 2020. The Customer Foresight Territory. In: <i>Marketing Review St Gallen</i>. (3), p.888–895. • HEIJDEN, Kees van der, 2009. <i>Scenarios: the art of strategic conversation</i>. Chichester [u.a.]: Wiley. ISBN 0-470-02368-6, 978-0-470-02368-6 • KRUPP, Steven, Paul J. SCHOEMAKER and David J. TEECE, 2014. <i>Winning the long game: how strategic leaders shape the future</i>. New York: Public Affairs. ISBN 1-61039-447-X, 978-1-61039-447-5 • LIEBL, Franz, SCHWARZ, Jan Oliver, 2010. Normality of the Future: Trend Diagnosis for Strategic Foresight. In: <i>Futures</i>. (42 (4)), p.313-327. • ORIESEK, Daniel F., SCHWARZ, Jan Oliver, 2021. <i>Winning the uncertainty game: turning strategic intent into results with wargaming</i> [online]. London ; New York: Routledge PDF e-Book. ISBN 9781000289855, 9780367853594. Available via: https://doi.org/10.4324/9780367853594. • ROHRBECK, René, MENES ETINGUE, Kum, 2018. Corporate Foresight and Its Impact on Firm Performance: A Longitudinal Analysis. In: <i>Technological Forecasting and Social Change</i>. Volume 129(April), p.105-116. ISSN https://doi.org/10.1016/j.techfore.2017.12.013 • ROHRBECK, René, BATTISTELLA, Cinzia , HUIZINGH, Eelko , 2015. Corporate Foresight: An Emerging Field with a Rich Tradition. In: <i>Technological Forecasting & Social Change</i>. Volume 101(December), p.1-9. ISSN https://doi.org/10.1016/j.techfore.2015.11.002 • ROHRBECK, René, SCHWARZ, Jan Oliver, 2013. The Value Contribution of Strategic Foresight: Insights from an Empirical Study of Large European Companies. In: <i>Technological Forecasting and Social Change</i>. Volume 80(8), p.1593–1606. ISSN https://doi.org/http://dx.doi.org/10.1016/j.techfore.2013.01.004 • SCHOEMAKER, Paul J. and Robert E. GUNTHER, May 2013. <i>Profiting from uncertainty: strategies for succeeding no matter what the future brings</i>. New York: Atria Books. ISBN 978-1-5011-6175-9 • SCHWARZ, Jan Oliver, 2015. The ‘Narrative Turn’ in Developing Foresight: Assessing How Cultural Products Can Assist Organisations in Detecting Trends. In: <i>Technological Forecasting and Social Change</i>. (90 (Part B)), p.510–513. ISSN https://doi.org/http://dx.doi.org/10.1016/j.techfore.2014.02.024 • SCHWARZ, Jan Oliver, ROHRBECK, René, WACH, Bernhard , 2019. Corporate Foresight as a Microfoundation of Dynamic Capabilities. In: <i>FUTURES & FORESIGHT SCIENCE</i>. (e28)ISSN https://doi.org/10.1002/ffo2.28
Additional remarks:
No additional remarks.