Technische Hochschule Ingolstadt

Module Handbook
AI Engineering of Autonomous Systems

Faculty of Electrical Engineering and Computer Science

As per: 2023-07-18

Content

1 Introduction and Overview

The rise of AI and autonomous systems is about to revolutionise various industries and find application in a wide range of fields, from transportation and logistics to healthcare and agriculture. Self-driving cars are transforming the automotive industry, promising safer and more efficient transportation. Unmanned aerial vehicles (UAVs) are revolutionising delivery services, enabling quick and reliable parcel distribution. In industries like manufacturing and warehousing, autonomous robots streamline operations, enhancing productivity and reducing costs. As the demand for AI engineers and experts continues to soar, this Master‘s programme aims to nurture a new generation of professionals who can harness the power of AI to create innovative and intelligent autonomous systems.

Throughout this program, students will learn how to design, develop, and deploy intelligent systems that can learn, make decisions and operate autonomously, i.e., without human intervention. Basic building blocks of autonomous systems such as sensor networks and data fusion, data engineering, computing as well as communication technologies are explored and combined with AI engineering methods like perception and cognition, machine learning and decision making.

2 Programme Description

2.1 Contents

The programme consists of compulsory modules in the following areas:

Intelligent Perception and Exploration

Sensors are the sensory organs of autonomous systems, key to their mobility and autonomy. Data from multiple and even different sensors are combined to quickly and accurately communicate information about the environment, physical events, activities or situations to decision-making components.

Planning, Control and Decision Making

Planning with intelligence is a prerequisite for autonomous and predictive action. Systems need to be able to plan their actions in order to achieve a given goal and to respond to unexpected or new situations by changing their behaviour. Machine learning methods are used to combine sensor-data with past experience and draw conclusions that can be used to improve actions.

Software Methods and System Development

The development of autonomous systems is approached from a software engineering perspective. Various characteristics of autonomous systems, architectures, and models will be covered in order to demonstrate the technical feasibility of systems that dynamically adapt their behaviour to chang-es in operating conditions by means of software.

3rd Semester	Master's Thesis *[30 ECTS]*						
Summer Semester	Machine Perception and Cognition *[5 ECTS]*	Principles of Autonomy and Decision Making *[5 ECTS]*	Computing and Connectivity Technologies *[5 ECTS]*	General Elective *[5 ECTS]*	Elective *[5 ECTS]*	Team Project *[5 ECTS]*	2nd Semester
Winter Semester	Sensor Networks Technologies and Sensor Data Fusion *[5 ECTS]*	System Identification, Modeling and Simulation *[5 ECTS]*	Data Engineering and Analytics *[5 ECTS]*	Systems Engineering and Architecting for Edge Computing *[5 ECTS]*	Elective *[5 ECTS]*	Scientific Seminar & Ethical Considerations in Autonomous System Design *[5 ECTS]*	1st Semester

Legend				
	Cluster 1	Intelligent Sensing and Exploration	Cluster 3	Software Methods and Systems Development
	Cluster 2	Planning and Control / Decision Making	Cluster 4	Personal Growth and Team Work

The compulsory part is complemented by elective modules. These modules focus on specific aspects of the development of autonomous systems, automotive applications, innovation management, or engineering processes applied in tech companies as well as German language courses.

The Scientific Seminar introduces the students to a state-of-the-art topic in AI engineering. The topic will be presented and discussed with peers as well as summarised in a seminar paper. The Team Project provides students with an experience of 'learning by doing' and collaboration in a team of their peers by solving an engineering problem using the acquired engineering skills.

2.2 Structure

The programme starts in both the summer and winter semesters. The duration of the programme is 3 semesters. Two semesters of compulsory and elective modules (each offered once a year in either summer or winter term) are followed by one semester for the Master's thesis.

In the first semester, each student participates in the Scientific Seminar as well as Ethical Considerations in Autonomous System Design. In the second semester, each student joins a Team Project.

The modules are taught in presence at the Technische Hochschule Ingolstadt (THI).

No.	Module	Winter-/1st-Semester			Summer-/2nd-Semester			3rd Semester		
		SWS	CP	Exam	SWS	CP	Exam	SWS	CP	Exam
1	Machine Perception and Cognition				4	5	WE			
2	System Identification, Modeling and Simulation	4	5	WE						
3	Data Engineering and Analytics	4	5	WE						
4	Scientific Seminar	2	2,5	SA						
5	Ethical Considerations in Autonomous System Design	2	2,5	OE						
6	Sensor Networks Technologies and Sensor Data Fusion	4	5	WE						
7	Principles of Autonomy and Decision Making				4	5	PE			

8	Computing and Connectivity Technologies				4	5	OE			
9	Systems Engineering and Architecting for Edge Computing	4	5	WE						
10	Team Project				4	5	Proj			
11	General elective				4	5	LN			
12	Science Elective	4	5	LN	4	5	LN			
13	Master's Thesis							0	30	
13.1	Master's Thesis									MA
13.2	Colloquium									CO

WE Written Exam

OE Oral Exam

PE Practical Exam

SA Seminar Presentation and Paper

Proj Project Work, Presentation and Paper

MA Master's Thesis, written form

CO Colloquium

LN Written, Oral or Practical Exam

2.3 Graduation

After successful completion of the Master`s Programme, the Technische Hochschule Ingolstadt awards the academic degree:

Master of Engineering (M.Eng.)

2.4 Advisor

For all technical and functional questions and problems with regards to contents of the Master‘s programme please contact:

Prof. Dr.-Ing. Michael Mecking

Please adhere to the published consultation hours.

2.5 Programme Coordinator

For questions concerning the organisational execution of the study programme please contact:

Prof. Dr.-Ing. Michael Mecking

Please adhere to the published consultation hours.

3 Description of Modules

Compulsary modules

Machine Perception and Cognition			
Module abbreviation:	AI_MachPerception	**Reg.no.:**	1
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	1

Responsible for module:	Mecking, Michael		
Lecturer:			
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total: 125 h		
Subjects of the module:	Machine Perception and Cognition		
Lecture types:	SU/Ü - lecture with integrated exercises		
Availability of the module:	None		

Examinations:

schrP90 - written exam, 90 minutes

Additional Explanation:

None

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

By the end of the module students should have:

- developed a critical understanding of the contemporary deep machine learning topics presented, how these are applicable to relevant industrial problems and have future potential for emerging needs in both a research and industrial setting,
- developed an advanced knowledge of the principles and practice of analysing relevant computer vision and radar deep machine learning based algorithms for machine perception,
- developed highly specialised and advanced technical skills to formulate and solve problems that involve the use of contemporary deep machine learning approaches within the context of autonomous systems and computer vision tasks using a range of algorithmic approaches,
- developed a highly specialised experience in software solutions that make use of contemporary deep machine learning approaches to address both industrial and research application tasks within the context of machine perception and computer vision for autonomous systems.

Content:
Themes will be chosen from contemporary areas of deep machine learning applied to tasks within the context of machine perception, computer vision and autonomous systems including the following: • scene reconstruction and understanding from multiple images, video or radar, • scene reconstruction and understanding from active sensing, • simultaneous localisation and mapping (SLAM) from varying sensor inputs, • visual odometry from varying sensor inputs, • guidance and control, • contemporary and emerging research and applications.
Literature:
• SZELISKI, Richard, 2022. *Computer Vision: Algorithms and Applications* [online]. Cham: Springer International Publishing PDF e-Book. ISBN 978-3-030-34372-9. Available via: https://doi.org/10.1007/978-3-030-34372-9. • DICKMANNS, Ernst Dieter, 2007. *Dynamic vision for perception and control of motion* [online]. London: Springer PDF e-Book. ISBN 978-1-84628-637-7, 978-1-84628-638-4. Available via: https://doi.org/10.1007/978-1-84628-638-4.
Additional remarks:
None

System Identification, Modeling and Simulation			
Module abbreviation:	AI_SysIdent	**Reg.no.:**	2
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	1

Responsible for module:	Ebert, Bernd Martin		
Lecturer:	Ebert, Bernd Martin		
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total: 125 h		
Subjects of the module:	System Identification, Modeling and Simulation		
Lecture types:	SU/Ü - lecture with integrated exercises		
Availability of the module:	None		

Examinations:

schrP90 - written exam, 90 minutes

Additional Explanation:

None

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

To be determined

Content:

To be determined

Literature:

Will be specified at the beginning

Additional remarks:

None

Data Engineering and Analytics

Module abbreviation:	AI_DataEng	**Reg.no.:**	3
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	1

Responsible for module:	Schmidtner, Stefanie		
Lecturer:	Schmidtner, Stefanie		
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total: 125 h		
Subjects of the module:	Data Engineering and Analytics		
Lecture types:	SU/Ü - lecture with integrated exercises		
Availability of the module:	None		

Examinations:

schrP90 - written exam, 90 minutes

Additional Explanation:

None

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

Data analytics and data engineering are fundamental fields for the development of automated systems. The aim of the lecture is to give students a sound understanding of data analytics methods and to convey fundamentals in data engineering.

After finishing this course including excercises students are able to

- choose and calculate appropriate metrics and visualizations for describing a data set.
- understand and master fundamental data analysis and machine learning methods.
- have deep knowledge about model assessment and inference techniques for linear and non-linear models.
- know fundamentals of data engineering.

Content:

- Data visualization
- Data cleaning and data quality
- Fundamentals of statistical learning and machine learning
- Linear Regression
- Classification

- Model assessment, selection and inference: Cross-Validation & Bootstrap
- Decision Trees
- Unsupervised Learning
- Neural networks (ANN, ResNet, CNN)
- Fundamentals of data engineering (data modelling, data warehouse, data lake, parallel and distributed computing, data pipelines)

Literature:

- WILKE, Claus, March 2019. *Fundamentals of data visualization: a primer on making informative and compelling figures*. 1. edition. Beijing: O'Reilly. ISBN 978-1-492-03108-6
- JAMES, Gareth, WITTEN, Daniela, HASTIE, Trevor, TIBSHIRANI, Robert, TAYLOR, Jonathan, 2023. *An Introduction to Statistical Learning: with Applications in Python* [online]. Cham: Springer International Publishing PDF e-Book. ISBN 978-3-031-38747-0. Available via: https://doi.org/10.1007/978-3-031-38747-0.
- HASTIE, Trevor, Robert TIBSHIRANI and Jerome H. FRIEDMAN, 2017. *The elements of statistical learning: data mining, inference, and prediction*. Second edition, corrected at 12. edition. New York, NY: Springer. ISBN 978-0-387-84857-0, 0-387-84857-6
- BISHOP, Christopher M., 2016. *Pattern recognition and machine learning*. softcover reprint of the original 1st edition 2006. edition. New York, NY: Springer. ISBN 978-1-4939-3843-8
- LESKOVEC, Jure, Anand RAJARAMAN and Jeffrey D. ULLMAN, 2020. *Mining of massive datasets*. T. edition. Cambridge: Cambridge University Press. ISBN 978-1-108-47634-8
- RYZA, Sandy and others, 2017. *Advanced analytics with Spark: patterns for learning from data at scale*. s. edition. Beijing: O'Reilly. ISBN 978-1-4919-7295-3

Additional remarks:

No remarks.

Scientific Seminar

Module abbreviation:	AI_ScienSeminar	**Reg.no.:**	4
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	1

Responsible for module:	Mecking, Michael		
Lecturer:	Ulreich, Fabian		
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	2.5 ECTS / 2 SWS		
Workload:	Contact hours: 24 h Self-study: 39 h Total: 63 h		
Subjects of the module:	Scientific Seminar		
Lecture types:	S - seminar		
Availability of the module:	None		

Examinations:

SA - seminar paper with written composition (written composition 8 - 15 pages) and presentation (15 - 20 pages)

Additional Explanation:

None

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

After a successful completion of the module, the students

- have gained and deepened their ability to independently acquire knowledge in a technical field by means of literature research and analysis.
- are able to present this knowledge comprehensibly within the framework of an oral presentation using suitable supportive media.
- are able to follow a presentation and to critically and professionally discuss the contents with the speaker.
- have strengthened their interdisciplinary and communicative competences.
- are able to summarise the content of their presentation in the form of a brief written elaboration.

Content:

The technical topic of the seminar changes from course to course. The subject is mostly embedded into an area closely related to AI Engineering of Autonomous Systems:

- The respective lecturer compiles a collection of publications from the technical literature.

- In the course of the seminar, each student is required to present a paper/topic that was assigned by either lot or choice at the beginning of the semester.
- In the preparation phase, each student must conduct an independent literature research on the topic and aggregate the results.
- The student will give an oral presentation on the topic lasting about 30-45 minutes followed by a discussion with peers. Participation in the discussions is contributing to the final grade.
- In addition to an oral presentation, the student is required to prepare a written paper on the topic of the presentation. This paper should summarise the main contents.

The respective instructor will communicate detailed information on deadlines and expectations regarding the presentation as well as the written elaboration at the beginning of the semester.

Literature:

- will be announced at the beginning of the semester

Additional remarks:

Attendance is compulsory in this module.

Ethical Considerations in Autonomous System Design

Module abbreviation:	AI_Ethic	**Reg.no.:**	5
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	1

Responsible for module:	Uhl, Matthias		
Lecturer:	Uhl, Matthias		
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	2.5 ECTS / 2 SWS		
Workload:	Contact hours: 24 h Self-study: 39 h Total: 63 h		
Subjects of the module:	Ethical Considerations in Autonomous System Design		
Lecture types:	seminaristischer Unterricht		
Availability of the module:	None		

Examinations:

mdlP - oral exam, 15 minutes

Additional Explanation:

None

Prerequisites according examination regulation:

None

Recommended prerequisites:

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Objectives:

On successful completion of the course, students will be able to

- outline the most pressing questions currently discussed in the ethics of autonomous systems.
- distinguish meta-ethical, normative, and empirical arguments in ethics.
- know the most important normative theories and are able apply them to the field of autonomous system design.
- apply ethical arguments to case studies from the field of autonomous systems, e.g., self-driving cars.
- discuss the role of empirical research for the ethics of human-machine interaction and machine ethics.
- transcend their own normative viewpoint by critically reflecting on it.

Content:

The ethics of autonomous systems deals with questions of machine ethics and ethics of human-machine interaction. We will tackle both fields in the course. Machine ethics asks which morality artificial systems should apply. In which sense can they take ethical decisions? Who should bear the responsibility if something goes wrong? Should we ever leave ethical decisions to autonomous systems or do we always have to keep the human in the loop?

The ethics of human-machine interaction is interested in the ethical influence that the cooperation and competition with autonomous systems has on our own moral conduct. We need a profound empirical understanding about the unintentional and often subtle effects that these interactions have on us as humans. Do we still own our decisions if we merely follow the advice of a recommender system? Does the mediation of our experience through technology change the way we think about moral issues? Can we shape people's moral behavior through the design of human-machine interfaces?
Literature:
• NYHOLM, Sven, 2022. *This is Technology Ethics: An Introduction*. 1. edition. ISBN 978-1119755579 • COECKELBERGH, Marc, 2020. *AI Ethics*. 1. edition. ISBN 978-0262538190
Additional remarks:
None

Sensor Networks Technologies and Sensor Data Fusion

Module abbreviation:	AI_SensorNetworks	**Reg.no.:**	6
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	1

Responsible for module:	Mecking, Michael		
Lecturer:			
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total: 125 h		
Subjects of the module:	Sensor Networks Technologies and Sensor Data Fusion		
Lecture types:	SU/Ü - lecture with integrated exercises		
Availability of the module:	None		

Examinations:

schrP90 - written exam, 90 minutes

Additional Explanation:

None

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

After successfully completing this module the students shall be able to

- understand the fundamental principles of sensor networks.
- understand communication in sensor networks.
- apply advanced linear and non-linear digital signal processing to a multitude of sensors.
- describe and model the most common sensors used in sensor fusion applications.
- implement basic algorithms for simultaneous localisation and mapping (SLAM).
- apply sensor fusion to different sensors like cameras, radar, etc..
- use AI methods like, e.g., federated learning to the field of sensor fusion and sensor networks.

Content:

The module comprises the following aspects of sensor networks and sensor data fusion:

- basics and advanced concepts of wireless sensor networks,
- hardware aspects of sensor nodes,
- routing in wireless networks,
- time synchronisation and localisation in wireless networks,

- data/signal processing in wireless sensor networks,
- need for multi-sensor data fusion,
- various approaches to data fusion,
- representations of data and data fusion architectures,
- algorithmic approaches to data fusion,
- applications of wireless sensor networks.

Literature:

- KARL, Holger and Andreas WILLIG, 2007. *Protocols and architectures for wireless sensor networks*. R. edition. Chichester [u.a.]: Wiley. ISBN 978-0-470-51923-3, 0-470-51923-1
- KOCH, Wolfgang, 2014. *Tracking and Sensor Data Fusion: Methodological Framework and Selected Applications* [online]. Heidelberg: Springer PDF e-Book. ISBN 978-3-642-39271-9, 978-1-306-20127-8. Available via: https://doi.org/10.1007/978-3-642-39271-9.

Additional remarks:

None

Principles of Autonomy and Decision Making

Module abbreviation:	AI_PrincAutonomy	**Reg.no.:**	7
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	1

Responsible for module:	Belzner, Lenz		
Lecturer:			
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total: 125 h		
Subjects of the module:	Principles of Autonomy and Decision Making		
Lecture types:	SU/Ü/PR - seminar based teaching/Exercise course/laboratory		
Availability of the module:	None		

Examinations:

Practical Exam

Additional Explanation:

None

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

This course covers algorithmic decision making in the context of Markov decision processes and stochastic games, using statistical planning and machine learning algorithms (e.g., predictive models, imitation learning, reinforcement learning). The course also includes autonomous systems engineering, with particular emphasis on safety, verification, and testing of decision-making systems.

Content:

- probabilistic modeling
- optimization (heuristic, gradient-based)
- sequential decision making and search
- Markov decision processes
- dynamic programming
- statistical planning (bandits, stacked bandits, MCTS, cross-entropy planning)
- reinforcement learning
- multi-agent systems (games, stochastic games, MARL)
- safety, testing and verification (risk, uncertainty, coevolution)

Literature:
Will be specified at the beginning
Additional remarks:
None

Computing and Connectivity Technologies

Module abbreviation:	AI_CompConn	**Reg.no.:**	8
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	1

Responsible for module:	Mecking, Michael		
Lecturer:			
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total: 125 h		
Subjects of the module:	Computing and Connectivity Technologies		
Lecture types:	SU/Ü - lecture with integrated exercises		
Availability of the module:	None		

Examinations:

mdlP - oral exam, 15 minutes

Additional Explanation:

None

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

After successfully completing this module, the students shall be able to:

- understand the services provided by 5G/6G mobile communication systems,
- understand and apply massive MIMO technology and its use to achieve both high system throughput as well as low-latency communication,
- apply AI engineering technology to the physical layer of communication systems,
- understand the basic principles of cryptology as building block for secrecy technologies like, e.g., TLS, IPsec, MACsec.

Content:

- Introduction to 5G/6G mobile communication services eMBB, URLLC and mMTC
- Shannon's Channel Coding Theorem
- Ergodic and outage capacity of AWGN and fading channels
- Ergodic and outage capacity of MIMO channels
- The concept of massive MIMO
- Realisation of physical layer communication tasks using AI and ML technologies

• Key concepts of symmetric and asymmetric cryptology • Application of these concepts in secrecy protocols TLS, IPsec, MACsec and blockchain technologies
Literature:
• KUROSE, James F. and Keith W. ROSS, 2022. *Computer networking: a top-down approach*. E. edition. Harlow, United Kingdom: Pearson. ISBN 978-1-292-40546-9, 1-292-40546-5 • TANENBAUM, Andrew S., Nick FEAMSTER and David WETHERALL, 2021. *Computer networks*. s. edition. Harlow, UK: Pearson. ISBN 978-1-292-37406-2
Additional remarks:
None

Systems Engineering and Architecting for Edge Computing

Module abbreviation:	AI_SystemsEng	**Reg.no.:**	9
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	1

Responsible for module:	Membarth, Richard		
Lecturer:	Membarth, Richard		
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total: 125 h		
Subjects of the module:	Systems Engineering and Architecting for Edge Computing		
Lecture types:	SU/Ü/PR - seminar based teaching/Exercise course/laboratory		
Availability of the module:	None		

Examinations:

schrP90 - written exam, 90 minutes

Additional Explanation:

None

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

After successful participation in the module courses, students are able to

- understand the characteristics of embedded architectures,
- identify optimization potential for algorithms to meet resource constraints,
- realize algorithms on embedded systems,
- optimize 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
- resource constraints and scheduling
- programming for embedded architectures
- deep learning on edge devices
  - algorithms for CNNs

- network quantization
- domain-specific architectures
  - Google TPU
  - NVIDIA Jetson

Literature:

- PATTERSON, David A. and John L. HENNESSY, 2020. *Computer Organization and Design: The Hardware Software Interface*. R. edition. Cambridge, MA, USA: Morgan Kaufmann. ISBN 978-0-12-820331-6
- GOODFELLOW, Ian, Yoshua BENGIO and Aaron COURVILLE, 2016. *Deep Learning*. 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.

Team Project

Module abbreviation:	AI_Project	**Reg.no.:**	10
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	2

Responsible for module:	Mecking, Michael		
Lecturer:			
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total: 125 h		
Subjects of the module:	Team Project		
Lecture types:	Prj - project		
Availability of the module:	None		

Examinations:

Einsetzungstext ist leer!

Additional Explanation:

The team project is a group work in which several students work on a common task. Each student has to contribute individually to the task, submit a project report and present the results orally. According to the APO, the scope of the project report is 1500 words to 7500 words or approx. 5 to 25 pages, the scope of the oral presentation is 15 to 45 minutes according to the APO. The project report is to be written with a word processing programme.

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

After successfully completing this module the students shall be able to

- organise themselves in a team, discuss the project in varying but always appropriate detail, report progress in oral and/or written form,
- apply the competencies acquired during their Master studies in order to analyse a complex technical task and successfully work on it in a team over the period of a whole semester,
- deal with technical and non-technical problems. that may occur during the implementation of a project lasting several weeks,
- critically question the objectives of the project and balance them in the sense of an overall success of the project,
- convincingly present project results in front of an audience,
- write a focused report containing analysis, solution concept and implementation of the project.

Content:
Working on a team project in the field of AI engineering and autonomous systems. Potential topics are compiled every semester, according to the current research topics from THI professors, labs or research facilities as well as project offers from companies. Project management and organisation are carried out by students. The lecturer only acts as a coach, mentor and/or client. The project management method can be classical or agile. The decision about which method to use is up to the project team. At the beginning of the project, the lecturer clearly communicates expectations regarding the deadlines as well as type and scope of deliverables to be provided by the team. Frequency and duration of planning sessions as well as work meetings are to be discussed.
Literature:
• will be announced by lecturer at the beginning of the project
Additional remarks:
None

Master Thesis

Module abbreviation:	AI_MasterThesis	**Reg.no.:**	13
Curriculum:	**Programme**	**Module type**	**Semester**
	(SPO WS 23/24)	Compulsory Subject	3

Responsible for module:	Mecking, Michael		
Lecturer:			
Language of instruction:	English	**Language of exam:**	English
Credit points / SWS:	30 ECTS / 0 SWS		
Workload:	Contact hours: 0 h Self-study: 750 h Total: 750 h		
Subjects of the module:	13.1: Master's Thesis 13.2: Colloquium		
Lecture types:	13.1: Prj - project 13.2: S - seminar		
Availability of the module:	None		

Examinations:

13.1:Master-Thesis
13.2:Colloquium

Additional Explanation:

In general, students look for a topic for their Master's thesis on their own. Potential topics are either offered internally by university lecturers in notices/online or result from the cooperation of the student with a company.

In the case of an externally provided topic, the student must convince a university lecturer of his or her topic so that the lecturer assumes the role of first examiner. For this purpose, it is advisable to outline the topic and the planned approach in a short exposé.

Prerequisites according examination regulation:

None

Recommended prerequisites:

None

Objectives:

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

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

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

Content:

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

- scientific analysis of a complex problem specific to the course of study against the background of the state of the art in science and technology,
- literature research, especially considering current international publications in scientific journals,
- development of a creative solution concept appropriate to the context of the problem, taking into account current scientific, technical and operational aspects,
- comprehensive evaluation of alternative solution concepts and selection of the best solution concept (technical, economic evaluation),
- implementation of the selected solution concept of the complex problem specific to the course of study,
- critical and comprehensive analysis of the obtained results using appropriate engineering methods,
- project management (especially time and, if necessary, budget management),
- comprehensible and formally correct presentation and documentation of the solution and results,
- good scientific practice and scientific working methods.

Literature:

Will be specified at the beginning

Additional remarks:

Keep your supervisors and primary examiners regularly informed of your progress. In particular, clarify their expectations regarding the content of the thesis. A whole semester is estimated for working on the Master's thesis (30 ECTS) which in terms of scope and content of a Master's thesis has much higher requirements than a Bachelor's thesis. In particular, the scientific character should be emphasised more strongly in a Master's thesis:

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