Qualification Objectives
Master Mechatronic and
Cyber-Physical Systems

Faculty of Applied Natural Sciences and Industrial Engineering

and

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of the Deggendorf Institute of Technology

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Gender Neutrality

For reasons of readability and clarity, the joint use of feminine and masculine forms or other designations of feminine or masculine persons is mostly avoided. All designations for the different groups of university members equally refer to feminine and masculine members of the respective group.

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1 Course Objectives

The master programme Mechatronic and Cyber-Physical Systems (MMC) is to enable diploma or undergraduate students of Mechatronics or closely related study programmes to substantiate their findings gained so far with theoretical knowledge in order to meet the challenges of modern research and development tasks significantly.

This study programme complements undergraduate or diploma studies in depth. Graduates are to be qualified for creative work in research and development departments. Furthermore, particularly qualified students are to acquire the fundamentals in order to absolve a PhD programme or work in scientific fields.

2 Learning Outcomes of the Course

The study programme consists of three semesters and is completed by an independent scientific paper (master thesis).
The master programme is module-based and encompasses three study semesters.
In total, students can acquire 90 ECTS credit points.

The learning outcomes of the individual modules including their detailed objectives as well as the knowledge, skills and competencies to be acquired by the graduates, are further described in the module handbook for the master programme Mechatronic and Cyber-Physical Systems at the DIT. The modules in the module handbook are listed according to their respective module number of the study and examination regulations.

Professional and Methodical Competence

The consecutive master programme enables undergraduate students of Mechatronics or other closely related study fields to deepen their knowledge and skills on networked systems in Digital Production comprehensively.

Within four technologically-oriented study units, modern simulation systems, cooperative and autonomous systems, innovative human-machine interfaces as well as additive manufacturing processes are treated.

Additionally, you will acquire the expert knowledge, skills and methods necessary to apply scientific findings and processes to the industry and service economy independently.

Two interdisciplinary study units allow for the treatment of specific application fields of cyber-physical systems as well as functional safety of software-based control and automation systems.

Students acquire fundamental skills and competencies about concepts, findings and methods in compliance with the current state of science and are qualified to familiarise themselves independently with technical advancements. The course is to qualify students for scientifically-founded engineering activities in the following fields of work:

- development (conception, design, calculation, simulation and construction of hardware and software for mechatronic and cyber-physical systems),
- design of digitalised manufacturing and production systems,
- quality assurance,
- research and teaching.

A wide-ranging, qualified and scientifically founded training is to equip graduates for working in diversified professions. Career options are not only limited to economic and supply companies but further encompass research and teaching activities as well as independent practice.

The master thesis and master seminar demonstrate the students' ability to apply the knowledge and skills acquired in their studies independently to complex tasks and the presentation thereof in an appropriate form both written and orally. Correspondingly, students can demonstrate that they have acquired the ability to conduct scientific work independently.

The skills acquired form the basis for the continuation of studies, a PhD in Mechatronics or another closely related field.

Social and Personal Competence

The master programme Mechatronic and Cyber-Physical Systems fosters social competence, communication and presentation skills. Upon entry into professional life, the high level of practical relevance prepares students for socialisation and operational as well as scientific work environments.

In addition to technical and methodological knowledge, corresponding management techniques as well as social competencies are conveyed, too.

The case studies integrated in four out of eight modules not only promote technical skills but also foster personal and social competencies. The case studies offer the ideal opportunity to apply theoretical knowledge gained from the respective modules into practice. Small teams deal with individual scenarios. In the process, different solution approaches collide, which demands discussion in order to find a practical solution within the group eventually. Decision-making competencies are equally trained. Moreover, the case studies offer students the opportunity to consider problems from different perspectives. Theoretical knowledge is connected with the analyses elaborated in order to understand and explain the respective scenario. The case studies also prepare students ideally for their everyday working life by working within a team. A group presentation on the findings obtained is also part of the case studies.

Graduates of the study programme Mechatronic and Cyber-Physical Systems are capable of presenting work results in a structured manner and to further discuss their findings in front of an expert audience. Furthermore, graduates are qualified to organise themselves independently and to demonstrate team skills as well as high leadership competence for interdisciplinary collaboration.

3 Course and Qualification Objectives

Knowledge, skills and competencies acquired from the individual lectures are listed in the table below.

Table 1: Learning Outcomes in the Master Programme "Mechatronic and Cyber-Physical Systems"	
1) Consolidation: Cyber-Physical Systems	**Knowledge:** expert knowledge acquired on the areas of embedded systems, wireless technologies, intelligent systems etc.
	Skills: Students understand, analyse and synthesise information. Discussion on significant cyber-technical questions and comprehension of different business concepts.
	Competencies: basic understanding, analysis and recognition of different functionalities of system components within a cyber-physical system structure.
2) Consolidation: Cooperative and Autonomous Systems	**Knowledge:** autonomous systems, modell-building, obstacle detection, robot simulations, programming etc.
	Skills: robot programming, verification of robot movements, application of autonomous systems, robot relations with simulation systems
	Competencies: application of advanced knowledge in Robotics. Targeted analysis and application of robotics methods and use of generated methods in simulation models.
3) Consolidation: Modern Simulation Systems	**Knowledge:** deepened knowledge development in model-building and modeling processes, experimental generation methods of dynamic systems, Machine Learning, simulation systems.
	Skills: application of state machines for modelling event-driven systems, verification of results, application and evaluation of model suitability.
	Competencies: increasingly virtual product development processes can be created by models specifically selected and generated.
4) Consolidation: Innovative Human-Machine Interfaces	**Knowledge:** transfer of fundamental knowledge on essential aspects involving digital extension options of "Extended Reality".
	Skills: software applications for realisation of HMI, VR/ AR systems and applications.
	Competencies: Students can design, criticise and implement mobile Human-Machine Interfaces that meet the guidelines for usability, user-friendliness, user experience and quality of experience.
5) Consolidation: Additive Manufacturing Processes	**Knowledge:** Students understand the production process of generative manufacturing (Additive Manufacturing – AM) in detail.

	Skills: description of common AM technologies, understanding of AM production chain, calculation of process key indicators for AM, knowledge on metal-based AM technologies
	Competencies: methods and problem-solving in the AM field can be elaborated. Students can understand the future perspectives of AM technology.
6) Consolidation: Study-Related Elective (FWP)	**Knowledge:** within the framework of this module, students can choose from a different range of electives updated each semester.
	Skills: vary depending on the course selected.
	Competencies: vary depending on the course selected. Generally, students are to develop competencies within a field of mechatronic and cyber-physical systems self-organised and independently yet guided by their lecturers.
7) Consolidation: Functional Safety	**Knowledge:** Functional Safety is classified as a comprehensive field of process and machine safety. Students develop general objectives and influencing factors for the application of safety engineering.
	Skills: Founded skills of safety engineering, understanding of legal framework conditions and processes related to the creation of technical guidelines/norms as well as the implementation of European standards. CE certification, EN ISO 12100, EN ISO 13849, ISO 26262
	Competencies: Students acquire the ability to conduct targeted research on norms and guidelines. Furthermore, they are able to conduct risk analyses according to EN ISO 12100.
8) Interdisciplinary Competence: Master Module	**Knowledge:** The study contents transferred are applied in the form of a scientific work.
	Skills: independent, technical problem-solving of a larger coherent topic and scientific result processing. The objective, amongst others, is to solidify and apply the ability to document the results transparently.
	Competencies: Upon successful completion of the master thesis, students are able to deal with complex scientific/technical tasks independently. They solve problems using digital methods or tools and demonstrate a skilled command of networked cyber-physical systems.

4 Learning Outcomes of the Modules / Module Objectives / Target Matrix

The individual modules, their detailed objectives and the competencies graduates need to acquire are further described in the module handbook of this master programme. The following table establishes the link between the individual modules and the objectives of the master programme described in the previous section.

Target Matrix of the Modules in the Master Programme "Mechatronic and Cyber-Physical Systems"

Module	Objectives											
	Knowledge				Skills				Competencies			
	Scientific-Technical Fundamentals	Engineering Methodology	Engineering Practice and Product Development	Interdisciplinary	Scientific-Technical Fundamentals	Engineering Methodology	Engineering Practice and Product Development	Interdisciplinary	Scientific-Technical Fundamentals	Engineering Methodology	Engineering Practice and Product Development	Interdisciplinary
Module MCS-1 Cyber Physical Systems	x	x	xx		x	x	xx		x	x	xx	
Module MCS-2 Cooperative and autonomous systems		xx	x			xx	x			xx	x	
Module MCS-3 Case Study Cooperative and autonomous systems			xx	xx			xx	xx			xx	xx
Module MCS-4 Advanced Modeling and Simulation	x	xx	x		x	xx	x			xx	x	
Module MCS-5 Case Study Mechatronic System Simulation			xx	xx			xx	xx			xx	xx
Module MCS-6 Human Machine Interfaces	x	xx	x		x	xx	x		x	xx	x	
Module MCS-7 Case Study VR/ AR in System Engineering			xx	xx			xx	xx			xx	xx
Module MCS-8 Additive Manufacturing	x	x	xx		x	x	xx			x	xx	
Module MCS-9 Case Study Cyber-Physical production systems using AM			xx	xx			xx	xx			xx	xx
Module MCS-10 Subject-related elective course (FWP)		x	xx	x		x	xx	x		x	xx	x
Module MCS-11 Functional Safety		xx	xx			xx	xx			xx	xx	
Interdisciplinary Area												
Module MCS-12 Master module				xx				xx				xx

Key: xx strong reference; x intermediate reference