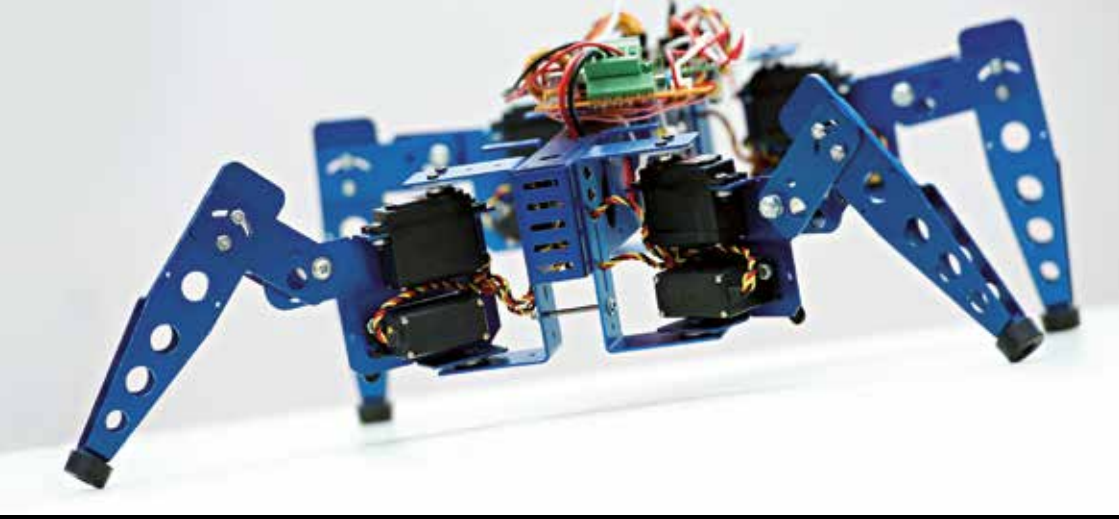
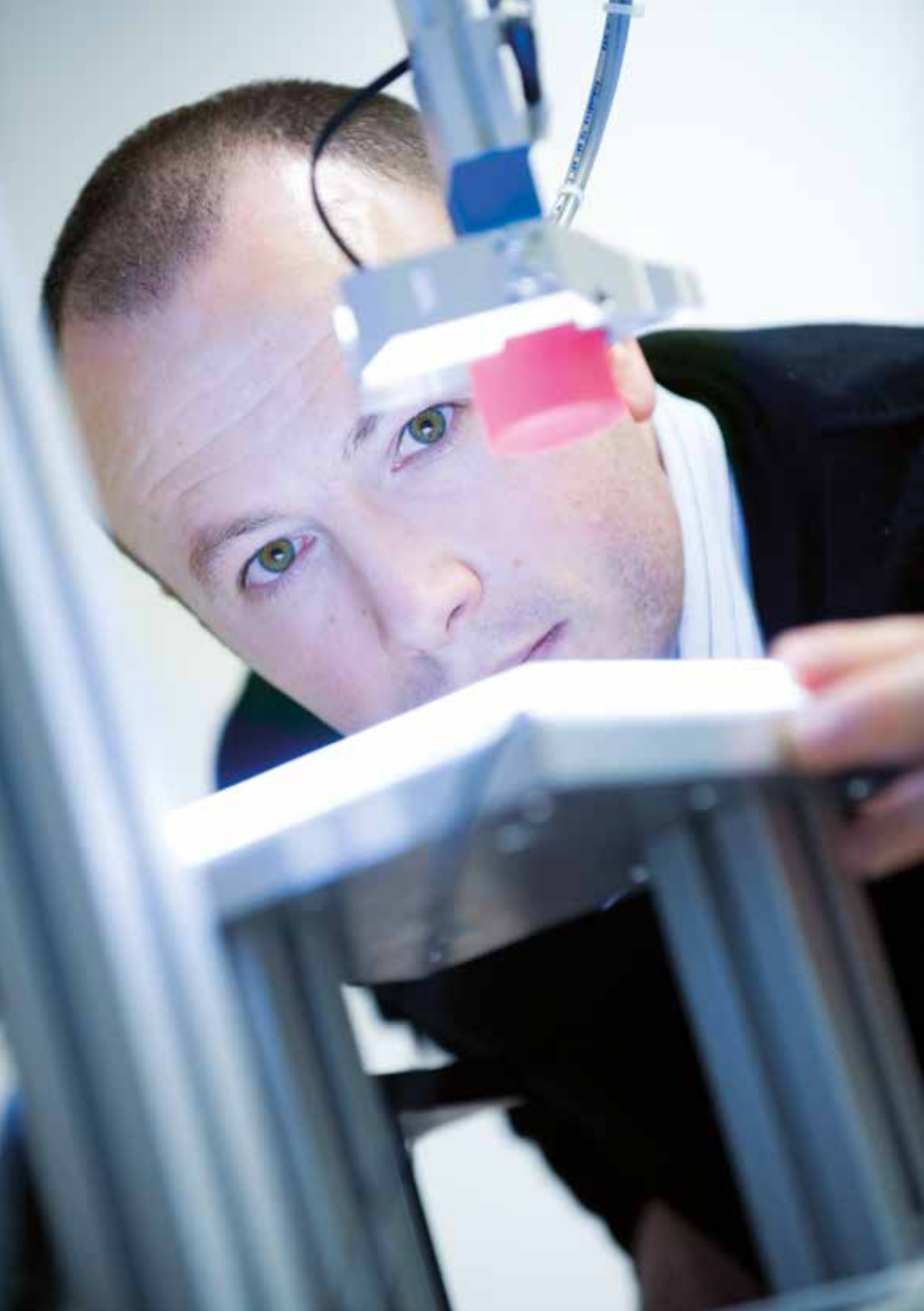


Mechatronics
Master of Science

FACULTY 08
MECHANICAL ENGINEERING AND MECHATRONICS

FH AACHEN
UNIVERSITY OF APPLIED SCIENCES



Mechatronics

Before you start

The practical degree programme

General Information

You will find all relevant information with respect to the course of studies Mechatronics in the internet. For that purpose, just photograph the QR code and use the adequate reader of your mobile phone*.

* Please note: Costs may arise upon initiating the web page.

Introducing the degree programme

Mechatronics is an exciting interdisciplinary field of engineering, based on mechanical and electrical engineering, control engineering as well as signal and data processing.

Mechatronic systems sense their environment by multiple sensors, process the sensor signals and act back on the world by actuators. They can be found in almost all technological fields. Examples are current automobiles, airplanes, CD-players, washing machines or automated industrial production lines.

Very typical for mechatronic systems is a high degree of integration of the different system components. The strong linkage between mechanical and electrical parts requires a new integrated design philosophy. It is no longer possible to develop the mechanical and electrical subsystems independently. Mechatronic system design simultaneously considers the mechanical, electrical and all other physical domains involved.

If you are a creative engineer interested in learning about the latest technology in this multidisciplinary field, have a closer look at the Master of Science program in Mechatronics at the FH Aachen.

Aachen is a lively and beautiful city with many historic roots. Today it is strongly influenced by the many students and scientists living and working here. Its location directly at the border to the Netherlands and Belgium gives it an international flair.

Be a part of it. We are looking forward to welcoming you in Aachen.

Yours
Prof. Dr. Klaus-Peter Kämper
(Coordinator of the Master programme in Mechatronics)

Mechatronics

The FH Aachen and the city of Aachen a good location to start a career.

The FH Aachen (University of Applied Sciences) has approx. 12.500 students, 220 professors, more than 300 lecturers from industry and 600 staff members. It is thus one of the largest universities of applied sciences in Germany and offers study programs in many engineering disciplines, business studies and design.

Teaching and research at FH Aachen is very much application and industry centered. We collaborate with a large number of industrial companies and R&D institutions in applied research and development projects as well as in educating our students. For example many thesis projects in the engineering study programs are performed in close cooperation with a company or commercial R&D institution.

The city of Aachen has approx. 250000 inhabitants, of which more than 40.000 are students at one of the four universities in Aachen. Thus Aachen is very much a student city, which caters for every taste in culture, sports and many pubs and restaurants.

However, Aachen is also a science and engineering city, where many small and large innovative companies operate research and development departments. Prominent names are Philips, Ford, Ericsson, Matushita, Mitsubishi, Talbot, Saint Gobain, Continental, Grünenthal and Aixtron. High-tech companies profit from the enormous know how in the universities and the well educated young engineers and scientists.

Aachen has many historic roots from roman times to Charlemagne. The picturesque center around the cathedral and the town hall attracts many tourists.

Aachen is located directly at the border to the Netherlands and Belgium and is thus a very European town. Highlights for outdoor fans are the nearby low mountain range Eifel and the moor area Hohes Venn. Fascinating towns like Cologne, Maastricht and Liege can be reached within an hour.

Mechatronics
an interdisciplinary approach

Product development processes in industry are rapidly changing. Products, whether consumer goods or investment goods, are getting more complex, the product life cycles are getting shorter and product development has to be performed in an interdisciplinary team in a shorter time and with a reduced budget.

Successful product development under these circumstances requires a team with professional skills with increasing technical depths as well as increasing technical broadness. The growing demand for interdisciplinary know how results from a clear trend towards highly integrated mechanical – electrical – electronic products, in short mechatronic products.

Mechatronic systems autonomously gather information, evaluate the data with the help of e.g. microcontrollers and carry out consequential actions. You might compare the necessary sensors (e.g. for temperature, position, pressure, acceleration or angular rate) with human senses, signal processing with the human brain and the actuators with limbs and muscles.

The additional trend towards miniaturization furthermore enhances the need for an integrated design philosophy.

Industry therefore requires engineers with sufficient know how in both large technical fields, mechanical engineering (mechanics) and electrical engineering (electronics) to truly enable them to successfully perform integrated product development processes in a team. In addition they should have sufficient in-depth know how in one of these fields in order to be able to follow the latest technical developments and apply them in state-of-the-art mechatronic development projects.

Competences
your new intellectual capital

The Master of Science program in Mechatronics imparts knowledge in mechanical engineering, electrical engineering and information technology. The focus of the program is the interaction of theses disciplines within mechatronic systems.

The program prepares students for versatile interdisciplinary engineering functions in a broad range of industrial fields. These tasks include developing, calculating, planning, dimensioning and designing of new or improved technical products. Most typically these are complex products, where mechanical and electronic functions are strongly intertwined. The field of development and design of modern automated production lines is another example where many engineering tasks require mechatronic know-how.

The students acquire technical and methodical competences which enable them to recognize and analyse corresponding problems, find creative and innovative solutions and develop application ready mechatronic products. They are enabled to develop complex mechatronic systems that allow faster, cheaper and smaller product solutions.

Furthermore the program helps students to develop and extend their abilities to carry out and manage research and development projects in the field of mechatronics. They learn to work in international teams and gain many intercultural experiences.

Career chances much in demand

The ubiquitous and increasing trend towards new products with integrated mechanical and electrical functions leads to a high demand for mechatronics engineers with substantial know-how in both, mechanical and electrical engineering as well as their integration.

Graduates of the Master program in Mechatronics are provided a broad range of job opportunities. In Germany most of the 5000 mechanical engineering companies by now employ mechatronic concepts in their products. Mechatronic engineers can be found in a variety of functions such as product development, production and fabrication technology, assembly automation, quality control and technical sales.

Mechatronic engineers presently have outstanding career chances. According to all German and European industrial and engineering associations the demand for well educated and application oriented mechatronics engineers will continue to steadily rise in the future. Since the expected number of graduates in this field is much lower than the industrial needs the professional chances for mechatronics engineers are predicted to remain excellent in the years to come.

Statements of students and alumni

Tushar Chaugari
M.Sc. Mechatronics (2006-2008)
The reputation of Mechatronics at FH Aachen was impressive and I really wanted to study there. Even though the course is demanding, there is a good balance between work and free time here. I also like the emphasis on practical work, which has helped me to have a better understanding of the lectures. The Department is welcoming and friendly, the professors and staff are always willing to help with any problems.

The course is well structured and covers the aspects of Mechatronics, which helped me pinpoint my strengths and weaknesses and further choose my area of interest. I did a 12-month student job at an European Institute last year, which has considerably improved my skills at work. This kind of experience is very important to future employers and I would definitely recommend it.

Although I come from a far away city called Pune in India, which is altogether a different city as compared to Aachen, I like it very much here since there is so much to do here and there is always something going on.

FH Aachen is a well recognised University in whole of Germany and has given me good prospects for the future. I have completed a 6-Month Internship at the German Aerospace Centre in Munich and will be continuing with my Master thesis.

Emily Claire Were
M.Sc. Mechatronics (2003-2005)
Studying at FH Aachen helped me not only gain technical skills but also great interpersonal skills interacting with students from various countries. Mechatronics provides knowledge in the different engineering branches enabling one to fit in many more career branches, unlike the traditional engineering studies where one is confined to a specific direction. Immediately after my studies, I joined Ericsson GmbH in Düsseldorf as a service Engineer where I am currently working.

Sandeep Unnikrishnan
M.Sc. Mechatronics (2002-2005)

Hello Everyone! I am Sandeep Unnikrishnan, a former MSc. Mechatronics student (2002-2005) of the University of Applied Sciences Aachen (FH-Aachen). After my master studies there, I am currently working as a PhD student at the University of Twente in Enschede in the Netherlands. My present research project is about Fabrication and characterization of micro fuel cells, which is directly related to my specialization subject – MEMS, during my MSc. Mechatronics program. Studying at the FH-Aachen was a great experience for me. The faculty and the students were very friendly and helpful. The practice oriented teaching methods followed at the FHAachen has been very helpful for me to solve real-life engineering problems faced during my research now. The knowledge and training given by the FH-Aachen staff was really helpful for my professional career. Apart from the studies and work, the nice personal and cultural experiences that I felt in Aachen are inexplicable. I am glad to have studied at FH-Aachen and now to be a part of its Alumnus.

Thomas Bücker
M.Sc. Mechatronics (2009-2011)

I can highly recommend the master course in mechatronics at the FH Aachen. My favourite work field is sensor and actuator technolgy and the classes and facilities at the faculty for mechatronics has been a great place to improve my knowledge and experience. During the courses I had a lot of options to employ theroretical knowledge in practice. The laboratories in this university are well equipped and it has been never a problem to stay in the laboratories outside the class hours to use the equipment. The number of students in a batch is limited, so the studying atmosphere is very convenient. Professors have been always helpful when there were questions. I made many friends from other countries and besides the technical aspect of studying I have gained a lot of intercultural experience.
Nowadays I am a test engineer at TRW in Düsseldorf. I am responsible for the validation of automotive steering systems and my daily work is the development and implementation of diverse tests on various conditions to approve functionality and durability of the mechatronic system. The study has been a perfect preparation to the working world and I thank my fellow students and the professors for the great years of study.

Before you start

Admission requirements

Academic entrance requirements | Applicants must have a Bachelor, Dipl.-Ing. or an equivalent academic degree in Mechanical Engineering, Electrical Engineering, Mechatronics or a related field. The Bachelor degree has to certify the completion of an at least 3 years study program or a minimum of 180 ECTS credits.

Prospective students, who received their Bachelor degree from a university outside the European Union, have to submit their results of the GRE General test (Graduate Record Examination).

Language requirements | New students have to provide evidence of a good knowledge of the English language by the TOEFL or an equivalent English language test. Minimum TOEFL scores are 210 on the computer-based test, 79 on the internet-based test, 550 on the paper-based test. Minimum IELTS score is 6.0. Native speakers from Australia, Canada, Ireland, New Zealand, United Kingdom and the USA are exempted from proving their knowledge of English.

Applicants whose study qualification was not achieved at a German speacking university have to provide proof of basic knowledge of the German language by the “Zertifikat Deutsch” (Level B1 certificate) or an equivalent German language certificate.

Selection of candidates | Application deadline is April 30th each year. A selection committee consisting of several professors teaching in the Master Mechatronics program carefully reviews all applications and checks their qualification for this program. Evaluation of the candidates qualification is based on the results of the Bachelor degree and the GRE scores.

The practical degree programme Mechtronics

Profile of the study programme

The Master of Science program in Mechatronics is an interdisciplinary 4 semester (i.e. 2 year) study program intended for students with a qualified Bachelor's degree in electrical engineering, mechanical engineering or related fields. It is a joint effort by the departments of Mechanical Engineering and Mechatronics (FB 8), Electrical Engineering and Information Technology (FB5) and Aerospace Engineering (FB6).

The continuous change of the job market for engineers and the increasing demand for engineers with an application oriented education enabling them to interdisciplinary scientific work led to the introduction of the Master program in Mechatronics in 2001 at FH Aachen. It provides a broad industrially oriented technical knowledge in mechatronic principles, components and system design.

The central idea of the study program is to educate highly qualified students with a first academic technical degree in a compact study program in order to prepare them for the manifold demands of mechatronic product development. At the beginning of the course the students are taught the fundamentals of the other disciplines, which were not the central topic of their first degree. In compulsory modules like Sensors & Actuators, Mechatronic System Simulation or Advanced Motion Control the students pick up the essentials of modern mechatronic systems and their components. The elective modules allow the students to acquire in depth knowledge on the application of mechatronics in certain technological fields like robotics, microsystems or automotive systems. All these modules are also aiming at enhancing the abilities of the students to perform application oriented research and development in the area of mechatronics. An integrated R&D project in the 2nd and 3rd semester familiarizes the students with project management and working in international teams.

The study program is finished by an application oriented master thesis, which can be written in industry or in a research laboratory. The thesis is thus an additional means of ensuring that the orientation towards industrial application dominating the whole study program complies with current industrial research and development standards.

A strong international orientation of the study program results from teaching the major part of the program in English. The use of the English language increases the attractiveness of this Master program for international students. On the other hand German students gain an additional international qualification by actively working with technical English, but also by the intense contact to the international students.

Curriculum

No.	Name of Module	C/E	Cr	SWS L	SWS P	SWS Lab	SWS SU	SWS ∑
1st Semester								
8144	Fundamentals of Electrical Engineering **	C	10	4	3	0	0	**7**
8143	Fundamentals of Mechanical Engineering **	C	10	4	3	0	0	**7**
	Wahlpflichtblock 1	E	10					
	MEMS/Microtechnology	E	5	3	1	0	0	**4**
	Analog and Digital Control Technology	E	8	3	1	2	0	**6**
	Advanced Engineering Mathematics	E	7	3	3	0	0	**6**
Total			**30**	-	-	-	-	-
2nd Semester								
	Systems Engineering	C	10	3	1	3	0	**7**
	Autonomous Mobile Robotic Sytems	C	5	2	1	1	0	**4**
	Elective block 2*	E	10					
	Mechatronics Project (Part 1)	E	4	0	0	0	2	**2**
Total			**29**					
3rd Semester								
8341	Mechatronic Systems Simulation	C	10	0	0	0	6	**6**
	Advanced Motion Control	C	5	2	1	1	0	**4**
	Sensors and Actuators	C	6	2	1	3	0	**6**
	Elective block 3*	E	8					
	Mechatronics Project (Part 2)	E	2	0	0	0	1	**1**
Total			**31**					
4th Semester								
	Master project	C	27					
	Thesis defense	C	3					
Total			**30**					

Cr: Credits
L: Lecture
C: Compulsory
P: Problem Session
E: Elective
Lab: Laboratory
SWS: Contact hours per week
SU: Seminar

No.	Name of Module	C/E	Cr	SWS L	P	Lab	SU	∑
Elective Modules								
58110	Automatisierung technischer Anlagen	E	6	2	1	1	0	4
58112	Objektorientierte Softwareentwicklung für Automnatisierungssysteme	E	6	2	1	1	0	4
58113	Elektronik für AAT	E	6	2	1	1	0	4
58607	Optische Nachrichtentechnik	E	6	2	1	1	0	4
58611	SQM - Software Qualitätsmanagement	E	6	2	1	1	0	4
58613	Medientechnik und Streaming	E	6	2	1	1	0	4
58614	Management von technischen Innovationen	E	6	2	1	1	0	4
58655	Rechnergestützter Regelungsentwurf	E	6	2	1	1	0	4
58656	Leistungselektronik für AAT	E	6	2	1	1	0	4
58657	Energieeffizienz und Gebäudeautomation	E	6	2	1	1	0	4
58658	Rapid Control Prototyping	E	6	2	1	1	0	4
58659	3D-Bildverarbeitung	E	6	2	1	1	0	4
61901	Advanced Control Technology	E	5	2	1	0	0	3
61902	Advanced CAD Methods	E	5	0	0	4	0	4
61904	Actuator Systems	E	5	2	2	0	0	4
61921	Vehicle Acoustics	E	5	2	1	1	0	4
61933	Advanced Automotive Electronics	E	5	2	1	1	0	4
61934	Design of Electronic Powertrain Management Systems	E	5	2	1	1	0	4
61936	General Management of Automotive Suppliers	E	5	2	1	1	0	4
62907	Mathematical Optimization	E	5	2	1	1	0	4
62912	Applied Computational Fluid Dynamics	E	5	2	1	0	0	3
83601	Simulation of Structures, Fields and Flows	E	8	4	0	2	0	6
83602	Advanced Fabrication Technologies	E	8	2	2	2	0	6
83603	Micromechatronic Systems	E	8	2	0	2	2	6
83616	Application of Mechatronics Systems	E	8	2	2	2	0	6
	Industrial Communication	E	8	2	2	2	0	6

* Students with a first degree in Mechatronics have to choose elective modules with at least 28 credits in total. Students whose first degree is not in Mechatronics, have to choose elective modules with at least 18 credits in total.
** Students with a first degree in Mechanical Engineering have to choose the module „Fundamentals of Electrical Engineering“, while students with a first degree in Electrical Engineering have to take the module „Fundamentals of Mechanical Engineering“. Students with a first degree in Mechatronics do not have to take any of the fundamentals.

Cr: Credits C: Compulsory E: Elective SWS: Contact hours per week
L: Lecture P: Problem Session Lab: Laboratory SU: Seminar

Compulsory Modules

8143 **10 Credits**

Fundamentals of Mechanical Engineering |
Prof. Dr.-Ing. Markus Schleser, Prof. Dr.-Ing. Joachim Benner
Students get familiar with the fundamentals of technical mechanics. In particular they learn about the determination of stress, deformation and motion of selected structures due to applied loads. They know about the calculation of product life data for selected problems and selected applications of DFX-methods.

8144 **10 Credits**

Fundamentals of Electrical Engineering |
Prof. Dr. rer. nat Felix Hüning
The students are meant to acquire or to refresh the fundamental principles of electrical engineering and shall be enabled to follow further courses successfully.

8145 **7 Credits**

Advanced Engineering Mathematics |
Prof. Dr. rer. nat. Wilhelm Hanrath
The students learn and refresh special techniques of engineering mathematics, in particular Fourier- and Laplace transformations. These techniques are important for the analysis and the design of mechatronics systems and are required for advanced courses in the master program.

7 Credits

Analog and Digital Control Technology |
N.N.
A large variety of mechanical and electrical processes in mechatronics afford precise and reproducable behaviour. Therefore the students will learn how to model such processes in the continuous time- and frequency domain. They will be able to set up process descriptions in order to use them for the design ofa control system. They will come to understand that the dynamics of control systems play an important role for the stability and quality of the control process. The students will also realize that the control behaviour can be considerably improved by an appropriate control structure in order to achieve precision and reproducable behaviour. As digital systems allow to establish sophisticatied control concepts in production-, transport- or manufacturing processes the students learn approaches and skills to set up computer-based or embedded controllers instead of continuous systems. They will discuss the specific benefits and tradeoffs. They learn to set up the discrete time process dynamics of

drive systems, mechatronics or process technology. This will enable them to use process simulation and control design tools and to determine and evaluate the digitally controlled system's properties. This will enable them to parametrize the digital controllers accordingly. They will furthermore lay out logical controllers, realize them in specific programming languages and use, test and develop them for given processes.

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5 Credits

MEMS/Micro Technolgy | *Prof. Dr. rer. nat. Klaus-Peter Kämper*

Modern microtechnologies are essential for the cost effective fabrication of complex microsystems (MEMS), which are an essential part of many current mechatronic systems. Without low cost, but high performance, microsensors many mechatronic products would not be feasible.
In this module the students acquire knowledge of the most important technologies in microengineering. They will be able to judge and classify all major microstructuring technologies for silicon and metallic, polymeric and ceramic materials. The students will also be familiar with most important assembly and packaging technologies for microsystems.

8146 **6 Credits**

Sensors and Actuators | *Prof. Dr. rer. nat. Klaus-Peter Kämper*

The learning objective is to gain knowledge on the functional principle, structure and fabrication of modern sensors and actuator
The students shall be enabled to select and characterize modern sensors and actuators and to integrate them in mechatronic systems. They get acquainted with modern graphical oriented development systems for PC based data acquisition and control technology. By working in small teams they gain experience in project work, self organization, presentation techniques and moderating a team.

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10 Credits

Systems Engineering | *Prof. Dr.-Ing. Jörg Wollert*

How to engineer complex mechatronic systems? This essential question will be answered during the lecture „Systems Engineering". Under systems engineering one understand the interdisciplinary approach on analysing, modelling, designing, constructing and maintaining a system during the whole life cycle. Especially in mechatronic systems there are great

challenges to achieve reliable and maintainable systems.
The course consists of two parts. In the first part the students will learn basics on requirement analysis, writing technical specifications and describing technical use cases and further corresponding issues. Classical and agile development strategies will be discussed.

- Holistically engineering processes – technical and organisational view
- Managing complexity through object oriented and modell based architectures
- Requirements engineering
- Prototype oriented development
- Using modelling languages for the formal description of systems
- Life cycle models and development models
- The V-Model as example for a tailorable dveleopment cycle
- Scrum as example for an agile development cycle
- SPICE model for the evaluation of development processes

In the second part a practical mechatronic problem will be solved with the learned strategies.

- Developing solving strategies from a formal specification document
- Creating detailed requirement specification
- Setting up a agile project controlling
- Realization of the whole project in hard- and software
- Documentation of the development process under quality aspects.

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10 Credits

Advanced Robotics and Autonomous Mobile Systems | *Prof. Dr.-Ing. Stephan Kallweit, Prof. Dr. rer. nat. Alexander Ferrein, Prof. Ingrid Scholl*
The participants are able to distinguish between different kinematics for industrial robots and know their applications. They are able to use the transformations and solve the inverse and the forward transformations with different methods. The main components of industrial robots are known and the participants are able to program industrial robots in IRL. In the field of mobile robotics the participants are able to explain the basics of kinematic and know the fundamentals of autonomous robotics like locomotion, perception, localization, navigation and path planning. In this context the participants are able to apply the basics of probabilistic reasoning

for e.g. localization and path planning of mobile robots. In addition the participants are familiar with the ROS framework which is used for industrial robots but as well for mobile autonomous systems.

8341 **10 Credits**

Mechatronic Systems Simulation | *Prof. Dr.-Ing. Günter Schmitz*

The learning objective of this module is the understanding and application of various simulation methods and creation of models.

The students learn about methods of simulation with behavioral models incl. state machines, methods of lumped element simulation, hardware in the loop simulation (HIL), rapid controller prototyping, modeling for the various simulation methods and the coupling of simulation tools.

8342 **5 Credits**

Advanced Motion Control | *Prof. Dr.-Ing. Karl-Josef Lux*

The goal of this module is to achieve an understanding of rotational electrical machines, dimensioning, design and development of electrical drives and drive control. The topics treated include design, principles and fundamental behavior of rotational electrical machines, dynamic behavior of electrical drives, control of electrical drives, field oriented control, measurements of the fundamental behavior of rotational electrical machines, the dynamics of electrical drives and the control of electrical machines.

4+2 Credits

Mechatronic Project (Part 1 + 2) | *All Professors active in the Master of Science in Mechatronics program*

The students will apply the previously acquired knowledge to solve an unknown technical problem and independently gather new technical know how relevant for the project task. These tasks represent current industrial problems and development assignments.

The students get familiar with project management and interdisciplinary team work. They have learned to present and document their results according to international standards.

Elective Modules

83601 **8 Credits**

Simulation of Structures, Fields and Flows | *Prof. Dr.-Ing. Hans-Jürgen Raatschen*

The theoretical background of Finite Element Analysis shall be understood to gain insight into the application potentials and restrictions of the method. Application of Finite Element Analysis shall be practiced performing computer simulations of selected problems of mechatronics.

Language of instruction: English

83602 **8 Credits**

Advanced Fabrication Technologies | *Prof. Dr.-Ing. Andreas Gebhardt*

After this module the students should know new Methods und Processes used in Manufacturing Technology. Based on the two examples Additive Manufacturing and Laser Material Processing the students should understand that manufacturing must be connected to digital product modeling and that this has to be integrated into the manufacturing process. Furthermore the students should know the criteria fore the decision of using new manufacturing processes and be able to apply it properly.

Language of instruction: English

83603 **8 Credits**

Micromechatronic Systems | *Prof. Dr. rer. nat. Klaus-Peter Kämper*

The students get to know important design rules, design principles and design methods for micro components and micro systems. They acquire knowledge on the working principles, the design and the fabrication technologies of important industrial micro systems. They learn about important measuring and testing methods in micro technology.

Language of instruction: English

83616 **8 Credits**

Application of Mechatronics Systems | *Prof. Dr.-Ing. Jörg Wollert*

It is the aim of this module to extend theoretical and practical knowledge on advanced technologies applied in the design and application of mechatronic systems. to understand the functional principles of mechatronic devices like sensors, actuators and control elements and how they interoperate inside mechatronic systems towards common goals and to extend expertise and skills in the transition of mechatronic systems technology into practical application.

Language of instruction: English

58607 **6 Credits**

Optische Nachrichtentechnik | *Prof. Dr.-Ing. Thomas Mühl*

Die Studierenden lernen die Grundlagen und Eigenschaften der wesentlichen Komponenten optischer Übertragungs- und Messsysteme kennen. Sie werden in die Lage versetzt, nach gegebenen Anforderungen die geeigneten Baugruppen auszuwählen, zu charakterisieren und auch komplexere Systeme zu analysieren oder zu entwerfen. Sie verstehen die Prinzipien der optischen Messverfahren und können Sie ergebnisorientiert anwenden.

Language of instruction: German

58611 **6 Credits**

Software Qualitätsmanagement | *Prof. Dr.-Ing. Michael Trautwein*

Zunehmende Komplexität der Software, speziell in verteilten Systemen, sowie hohe Anforderungen an die Sicherheit für Leben und hohe materielle Werte, aber auch die Notwendigkeit, Kosten in der Entwicklung und Wartung zu begrenzen, erfordern die Integration von

Qualitätssicherungsmaßnahmen in den Software-Entwicklungsprozess.
Es werden die Basisvoraussetzungen für eine effektive Software-Entwicklung mit integrierten Anteilen aus SW-Qualitätsmanagement, -sicherung und -kontrolle sowie die Bedürfnisse eines optimalen Qualitätsmanagements erläutert. Neben der Klärung von grundlegenden Fachbegriffen wird Bezug zum V-Modell der Softwareentwicklung hergestellt, wobei die Einsatzpunkte für Qualitätskontroll-Maßnahmen parallel zur zeitlichen Reihenfolge der Software-Entwicklungsphasen besprochen werden. Die Studenten sind außerdem in der Lage, die Qualitätsanforderungen und -merkmale zu ermitteln.
Die Aufstellung von SW-Qualitätssicherungsmaßnahmen beginnt bereits bei der Etablierung eines Qualitätsmanagements als vorbereitende Schritte. Danach erfolgen die QS-Maßnahmen bei der Problemanalyse und darauf folgender Konzeption. Die Maßnahmen bei Design und Realisierung einerseits und Inbetriebnahme der SW sowie Wartung andererseits werden mit praktischen Beispielen belegt, wobei besonderer Wert auf die Dokumentation und das dokumentierte Testen gelegt wird. Die Zusammenstellung der erarbeiteten Richtlinien und die planerische Bewertung des SW-QM schließen den Zyklus ab.
Language of instruction: German

62907 **5 Credits**

Mathematical Optimization | *Prof. Dr. rer. nat. Klaus Bullerschen*
Acquisition of the basic mathematical and information technological knowledge of the subjects mentioned below and the qualification for the independent application of this knowledge to engineering and business management problems. The naturally versatile mathematical and information technological methods support the subject spreading comprehension of the graduates and their possible employment in interdisciplinary teams. In the training the students are to mutually assist each other for the development of their team ability.
Language of instruction: English

61901 **5 Credits**

Advanced Control Technology | *Prof. Dipl.-Ing. J.-Michael Bauschat*
The main objective of this module is to gain competence in designing and calculating a complete control loop. The topics treated include state-vector control, stability augmentation systems, command systems, elimination of disturbances, intermeshed control loops, pilot control, cascade control, interacting control, time-varying and nonlinear control systems, two-step and three-step controllers, design criteria, control effectiveness, root locus, adjustment rules, stability of closed-loop systems, stability criteria, fuzzy-control and control loop design with MATLAB and SIMULINK.
Language of instruction: English

61933 **5 Credits**

Advanced Automobile Electronic Systems | *Prof. Dr.-Ing. Günter Schmitz*
Within this modules should acquire knowledge and comprehension of complex interdependencies in the integration of electronic components and modules in the complete vehicle system. They will gain the ability to transfer fundamental electronic and mechanical knowledge to interoperating components in a vehicle and to analyze the overall behavior. They will achieve competence to solve new tasks and problems in the realm of vehicle electronics as well as train their ability to work in interdisciplinary teams.
Language of instruction: English/German

62912 **5 Credits**

Applied Computational Fluid Dynamics | *Prof. Dr.-Ing. Frank Janser, Prof. Dr.-Ing. Marc Havermann*

The main aim of this module is to develop the competence to solve difficult fluid dynamic problems numerically. To do so a deeper understanding of turbulent flows, far in excess of the Bachelor study, and of the numerical solutions of turbulent flow problems has to be gained. This is mandatory for any judicious decision if a particular fluid dynamic problem is prone for a numerical solution and which turbulence model will render the optimal solution. The most common numerical codes and turbulence models will be demonstrated using practical examples (aerospace and automotive).

Language of instruction: English/German

58113 **6 Credits**

Elektronik für AAT | *Prof. Dr. rer. nat. Felix Hüning*

Die Studierenden kennen die wesentlichen Elemente von Embedded Systemen, wie sie in Geräten der Antriebs- und Automatisierungstechnik zu finden sind. Dazu gehören zum Einen softwareverarbeitende Standardkomponenten wie Mikroprozessoren und Mikrokontroller mit den dazugehörigen Echtzeitbetriebssystemen. Desweiteren lernen die Studierenden die Grundlagen programmierbarer Logikbausteine sowie deren Entwurf mittels Hardwarebeschreibungssprachen wir VHDL. Sensoren als wesentliche Komponenten von Automatisierungssystemen sind den Studierenden bekannt. Zudem nimmt die Kommunikation zwischen Sensoren, Aktoren und den Peripheriekomponenten der Embedded Systeme über Bussysteme und Punkt-zu-Punkt Verbindungen einen wichtigen Teil ein. Die für Automatisierungssysteme typischen Kommunikationsschnittstellen – und protokolle sowie deren elektronische Anschaltung sind den Studierenden bekannt.

In der Übung werden die Themen vertieft und angewendet, so dass die Studierenden selbständig Anutomatisierungssysteme analysieren und Lösungskonzepte anhand von Praxisbeispielen erarbeiten können. Das Praktikum wird in Form von Projektarbeit durchgeführt. Dabei bearbeiten, konzeptionieren und realisieren Studierendengruppen eigenständig ein Projekt aus dem Bereich der Elektronik für Automatisierungssysteme.

Language of instruction: German

61902 **5 Credits**

Advanced CAD Methods | *Prof. Dr.-Ing. Bruno Burbaum*

The participants of this lecture will learn how to create simple as well as advanced surfaces and shapes using the surface modeling features of CATIA V5. Besides creating single surfaces there will be shown different ways how to combine these surfaces to full-parameterized parts. There will be shown useful methods how to create 3D models from scratch. The lecture will show its participants how to create parts with complex surfaces which are input for a large number of interdisciplinary application. 3D models are often processed by CAE- (stress analysis, crash simulation, etc.) and CAM- (computer aided manufacturing; Rapid Prototyping, etc.) related software tools.

Language of instruction: English

61904 **5 Credits**

Actuator Systems | *Prof. Dr.-Ing. Peter Dahmann*

The module qualifies for the description and calculation of linear and rotary actuators acting on the basis of hydraulic, pneumatic and electro-mechanical principles. It enables them to analyze these actuators both conservative as well as by means of digital simulation. Thus one can gain the

qualification, the problems which arise in the use of actuators in systems to solve independently. Actuators are usually part of an overall system. Therefore the power to think in interdisciplinary and cross-disciplinary understanding is obtained. By the independent design of a hydrostatic drive cylinder with the digital simulation, the competence is achieved, not only to use acquired knowledge, but also to solve unknown problems in productive use.
Language of instruction: English

58110 **6 Credits**

Automatisierung technischer Anlagen | *Prof. Dr.-Ing. Ulrich Hoffmann*
Die Studierenden können Prozesse aus der Elektro- und Antriebstechnik, der Mechatronik und der Verfahrenstechnik analysieren und mit fachspezifischen und mathematischen Hilfsmitteln beschreiben. Sie können für diese Prozesse zum Zwecke der steuerungs- oder regelungstechnischen Automatisierung geeignete Modelle rechnergestützt aufbauen und das interessierende Prozessverhalten simulieren.
Die Studierenden kennen Regelungs- und Steuerungsstrategien und -hierarchien, die sie für die Automatisierung anwenden und rechnergestützt erproben können. Sie entwerfen geeignete Automatisierungskonzepte auf der Prozess- und Betriebsleitebene und planen die Realisierung der dazu nötigen Systeme. Sie sind in der Lage, die Automatisierungssysteme zu realisieren und in Betrieb zu nehmen. Sie können die Zusammenhänge zwischen Simulationen und realem Verhalten der automatisierten Prozesse bewerten.
Language of instruction: German

58659 **6 Credits**

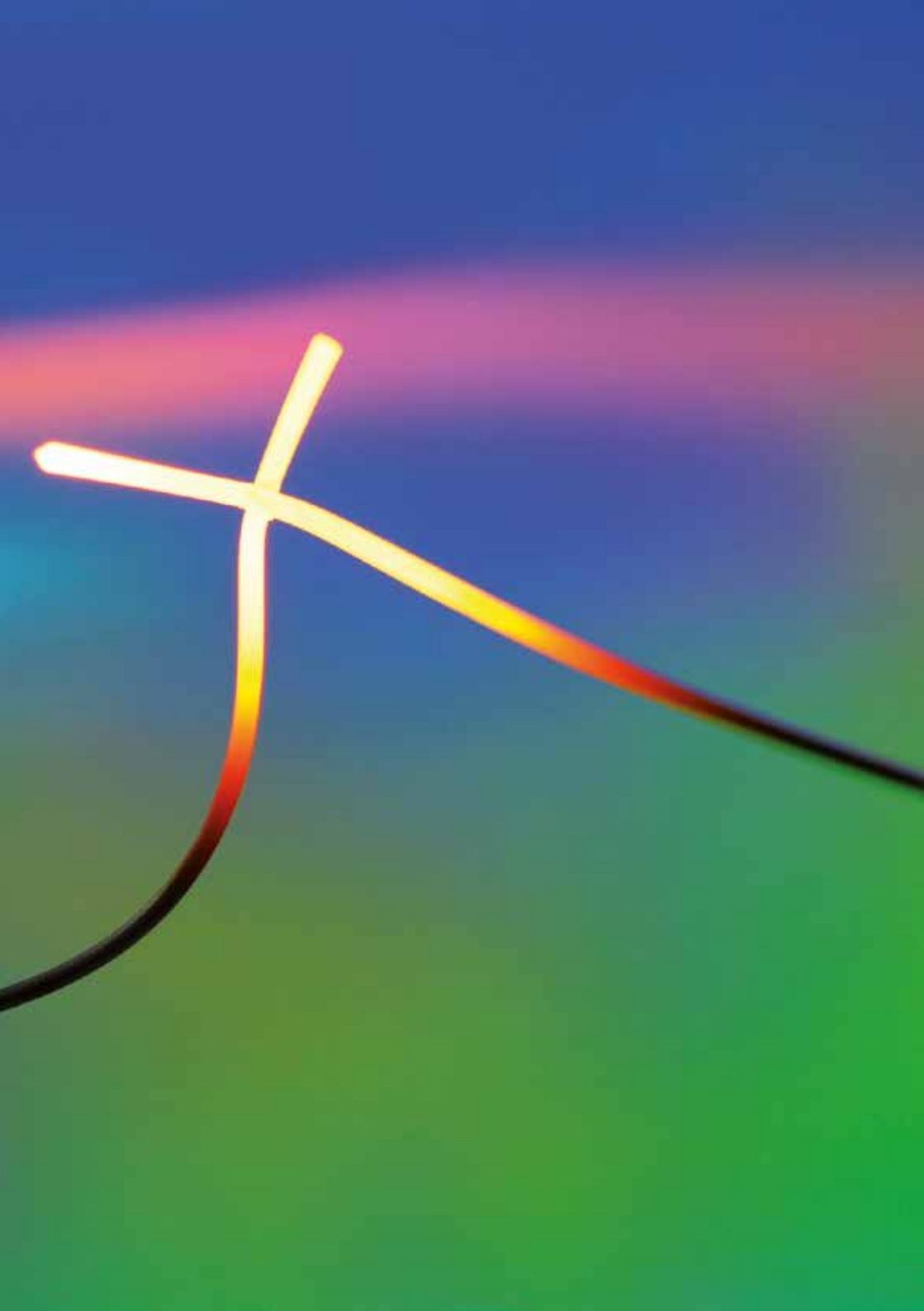
3D-Bildverarbeitung | *Prof. Dipl.-Inf. Ingrid Scholl*
Die Studierenden erlernen moderne fortgeschrittene Techniken und Algorithmen in der 3D Bildverarbeitung. Neben dem theoretischen Verstandnis der behandelten Verfahren, werden diese im Praktikum angewendet und implementiert.

58624 **6 Credits**

Medientechnik und Streaming | *Prof. Dr.-Ing. Frank Hartung*
n der Vorlesung erwerben die Studierenden grundlegendes Wissen und Verständnis der technischen Grundlagen und Konzepte der Medieniibertragung über |P—basierte Netzwerke. Die Komponenten von der Kompression, Formatierung in Fiie- und Stream-Formate, bis hin zur Übertragung mit Streaming-Verfahren, werden zueinander in Beziehung gesetzt, und die Schnittstellen erkannt.
Fortgeschrittene Aspekte wie Cloud-basiertes Streaming und Schutz von Mediendaten gegen unberechtigten Zugang werden ebenfalls erarbeitet und verstanden.
lm Praktikum erarbeiten die Teilnehmer die Funktionsweise der einzelnen Teiltechniken und Komponenten. Das Praktikum nutzt weitgehend die Software MATLAB.

58614 **6 Credits**

Management von technischen Innovationen | *Prof. Dr.lng. Martin Wolf*
Aufgrund des rasanten technischen Fortschritts werden die Produktiebenszyklen insbesondere von technisch hochwertigen Produkten immer kiirzer. Aus diesem Grund ist es für jedes Unternehmen lebenswichtig, dass es stäindig neue Innovationen entwickelt und sich immer wieder neu erfindet.
In dieser Vorlesung wird vorgestelit wie es ein Unternehmen schaffen kann, mit dem technischen Fortschritt Schritt zu halten. Es werden Prozesse und Methoden gezeigt (und ausprobiert), die auf der einen Seite die Grundlage fur neue ideen bilden, auf der andern Seite deren Weiterentwicklung organisatorisch und technisch sicherstellen.



61921 **5 Credits**

Vehicle Acoustics | *Prof. Dr.-Ing. Jan-Welm Biermann*

The study module describes beside the fundamental physics and acoustics, at first place the relevant valid regulations, limits, measurement standards and procedures. In a follow, specific vehicle noise sources i.e. powertrain, brakes or tyres according to their noise origin and realistic solutions of noise reduction will be handled.
Basics on today's traffic conditions is to be discussed, in how far vehicle manufactures, users as well as governments are able to effect the reduction of traffics noise. Demonstrations of applied techniques of noise reduction using examples of performed research projects will complete the study module.

58112 **6 Credits**

Objektorientierte Softwareentwicklung fiir Automatisierungssysteme | *Prof. Dr.-Ing. Michael Bragard*

Die Studierenden haben die informationstechnischen Grundlagen zur objektorientierten Programmierung (OOP) von Antriebs- und Steuerungssystemen kennengelernt.
Sie kennen die Konzepte der OOP und die damit verbundenen Begriffe, wie Klassen, Polymorphismus und Vererbung.
Die bei der modernen Entwicklung einer Softwarearchitektur wichtigen Entwurfsmethoden, d.h. die Modellierung und Verwendung von Mustern, sowie die Möglichkeiten und Grenzen moderner Entwicklungswerkzeuge sind ihnen bekannt.
Die Studierenden sind in der Lage, die objektorientierte Programmierung für die Implementierung von Modellen dynamischer Systeme anzuwenden. Das Spektrum der dynamischen Systeme reicht von Lotka-Volterra Systemen bis zu Wartesystemen. Teile der Übungen und Praktika werden als Projektarbeiten in Kleingruppen durchgeführt, wobei Einzelaufgaben als auch Teamaufgaben gelöst werden müssen. Die Bearbeitung der Projektaufgaben erfordert die Anwendung der im Bachlorstudiengang erworbenen Fachkenntnisse . Von Absolventen mit Masterabschluss werden kommunikative Fähigkeiten erwartet, die beispielsweise durch die Bearbeitung der Aufgaben im Team und der Präsentation von Arbeitsergebnissen vor den Kursmitgliedern verstärkt werden. Der Anteil der Projektaufgaben kann in Abhängigkeit der Studierendenzahlen bis zu 50% zeitlichen Aufwände für das Modul betragen.

61934 **5 Credits**

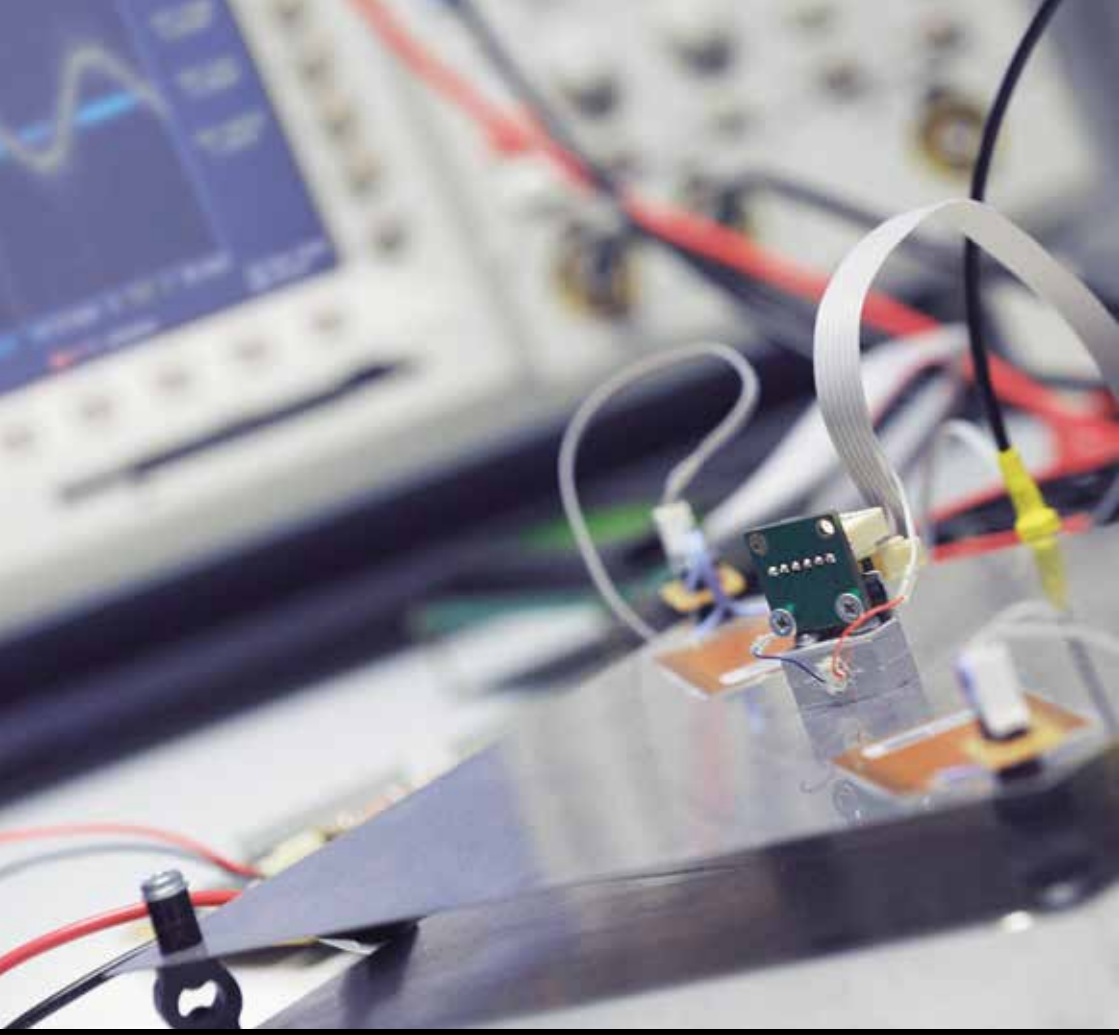
Design of Electronic Powertrain Management Systems | *Prof. Dr.-Ing. Günter Feyerl*

Well-funded knowledge of the technical background of the Software Structure of Power Train Control and the interaction of the different control Units within the powertrain bus system as well as Abilities in design of new or redesign of existing functionalities and the testing of control functions in the control units. Ability to work in interdisciplinary teams.

61936 5 Credits

General Management of Automotive Suppliers | *N.N.*

Engineering studies are often a springboard for general management careers in the automotive industry. The course willl introduce four selected entrepreneurial tasks from experience. The participants are challenged with turnaround situations. The lecture details due diligences topics during merger&acquisition processes. Key account management as a typical career step for engineers will be explained.
The study module is rounded off with a discussion of management versus leadership. In the practical training the learned is reinforced with examples out of current commercial life.



General Information

Organisational matters

Length of study period and commencement | The standard length of the study period for the Master of Science program in Mechatronics, including the Master project, is 4 semesters. New students are only admitted in the winter semester.

All students have to pay a contribution each semester to finance the activities of the student union and another fee to support the work of ASTA (General Student Body). Included are the costs of the Semester Travel Ticket, valid on all public transportation in the larger Aachen area. Fees are newly fixed each semester. See *www.studierendensekretariat.fh-aachen.de* for details of these contributions. In 2015 they amount to 241, 30 Euros per semester

Application deadline | Applications have to be transmitted via the online application portal https://movein-fh-aachen.moveonnet.eu/movein/portal/studyportal.php?_language=en The application deadline each year is April 30th.

Application documents | Admission regulations are given in detail on the web page of the Master Mechatronics programme. See *www.fh-aachen.de* and enter the following webcode: **11111148**

Module description and lecture schedules | are available online at *www.campus.fh-aachen.de*

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