Hochschule Nordhausen

Fachbereich Ingenieurwissenschaften

Modulhandbuch für den Studiengang

Mechatronics

Erstellungsdatum: 28.11.2024

Modulübersicht für den Studiengang Mechatronics

0. Fachsemester				
ID	**Modulname**	**Version**	**ECTS**	**Verwendbarkeit**
716	Informatics and Communication Technology	1	5.0	PFLICHT
870	Basics in Electrical Engineering	2	5.0	PFLICHT
871	Basics in Thermal Engineering	2	5.0	PFLICHT
873	Scientific Practice and Writing	1	5.0	PFLICHT
908	German as a Foreign Language I	2	5.0	PROFIL
912	Technical English I	1	5.0	PROFIL
1012	Basics of Mechanical Engineering	1	5.0	PFLICHT
1. Fachsemester				
ID	**Modulname**	**Version**	**ECTS**	**Verwendbarkeit**
568	Project Management	1	5.0	PFLICHT
755	Industry 4.0	1	5.0	PFLICHT
783	Signals and Control	1	5.0	PFLICHT
787	Embedded Smart Systems	1	5.0	WAHLPFLICHT
867	Numerical Methods in Heat and Mass Transfer	1	5.0	WAHLPFLICHT
910	German as a Foreign Language II	2	5.0	PROFIL
914	Technical English II	1	5.0	PROFIL
1010	Power-to-X	1	5.0	WAHLPFLICHT
1013	Mechatronic Systems	1	5.0	PFLICHT
2. Fachsemester				
ID	**Modulname**	**Version**	**ECTS**	**Verwendbarkeit**
780	Wireless Sensor Networks	1	5.0	PFLICHT
851	Wind Power Plants	1	5.0	WAHLPFLICHT
852	Photovoltaic Systems	1	5.0	WAHLPFLICHT
859	Solar Thermal Laboratory	1	5.0	WAHLPFLICHT
1014	Robotics / CNC Machines	1	5.0	PFLICHT
1015	Unmanned Vehicles	1	5.0	PFLICHT
1016	Unmanned Vehicles Lab	1	5.0	PFLICHT
1017	Electronics Circuits	1	5.0	PFLICHT
3. Fachsemester				
ID	**Modulname**	**Version**	**ECTS**	**Verwendbarkeit**
1030	Abschlussmodul Mechatronics	1	30.0	PFLICHT

Modul-No.	568	MA	
Modul name	**Project Management**		
Modul coordinator	Rutz, Michael		
Title	Project Management		
Title of examination	Project Management		
Course Type / SWS	3 SWS Lecture / 1 SWS Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:
1 Basics
• definition and characteristics of projects • short history of Project Management • Project Life Cycle
2 Initialisation
• project goals • Stakeholder Analysis • rough planning • Project Organisation
3 Planning
• Project Structuring • Time Management • Resource Planning
4 Execution
• role of Project Manager and Project Team • Team Development • Project Management • Communication • Risk Management • Quality Management
5 Project Closing
6 Agile Project Management
• advantages of agile methods • Scrum

Learning objectives: Students are able to plan projects and organise their implementation. They have learned the basics of project management for industrial applications. They have an overview of selected methods, tools (software) and information systems for planning and controlling industrial projects. The students are able to plan, organise and document a project with the help of a project example. They are able to present the project idea, the progress and the results.

Recommended Literature

Dionisio, Cynthia Snyder (2018): A project manager´s book of tools and techniques. a companion to the PMBOK Gui-de. Hoboken, New Jersey: Wiley.
Lester, Albert (2014): Project Management, planning and control. Managing Engineering, Construction and Manufac-turing Projects to PMI, APM and BSI Standards. 6. Aufl. Oxford: Butterworth-Heinemann.
Project Management Institute, Inc. (2021): A Guide to the Project Management Body of Knowledge (PMBOK Guide) and The Standard for Project Management. 7. Aufl.

Forms of teaching / Prerequisites for participation

This module is a classical lecture combined with exercises. There are no formal requirements for participation.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

no formal requirements

ECTS credit points and grading

Students need to pass the module examination, which encompasses all contents of the lecture. Type of examination: written examination with a duration of 120 min. Alternative types of examination are possible The grade corresponds to the grading of the written examination or the submitted project documentation. When com-pleting the unit successfully, students are granted 5 credit points (ECTS).

Frequency of offer / Duration of module

SOMMER	The module is lectured in one semester.

Work load

The total workload for this module is 150 hours; this corresponds to 5 ECTS credits. This workload results from the presence at the lectures with with integrated exercises (about 45 hours). As part of the self-study, the lecture material should be reworked (about 55 hours). The preparation and execution of the examination is about 50 hours.

Modul-No.	716	MA	
Modul name	**Informatics and Communication Technology**		
Modul coordinator	Hühn, Thomas		
Title	Informatics and Communication Technology		
Title of examination	Informatics and Communication Technology		
Course Type / SWS	2 SWS Lecture / 2 SWS Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:

a) Informatics

- Introduction: Information processing in technological systems, information processing systems, IPO-mode
- Basics of coding
- IP-Systems without memory circuits: Normal Form theorem
- IP-Systems with memory circuits and automata
- Flip-Flops, creation of a memory through feedback, basics of automation theory
- Computers as programmable systems with memory, Von-Neumann Architecture
- Solvability of problems: Computability of problems, Turing machine, complexity

b) Communication Technology

- Introduction into information theory
- Signals in time and frequency domain
- Analog-Digital-Conversion
- Baseband transmission and line coding
- Digital modulation and demodulation
- dB-calculation

Objectives:

The lecture submits basics knowledge about computers which enable engineers and computer scientist to en-hance their usage, developing and programming of computers. The students are able to understand the relation between bits in a computer and bits as information (quantity of information) and they will be aware that the in-terpretation (decoding) of bits is always context-sensitive. On completion, they are able to work and calculate with binary numbers (unsigned, complement of two, floating-point number). The attendants will master the de-scription of information through bits, octal numbers and hexadecimal. Furthermore, the students will be able to describe simple sequential information-processing problems as automata.

The students can display and explain communication relations as source-sink relation and apply the model of digital transmission on any communication scenario. They are familiar with the substance of information and the correlation of Information – Message (Data). The students know the basic terms of the information theory. They can classify continues and discrete information sources and know the meaning of important categories such as entropy (in information theory), redundance, redundancy reduction (entropy encoding) and can calcu-late the redundance and entropy for simple and discrete sources. They know about the relation of redundance and error correction. They can estimate the ability of code for error correction on basis of the Hamming distance.

The students know the analog-digital-conversion as source encoding of continuous sources. They master the sampling-theorem and the description of quantization errors with the help of the quantization noise.

The students can recognize the source coding/decoding as interface between information source or sink and digital channel, in the model of the digital transmission. They will be able to determine transfer functions through measurements. They know and master the essential digital modulation schemes and line coding schemes and can distinguish between bitrate, bandwidth and symbol rate (signal alternation speed). The acquisition of appli-cation-oriented knowledge is maintained especially through the conduction of laboratory experiments.

Recommended Literature

- Proakis, John u.a.: Grundlagen der Kommunikationstechnik. Pearson Studium 2004
- Widenfeller, Hermann: Grundlagen der Kommunikationstechnik. Teubner Stuttgart 2002.
- Mildenberger, O.: Informationstechnik kompakt; Theoretische Grundlagen. Viehweg Braunschweig 1999.

- Kreß, Dieter; Kaufhold, Benno: Signale und Systeme verstehen und vertiefen. Vieweg und Teubner Verlag Wiesbaden, 2010.

Forms of teaching / Prerequisites for participation

Lecture with integrated exercises
The students receive next to the lecture script a summary of exercises and instruction for the conduction of ex-periments in the laboratory. Those manuals contain a theory part that deepen the required knowledge for con-ducting the experiments. The following literature is recommended for the preparation or postprocessing of the course:

- Proakis, John u.a.: Grundlagen der Kommunikationstechnik. Pearson Studium 2004
- Widenfeller, Hermann: Grundlagen der Kommunikationstechnik. Teubner Stuttgart 2002.
- Mildenberger, O.: Informationstechnik kompakt; Theoretische Grundlagen. Viehweg Braunschweig 1999.
- Kreß, Dieter; Kaufhold, Benno: Signale und Systeme verstehen und vertiefen. Vieweg und Teubner Verlag Wiesbaden, 2010.

For the attendance are knowledge of higher mathematical functions required, especially differential and inte-gral calculation.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

Assessment is performed as written examination (120 minutes). Students need to pass the module examination, which encompasses all contents of the lecture.

ECTS credit points and grading

5 ECTS credits

Frequency of offer / Duration of module

SOMMER	1 semester

Work load

150 h of total work load, from:

- 45 h of presence at lectures/exercises
- 45 h of self-study
- 30 h of exercising tasks at home
- 30 h of preparation and attendance for examination

Modul-No.	755	MA	
Modul name	**Industry 4.0**		
Modul coordinator	Brodhun, Christoph		
Title	Industrie 4.0		
Title of examination	Industry 4.0		
Course Type / SWS	2 SWS Lecture with Lab / 2 SWS Lecture with Lab		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Course Description:
The lecture deepens the knowledge regarding the logistical activities within and between companies as well as end users. The following are dealt with in detail:

1. Basics and Trends
2. Definition, Goals, Integration
3. Potentials, Effects, Need for Design
4. Practical Examples

Objectives:
After successful participation in the lecture, the students have a production-specific overview of the subject of Industry 4.0 and Smart Factory. The students know the basic ICT technologies in manufacturing companies. They are familiar with cyber-physical systems (CPS) and radio frequency identification (RFID). They can also transform the benefits from big data analytics into smart data. Upon completion of the learning process, the successful student will be able to answer specific questions about security aspects in data networks including cloud approaches. As part of the Industry 4.0 course, students develop the essential basics of the topic and undertake a critical reflection against the background of data security, workplace development, etc. In addition, seminar presentations convey the essential technology drivers to the students. Building on this knowledge, the students can apply the knowledge they have acquired in form of a publication on the subject of Industry 4.0 in a company. It is important to develop the requirements in order to implement the guiding principles of Industry 4.0 at a medium-sized practice partner and to present this requirements paper to a selected group of employees. The students understand the potential and the degree of complexity of future-oriented production scenarios and they can identify with specific project topics.

Recommended Literature

- Vogel-Heuser, B.; Bauernhansl, T.; Ten Hompel, M.; (Hrsg) (2017): Handbuch Industrie 4.0 Bände 1-4
- Vogel-Heuser, B.; Bauernhansl, T.; Ten Hompel, M.; (Hrsg.) (2014): Industrie 4.0 in Produktion, Automatisierung und Logistik Anwendung Technologien · Migration, Springer, Wiesbaden
- Meinhardt, S.; Pflaum, A. (Hrsg.) (2019): Digitale Geschäftsmodelle Band 2: Geschäftsmodell-Innovationen, digitale Transformation, digitale Plattformen, Internet der Dinge und Industrie 4.0. Wiesbaden : Springer Vieweg, 2019
- Heyse, V. (2018): Mittelstand 4.0 - eine digitale Herausforderung : Führung und Kompetenzentwicklung im Spannungsfeld des digitalen Wandels. Münster : Waxmann, 2018
- https://www.bmbf.de/files/Umsetzungsempfehlungen_Industrie4_0.pdf

Forms of teaching / Prerequisites for participation

Lecture, tutorials, exercises and assignments. The topics are deepened through excursions and discussions. Films, case studies and short presentations complement the lectures.

Bachelor degree & interest to investigate further.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

35 % written exam 65 % assignments

ECTS credit points and grading	
Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS	
Frequency of offer / Duration of module	
SOMMER	1 semester
Work load	
150 h of total work load, from: 30h lecture participation (online or in presence) 30h seminar participation (online or in presence) 30h homework & self-study 60h presentation & team work	

Modul-No.	780	MA	
Modul name	**Wireless Sensor Networks**		
Modul coordinator	Schölzel, Mario		
Title	Wireless Sensor Networks		
Title of examination	Wireless Sensor Networks		
Course Type / SWS	4 SWS Lecture		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:

WSNs and their applications and limitations

Hardware and Operating System part:

- Basics of transmission technology and ISM regulations
- Hardware architectures for WSN motes
- Low power techniques in motes
- Operating systems for WSNs

Simulation of WSNs

Protocols for WSNs

- PHY-Layer
- MAC- and WSN MAC state monitoring at the PHY-layer
- routing protocols for WSNs: bable, olsr v1/v2 & batman

Addressing in WSNs

- publish/subscribe

Network topologies and network stacks

- ZigBee
- Linux network stack implementation
- monitore/collect/merge measurement races with open source tools

Objectives:

After successfully passing the lecture, the students know:

- Typicaly applications of wireless sensor networks
- They know the properties of various protocols
- They are able to choose an appropriate hardware base for setting up a wireless sensor network
- They are able to develop low-power applications for wireless sensor networks
- They are able to implement WSN applications for collecting data and transmitting data to a data sink

Recommended Literature

Protocols and Architectures for Wireless Sensor Networks Holger Karl; Andreas Willig, Wiley, ISBN 0-470-09510-5
Distributed Sensor Networks S. Sitharama Iyengar and Richard. R. Brooks, Chapman & Hall/CRC, ISBN 1-58488-383-9
Wireless Sensor Networks, Architectures and Protocols Edgar H. Callaway, Jr, Auerbach Publications ISBN 0-8493-1823-8
Sensor Technology Handbook John S. Wilson, Newnes ISBN 0-7506-7729-5
Ad Hoc Wireless Networks Mohamed Ilyas, CRC Press, ISBN 0-8493-1332-5
Markus Krauße, Rainer Konrad: Drahtlose ZigBee-Netzwerke – ein Kompendium, Springer Vieweg, 2014.
Fred Eady: Hands-On ZigBee – 1st edition, Elsevier, 2007.

Forms of teaching / Prerequisites for participation

Lecture with integrated exercises and labs on selected topics

No course specific requirements.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

Assessment is performed either as written examination (90 minutes) or oral examination. Students need to pass the module examination, which encompasses all contents of the lecture.

ECTS credit points and grading

5 ECTS credits

Frequency of offer / Duration of module

SOMMER	1 semester

Work load

150 h of total work load, from:

- 45 h of presence at lectures/exercises
- 55 h of self-study
- 50 h of preparation for examination

Modul-No.	783	MA	
Modul name	**Signals and Control**		
Modul coordinator	Viehmann, Matthias		
Title	Signals and Control		
Title of examination	Signals and Control		
Course Type / SWS	4 SWS Lecture		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:
The objective of this course is to understand the signal types and the fundamentals of sensors, the signal conditioning and the signal processing. Furthermore digital controller will be investigated in simulation and application.

Objectives:
- Signal types, Sensor examples
- Signal conditioning (amplifiers, filter circuits)
- Analog digital converter, digital analog converter
- Digital signal processing
- Digital filter
- Fast Fourier Transformation (FFT)
- Digital controller
- Simulation of control loops

Recommended Literature

Franco, S.: Design with Operational Amplifiers and Analog Integrated Circuits. New York: The McGraw-Hill Companies, 4. Edition, 2015
Viehmann, M.: Operationsverstärker – Grundlagen, Schaltungen, Anwendungen. 2., überarbeitete und erweiterte Auflage. München: Hanser, 2020
Engelberg, S.: Digital Signal Processing. Language: English. ISBN: 1848001185. Springer-Verlag GmbH

Forms of teaching / Prerequisites for participation

Lecture including exercises

No course specific requirements.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

Assessment is performed either as written examination (90 minutes) or oral examination. Students need to pass the module examination, which encompasses all contents of the lecture.

ECTS credit points and grading

5 ECTS credits

Frequency of offer / Duration of module

SOMMER	1 semester

Work load

150 h of total work load, from:
- 45 h of presence at lectures/exercises
- 55 h of self-study

- 50 h of preparation for examination

Modul-No.	787	MA	
Modul name	**Embedded Smart Systems**		
Modul coordinator	Schölzel, Mario		
Title	Embedded Smart Systems		
Title of examination	Embedded Smart Systems		
Course Type / SWS	4 SWS Lecture/Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:
The module gives an introduction into the design and development of embedded systems that can be tailored to user specific applications. To fulfil this objective, the lectures present an overview of hardware architectures and components and their interconnection. The lectures also teach techniques for modeling HW-/SW-systems and assessing performance and power metrics of such systems:

- HW-Components for embedded systems, their architecture, and their interconnection: General Purpose Processor, Microcontroller, DSP, ASIP, FPGA, ASIC, busses, Memory-Mapped-I/O
- Design approaches and methods: Y-Chart, Top-Down, Bottom-Up, Middle-Out, Hardware-/Software-Codesign
- Power, Performance, and area profiling/estimations
- Methods and tools for synthesis: System synthesis, high-level-synthesis of HW-accelerators, FPGA design synthesis, Software-Synthesis
- Models: communicating processes, KPN, data flow graphs, SDF, Petri nets, state-based models, control flow graphs
- Tools for modeling: Ptolemy, SystemC, SystemC-TLM, FPGA-Design tool

In accompanying exercises and labs on selected topics, students will practice the use of some of the synthesis and modeling tools. They also have to explain their solutions.

Objectives:
After successful completion of the course unit, the students will:
- Know typical components and their interactions for building embedded systems (T2, T3, T6)
- Know and be able to apply models for specifying embedded systems at various levels of abstraction (P4, T1, T5, T8)
- Be able to analyze, estimate and determine power, area and performance parameters of such systems during the design phase (P1, T2, T5)
- Model and develop systems with new hardware accelerators of low and medium complexity in the area of embedded systems (P2, T1, T5)
- Know typical tools for the design and development process (T8)
- Be able to present and discuss their solutions (P3)

Recommended Literature

De Micheli, G.: Synthesis and Optimization of Digital Circuits. – New York: McGraw-Hill, 1994
P. Marwedel: Embedded System Design, Springer, 2004.

Forms of teaching / Prerequisites for participation

Lecture with integrated exercises and selected labs.

No course specific requirements.

Usability of module

This module is elective for: Mechatronics

Requirements for receiving ECTS credit points

Assessment is performed as a written examination (90 minutes)

ECTS credit points and grading	
The course grade is the grade of the examination.	
Frequency of offer / Duration of module	
SOMMER	1 semester
Work load	
150 h of total work load, from: • 45 h of presence at lectures/exercises • 55 h of self-study • 50 h of preparation for examination	

Modul-No.	851	MA	
Modul name	**Wind Power Plants**		
Modul coordinator	Link, Thomas		
Title	Wind Power Plants		
Title of examination	Wind Power Plants		
Course Type / SWS	4 SWS Lecture / 1 SWS Lab		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:

- Classification of Wind Turbines
- Aerodynamics of Wind Turbines
- Betz's Theory and Schmitz's Design rules
- Aerodynamic of the Darrieus Turbine
- Control of Wind Turbines
- Wind Turbine Design
- Wind Characteristics and Resources
- Hands-on-Training with an Aero-Elastic-Code

Learning goals:

The participants know the fundamental physical procedures that are vital for the usage of wind energy. They can use lift diagrams and calculate lift and resistance for given diagrams. The students are able to evaluate the optimal shapes for predefined profiles using Betz's law and determine efficiency and the power coefficient of wind turbines under idealized conditions. They are familiar with the different regulation concepts used in wind energy systems and are able to show the constructive peculiarities of the installations. The students know the advantages and disadvantages of applied construction variants of wind turbines. They are able to work with probability density functions and capable of calculating wind velocity for given roughness lengths to then estimate the power output of wind turbines using power curves.
Due to their internship, the participants are able to utilize the basic functions of the software Bladed. They can design a wind turbine with predefined features and select different design options using Bladed.

Recommended Literature

1. R. Gasch, J. Twele, Wind Power Plants, Springer, 2012
2. J.-P. Molly, Windenergie: Theorie, Anwendung, Messung, Verlag C. F. Müller, 1990
3. E. Hau, Wind Turbines, Springer, 2006
4. J. F. Manwell, et. al., Wind Energy Explained: Theory, Design and Application, Wiley, 2009

Forms of teaching / Prerequisites for participation

Lecture with included exercises. Practical training in small groups with the wind farm planning tool Wind Pro (only RES). Experimental work in small groups in the wind tunnel lab.

Master students: Requirement for earning credit points is a test performance rated at least „sufficient“ in the module exam (written exam, 90 min) and a completed practical training as well the completed wind tunnel lab.

Bachelor students: Requirement for earning credit points is a test performance rated at least „sufficient“ in the module exam (written exam, 90 min). In the exam 4 questions out of 5 can be chosen. Additional the wind tun-nel lab has to be completed.

Usability of module

This module is elective for: Mechatronics

Requirements for receiving ECTS credit points

Requirement for earning credit points is a test performance rated at least „sufficient“ in the module exam (written exam, 90 min) and a completed internship as a prerequisite.	
ECTS credit points and grading	
The grade corresponds to the grading of the exam. When completing the unit successfully, students are granted 5 credit points (ECTS).	
Frequency of offer / Duration of module	
WINTER	The module is lectured in one semester
Work load	
Master students: The workload consists of visiting lectures (33,75 h) preparation and debriefing of the subject matters (45,25 h), participation and preparation of the practical training (16 h), participation and preparation of the wind tunnel laboratory (20 h). Preparation of the written exam (35 h). Bachelor students: The workload consists of visiting lectures (33,75 h) preparation and debriefing of the subject matters (53,25 h), participation and preparation of the wind tunnel laboratory (20 h). Preparation of the written exam (43 h). The total workload amounts to 150 h which corresponds to 5 ECTS.	

Modul-No.	852	MA	
Modul name	**Photovoltaic Systems**		
Modul coordinator	Gerstenberg, Lukas		
Title	Photovoltaic Systems		
Title of examination	Photovoltaic Systems		
Course Type / SWS	4 SWS Lecture		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:
The students should achieve consolidated knowledge about installation, dimensioning and application of photovoltaic systems. In addition, the students get a profound introduction to the physics of solar cells.

1. Introduction:
   History of photovoltaics - current trends and actors
2. Basics:
   Introduction to semiconductor theory - generation and recombination processes - the solar cell as a p-n junction - modelling a real solar cell - thermodynamics of solar energy conversion
3. Technology:
   Production process for silicon solar cells - production process for thin-film solar cells – measuring in photovoltaics
4. System technology:
   From the single solar cell to a solar generator – control of solar generators - operation of grid-connected photovoltaic systems - operation of off-grid photovoltaic systems
5. System design
   Irradiation analysis - shading effects - mounting and interconnection - converters – grid connection – energy yield forecast - operation and maintenance of photovoltaic systems - economics

Learning goals:
After successfully completing the module, the students have a deeper knowledge about solar cells as a semiconductor. They confidently deal with cell and module characteristics and use them, for example, to understand phenomena in interconnecting single modules to generators. Furthermore, the students are able to plan a photovoltaic system using standard design software and estimate the energy yield.

Recommended Literature

[1] Mertens: Photovoltaics: Fundamentals, Technology and Practice. John Wiley & Sons Inc, 2018. (introducing)
[2] Deutsche Gesellschaft für Sonnenenergie (DGS): Planning and Installing Photovoltaic Systems. A Guide for In stallers, Architects and Engineers, 3rd Edition. (introducing)
[3] Wesselak/Voswinckel: Photovoltaik, Springer 2016 (introducing – only in german)
[4] Luque/Hegedus: Handbook of Photovoltaic Science and Engineering, Wiley, Chichester, 2011 (deepening)
[5] Würfel: Physics of Solar Cells, Wiley, Chichester, 2009 (deepening)

Forms of teaching / Prerequisites for participation

The course takes the form of a lecture with integrated exercises and with the active involvement of the students. Exercises and case studies on the central topics of the lecture are presented, discussed and solved together. In addition, one practical laboratory experiment will be carried out in small groups of three students. Each group works out a report for the experiment. The report is graded zero to five points.

Usability of module

This module is elective for: Mechatronics

Requirements for receiving ECTS credit points

B.Eng.: The assessment is performed as written examination Students need to pass the module examination (60 min.), which encompasses the practical contents of the lecture (section 1, 4, and 5). The prerequisite for the award of credit points is successful participation in the practical laboratory experiment (preliminary examination) with a grading of one to five points for

the report and successful passing of the examination.
M.Eng.: The assessment is performed as written examination Students need to pass the module examination (90 min.), which encompasses all contents of the lecture (section 1-5). The prerequisite for the award of credit points is successful participation in the practical laboratory experiment (preliminary examination) with a grading of one to five points for the report and successful passing of the examination.

ECTS credit points and grading	
5 ECTS credits	
Frequency of offer / Duration of module	
SOMMER	The module is lectured in one semester
Work load	
The workload for this module is 150 h; this corresponds to 5 ECTS credits. This workload results from the attendance of lectures with active participation of the students (45 h) as well as the preparation and follow-up of the two laboratory experiments (15 h). Within the framework of self-study, the material covered in the lecture is to be reworked and discrete computer exercises should be carried out (about 75 hours). The preparation and execution of the examination is about 30 hours.	

Modul-No.	859	MA	
Modul name	**Solar Thermal Laboratory**		
Modul coordinator	Leibbrandt, Pascal		
Title	Solar Thermal Laboratory		
Title of examination	Solar Thermal Laboratory		
Course Type / SWS	4 SWS Lecture with Lab		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:

- Solar collectors, components and systems
  - Collector types, characteristics
  - Collector loop, operating mode
  - Heat storage, heat exchanger, controls
- System design, economics
  - System types, characteristics
- Laboratory experiments
  - Collector front glazing – STL 1
  - Collector test (QDT) – STL 2
- Current research

Learning goals:

The students have knowledge about the various solar thermal collector types, design and function. They can dimension various solar loop types and design them using typical key figures. The economic viability of the investments and the basics of investment calculation is known to the students. By using typical and standardizes test methods (test rig design, data acquisition and evaluation) the students are able to test solar collectors and solar loop components in laboratory.

Recommended Literature

[1] Duffie; Beckman: Solar Engineering of Thermal Processes. 4th Edition. Wiley & Sons, Hoboken (2013)
[2] Schabbach; Leibbrandt: Solarthermie – Wie Sonne zu Wärme wird. Springer, Berlin (2017)
[3] Nellis; Klein: Heat Transfer. 1st Edition. Cambridge University Press, Cambridge (2008)
[4] Wesselak, Schabbach; Link; Fischer: Regenerative Energietechnik. Springer Vieweg, Berlin (2017)

Forms of teaching / Prerequisites for participation

Solar Thermal Laboratory

There are no formal requirements for participation. Basics in physics, mathematics and mechanics are recommend-ed. Basic knowledge in renewable energies and heat transfer is useful.

Usability of module

This module is elective for: Mechatronics

Requirements for receiving ECTS credit points

Assessment is performed as written examination (120 minutes).

ECTS credit points and grading

5 ECTS credits

Frequency of offer / Duration of module

WINTER	The module is lectured in one semester

Work load

The total workload for this module is 150 hours; this corresponds to 5 ECTS credits. This workload results from the presence at the lectures with an active participation of the students in the laboratory (about 45 hours). As part of the self-study, the lecture material should be reworked (about 55 hours). The preparation and execution of the examination is about. 50 hours.

Modul-No.	867	MA	
Modul name	**Numerical Methods in Heat and Mass Transfer**		
Modul coordinator	Leibbrandt, Pascal		
Title	Numerical Methods in Heat and Mass Transfer		
Title of examination	Numerical Methods in Heat and Mass Transfer		
Course Type / SWS	2 SWS Lecture / 2 SWS Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:

1. Introduction, applications
2. Basics on heat transfer
3. CFD-workflow, basic software components (CAD-modeller, mesher, physics, plots and reports)
4. Basics on CFD, mesh generation and diagnostics, physics models
5. Optimization of heat transfer problems, automation

Learning goals:

The students have knowledge about the phenomena of heat transfer and the simulation of heat transfer processes. They are able to use a commercial CFD software and interpret the simulation results. They understand the problems of residual and discretization convergence. The students can solve engineering problems like investigation and optimization of heat transfer problems.

Recommended Literature

- Baehr; Stephan: Wärme- und Stoffübertragung. 7. Auflage. Springer, Heidelberg, Dordrecht, London, New York (2010)
- Duffie; Beckman: Solar Engineering of Thermal Processes. 4th Edition. Wiley & Sons, Hoboken (2013)
- Kreith; Bohn: Principles of Heat Transfer. 6th Edition. Brooks/Cole, Pacific Grove (2001)
- Polifke; Kopitz: Wärmeübertragung. 2. Auflage. Pearson Studium, München (2009)
- Ferziger; Peric: Numerische Strömungsmechanik. 1. Auflage. Springer, Berlin, Heidelberg (2008)
- Hirsch: Numerical Computation of Internal & External Flows. 2nd Edition. Butterworth-Heinemann, Burlington (2007)

Forms of teaching / Prerequisites for participation

The module consists of a lecture with integrated exercises.

There are no formal requirements for participation. Basics in physics, mathematics and mechanics are recomended. Basic knowledge in renewable energies and heat transfer is useful.

Usability of module

This module is elective for: Mechatronics

Requirements for receiving ECTS credit points

Assessment is performed as written examination (120 minutes).

ECTS credit points and grading

The grade corresponds to the grading of the exam. When completing the unit successfully, students are granted 5 credit points (ECTS).

Frequency of offer / Duration of module

SOMMER	The module is lectured in one semester.

Work load

The total workload for this module is 150 hours; this corresponds to 5 ECTS credits. This workload results from the presence at the lectures with with integrated exercises (about 45 hours). As part of the self-study, the lecture material should be reworked (about 55 hours). The preparation and execution of the examination is about 50 hours.

Modul-No.	870	MA	
Modul name	**Basics in Electrical Engineering**		
Modul coordinator	Wang, Jiayi		
Title	Basics in Electrical Engineering		
Title of examination	Basics in Electrical Engineering		
Course Type / SWS	2 SWS Lecture / 2 SWS Exercise / 0.5 SWS Lab		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content

Part 1: DC Systems

- Resistances and Temperatures
- Serial and parallel connections Feld
- Voltage & Current Divider
- Kirchhoff's Laws
- Mesh Flow Analyses

Part 2: Single Phase Systems

- Complex Numbers
- Complex Operators
- Simple circuits driven by sinusoidal voltage
- Real, Reactive and Apparent Power
- Power Factor and compensation

Part 3: Three Phase Systems

- Introduction multiphase systems
- Star and Delta connection
- Basics Generators
- Basics Transformers

Learning goals:

The students will get a basic introduction of Electrical Engineering. Part I contains the knowledge to analyze easy circuits, feed by direct voltage. Resistances as a function of the temperature and serial and parallel connections will be treated. Finally Kirchhoff's Laws will be introduced. All contents of part I also can be applied for Part II & III. Complex numbers will be used to deal with sinusoidal functions as a basic procedure.

Part II will be focused to the basic calculation of simple circuits, driven by DC voltage. The meaning of the Power Factor and the apparent power will be clarified.

Part III will be more practical orientated. The students will deal with the multiphase systems and the possibility to connect the systems into Star- or Delta-Connection. Generators and Transformers will be introduced with their practical applications. Complicate calculations etc. will be avoided.

Recommended Literature

Literatur:

- Lecture Scripts will be uploaded
- Sample task will be uploaded

Forms of teaching / Prerequisites for participation

Teaching forms as stated above

There are no formal requirements for participation. Basics in physics, mathematics and mechanics are recommended. Basic

knowledge in thermodynamics, heat transfer and renewable energies is useful. Lecture Scripts will be uploaded and sample task will be uploaded
Usability of module
This module is mandatory for: Mechatronics
Requirements for receiving ECTS credit points
Assessment is performed as written examination (90 minutes). Other permissible forms of examination (online, oral, homework, etc.) are possible if they are announced by the person responsible for the module at the beginning of the semester.
ECTS credit points and grading
The grade of the module M870 corresponds to the grade of the exam. With the grading, 5 credit points (ECTS) are awarded.
Frequency of offer / Duration of module

WINTER	1 Semester

Work load
The total workload for this module is 150 hours; this corresponds to 5 ECTS credits. This workload results from the presence at the lectures with an active participation of the students in the (virtual) laboratory (about 45 hours). As part of the self-study, the lecture material should be reworked (about 55 hours). The preparation and execution of the examination is about 50 hours.

Modul-No.	871	MA	
Modul name	**Basics in Thermal Engineering**		
Modul coordinator	Rathje, Rio		
Title	Basics in Thermal Engineering		
Title of examination	Basics in Thermal Engineering		
Course Type / SWS	4 SWS Lecture / 0.5 SWS Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Contents:

Thermodynamics

1. Thermodynamics
2. Systems, States, and Processes
3. First Law of Thermodynamics (Conservation of Energy)
4. The Second Law of Thermodynamics (Entropy and the Trend Toward Equilibrium)
5. Energy conversion and the second law
6. Properties and property relations of fluids (pure substances, multiphase, mixtures, psychrometrics)
7. Thermodynamic processes in closed and open systems and cycles
8. Thermodynamic Machines and Components: Efficiencies and Irreversible Losses

Heat Transfer

1. Conduction (steady state, transient)
2. Convection (external and internal flow and free convection)
3. Boiling and Condensation
4. Radiation

Learning Goals:

The students have reviewed the principles of thermodynamics and heat transfer and their calculation. Even if these basics were not part of the first bachelor's course, they have acquired the necessary knowledge in these areas to be able to take more advanced courses in this area at master's level in the following semesters.
In the virtual lab, students learned how to use thermodynamic and computational fluid dynamics software to calculate complex processes such as cyclic processes and multiphase flows.

Recommended Literature

- Wesselak; Schabbach; Link; Fischer: Handbuch Regenerative Energietechnik. Berlin: Springer Vieweg, 2017
- H. Struchtrup, Thermodynamics and Energy Conversion. Berlin, Heidelberg: Springer Berlin Heidelberg, 2014.
- S. Bhattacharjee, Thermodynamics. New York: Pearson, 2016.
- Nellis; Klein: Heat Transfer. 1st Edition. Cambridge University Press, Cambridge (2008)
- VDI, VDI Heat Atlas. Berlin London: Springer, 2010.

Forms of teaching / Prerequisites for participation

The Basics in Thermal Engineering are mainly taught in a classical lecture. The lecture is supplemented by exercises in which application examples are discussed and a practical laboratory course.

There are no formal prerequisites for participation. Basic knowledge in physics, mathematics and mechanics is recommended. Basic knowledge in thermodynamics, fluid dynamics and heat transfer is helpful.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

The assessment will take the form of a written, presence-based exam (90 minutes). Other permissible forms of examination (online, oral, homework, etc.) are possible if they are announced by the responsible person of the module at the beginning of the semester.
ECTS credit points and grading
The grade of the module M871 corresponds to the grade of the exam. With the grading, 5 credit points (ECTS) are awarded.
Frequency of offer / Duration of module

WINTER	The module is lectured in one semester.

Work load
The total workload for this module is 150 hours, corresponding to 5 ECTS. This workload results from the attendance of lectures including an active participation of the students in the (virtual) laboratory (approx. 45 hours) and supervised exercises in a tutorial (approx. 11 hours). Self-study should include a review of the lecture material (approximately 50 hours). Preparing for and taking the exam requires approximately 44 hours.

Modul-No.	873	MA	
Modul name	**Scientific Practice and Writing**		
Modul coordinator	Wesselak, Viktor Aberle, Alexandra		
Title	A: Scientific Practice B: Scientific Writing		
Title of examination	Scientific Practice and Writing		
Course Type / SWS	4 SWS Lecture		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

A: Scientific Practice

Contents:

Students are taught the acquisition, evaluation and preparation of technical information as a central working technique in the engineering sciences, both in preparation for their master thesis and for their professional life.

1. What does scientific research mean?
2. Literature research
   Libraries and databases for the engineering sciences - Search techniques - Online search in free and fee-based databases - Content indexing of a library using the example of the University of Applied Sciences Nordhausen - Dealing with thessaurs
3. Technical standards
   Objectives and procedures of technical standardization - National and international standards boards - Researching and reading technical standards
4. Patents and industrial property rights
   Objectives and procedures in industrial property protection – patents, utility models, trademarks and designs - national and international patent organizations – German employee invention law - searching and reading patents - patentability of software
5. Writing of academic texts and lectures
   Presentation and structure - Literature references - Lecture structure - Presentation techniques - Examples of bad practice

Learning goals:

After successful completion of the module, students are able to research scientific or technical information, to procure it and to classify the research results with regard to their completeness and credibility. Furthermore, they are aware of the importance and practice of correct citation.

B: Scientific Writing

Contents:

1. Analysing academic languages: style and register, language structures
2. Elements of writing professional and/or academic texts: writing a paragraph; referencing, citing, quoting
3. Writing different text types: e.g. writing a tender, a quote, report and/or article

Learning goals:

Students have essential theoretical knowledge of writing different types of texts, e.g. typical professional documents. They have knowledge of the linguistic characteristics of the written language English as a scientific language, but also for use in a professional context. Students can gather information from specialised texts and internet sources and produce their own texts on topics relevant to their studies in English. They can deal with primary and secondary sources as well as the usual reference methods and citation styles.

Recommended Literature

1. Griffiths, P. (2007), Scientific Writing, Reading.
2. Macgilchrist, F. (2014), Academic Writing, Paderborn.
3. McCarthy, M. / O'Dell, F. (2011) English Vocabulary in use, Cambridge.
4. McCarthy, M. / O'Dell, F. (2016), Academic Vocabulary in Use, Cambridge, Stuttgart.
5. Oshima, A. / Hogue, A. / Curtis, J. (2020), Longman Academic Writing Series, White Plains, NY.

Forms of teaching / Prerequisites for participation

The module is a lecture with practical exercises and with active participationt of the students. The students apply their knowledge in writing short acedemic texts on a given technical topic.

No course specific requirements

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

Prerequisite for the award of credit points is regular course participation and:
A: the successful completion of the academic paper and its timely submission or presentation,
B: written and/or oral examination.

ECTS credit points and grading

The module grade corresponds to the arithmetic mean of the successfully completed examinations in the two parts A and B. With an examination grade of at least 4.0, 2.5 credit points (ECTS) are awarded in each part, with the module grade thus totalling 5 credit points.

Frequency of offer / Duration of module

WINTER	The module must be completed within one semester.

Work load

Participation in both courses (50 h); preparation and follow-up (to the lectures/seminars) (25 h); writing an academic paper in part A (50 h), preparation for examination in part B = 25 h. The entire workload encompasses 150 hours, which corresponds to 5 ECTS credit points.

Modul-No.	908	MA	
Modul name	**German as a Foreign Language I**		
Modul coordinator	Aberle, Alexandra		
Title	German as a Foreign Language I		
Title of examination	German as a Foreign Language I		
Course Type / SWS	4 SWS Seminar		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

The module consists of 4 SWS and takes the promotion of individual language skills in the context of obtaining a UNIcert certificate into account.

A1.1
Vocabulary: introduction; communication in a very simple manner in relation to everyday needs, place of living, family and friends, hobbies and preferences
Grammar: simple word order; different sentence types (statement, question and command); adjectives; singular and plural nouns; present tense of special verbs; definite and indefinite articles; personal pronouns

A2.1
Vocabulary: communication about one's past and education; showing emotions; expressing advantages and disadvantages
Grammar: sub-clauses (weil, dass, wenn), adjectives (comparative and superlative), preterite forms of modal verbs, reflexive verbs, genitive with names, possessive articles in dative

B1.1
Vocabulary: expressing reasons for preferences and dislikes; arrange/book a holiday; understand announcements; write a comment; express past experiences, describe changes in life; apply for a job/internship; environmental protection
Grammar: Use of Infinitiv mit zu and the verb lassen; subordinate clauses with weil, da and obwohl; prepositions: genitive (trotz and wegen), prepositions used with time (dative and genitive); subordinate clauses with damit and um zu; conjunctive II with modal verbs, sein and haben

Recommended Literature

Bahn, Steve et al.: Kurs DaF A2, Deutsch für Studium und Beruf. Stuttgart: Klett 2024.
Dengler, Stefanie; Paul Rusch, Helen Schmitz and Tanja Sieber: Netzwerk neu A1B1. Klett, 2019.
Dengler, Stefanie; Paul Rusch, Helen Schmitz and Tanja Sieber: Netzwerk neu B1. Klett, 2021.
Jin, Friederike and Ute Voss: Grammatik aktiv: A1 –B1. Üben, Hören, Sprechen. Berlin: Cornelsen, 2023.

Forms of teaching / Prerequisites for participation

Interactive Language Course

Usability of module

This module is a profile module for: Mechatronics

Requirements for receiving ECTS credit points

Active seminar participation obligatory

ECTS credit points and grading

ECTS: 5 credit points according to the ECTS (European Credit Transfer and Accumulation System).
Types of examination: written examination (60 min.) and oral examination.
The final grade is the arithmetic mean of the examinations.

Frequency of offer / Duration of module

WINTER	1 Semester

Work load
Participation in the course = 50 h Preparation and follow-up (of the lecture) = 55 h Preparation for examination = 45 h The entire work load encompasses 150 hours, which equals 5 ECTS credit points.

Modul-No.	910	MA	
Modul name	**German as a Foreign Language II**		
Modul coordinator	Aberle, Alexandra		
Title	Deutsch als Fremdsprache II		
Title of examination	German as a Foreign Language II		
Course Type / SWS	4 SWS Seminar		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

The module consists of 4 SWS and takes the promotion of individual language skills in the context of obtaining a UNIcert certificate into account.

A1.2
Vocabulary: simple and direct communication skills in routine situations; participants understand commonly used expressions related to them directly (personal information, education, shopping and geography)
Grammar: details of time, manner and place; perfect tense of haben and sein; auxiliary and modal verbs; separable and inseparable verbs; nominative and dative nouns and prepositions; imperative forms

A2.2
Vocabulary: enquire: ask for information and direction; express one´s opinion; give recommendations; express apologies, complaints and consequences; ask for a favour; describe a picture in detail
Grammar: indirect questions; conjunctive II (sollte) to give a recommendation; adverbs: deshalb, trotzdem; changing prepositions (dative and accusative); verbs used with dative and accusative; subordinate clauses with als and wenn; verbs with fixed prepositions; indefinite pronouns

B1.2
Vocabulary: understand and describe relationships; discuss/solve conflict situations; offer, accept and/or reject help; participate in a discussion; selective reading (finding key words in articles); descriptions of people and processes
Grammar: Plusquamperfekt; subclauses used with time (bevor, bis, nachdem, seit, während); sentence structure (use of nicht); the passive voice (Präsens, Präteritum, Perfekt and modal verbs); adjectives used as nouns, articles used as pronouns (irgendein/-eine/-welche); sentences with je..., desto/umso...; use of participle I and II as adjectives

Recommended Literature

Bahn, Steve et al.: Kurs DaF A2, Deutsch für Studium und Beruf. Stuttgart: Klett 2024.
Dengler, Stefanie; Paul Rusch, Helen Schmitz and Tanja Sieber: Netzwerk neu A1B1. Klett, 2019.
Dengler, Stefanie; Paul Rusch, Helen Schmitz and Tanja Sieber: Netzwerk neu B1. Klett, 2021.
Jin, Friederike and Ute Voss: Grammatik aktiv: A1 –B1. Üben, Hören, Sprechen. Berlin: Cornelsen, 2023.

Forms of teaching / Prerequisites for participation

Interactive Language Course

Usability of module

This module is a profile module for: Mechatronics

Requirements for receiving ECTS credit points

Active seminar participation obligatory

ECTS credit points and grading

ECTS: 5 credit points according to the ECTS (European Credit Transfer and Accumulation System).
Types of examination: written examination (60 min.) and oral examination.
The final grade is the arithmetic mean of the examinations.

Frequency of offer / Duration of module

SOMMER	1 Semester
Work load	
Participation in the course = 50 h Preparation and follow-up (of the lecture) = 55 h Preparation for examination = 45 h The entire work load encompasses 150 hours, which equals 5 ECTS credit points.	

Modul-No.	912	MA	
Modul name	**Technical English I**		
Modul coordinator	Aberle, Alexandra		
Title	Technical English I		
Title of examination	Technical English I		
Course Type / SWS	4 SWS Seminar		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives
Topics in Technical English I include materials engineering and properties, tools and equipment, general chemistry as well as mechanics. Language skills encompass selected chapters of grammar for language correctness, reading comprehension and writing skills (reports and instructions). With the acquired skills, students can follow presentations and understand written texts on scientific issues as well as describe technical processes. In doing so, they use appropriate terminology from the fields of engineering as well as adequate grammatical structures. They understand manuals and can give instructions in written form.
Recommended Literature
Bonamy, David: Technical English, Pearson 2022. Ibbotson, Mark: Cambridge English for Engineering, Cambridge 2008. Murphy, Raymond: English Grammar in Use, Cambridge, current edition.
Forms of teaching / Prerequisites for participation
Participation in placement test as a pre-requisite. Active seminar participation required.
Usability of module
This module is a profile module for: Mechatronics
Requirements for receiving ECTS credit points
Students need to pass the module examination, which encompasses all contents of the language course. Types of examination: written examination (60 min.) and oral examination (15 min.). Alternative types of examination are possible.
ECTS credit points and grading
Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS (European Credit Transfer and Accumulation System). The final grade results from the arithmetic mean of the partial performances.
Frequency of offer / Duration of module

WINTER	The module is performed and must be completed within one semester.

Work load
Participation in the course = 50 h Preparation and follow-up (of the lecture) = 55 h Preparation for examination = 45 h The entire work load encompasses 150 hours, which equals 5 ECTS credit points.

Modul-No.	914	MA	
Modul name	**Technical English II**		
Modul coordinator	Aberle, Alexandra		
Title	Technical English II		
Title of examination	Technical English II		
Course Type / SWS	4 SWS Seminar		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives
Topics include Materials Sciences and Chemistry, Environmental Sciences and Ecology, Process Engineering (bio/chem/mech), lab reports and analyses. Language skills encompass reading comprehension, giving instructions, giving presentations, explaining processes, referring to plans and structural design and various aspects of the English grammar (e.g. passive voice, conditionals, modal verbs, adverbs and adjectives). Endowed with these skills, students describe scientific issues and technical processes. They use appropriate terminology from the fields of academia and engineering as well as grammatical structures. They can give instructions in oral and written form and hold scientific presentations.
Recommended Literature
Bonamy, David: Technical English, Pearson 2022. Ibbotson, Mark: Cambridge English for Engineering, Cambridge 2008. Murphy, Raymond: English Grammar in Use, Cambridge, current edtion.
Forms of teaching / Prerequisites for participation
Prerequisite: participation in placement test. This module only applies to students with mother tongue German. Active seminar participation required.
Usability of module
This module is a profile module for: Mechatronics
Requirements for receiving ECTS credit points
Students need to pass the module examination, which encompasses all contents of the lecture. Type of examination: written examination (60 min.) and oral examination with a duration (30 min). Alternative types of examination are possible.
ECTS credit points and grading
Modules are assessed by a module examination, which is credited by 5 credit points according to the ECTS (European Credit Transfer and Accumulation System).
Frequency of offer / Duration of module

SOMMER	The module is performed and must be completed within one semester.

Work load
Participation in the course = 50 h Preparation and follow-up (of the lecture) = 55 h Preparation for examination = 45 h The entire work load encompasses 150 hours, which equals 5 ECTS creditpoints.

Modul-No.	1010	MA	
Modul name	**Power-to-X**		
Modul coordinator	Voswinckel, Sebastian		
Title	Power-to-X		
Title of examination	Power-to-X		
Course Type / SWS	4 SWS Lecture/Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Contents:

1. Introduction
   Energy demand in crucial sectors
2. Power-to-heat (PtH)
   electrode heater – heat pumps
3. Power-to-gas (PtG)
   electrolysis of water - water gas shift reaction – Sabatier process – products – transport and distribution
4. Power-to-Liquid (PtL)
   Reforming – Cracking - Fischer-Tropsch synthesis – products – transport and distribution
5. Problems
   energy and carbon dioxid balancing principles – carbon sources – limited of organic materials – sustainability

Learning goals:

The students know the principle and purpose of Power-to-X technologies. They know the main products and process routes for its production. They can quantify the inputs and outputs of PtX systems and calculate the efficiencies of the process routes and the carbon footprint of the products. The students are able to define technically and economically based preferences products and process routes under given boundary conditions.

Recommended Literature

The literature will be announced in the lecture

Forms of teaching / Prerequisites for participation

Teaching forms as stated above

No course specific requirements

Usability of module

This module is elective for: Mechatronics

Requirements for receiving ECTS credit points

B.Eng.: The assessment is performed as written examination Students need to pass the module examination, which encompasses all contents of the lecture.

M.Eng.: The assessment is performed as written examination and by the submission of a term paper. Students need to pass the module examination, which encompasses all contents of the lecture

ECTS credit points and grading

B.Eng.: The module grade corresponds to the grading of the successfully completed examination. With an examination grade of at least 4.0, 5 credit points (ECTS) are awarded.

M.Eng.: The module grade corresponds to the arithmetic mean of the successfully completed examination and the successful completion of the term paper and its timely submission.With an total grade of at least 4.0, 5 credit points (ECTS) are awarded.

Frequency of offer / Duration of module

SOMMER	The module must be completed within one semester.

Work load

B.Eng.: Participation in the course (45 h); preparation and follow-up (55 h); preparation for examination (50 h)

M.Eng.: Participation in the course (45 h); preparation and follow-up (25 h); writing an academic paper (55 h); preparation for examination (25 h)

The entire workload encompasses 150 hours, which corresponds to 5 ECTS credit points.

Modul-No.	1012	MA	
Modul name	**Basics of Mechanical Engineering**		
Modul coordinator	Link, Thomas		
Title	A: Mechanical Engineering B: Fluid Dynamics		
Title of examination	Basics of Mechanical Engineering		
Course Type / SWS	2 SWS Lecture / 2 SWS Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:

A: Mechanical Engineering

1. Static and dynamic equilibrium for forces and torques
2. Loads of components and load distribution in components
3. Material Properties of components
4. Mechatronic components for machines
5. Design of mechanical elements
6. Manufacturing of mechanical elements

B: Fluid Dynamics

1. Bernoulli's equation in branched systems
2. Linear Momentum Equation and Rankine’s Momentum Theory
3. Angular Momentum Equation
4. Euler’s pump and turbine equation
5. Flow past blunt bodies
6. Compressible flows
7. Similarity theory

Competence

The students define Static and dynamic equilibrium for forces and torques. This is the base for the calculation of the loads in the components. With the knowledge of the material properties they are able to design mechanical elements. The students get an overview on mechatronic components and can use them to design complex mechanical components. At the end they learn how to manufacture this parts.

Students can apply Bernoulli's equation in branched systems. Using the momentum theorem, they are able to calculate forces on components with flow around and through them for two- and three-dimensional flow problems. Students are familiar with Rankine's jet theory and thus have the basics to understand Betz's theory for wind turbines. They are familiar with the differences between incompressible and compressible flows and are able to calculate simple compressible flow cases. Students are familiar with the application of the pi theorem in similarity theory and are able to derive similarity indices for a wide variety of problems and thus correctly transfer measurements on a model scale to large-scale designs.

Recommended Literature

- Munson et. al. Introduction to Fluid Dynamics. Wiley
- Mark Huber. The Beginner's Guide to Engineering: Mechanical Engineering
- Erik Oberg et. al. Machinery's Handbook

Forms of teaching / Prerequisites for participation

The course takes the form of a lecture with 2 SH. Accompanying and partly integrated into the lecture, exercises of 2 SH are offered.

No course specific requirements.

Usability of module	
This module is mandatory for: Mechatronics	
Requirements for receiving ECTS credit points	
Assessment is performed as written examination (120 minutes).	
ECTS credit points and grading	
5 ECTS credits	
Frequency of offer / Duration of module	
WINTER	1 Semester
Work load	
150 h of total work load, from: • 45 h of presence at lectures/exercises • 55 h of self-study • 50 h of preparation for examination	

Modul-No.	1013	MA	
Modul name	**Mechatronic Systems**		
Modul coordinator	Neitzke, Klaus-Peter		
Title	Mechatronic Systems		
Title of examination	Mechatronic Systems		
Course Type / SWS	4 SWS Lecture/Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:
Students understand the structure of mechatronic systems. They learn the system technology principles and the function of the building blocks (subsystems). They understand how different types of actuators and sensors work.

Objectives:

- Structure and operating principles of mechatronic systems
- Mechatronic sensors
- Mechatronic actuators
- Signal conditioning and transmission
- Processor technology and computer science
- Communication technology and networking
- Regulators and controls
- Actuators and drive systems
- Power supply and power control
- Basic structural elements

Recommended Literature

Klaus Janschek: Mechatronic Systems Design. Springer Text book
Rolf Isermann: Mechatronic Systems. Springer Text book

Forms of teaching / Prerequisites for participation

Lecture with integrated exercises.

No course specific requirements.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

The assessment is performed as written examination (120 minutes). Students need to pass the module examination, which encompasses all contents of the lecture.

ECTS credit points and grading

5 ECTS credits

Frequency of offer / Duration of module

WINTER	1 semester

Work load

150 h of total work load, from:

- 45 h of presence at lectures/exercises
- 55 h of self-study
- 50 h of preparation for examination

Modul-No.	1014	MA	
Modul name	**Robotics / CNC Machines**		
Modul coordinator	Neitzke, Klaus-Peter		
Title	Robotics / CNC Machines		
Title of examination	Robotics / CNC Machines		
Course Type / SWS	4 SWS Lecture/Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:
The aim of this course is to understand the technology and operation of robotics and CNC machines. The consideration includes theory and the practical implementation. The student should be able to develop and use these systems themselves.

Objectives:
- Kinematics of robots
- Estimation of the forces, moments and accelerations
- Types of robots and CNC machines
- Applications for robots
- Machining of materials
- Different types of CNC machines
- Rapid prototyping
- Practical applications in the industry

Recommended Literature

Peter Hehenberger. Reverse Engineering und Rapid Prototyping. Springer book
Ali Kamrani et al. Rapid Prototyping. Springer book

Forms of teaching / Prerequisites for participation

Lecture with integrated exercises.

No course specific requirements.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

The assessment is performed as written examination (120 minutes). Students need to pass the module examination, which encompasses all contents of the lecture.

ECTS credit points and grading

5 ECTS credits

Frequency of offer / Duration of module

WINTER	1 semester

Work load

150 h of total work load, from:
- 45 h of presence at lectures/exercises
- 55 h of self-study
- 50 h of preparation for examination

Modul-No.	1015	MA	
Modul name	**Unmanned Vehicles**		
Modul coordinator	Neitzke, Klaus-Peter		
Title	Unmanned Vehicles		
Title of examination	Unmanned Vehicles		
Course Type / SWS	4 SWS Lecture/Exercise		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:
The aim of this course is to understand the technology and operation of unmanned ground and air vehicles. The consideration includes theory and the practical implementation. The student should be able to develop and use these systems themselves.

Objectives:
- Application of automation and control technology
- Overview on the mechanical dynamics and aerodynamics
- Showing the ability to influence the flight and driving curves
- Navigation by vectors and coordinates and by obstacles
- Description of cascade algorithms in autopilots
- Investigations into the stability of navigation algorithms
- Description of the necessary components
- Overview on possible flight applications

Recommended Literature

K.P.Valavanis et al.: Unmanned Aircraft Systems. Springer 2008
International Micro Air Vehicles, Conferences and Competitions. https://www.imavs.org/
Unmanned Systems. https://www.worldscientific.com/worldscinet/us
International Journal of Micro Air Vehicles. https://journals.sagepub.com/home/mav

Forms of teaching / Prerequisites for participation

Lecture with integrated exercises.

No course specific requirements.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

The assessment is performed as written examination (120 minutes). Students need to pass the module examination, which encompasses all contents of the lecture.

ECTS credit points and grading

5 ECTS credits

Frequency of offer / Duration of module

WINTER	1 semester

Work load

150 h of total work load, from:

- 45 h of presence at lectures/exercises
- 55 h of self-study
- 50 h of preparation for examination

Modul-No.	1016	MA	
Modul name	**Unmanned Vehicles Lab**		
Modul coordinator	Neitzke, Klaus-Peter		
Title	Unmanned Vehicles Lab		
Title of examination	Unmanned Vehicles Lab		
Course Type / SWS	4 SWS Lab		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:
The aim of this course is to collect practical experiences of unmanned ground and air vehicles. The consideration is focused on the practical implementation. The student should be able to use these systems themselves.

Objectives:
- Define and design unmanned ground and air vehicles
- Develop and test of the necessary hardware components
- Develop and test algorithms in autopilots
- Test complete unmanned ground and air vehicles

Recommended Literature

K.P.Valavanis et al.: Unmanned Aircraft Systems. Springer 2008
International Micro Air Vehicles, Conferences and Competitions. https://www.imavs.org/
Unmanned Systems. https://www.worldscientific.com/worldscinet/us
International Journal of Micro Air Vehicles. https://journals.sagepub.com/home/mav

Forms of teaching / Prerequisites for participation

Practical work in the lab.

No course specific requirements.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

The assessment based on the work in the laboratory and the minutes, protocols and reports submitted.

ECTS credit points and grading

5 ECTS credits

Frequency of offer / Duration of module

WINTER	1 semester

Work load

150 h of total work load, from:
- 45 h of presence in the lab
- 55 h of self-study
- 50 h of preparation for examination

Modul-No.	1017	MA	
Modul name	**Electronics Circuits**		
Modul coordinator	Viehmann, Matthias		
Title	Electronics Circuits		
Title of examination	Electronics Circuits		
Course Type / SWS	4 SWS Lecture		
Language / CP / Workload	English	5.0	150
Requirements for attendance	no		

Content and objectives

Content:

- Digital technology components
- Design and optimization of digital circuits
- Analog technology components
- Design of analog circuits
- Design of mixed signal circuits
- Simulation and diagnostics of electronic circuits

Objectives:

After successful completion of the course:

- Students understand basic problems in electronic circuit technology.
- They know techniques and methods for overcoming these problems.
- They recognize the advantages and disadvantages of different solutions.
- They are able to simulate and develop analog and digital circuits using software tools.
- They have acquired practical skills for setting up experimental circuits.
- Students can apply their English skills.

Recommended Literature

Literature:

- Franco, S.: Design with Operational Amplifiers and Analog Integrated Circuits. New York: The McGraw-Hill Companies, 4. Edition, 2015
- Viehmann, M.: Operationsverstärker – Grundlagen, Schaltungen, Anwendungen. 2., überarbeitete und erweiterte Auflage. München: Hanser, 2020
- Script and data sheets in the course directory
- Further literature references in the lecture

Forms of teaching / Prerequisites for participation

Lecture with integrated practical laboratory exercises. No course specific requirements.

Usability of module

This module is mandatory for: Mechatronics

Requirements for receiving ECTS credit points

Assessment is performed either as written examination (120 minutes). Students need to pass the module examination, which encompasses all contents of the lecture.

ECTS credit points and grading

Final grade corresponds to the exam grade. 5 ECTS with at least a grade of sufficient.

Frequency of offer / Duration of module

WINTER	1 semester

Work load
150 h of total work load, from: • 45 h of presence at lectures/exercises; • 55 h of self-study; • 50 h of preparation for examination

Modul-Nr.	1030	MA	
Bezeichnung	**Abschlussmodul Mechatronics**		
Verantwortlicher	Neitzke, Klaus-Peter		
Titel der Lehrveranstaltung(en)	A: Masterarbeit B: Kolloquium		
Prüfungsbezeichnung	Abschlussmodul Mechatronics		
Lehrformen / SWS			
Sprache / CP / Workload	Deutsch	30.0	900
Formale Teilnahmebedingungen	keine		

Inhalte und Qualifikationsziele

Inhalte:
Das Abschlussmodul (30 CP) dient dazu, die Fähigkeiten der Studierenden weiterzuentwickeln und zu bewerten. Hierzu ist eine wissenschaftliche und praxisrelevante Problemstellung auf dem Gebiet der Mechatronik selbständig unter Anwendung des Theorie- und Methodenwissens der Ingenieurwissenschaften zu bearbeiten und gemäß wissenschaftlichen Standards zu dokumentieren.

Masterarbeit (26 CP)
Die Masterarbeit soll zeigen, dass der/die Studierende in der Lage ist, innerhalb einer vorgegebenen Frist von 20 Wochen eine Problemstellung aus seinem Fach selbständig und mit wissenschaftlichen Methoden zu bearbeiten. Das Thema der Masterarbeit ist eine ingenieurwissenschaftliche Fragestellung auf dem Gebiet der Mechatronik. Dabei kann es sich um Fragestellungen der Forschung, Entwicklung, Projektierung oder Modellierung handeln.

Masterkolloquium (4 CP)
Das Masterkolloquium bildet den fachlichen Abschluss des Studiums. Im Rahmen des Masterkolloquiums erhält der/die Studierende die Gelegenheit, seine Masterarbeit in einem Vortrag vorzustellen und zu verteidigen. Inhalt des Kolloquiums sind Fragen zum Studium und zu dem Fachgebiet, dem die Masterarbeit entnommen ist. Die Dauer des Masterkolloquiums beträgt in der Regel 60 Minuten.

Lernziele:
Die Studierenden sind in der Lage, eine Problemstellung auf dem Gebiet der Mechatronik selbständig unter Anwendung wissenschaftlicher Methoden der Ingenieurwissenschaften zu bearbeiten und gemäß wissenschaftlichen Standards zu dokumentieren

In diesem Modul werden nicht nur fachliche Kompetenzen, sondern auch wesentliche Schlüsselkompetenzen (Projektarbeit, Selbständigkeit, Praxistransfer, Präsentationskompetenz) gefordert und deren Entwicklung gefördert.

Literaturempfehlungen

Für dieses Modul gibt es keine Literaturempfehlungen.

Lehr- und Lernformen / Voraussetzung für die Teilnahme

Eigenständige wissenschaftliche Arbeit des/der Studierenden betreut durch den Erst- bzw. Zweitprüfer.

Zulassung zur Masterarbeit gemäß Prüfungsordnung.

Verwendbarkeit

Dieses Modul ist Pflicht für: Mechatronics

Voraussetzungen für die Vergabe von ECTS-Leistungspunkten

Eine mindestens mit „ausreichend“ bewertete Masterarbeit sowie ein mindestens mit „ausreichend“ bewertetes Kolloquium.

ECTS-Leistungspunkte und Benotung

In dem Modul werden Leistungspunkte und Noten getrennt ausgewiesen.

Häufigkeit des Angebots / Dauer des Moduls	
JEDES	Das Modul wird in jedem Semester angeboten.
Arbeitsaufwand (work load)	
Die gesamte Arbeitsbelastung umfasst 900 h, dies entspricht 30 CP.	