# Module Manual
# of the Master Program Renewable Energy and E-Mobility (REEMM)
# of the University of Applied Science Stralsund

## Contents

## Compulsory Modules

The following table entries in the line "Regular Semester" refer to the Master with a standard period of study of three semesters In the case of the Master with a standard study period of four semesters, the term "Regular Semester" in the Master's thesis increases by one semester.

| | | | | |
|---|---|---|---|---|
| Course | **REEMM1000 - Selected Chapters of Mathematics** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM1100 - Selected Chapters of Mathematics** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st semester | Regular semester | 2nd semester |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | Compulsory |
| Educational methods/SWH | Methods | Lecture and follow-up course work, exercise, seminar | | |
| | Number SWH | 0 lectures + 3 seminar-style tuition + 1 exercise+ 0 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Written exam, 2 h (Klausur, 2 h) | | |
| Learning outcomes | | The students know the concept and applications of systems of differential equations. They can apply numerical methods to solve initial value problems and boundary value problems. The students know and can apply the theory for solving systems of linear differential equations. They understand the fundamentals of the theory of partial differential equations. | | |
| Content | | Systems of differential equations: Existence, uniqueness and stability of solutions; Numerical methods for approximating solutions using MATLAB.<br>Boundary value problems: Numerical methods.<br>Introduction to partial differential equations with examples the 2-dimensional heat equation, wave equation and Laplace equation | | |
| Literature /references | | Richard L. Burden, J. Douglas Faires: Numerical Analysis, 9th ed., Brooks/Cole, Cengage Learning 2011<br>Ward Cheney, David Kincaid: Numerical Mathematics and Computing, 6th ed., Thomson Brooks/Cole 2008<br>William Trench: Elementary Differential Equations with Boundary Value Problems, Brooks/Cole 2001<br>William Trench: Elementary Differential Equations, 2013, http://digitalcommons.trinity.edu/mon/8 | | |

| | | | | |
|---|---|---|---|---|
| Course | **REEMM1300 - System Theory** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM1300 - System Theory** | | |
| | Language | English, optional German possible | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | Compulsory |
| Educational methods/SWH | Methods | Lecture and follow-up course work, exercise | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 2 exercise + 0 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | Basic knowledge in control engineering and physics, Laplace transformation, differential and integral calculus | | |
| Examination procedure | | Written exam, 2 h (Klausur, 2 h) | | |
| Learning outcomes | | Students should acquire well founded system theoretical knowledge, i.e. describe and analyze dynamic systems as well as apply the methods to SISO and MIMO-systems and to be able to apply their system theory knowledge to problems of communications engineering and control technology | | |
| Content | | Description of linear time-invariant systems in the time and frequency domain; Analysis of analogue and time-discrete SISO and MIMO systems in the state space (controllability, observability and stability), state controller and observer design, method for system analysis | | |
| Literature /references | | Franklin, G.F.; Powell, J. D.; Emami-Naeini, A.: Feedback Control of Dynamic Systems, Pearson; 7 edition, 2017.<br>Goodwin, G. C.; Graebe F. S.; Salgado, M. E.: Control System Design, , Pearson, 2001.<br>Steffenhagen, B. :Kleine Formelsammlung Regelungstechnik, Carl Hanser Verlag 2010.<br>Further literature will be announced during the course. | | |

| | | | | |
|---|---|---|---|---|
| Course | **REEMM1400 - Renewable Energy Systems** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM1400 - Renewable Energy Systems** | | |
| | Language | English, optional German possible | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st semester | Regular semester | 2nd semester |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | compulsory |
| Educational methods/SWH | Methods | Lecture, exercise and follow-up course work, seminar | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 2 exercise + 0 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur, 2 h und Übungsschein) | | |
| Learning outcomes | | The students have acquired knowledge about the theoretical description, technical possibilities and practical implementation problems in the transition from conventional to regenerative decentralized energy supply systems by intensifying their methodological knowledge. They are able to systematically apply the acquired abilities and knowledge in the profession. | | |
| Content | | Installation and planning of regenerative energy generators - offshore and onshore technology - energy storage - power grid integration - island grid configuration- intelligent grid protection - grid control and monitoring – frequency stability in distribution networks –- optimization process for decentralized energy management | | |
| Literature /references | | Quaschning, V.: Understanding Renewable Energy Systems; Earthscan/Routledge London, 2nd edition 2016.<br>Quaschning, V.: Renewable Energy and Climate Change; John Wiley & Sons, Ltd Chichester, 1st edition 2010.<br>Lund, H.: Renewable Energy Systems, Elsevier, 2nd Edition 2014.<br>Kaltschmitt, M.; Streicher, W.; Wiese, A.: Renewable Energy Technology, Economics and Environment, Springer Verlag, 2007.<br>Further literature will be announced during the course. | | |

| | | | | |
|---|---|---|---|---|
| Course | **REEMM2010...2050 - Elective Modules (AO) I to V** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM2010, REEMM2020, REEMM2030, REEMM2040, REEMM2050**<br>**Elective Modules I to V** | | |
| | Language | English, optional German possible | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st or 2nd or 3rd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | compulsory |
| Educational methods/SWH | Methods | Lecture and follow-up course work, exercise, seminar, laboratory | | |
| | Number SWH | 4 | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | In accordance with the examination procedure defined for the chosen module in the FPO | | |
| Learning outcomes | | The students acquire complementary skills as well as profound knowledge in the selected fields:<br>• current topics of renewable energies<br>• wind power plants<br>• hydrogen technology<br>• solar systems<br>• control of electrical drives<br>• electro mobility<br>• advanced power electronics<br>• sustainable non-fossil mobility<br>• vehicle simulation<br>• vehicle management systems<br>depending on the current range of elective modules and the interests of the students | | |
| Content | | Courses are offered according to §6 of the regulations of study programme or from the above-mentioned topic pool (list of modules (AO) in the appendix). The theme pool is open, which means that the offer can vary from semester to semester. | | |
| Literature /references | | Depending on the offered course | | |

| | | | | |
|---|---|---|---|---|
| Course | **REEMM2060...2080 - Elective Modules (F) I to III** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM2060, REEMM2070, REEMM2080 Elective Modules (F) I to III** | | |
| | Language | English, optional German possible | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st or 3rd semester | Regular semester | 2nd semester (3S, 4SwP) 3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | compulsory |
| Educational methods/SWH | Methods | Lecture and follow-up course work, exercise, seminar, laboratory | | |
| | Number SWH | 4 | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | In accordance with the examination procedure defined for the chosen module in the FPO. | | |
| Learning outcomes | | The students expand their practice-oriented interdisciplinary knowledge in relation to related engineering or economics, deepen their knowledge in the field of electrical engineering or computer science based on their bachelor's degree or deepen their language skills, depending on the current range of elective modules and the interests of the students. | | |
| Content | | Courses are offered according to §6 of the regulations of study programme or from the above-mentioned topic pool (list of modules (F) or (AO) in the appendix). The theme pool is open, which means that the offer can vary from semester to semester. | | |
| Literature /references | | Depending on the offered course | | |

| | | | | |
|---|---|---|---|---|
| Course | **REEMM2200 - Methods of Power Engineering** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM2200 - Methods of Power Engineering** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | compulsory EE elective AE |
| Educational methods/SWH | Methods | Lecture and follow-up course work, exercise, laboratory | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 1 exercise+ 1 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur, 2 h und Übungsschein) | | |
| Learning outcomes | | The students are able to explain and to implement practically oriented procedures to stabilize, secure and optimize electrical supply and consumer installations. | | |
| Content | | Flexible AC Transmission Systems – passive and active power filters – space vector model of electrical three phase systems – control of active power filters - high voltage DC transmission – lightning protection methods – switching operation and travelling waves – supply reliability in public mains supply | | |
| Literature /references | | Leonhard, W.: Control of Electrical Drives, Springer.<br>Akagi, A., Watanabe, E.H., Aredes, M.: Instantaneous Power Theory and Applications to Power Conditioning.<br>Trzynadlowski, A.M.: Modern Power Electronics.<br>Constantinescu-Simon, L.: Handbuch Elektrische Energietechnik, Vieweg Verlag, Braunschweig, 1997.<br>Phillipow, E.: Theoretische Elektrotechnik, Verlag Technik, Berlin, 1986.<br>Further literature will be announced during the course. | | |

| | | | | |
|---|---|---|---|---|
| Course | **REEMM3600 - Quality in Automotive Industry** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3600 - Quality in Automotive Industry** | | |
| | Language | English, optional German possible | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | Compulsory |
| Educational methods/SWH | Methods | Seminar and post-seminar work, laboratory | | |
| | Number SWH | 0 lectures + 3 seminar-style tuition + 0 exercise+ 1 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h seminars, laboratory, consultation | | |
| | Self-study | 116 h preparative and post-seminar work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Written exam, 2 h (Klausur, 2 h) | | |
| Learning outcomes | | The students are well versed in organisational and statistical methods to implement and maintain quality management systems in organisations with reference to automotive industry. Methods and concepts of quality management in automotive industry can be applied. Especially the zero defects objective will be focused.<br>The students have the ability, to implement the requirements of the applicable quality standard in its current issue. | | |
| Content | | Quality management systems and standards, used in automotive industry. ISO 9001, ISO/TS 16949, International Automotive Task Force IATF. Process approach: quality management system; management responsibility; resource management, product realization; measurement analysis and improvement.<br>Customers focus, corrective and preventive actions, Total Quality Management, Six Sigma, statistical methods, capability, statistical process control, measuring systems analysis, production part approval process, production process release procedure | | |
| Literature /references | | ISO/TS 16949 current revision<br>current state QM-literature, stated in the lecture | | |

| | | | | |
|---|---|---|---|---|
| Course | **REEMM3800 - Energy and Environmental Management** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3800 - Energy and Environmental Management** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | Compulsory |
| Educational methods/SWH | Methods | Lecture and follow-up course work, seminar | | |
| | Number SWH | 0 lectures + 3 seminar-style tuition + 0 exercise+ 0 laboratory + 1 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Oral examination 30 min (Mündliche Prüfung, 30 min) | | |
| Learning outcomes | | The students have established understanding for the necessity of sustainable development from global to microeconomic level. They appreciate the relationships between the greenhouse effect, climate change and resulting international conventions and agreements.<br>They are well-informed about the state and problems of the German energy transition process, emissions trade, environmental management systems and ways to increase the efficiency of energy conversions, energy saving and integration of all types of renewable energy. | | |
| Content | | Sustainability, UN Conferences for Environment and Development, implementation in the EU and Germany; global environmental problems (stratospheric ozone depletion, greenhouse effect); United Nations Framework Convention on Climate Change, Conferences of the Parties, EU climate policy, emission trade, JI and CDM; IPCC Assessment Reports, increase in efficiency during energy conversion, assessment of nuclear energy, energy management (ISO 50000), electricity stock exchange, contracting, CCS; environmental management systems, licensing procedures and Environmental Impact Assessment procedures (e.g. wind power plants) | | |
| Literature /references | | Current free publications and documents, e.g. the last IPCC Assessment Report, the EMAS III regulation or the Federal Environmental Agency Guideline for the Implementation of Energy Management Systems, are available on the ILIAS Database (e-learning system). In-depth publications will be referred to during the lectures. | | |

| | | | | |
|---|---|---|---|---|
| Course | **REEMM5000 - Master thesis with colloquium** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM5000 - Master thesis with colloquium** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 3rd semester | Regular semester | 3rd semester |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | Compulsory |
| Educational methods/SWH | Methods | | | |
| | Number SWH | | | |
| Work load | Presence study | at least 16 h | | |
| | Self-study | 884 h | | Σ 900 h |
| ECTS-points | | 30 (Master-thesis: 27 CP, Master-colloquium: 3 CP) | | |
| prerequisite according study regulations | | see §§ 5 and 7 of the relevant examination regulations | | |
| Additional recommended requirements | | | | |
| Examination procedure | | - Master's thesis (6 months, maximum of about 100 pages plus structure and appendix, §§ 24 - 26 General examination regulation)<br>- Master-colloquium (see § 27 General examination regulation) | | |
| Learning outcomes | | Proof of the ability to meet the requirements of the master's degree stipulated in § 2 of the study regulations. In particular, the candidates demonstrate with this work that they have deepened theoretical knowledge beyond the professional knowledge acquired during the initial professional studies. By means of the special area treated in the Master thesis, they demonstrate that they are able to solve complex tasks. They can formulate new interdisciplinary solution approaches that go beyond the current knowledge. The Master's thesis shows that the students have broad analytical skills and can implement their knowledge in problem solving independently. Students apply their skills to recognize trends in the engineering sciences as well as future problems and requirements and can include them target-oriented in their activities. | | |
| Content | | Depend on the topic | | |
| Literature /references | | Depend on the topic | | |

In addition to the compulsory modules listed above, the curriculum for the 4-semester Master's Program Renewable Energy and E-Mobility with internship semester includes the internship semester.

| | | | | |
|---|---|---|---|---|
| Course | **REEMM4000 - Internship Semester** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM4000 - Internship Semester** | | |
| | Language | English or German | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 3rd semester | Regular semester | 3rd semester |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | Compulsory for 4SwP |
| Educational methods/SWH | Methods | Seminar: 2 SWH for follow-up colloquium | | |
| | Number SWH | | | |
| Work load | Presence study | 32 h | | |
| | Self-study | 868 h | | Σ 900 h |
| ECTS-points | | 30 | | |
| prerequisite according study regulations | | see study regulation, appendix 1 | | |
| Additional recommended requirements | | | | |
| Examination procedure | | internship report, ca. 20 pages (Praxisbericht, ca. 20 Seiten)<br>presentation, ca. 30 minutes (Präsentation, ca. 30 min)<br>activity report<br>(see study regulation, appendix 1) | | |
| Learning outcomes | | The students apply the knowledge acquired in their first degree of studies or in the modules taken so far in their present course of studies to solve practical problems in a company.<br>They acquire professional skills and knowledge and get acquainted with subject-specific problems and tasks from their future fields of activity. | | |
| Content | | In accordance with the activities stipulated in the internship contract and approved by the university during the internship | | |
| Literature /references | | Depend on the topic | | |

In addition to the compulsory modules listed above, the curriculum for the 4-semester Master's Program Renewable Energy and E-Mobility without internship semester still includes the project work.

| | | | | | |
|---|---|---|---|---|---|
| Course | **REEMM4100 - Project work** | | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM4100 - Project work** | | | |
| | Language | English | | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | | |
| | Semester | 3rd semester | Regular semester | 3rd semester | |
| | Duration | 1 semester | frequency | Annual | |
| | | | compulsory / elective | compulsory for 4SwoP | |
| Educational methods/SWH | Methods | independent scientific work | | | |
| | Number SWH | 0 lectures + 0 seminar-style tuition + 0 exercise+ 1 laboratory + 1 seminar | | | |
| Work load | Presence study | 32 h | | | Σ 360 h |
| | Self-study | 328 h | | | |
| ECTS-points | | 12 | | | |
| prerequisite according study regulations | | | | | |
| Additional recommended requirements | | | | | |
| Examination procedure | | performance record (written documentation of the project work) (Leistungsnachweis, schriftliche Dokumentation der Projektarbeit) | | | |
| Learning outcomes | | As part of a project work, in addition to technical competence, methodological and personnel skills are acquired. The students acquire the ability to independently work on a larger project, to organize themselves and their projects, and to deal appropriately with criticism and conflicts in a team. | | | |
| Content | | Topics are issued by the instructors | | | |
| Literature /references | | Depends on the topic. | | | |

## Elective Modules

| | | | | |
|---|---|---|---|---|
| Course | **Solar Systems** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM1700 - Solar Systems** | | |
| | Language | English, optional German possible | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st sem. in German<br>2nd sem. in English | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Exercise, seminar and follow-up course work, practice-oriented laboratory work | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 1 exercise+ 1 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | Σ 180 h |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Oral exam, 30 min and certificate of laboratory work (Mündliche Prüfung, 30 min und Übungsschein) | | |
| Learning outcomes | | The students have knowledge in the natural sciences and engineering of energy generation from solar radiation as well as the associated installation and its application. They have the ability to evaluate the individual possibilities of using the solar energy with regard to their suitability for use, taking into account the local conditions. | | |
| Content | | Solar radiation: Theoretical background, interaction between radiation and matter, greenhouse effect computations. Photovoltaics: Semiconductors, components of a PV system in island and grid-connected applications, planning and application of PV systems. Solar thermal systems: configurations, solar collectors, hot water storage, planning and applications, solar cooling, passive solar thermal systems. | | |
| Literature /references | | Larry D. Partain: Solar Cells and Their Applications, John Wiley & Sons, New York, 1995. Markvart, Tomas: Solar Electricity, John Wiley & Sons, New York, 1996. Goswami, D.Y. et. al.: Principles of Solar Engineering, Taylor & Francis 2000. Felix Peuser et. al.: Solar Thermal Systems, James & James, 2002. Soteris A. Kalogirou: Solar Energy Engineering, Elsevier | | |

| | |
|---|---|
| | 2009. Further literature will be announced during the course. |

| | | | | |
|---|---|---|---|---|
| Course | **Selected Topics of Control Engineering** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM2110 - Selected Topics of Control Engineering** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st or 3rd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Lecture and post-lecture work, exercise, laboratory work | | |
| | Number SWH | 0 lectures + 1 seminar-style tuition + 2 exercise+ 1 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and post-lecture work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur 2 h und Übungsschein) | | |
| Learning outcomes | | The students can actively apply the control technology for the analysis and synthesis of systems, single-loop and meshed control loops. The students have advanced knowledge of system analysis and identification as well as controller design. You can analyze and process more complex control tasks. On the basis of laboratory experiments, the engineering approach to the solution of practical tasks in the field of control engineering is promoted. The students can plan their own experiments, carry out their work, document their results and work in a team. | | |
| Content | | Concepts and presentation forms of controlled systems; Description of linear time-invariant systems in the time and frequency domain, advanced methods for process analysis and characteristic determination on lines, modeling for technical processes.<br>PID control: Principles, modifications, controllers with two degrees of freedom, practical aspects in use (integrator windup, bumpless H / A switching, limited D component), sampling control and digital implementation, Controler design in the time and frequency domain, tuning methods, further control concepts, smith predictor, introduction to nonlinear control, method of harmonic balance, laboratory experiments on the mentioned lecture contents | | |

| | |
|---|---|
| Literature /references | Franklin, G.F.; Powell, J. D.; Emami-Naeini, A.: Feedback Control of Dynamic Systems, Pearson; 7 edition, 2017.<br>Goodwin, G. C.; Graebe F. S.; Salgado, M. E.: Control System Design, , Pearson, 2001.<br>Steffenhagen, B. :Kleine Formelsammlung Regelungstechnik, Carl Hanser Verlag 2010.<br>Further literature will be announced during the course. |

| | | | | | |
|---|---|---|---|---|---|
| Course | **Electrical Energy Conversion and Transmission** | | | Quality/Degree: Master Sc. | |
| | Course, symbol, title | **REEMM2120 –Electrical Energy Conversion and Transmission** | | | |
| | Language | English | | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | | |
| | Semester | 1st or 3rd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) | |
| | Duration | 1 semester | frequency | Annual | |
| | | | compulsory / elective | elective | |
| Educational methods/SWH | Methods | seminar, laboratory work | | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 2 exercise+ 0 laboratory + 0 seminar | | | |
| Work load | Presence study | 64 h contact time | | | |
| | Self-study | 116 h Preparation and wrap-up, independent study, documentation of the experimental work | | | Σ 180 h |
| ECTS-points | | 6 | | | |
| prerequisite according study regulations | | | | | |
| Additional recommended requirements | | | | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur 2 h und Übungsschein) | | | |
| Learning outcomes | | The students are aware of fundamental methods to analytically describe electrical three phase systems for power transmission and electrical drive issues. They are able to practically apply the means of complex calculus to solve problems of balanced three phase systems. Basic electrical machine types are known and corresponding power balances can be calculated. | | | |
| Content | | Complex calculus (single phase system), extension of the complex calculus to balanced three phase systems (per phase equivalent circuit, delta to wye transformation), transformer, induction machine (squirrel cage), synchronous machine (non salient rotor, without reluctance effect) | | | |
| Literature /references | | Nagsarkar, T. K., Sukhija, M. S.: “Basic Electrical Engineering“, Oxford University Press,<br>ISBN – 10: 0195673921 or ISBN – 19: 978 - 0195673920 | | | |

| | |
|---|---|
| | Bobrow, L. S.: “Fundamentals of Electrical Engineering“, Oxford University Press, ISBN – 10: 0195105095<br>ISBN – 19: 978 - 0195105094<br>Rizzoni, G.: “Fundamentals of Electrical Engineering”, (4th chapter), online PDF<br>https://www.ece.rice.edu/~dhj/courses/elec241/col10040.pdf |

| | | | | |
|---|---|---|---|---|
| Course | **Power Electronics** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM2130 - Power Electronics** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st or 3rd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Lecture and post-lecture work, exercise, laboratory work | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 1 exercise+ 1 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and post-lecture work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur 2 h und Übungsschein) | | |
| Learning outcomes | | The students can apply the fundamental Fourier analysis and corresponding complex calculus to determine the power flow of periodic signals. They are able to analyse the power flow of simple DC/DC converter topologies. The students can distinguish different power semiconductor devices. Furthermore, principles of current commutation are known. Basic PWM methods of for three phase converter topologies can be applied. | | |
| Content | | Mean values and Root mean square values of generally periodic signals, Fourier transformation with focus on fundamental extraction, power flow analysis, different power semiconductors (Diode, MOSFET, IGBT, Thyristor), current commutation process, grid commutated converters, basic DC/DC converter topologies, basic self commutated three phase converter topologies, Pulse Width Modulation for three phase converters | | |
| Literature /references | | Trzynadlowski, A. M.: Introduction to Modern Power Electronics, John Wiley & Sons, 2016.<br>Mohan, N., Undeland, T.M., Robbins, W. P.: Power | | |

| | |
|---|---|
| | Electronics: Converters, Applications, and Design, John Wiley & Sons, 2002. |

| | | | | |
|---|---|---|---|---|
| Course | **Modelling of Physical Systems** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM2140 - Modelling of Physical Systems** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st or 3rd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Lecture and post-lecture work, exercise, laboratory work | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 0 exercise + 2 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and post-lecture work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur 2 h und Übungsschein) | | |
| Learning outcomes | | The students have deepened their technical knowledge, developed analytical and creative skills for problem solving, and acquired a broad knowledge of methods for system analysis. They master the creative modeling process and are able to abstract from technical problems and to form the appropriate mathematical models. They master the programming system MATLAB / Simulink and can implement the various mathematical description forms of technical systems in simulation models, also verify them and check them for plausibility. | | |
| Content | | Application of mathematical methods and numerical methods for modeling and simulation of real systems using the MATLAB / Simulink software system: introduction to Matlab / Simulink, description of LTI systems, application of Laplace transformation, consideration of technical systems in the frequency domain, analytical modeling and simulation using different example systems | | |
| Literature /references | | Franklin, G.F.; Powell, J. D.; Emami-Naeini, A.: Feedback Control of Dynamic Systems, Pearson; 7 edition, 2017.<br>Goodwin, G. C.; Graebe F. S.; Salgado, M. E.: Control System Design, , Pearson, 2001. | | |

| | |
|---|---|
| | Steffenhagen, B. :Kleine Formelsammlung Regelungstechnik, Carl Hanser Verlag 2010.<br>Further literature will be announced during the course. |

| | | | | | |
|---|---|---|---|---|---|
| Course | **Wind Power Plants** | | | Quality/Degree: Master Sc. | |
| | Course, symbol, title | **REEMM3000 – Wind Power Plants** | | | |
| | Language | English | | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | | |
| | Semester | 2nd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) | |
| | Duration | 1 semester | frequency | Annual | |
| | | | compulsory / elective | elective | |
| Educational methods/SWH | Methods | Seminar, exercise, laboratory work and follow-up course work | | | |
| | Number SWH | 0 lectures + 4 seminar-style tuition + 0 exercise+ 0 laboratory + 0 seminar | | | |
| Work load | Presence study | 64 h contact time | | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | | Σ 180 h |
| ECTS-points | | 6 | | | |
| prerequisite according study regulations | | | | | |
| Additional recommended requirements | | | | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur, 2 h und Übungsschein) | | | |
| Learning outcomes | | The students are aware of the theory and practical application of wind power plants. The focus of this lecture is set on grid tied wind power plants. Hence, the students are able to understand the principle of Maximum Power Point Tracking. The understand the numerical procedure of rotor blade design and are able to determine key parameters ofthe major components of the drive train like the gear box ratio or rated power of the generator. | | | |
| Content | | Dedicated fluid mechanics and air foil theory, different types of wind power plants (horizontal, vertical axis), numerical rotor blade design according to Schmitz, application of electrical drives to wind power conversion, design and speed control of the drive train | | | |
| Literature /references | | Gasch, Twele: Wind Power Plants, Springer, 2. edition.<br>Heier, S.: Grid Integration of wind energy conversion systems, John Wiley & Sons.<br>Molly, J.-P. : Windenergie, Hüthig Jehle Rehm.<br>Further literature will be announced during the course. | | | |

| | | | | |
|---|---|---|---|---|
| Course | **Hydrogen Technology** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3100 – Hydrogen Technology** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester (3S, 4SwP) 3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Seminar, exercise, laboratory work and follow-up course work | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 0 exercise+ 1 laboratory + 2 seminar | | |
| Work load | Presence study | 80 h contact time | | |
| | Self-study | 100 h preparative and follow-up course work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Oral exam, 30 min and certificate of laboratory work (Mündliche Prüfung 30 min und Übungsschein) | | |
| Learning outcomes | | The students have comprehensive theoretical knowledge about problems and technical solutions for the generation, storage and use of hydrogen as well as in the field of fuel cell technology. They are familiar with the most important processes and systems in terms of thermodynamic, energy-related and electrochemical description / modeling and with regard to the integration into power supply solutions and island grid systems. They are able to use these components and systems in application tasks. Participants are able to adapt and develop regenerative energy systems to market requirements by incorporating hydrogen-based processes. | | |
| Content | | Phys./chem. properties of hydrogen, hydrogen production by electrolysis and chem./biol. processes (incl. circle processes), storage and transport for stationary and mobile applications / hydrogen infrastructure; thermodynamics, theory and automation of fuel cells, hydrogen operation of gas turbines and combustion engines, safety aspects, 4 laboratory experiments corresponding to the main study subject | | |
| Literature /references | | Winter, C.-J.; Nitsch, J.: Hydrogen as an Energy Carrier / Wasserstoff als Energieträger, Springer, Berlin 1988 / 2011.<br>James Larminie, Andrew Dicks: Fuel Cell Systems Explained, Second Edition, John Wiley 2003.<br>Töpler, J.; Lehmann, J.: Hydrogen and Fuel Cell Technologies and Market Perspectives, Springer 2016.<br>Sterner, M.; Stadler, I.: Handbook of Energy Storage - | | |

| | |
|---|---|
| | Demand, Technologies, Integration, Springer 2018.<br>Additional literature is given during the lectures. |

| | | | | | |
|---|---|---|---|---|---|
| Course | **Fuel Cell Systems** | | | Quality/Degree: Master Sc. | |
| | Course, symbol, title | **REEMM3200 – Fuel Cell Systems** | | | |
| | Language | English | | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | | |
| | Semester | 2nd semester | Regular semester | 2nd semester | |
| | Duration | 1 semester | frequency | Annual | |
| | | | compulsory / elective | elective | |
| Educational methods/SWH | Methods | Seminar style tuition, exercise, laboratory work and follow-up course work | | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 1 exercise+ 1 laboratory | | | |
| Work load | Presence study | 64 h contact time | | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | | Σ 180 h |
| ECTS-points | | 6 | | | |
| prerequisite according study regulations | | | | | |
| Additional recommended requirements | | REEMM3100 or Knowledge in the field of hydrogen technology | | | |
| Examination procedure | | Oral exam, 30 min and certificate of laboratory work (Mündliche Prüfung 30 min und Übungsschein) | | | |
| Learning outcomes | | The students have a comprehensive knowledge to problem definitions and technical solutions with the conception and realization of fuel cell systems. They know the most important fuel cell types and their areas of application. They master the theoretical description, simulation and automation of PEM fuel cell systems as well as their integration into electrical island and supply networks and can use them in application tasks. | | | |
| Content | | Theory and modelling of fuel cells, fuel cell types, design and automation of PEM fuel cell systems, FC integration in drives and energy supply solutions, laboratory tests according to focus | | | |
| Literature /references | | O´Hayre, R. P.; Colella, W. G. u.a.: Fuel Cell Fundamentals, Wiley New York, 2009.<br>Winter, C.-J.; Nitsch, J.: Hydrogen as an Energy Carrier Springer, Berlin 1988 / 2011.<br>James Larminie, Andrew Dicks: Fuel Cell Systems Explained, Second Edition, John Wiley 2003.<br>Töpler, J.; Lehmann, J.: Hydrogen and Fuel Cell Technologies and Market Perspectives, Springer 2016.<br>Sterner, M.; Stadler, I.: Handbook of Energy Storage - Demand, Technologies, Integration, Springer 2018.<br>Kurzweil, P.: Brennstoffzellentechnik, Springer Vieweg 2013<br>Additional literature is given during the lectures. | | | |

| | | | | |
|---|---|---|---|---|
| Course | **Sustainable non-fossil mobility** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3300 – Sustainable non-fossil mobility** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Seminar, exercise, laboratory work and follow-up course work | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 2 exercise+ 0 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and follow-up course work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur 2 h und Übungsschein) | | |
| Learning outcomes | | The students are able to identify, simulate and complete drive chains for mobile applications based on sustainable non-fossil mobility concepts. | | |
| Content | | Mobility, society and the environment; sustainable fuel cycles – PtF and biofuel technologies; e-mobility with its main architectures; hydrogen based mobility – drive chains, vehicles and hydrogen production; cleaner mobility with internal combustion engines and turbines; actual examples. | | |
| Literature /references | | Larminie, J.; Lowry J.: Electric Vehicle Technology Explained, 2nd Edition, John Wiley 2012, ISBN: 978-1-119-94273-3.<br>Larminie, J.; Dicks, A.: Fuel Cell Systems Explained, 2nd Edition, John Wiley 2003, ISBN 0-471-49026-1<br>Töpler, J.; Lehmann, J.; Hydrogen and Fuel Cell Technologies and Market Perspectives, Springer 2016.<br>Additional literature is given during the lectures. | | |

| | | | | |
|---|---|---|---|---|
| Course | **Project Seminar E-Mobility** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3400 – Project Seminar E-Mobility** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | seminar, laboratory work | | |
| | Number SWH | 0 lectures + 0 seminar-style tuition + 0 exercise+ 2 laboratory + 2 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h Preparation and follow-up course work, independent study, documentation of the experimental work | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | Fundamentals of power electronics and content of the module "Control of Electrical Drives" | | |
| Examination procedure | | Experimental work, 90 h (Experimentelle Arbeit 90 h) | | |
| Learning outcomes | | The students are aware of fundamental concepts of E-Mobility and possess basic knowledge in the fields of electrical drives, electrical storage technologies and fuel cell technique. They are able to practically apply this knowledge to real vehicles. | | |
| Content | | Fundamentals of drive and carrier mechanics, fundamentals of electrical drives, fundamentals of hydrogen and storage technologies (battery and ultra capacitors), practical work on vehicle including sizing and test of single components | | |
| Literature /references | | Will be announced during lecture. | | |

| | | | | |
|---|---|---|---|---|
| Course | **Current subjects of renewable energy use I** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3410 – Current subjects of renewable energy use I** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester (3S, 4SwP) 3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Seminar and self-study, exercises and laboratory | | |
| | Number SWH | 0 lectures + 0 seminar-style tuition + 1 exercise+ 1 laboratory + 2 seminar | | |
| Work load | Presence study | 64 h contact time | | Σ 180 h |
| | Self-study | 116 h Preparation and follow-up course work, independent study, documentation of the experimental work | | |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Oral exam, 30 min (Mündliche Prüfung, 30 min) | | |
| Learning outcomes | | The aim of the module is that the students know and can classify new developments in the field of renewable energy. They are able to integrate the different types of renewable energy into the solution of practical tasks and are thus optimally prepared for the practice. | | |
| Content | | In the field of renewable energy a fast development can be observed. This applies to process development, realization of new system and automation concepts and the construction of new plants in practice. The aim of the module is to make the students familiar with new developments and to prepare them optimally for their practice. For this purpose, lecturers from the industry as well as from research institutions and from abroad are in cooperation with the university and will give lectures and support laboratory work. | | |
| Literature /references | | Will be announced during lecture. | | |

| | | | | |
|---|---|---|---|---|
| Course | **Current subjects of renewable energy use II** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3420 – Current subjects of renewable energy use II** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester (3S, 4SwP) 3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Lectures and self-study, exercises and laboratory | | |
| | Number SWH | 0 lectures + 0 seminar-style tuition + 1 exercise+ 1 laboratory + 2 seminar | | |
| Work load | Presence study | 64 h contact time | | Σ 180 h |
| | Self-study | 116 h Preparation and follow-up course work, independent study, documentation of the experimental work | | |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Oral exam, 30 min (Mündliche Prüfung, 30 min) | | |
| Learning outcomes | | The aim of the module is that the students know and can classify new developments in the field of renewable energy. They are able to integrate the different types of renewable energy into the solution of practical tasks and are thus optimally prepared for the practice | | |
| Content | | In the field of renewable energy a fast development can be observed. This applies to process development, realization of new system and automation concepts and the construction of new plants in practice. The aim of the module is to make the students familiar with new developments and to prepare them optimally for their practice. For this purpose, lecturers from the industry as well as from research institutions and from abroad are in cooperation with the university and will give lectures and support laboratory work. | | |
| Literature /references | | Will be announced during lecture. | | |

| | | | | |
|---|---|---|---|---|
| Course | **Advanced Power Electronics** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3500 - Advanced Power Electronics** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Seminar, exercise, laboratory and work follow-up course work | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 1 exercise+ 1 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and post-lecture work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | Fundamentals of power electronics | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur 2 h und Übungsschein) | | |
| Learning outcomes | | The students can distinguish between different DC/DC power converter topologies as part of switched mode power supplies. They can describe in principle basic three phase converter topologies including multiphase variations. The students understand the fundamentals of pulse width modulation and can apply corresponding control algorithms to the most common three phase converter topologies. | | |
| Content | | Power converter topologies of DC/DC converters for different switched mode power supplies are presented including zero current or voltage switching control schemes. In a succeeding chapter three phase power converters are developed and corresponding multilevel topologies are introduced.<br>As basic pulse width modulation methods for three phase applications space vector and subharmonic modulation methods are explained and finally compared with each other. | | |
| Literature /references | | Trzynadlowski, A. M.: Introduction to Modern Power Electronics, John Wiley & Sons, 2016.<br>Mohan, N., Undeland, T.M., Robbins, W. P.: Power Electronics: Converters, Applications, and Design, John Wiley & Sons, 2002. | | |

| | | | | |
|---|---|---|---|---|
| Course | **Project Renewable Energy** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3610 – Project Renewable Energy** | | |
| | Language | English, optional German possible | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st or 2nd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Seminaristic working form | | |
| | Number SWH | 0 lectures + 0 seminar-style tuition + 0 exercise+ 3 laboratory + 1 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h Preparation and follow-up course work, independent study, documentation of the experimental work | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | | | |
| Examination procedure | | Experimental work, 90 h (Experimentelle Arbeit, 90 h) | | |
| Learning outcomes | | In the context of a project work, professional competence as well as competencies in methods and personnel are acquired. Students are given the opportunity to independently work on a larger project in the field of renewable energies, to organize themselves and their projects, and to deal appropriately with the team with criticism and conflicts. | | |
| Content | | Topics are given by the lecturers | | |
| Literature /references | | Literature will be announced during lecture | | |

| | | | | |
|---|---|---|---|---|
| Course | **Control of Electrical Drives** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM3700 - Control of Electrical Drives** | | |
| | Language | English | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 1st or 3rd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Lecture and post-lecture work, exercise, laboratory work | | |
| | Number SWH | 0 lectures + 0 seminar-style tuition + 1 exercise+ 1 laboratory + 2 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h preparative and post-lecture work, individual studies, examination preparation | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | Fundamental of electrical machines and control engineering | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur 2 h und Übungsschein) | | |
| Learning outcomes | | The students can apply basic speed control methods to electrical drives comprising field oriented stator current control techniques. They are able to implement such control methods to different machine types such as induction and synchronous (reluctance) machines. | | |
| Content | | Space vector model of various electrical three phase machines. Efficiency optimized field oriented speed control of induction machines as well as synchronous (reluctance) machines, general (sensorless) speed control methods for three phase machines | | |
| Literature /references | | Advanced Electrical Drives: Analysis, Modeling, Control (Power Systems), Springer, 2010, De Doncker, R.<br>Control of Electrical Drives, Springer, 2001, Leonhard, W. | | |

| | | | | |
|---|---|---|---|---|
| Course | **Vehicle Management Systems** | | | Quality/Degree: Master Sc. |
| | Course, symbol, title | **REEMM 5400 - Vehicle Management Systems** | | |
| | Language | English, optional German possible | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | |
| | Semester | 2nd semester | Regular semester | 2nd semester (3S, 4SwP) 3rd semester (4SwoP) |
| | Duration | 1 semester | frequency | Annual |
| | | | compulsory / elective | elective |
| Educational methods/SWH | Methods | Exercise, laboratory, seminar | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 1 exercise+ 1 laboratory + 0 seminar | | |
| Work load | Presence study | 64 h contact time | | |
| | Self-study | 116 h Preparation and wrap-up, independent study, documentation of the experimental work | | Σ 180 h |
| ECTS-points | | 6 | | |
| prerequisite according study regulations | | | | |
| Additional recommended requirements | | Basics in Control Theory, Basics in MATLAB/SIMULINK | | |
| Examination procedure | | Written exam, 2 h and certificate of laboratory work (Klausur, 2 h und Übungsschein) | | |
| Learning outcomes | | After completion of the module, the students are able to describe the vehicle management systems function as well as to implement software algorithms using advanced control technology (optimal and non-linear controls as well as control in the state space) and their embedded implementation by means of the software engineering tool MATLAB / SIMULINK. The concept of the "vehicle" is extended to include cars, aircrafts and maritime systems of civilian and military or defense use. The students are to be enabled to abstract, conceptual, as well as signal related and system theoretical thinking in relations and gain access to transfer skills and problem solving skills. | | |
| Content | | Energy management, optimized accessories, Engine control units, On-Board-Diagnose System design using optimal, nonlinear and state space controllers for automotive dynamic control systems for: Automotive systems (Speed control, distance control, …) Integrated navigational systems for vessels (Navy-, cargo-, passenger vessels) and submarines and their weapon guidance systems as well as flight control systems for combat aircrafts, guided missiles and ballistic missiles | | |
| Literature /references | | ALKIN, Oktay. Signals and Systems. Hoboken: CRC Press, 2014, Description based upon print version of record. ISBN: 9781466598539. M. ETTER, Delores. Introduction to MATLAB®. Anju Mishra. 3. edition, global edition ed. | | |

| | |
|---|---|
| | Hoboken, NJ [u.a.]: Pearson, 2015. Always learning. F. FRANKLIN, Gene, DAVID POWELL, J. y ABBAS EMAMI-NAEINI, . Feedback control of dynamic systems. H. S. Sanjay. 7. ed., Global ed. ed. Boston, Mass. [u.a.]: Pearson, 2015. Always learning. Authorized adaptation from the United States edition.<br>L. PHILLIPS, Charles. Digital control system analysis & design. H. Troy Nagle and Aranya Chakrabortty. Fourth edition, global edition ed. Boston: Pearson, 2015. Always learning.<br>G. WEBSTER, John. Measurement, Instrumentation, and Sensors Handbook, Second Edition. Halit Eren. 2nd ed ed. Hoboken: Taylor and Francis, 2014, Description based upon print version of record. ISBN: 9781439848913. Measurement, instrumentation, and sensors handbook. John G. Webster and Halit Eren. 2. ed. ed. Boca Raton, Fla. [u.a.]: CRC Press, 2014. Includes bibliographical references and index. ISBN: Spatial, mechanical, thermal, and radiation measurement.<br>GRAHAM C. GOODWIN, STEFAN F. GRAEBE, MARIO E. SALGADO: Control System Design. Prentice Hall. ISBN: 0-13-958653-9.<br>KATSUHIKO OGATA: Modern Control Engineering. Prentice Hall. ISBN: 0-13-060907-2.<br>RICHARD C. DORF, ROBERT H. BISHOP: Modern Control Systems. Prentice Hall. ISBN: 0-13-127765-0 |

| | | | | | |
|---|---|---|---|---|---|
| Course | **Vehicle Simulation & Test Drive** | | | Quality/Degree: Master Sc. | |
| | Course, symbol, title | **REEMM5500 - Vehicle Simulation & Test Drive** | | | |
| | Language | English, optional German possible | | | |
| Assignment to the curriculum | Programme | Renewable Energy and E-Mobility | | | |
| | Semester | 1st or 2nd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) | |
| | Duration | 1 semester | frequency | Annual | |
| | | | compulsory / elective | elective | |
| Educational methods/SWH | Methods | Laboratory, seminar | | | |
| | Number SWH | 0 lectures + 2 seminar-style tuition + 0 exercise+ 2 laboratory + 0 seminar | | | |
| Work load | Presence study | 64 h contact time | | | |
| | Self-study | 116 h Preparation and wrap-up, independent study, documentation of the experimental work | | | Σ 180 h |
| ECTS-points | | 6 | | | |
| prerequisite according study regulations | | | | | |
| Additional recommended requirements | | Automotive Engineering I/II or comparable previous knowledge | | | |
| Examination procedure | | Experimental work, 30 h (Experimentelle Arbeit, 30 h) | | | |

| | |
|---|---|
| Learning outcomes | The student is able to model a vehicle and the surroundings (road and traffic), then perform a vehicle dynamic simulation on a computer and verify the results in experimental investigations. |
| Content | Presentation of different simulation programs for the interpretation of the driving behavior of motor vehicles, modeling of own developments, simulation calculation of existing test vehicles and experimental verification of the results. |
| Literature /references | Milliken, W., Milliken, D. L.: Race Car Vehicle Dynamics, SAE, Inc. ISBN 1-56091-526-9.<br>Gillespie, Th.D.: Fundamentals of Vehicle Dynamics. Warrendale: SAE, Inc. 1992<br>Fenton, J. Handbook of vehicle design analysis,1996, ISBN 0 85298 963 6<br>Further literature will be announced during the course |

| | | | | | |
|---|---|---|---|---|---|
| Course | **Human Resources Management** | | | Quality/Degree: Master Sc. | |
| | Course, symbol, title | **WMSSDM3000 - Human Resources Management** | | | |
| | Language | English | | | |
| Assignment to the curriculum | Programme | Simulation and System Design<br>Renewable Energy and E-Mobility | | | |
| | Semester | 1st or 3rd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) | |
| | Duration | 1 semester | frequency | Annual | |
| | | | compulsory / elective | elective | |
| Educational methods/SWH | Methods | Seminar-style lecture (Seminaristischer Unterricht) | | | |
| | Number SWH | 0 lectures + 4 seminar-style tuition + 0 exercise + 0 laboratory + 0 seminar | | | |
| Work load | Presence study | 64 h contact time | | | |
| | Self-study | 116 h | | | Σ 180 h |
| ECTS-points | | 6 | | | |
| prerequisite according study regulations | | | | | |
| Additional recommended requirements | | | | | |
| Examination procedure | | Case study incl. presentation 116 hours; for alternative forms of examination see examination regulation<br>(Fallstudie 116 Stunden inklusive Präsentation; alternative Prüfungsleistungen siehe Fachprüfungsordnung SSD) | | | |
| Learning outcomes | | - Theoretical and empirical understanding of organizational and cultural conditions for HRM in a globalized world and esp. challenges refer to demographic change.<br>- Be able to provide and coordinate HRM activities to solve all tasks performed in an organization with respect to its goals and based on scientific methods and tools. | | | |

| | |
|---|---|
| Content | - Landscape/ HRM concepts/ Distinction IHRM<br>- Organizational, cultural and societal context<br>- Diversity Management<br>- Intercultural training<br>- Strategic HRM |
| Literature /references | Bohlander, G.W.; Snell, S.A. (2012): Principles of Human Resource Management. 16th edition. South Western Learning.<br>Bourdieu, P. (1986): Ökonomisches Kapital, kulturelles Kapital, soziales Kapital. In: Soziale Ungleichheiten (Soziale Welt, Sonderheft 2), edited by Reinhard Kreckel.<br>Goettingen: Otto Schartz & Co.. 1983. pp. 183 -98. The article appears here for the first time in English. Translated by Richard Nice.<br>Hofstede, G. (2001), Culture's Consequence, Thousand Oaks, CA: Sage Publications.<br>Hofstede, G. (2002), "Images of Europe: Past, Present and Future", in: Warner M., Joynt P. (eds), Managing Across Cultures. Padstow: Thompson.<br>Rothlauf, J. (2014): A global view on intercultural management. Oldenbourg |

| | | | | | |
|---|---|---|---|---|---|
| Course | **International Accounting** | | | Quality/Degree: Master Sc. | |
| | Course, symbol, title | **SSDM3500 - International Accounting** | | | |
| | Language | English | | | |
| Assignment to the curriculum | Programme | Simulation and System Design<br>Renewable Energy and E-Mobility | | | |
| | Semester | 1st or 3rd semester | Regular semester | 2nd semester (3S, 4SwP)<br>3rd semester (4SwoP) | |
| | Duration | 1 semester | frequency | Annual | |
| | | | compulsory / elective | elective | |
| Educational methods/SWH | Methods | independent scientific work | | | |
| | Number SWH | 2 lectures + 0 seminar-style tuition + 2 exercise + 0 laboratory + 0 seminar | | | |
| Work load | Presence study | 64 h contact time | | | |
| | Self-study | 116 h | | | Σ 180 h |
| ECTS-points | | 6 | | | |
| prerequisite according study regulations | | | | | |
| Additional recommended requirements | | basic knowledge of accounting practices | | | |
| Examination procedure | | written exam 120 minutes<br>(Klausur 120 Minuten) | | | |
| Learning outcomes | | The students get a comprehensive introduction to financial | | | |

| | |
|---|---|
| | reporting according the International Financial Reporting Standards (IFRS). They learn how the standards are used in the preparation of financial statements. The students understand the underlying concepts of Accounting using IFRS. They are able to solve easy and moderately difficult accounting problems. |
| Content | • regulatory framework,<br>• IASB conceptual framework,<br>• financial reporting in practice, e.g. accounting of property, plant and equipment, intangible assets, inventories, long-term production orders, financial instruments, provisions, deferred items<br>• additional instruments of international financial reporting, e.g. cash flow statement, segment reporting |
| Literature /references | Harrison, Walter T., Horngreen Charles T., Thomas, C. William, Themin Suwardy: Financial Accounting. International Financial Reporting Standards, Pearson, 9. ed., 2013<br>Kolitz, David: Financial Accounting. A Concepts-Based Introduction, Routledge, 2016<br>Melville, Alan: International Financial Reporting: A Practical Guide, Pearson, 5. ed., 2015<br>Weygandt, Jerry J., Kimmel, Paul D., Kieso, Donald E.: Financial Accounting. IFRS Edition, Wiley, 3 ed., 2015 |

Explanation:

3S = 3-semester variant (3-semestrige Variante)

4SwP = 4-semester variant with internship semester (4-semestrige Variante mit Praxissemester)

4SwoP = 4-semester variant without internship semester (4-semestrige Variante ohne Praxissemester)

## Curricula

### Curriculum for the 3-Semester-Model

This study plan is valid for matriculation in the summer semester. If the matriculation is in the winter semester, the first and second semesters must be exchanged.

| Module | Type | 1. | 2. | 3. | SWH | ECTS |
|---|---|---|---|---|---|---|
| **Mathematical-scientific and technical bases** | | | | | **8** | **12** |
| REEMM1100 - Selected Chapters of Mathematics | CM | 4+0 | | | 4 | 6 |
| REEMM1300 - System Theory | CM | | 4+0 | | 4 | 6 |
| **Specialized technical bases of renewable energy** | | | | | **8** | **12** |
| REEMM1400 - Renewable Energy Systems | CM | 4+0 | | | 4 | 6 |
| REEMM2200 - Methods of Power Engineering | CM | | 3+1 | | 4 | 6 |
| **Application-oriented profiling, elective modules** | | | | | **20** | **30** |
| REEMM2010 - Elective Module (AO) I | EM | 4 | | | 4 | 6 |
| REEMM2020 - Elective Module (AO) II | EM | | 4 | | 4 | 6 |
| REEMM2030 - Elective Module (AO) III | EM | | 4 | | 4 | 6 |
| REEMM2040 - Elective Module (AO) IV | EM | | 4 | | 4 | 6 |
| REEMM2060 - Elective Module (F) I | EM | 4 | | | 4 | 6 |
| **Interdisciplinary qualifications (1 from 2)** | | | | | **4** | **6** |
| REEMM3600 - Quality in Automotive Industry | EM *) | 3+1 | | | 4 | 6 |
| REEMM3800 - Energy and Environmental Management | EM *) | | 3+1 | | 4 | 6 |
| **Master-Thesis with colloquium** | P | | | 6M | **6M** | **30** |
| | | | | | | |
| **Total** | | **20** | **20** | **6M** | **40 + 6M** | **90** |

### Curriculum for the 4-Semester-Model with Internship Semester

| Module | Type | 1. | 2. | 3. | 4 | SWH | ECTS |
|---|---|---|---|---|---|---|---|
| **Mathematical-scientific an technical bases** | | | | | | **8** | **12** |
| REEMM1100 - Selected Chapters of Mathematics | CM | 4+0 | | | | 4 | 6 |
| REEMM1300 - System Theory | CM | | 4+0 | | | 4 | 6 |
| **Specialized technical bases of renewable energy** | | | | | | **8** | **12** |
| REEMM1400 - Renewable Energy Systems | CM | 4+0 | | | | 4 | 6 |
| REEMM2200 - Methods of Power Engineering | CM | | 3+1 | | | 4 | 6 |
| **Application-oriented profiling, elective modules** | | | | | | **20** | **30** |
| REEMM2010 - Elective Module (AO) I | EM | 4 | | | | 4 | 6 |
| REEMM2020 - Elective Module (AO) II | EM | | 4 | | | 4 | 6 |
| REEMM2030 - Elective Module (AO) III | EM | | 4 | | | 4 | 6 |
| REEMM2040 - Elective Module (AO) IV | EM | | 4 | | | 4 | 6 |
| REEMM2060 - Elective Module (F) I | EM | 4 | | | | 4 | 6 |
| **Interdisciplinary qualifications (1 from 2)** | | | | | | **4** | **6** |
| REEMM3600 - Quality in Automotive Industry | EM *) | 3+1 | | | | 4 | 6 |
| REEMM3800 - Energy and Environmental Management | EM *) | | 3+1 | | | 4 | 6 |
| **Internship semester** | P | | | 21W | | **21W** | **30** |
| **Master-Thesis with colloquium** | P | | | | 6M | **6M** | **30** |
| | | | | | | | |
| **Total** | | **20** | **20** | **5M** | **6M** | **40+11M** | **120** |

**Curriculum for the 4-Semester-Model without Internship Semester**

| Module | Type | 1. | 2. | 3. | 4 | SWH | ECTS |
|---|---|---|---|---|---|---|---|
| **Mathematical-scientific an technical bases** | | | | | | **8** | **12** |
| REEMM1100 - Selected Chapters of Mathematics | CM | 4+0 | | | | 4 | 6 |
| REEMM1300 - System Theory | CM | | 4+0 | | | 4 | 6 |
| **Specialized technical bases of renewable energy** | | | | | | **8** | **12** |
| REEMM1400 - Renewable Energy Systems | CM | 4+0 | | | | 4 | 6 |
| REEMM2200 - Methods of Power Engineering | CM | | 3+1 | | | 4 | 6 |
| **Application-oriented profiling, elective modules** | | | | | | **32** | **48** |
| REEMM2010 - Elective Module (AO) I | EM | 4 | | | | 4 | 6 |
| REEMM2020 - Elective Module (AO) II | EM | | 4 | | | 4 | 6 |
| REEMM2030 - Elective Module (AO) III | EM | | 4 | | | 4 | 6 |
| REEMM2040 - Elective Module (AO) IV | EM | | 4 | | | 4 | 6 |
| REEMM2050 - Elective Module (AO) V | EM | | | 4 | | 4 | 6 |
| REEMM2060- Elective Module (F) I | EM | 4 | | | | 4 | 6 |
| REEMM2070 - Elective Module (F) II | EM | | | 4 | | 4 | 6 |
| REEMM2080 - Elective Module (F) III | EM | | | 4 | | 4 | 6 |
| **Interdisciplinary qualifications (1 from 2)** | | | | | | **4** | **6** |
| REEMM3600 - Quality in Automotive Industry | EM *) | 3+1 | | | | 4 | 6 |
| REEMM3800 - Energy and Environmental Management | EM *) | | 3+1 | | | 4 | 6 |
| **REEMM4100 Project work** | P | | | 360h | | **360h** | **12** |
| **Master-Thesis with colloquium** | P | | | | 6M | **6M** | **30** |
| | | | | | | | |
| **Total** | | **20** | **20** | **12 +360h** | **6M** | **52+6M +360h** | **120** |

**Explanations:**

Open list of elective modules (AO) (according to §6 of the regulations of study programme):

- Hydrogen Technology
- Solar Systems
- Wind Power Plants
- Advanced Power Electronics
- Vehicle Management Systems
- Control of electrical drives
- Project Seminar E-Mobility
- Current subjects of renewable energy use I and II
- Project Renewable Energy
- Sustainable non-fossil mobility
- Vehicle Simulation & Test Drive

Open list of elective modules (F) (according to §6 of the regulations of study programme):

- Selected Topics of Control Engineering
- Power Electronics
- International Accounting
- Electrical Energy Conversion and Transmission
- Modelling of Physical Systems
- Human Resources Management
- This list also contains all modules of the list AO.
- It is also possible to choose one of the modules "Quality in Automotive Industry" or "Energy and Environmental Management" if it was not chosen in the category interdisciplinary qualifications.

CM = Compulsory module, Pflichtmodul

EM = Elective module, Wahlpflichtmodul

*) = One of these two modules must be selected; on request, additional modules from the area of "Interdisciplinary qualification" from other Master's degree courses in the Department of Electrical Engineering and Computer Science can also be selected

6M = 6 months

360h = 360 hours

x + y = Lecture-/seminar-style tuition- / exercise hours + laboratory-/seminar hours

The subdivision of the semester week hours (SWH) during lecture-/ seminar-style tuition- / exercise hours + laboratory-/seminar hours is a proposal, which can be varied by the instructor in his / her own direction.

## Use of the modules in other programs

| Module | Elective/ Compulsory in REEMM | Use in other Programs | Elective/ Compulsory in the other program | SWH | ECTS |
|---|---|---|---|---|---|
| REEMM1100 - Selected Chapters of Mathematics | CM | SSDM | CM | **4** | **6** |
| REEMM1300 - System Theory | CM | - | | **4** | **6** |
| REEMM1400 - Renewable Energy Systems | CM | - | | **4** | **6** |
| REEMM1700 - Solar Systems | EM | - | | **4** | **6** |
| REEMM2110 - Selected Topics of control engineering | EM | - | | **4** | **6** |
| REEMM2120 - Electrical Energy Transmission | EM | - | | **4** | **6** |
| REEMM2130 - Power Electronics | EM | - | | **4** | **6** |
| REEMM2140 - Modelling of Physical Systems | EM | - | | **4** | **6** |
| REEMM2200 - Methods of Power Engineering | CM | ETM-EE<br>ETM-AE | CM<br>EM | **4** | **6** |
| REEMM3000 - Wind Power Plants | EM | ETM | EM | **4** | **6** |
| REEMM3100 - Hydrogen Technology | EM | ETM | EM | **4** | **6** |
| REEMM3200 - Fuel Cell Systems | EM | ETM | EM | **4** | **6** |
| REEMM3300 - Sustainable non-fossil mobility | EM | ETM | EM | **4** | **6** |
| REEMM3400 - Project Seminar E-Mobility | EM | ETM | EM | **4** | **6** |
| REEMM3410 - Current subjects of renewable energy use I | EM | ETM | EM | **4** | **6** |
| REEMM3420 - Current subjects of renewable energy use II | EM | ETM | EM | **4** | **6** |
| REEMM3500 - Advanced Power Electronics | EM | ETM | EM | **4** | **6** |
| REEMM3600 - Quality in Automotive Industry | EM | SSDM | EM | **4** | **6** |
| REEMM3700 - Control of Electrical Drives | EM | ETM | EM | **4** | **6** |
| REEMM3800 - Energy and Environmental Management | EM | ETM | EM | **4** | **6** |
| REEMM5400 - Vehicle Management Systems | EM | SSD<br>ETM | CM<br>EM | **4** | **6** |
| REEMM5500 - Vehicle Simulation and Test Drive | EM | SSDM,<br>ETM | EM | **4** | **6** |
| SSDM3500 - International Accounting | EM | SSDM | CM | **4** | **6** |
| WMSSDM - Human Resources Management | EM | SSDM | EM | **4** | **6** |

**Explanations:**

ETM: Master Program Electrical Engineering
SSDM: Master Program Simulation and System Design