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# B.Sc. Electrical Engineering and Information Technology (PO 2014)

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**Module manual**

Date: 01.09.2021



TECHNISCHE  
UNIVERSITÄT  
DARMSTADT

Department of Electrical Engineering  
and Information Technology

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Module manual: B.Sc. Electrical Engineering and Information Technology (PO 2014)

Date: 01.09.2021

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# 1 Fundamentals of Electrical Engineering and Information Technology

|  |  |   |  |                        |                              |
|--|--|---|--|------------------------|------------------------------|
| <b>Module name</b><br>Introductory Project |  |   |  |                        |                              |
| <b>Module Nr.</b><br>18-de-1010            | <b>Credit Points</b><br>2 CP   | <b>Workload</b><br>60 h                                   | <b>Self study</b><br>30 h                              | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                  |  |   | <b>Module owner</b><br>Prof. Dr.-Ing. Harald Klingbeil |                        |                              |
| <b>1</b>                                   | <b>Content</b><br>Based on a complex technical problem students will get to know an idea of the diversity of electrical and information engineering. The introductory project gives a perspective of the upcoming course of studies. It gives an introduction in engineering thinking and working. Groups of students will work in teams for one complete week. Each group of students will be accompanied by a team- and a technical tutor. |   |  |                        |                              |
| <b>2</b>                                   | <b>Learning objectives / Learning Outcomes</b><br>Students get to know problem analysis, information acquisition, team work, project management, and presentation of results.  |   |  |                        |                              |
| <b>3</b>                                   | <b>Recommended prerequisite for participation</b>  |   |  |                        |                              |
| <b>4</b>                                   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Oral Examination, Duration: 15 min, Pass/Fail Grading System)</li> </ul>  |   |  |                        |                              |
| <b>5</b>                                   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Oral Examination, Weighting: 100 %)</li> </ul>  |   |  |                        |                              |
| <b>6</b>                                   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST  |   |  |                        |                              |
| <b>7</b>                                   | <b>Grade bonus compliant to §25 (2)</b>  |   |  |                        |                              |
| <b>8</b>                                   | <b>References</b><br>lecture notes (will be handed out)  |   |  |                        |                              |
| <b>Courses</b>                             |  |   |  |                        |                              |
|  | <b>Course Nr.</b><br>18-de-1010-pj   | <b>Course name</b><br>Introductory Project (Project Week) |  |                        |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Harald Klingbeil, M. A. Stephanie Bockshorn, Dipl.-Soz. Goran Beil   |   |  | <b>Type</b><br>Project | <b>SWS</b><br>2              |

|   |  |   |  |                         |                              |
|---|--|---|--|-------------------------|------------------------------|
| <b>Module name</b><br>Electrical Engineering and Information Technology I |  |   |  |                         |                              |
| <b>Module Nr.</b><br>18-hs-1070   | <b>Credit Points</b><br>7 CP   | <b>Workload</b><br>210 h  | <b>Self study</b><br>135 h                         | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German   |  |   | <b>Module owner</b><br>Prof. Dr.-Ing. Jutta Hanson |                         |                              |
| <b>1</b>  | <b>Content</b><br>Units and Equations: Unit systems, equation writing.<br>Basic definitions: Charge, current, voltage, resistance, energy and power.<br>Currents and voltages in electrical circuits: Ohmic law, node and mesh equations, parallel and series connections, current and voltage measurement, linear and nonlinear elements, superposition method, star-delta-transformation, node and mesh analysis in linear circuits, controlled sources.<br>AC systems: Time-dependent currents and voltages, steady-state mode sinusoidal currents and voltages in linear RLC-circuits, phasor diagrams, resonances in RLC circuits, AC power, locus diagrams, two-port networks, transformer, polyphase systems. |   |  |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students will be able after visiting this lecture<br>* to utilize the basic equations in electrical engineering,<br>* to determine the currents and voltages in linear and nonlinear circuits,<br>* to analyze DC and AC systems,<br>* to calculate simple filter and resonant circuits,<br>* to apply the complex calculation in electrical AC systems.   |   |  |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>  |   |  |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)  |   |  |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)  |   |  |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc. ETiT, BSc iST, BSc MEC, BSc. Wi-ETiT, BSc CE, LA Physik/Mathematik   |   |  |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |   |  |                         |                              |
| <b>8</b>  | <b>References</b><br>Frohne, H. u.a. Moeller Grundlagen der Elektrotechnik<br>Clausert, H. u.a. Grundgebiete der Elektrotechnik 1 + 2  |   |  |                         |                              |
| <b>Courses</b>  |  |   |  |                         |                              |
|   | <b>Course Nr.</b><br>18-hs-1070-vl   | <b>Course name</b><br>Electrical Engineering and Information Technology I |  |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Jutta Hanson   |   |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|   | <b>Course Nr.</b><br>18-hs-1070-ue   | <b>Course name</b><br>Electrical Engineering and Information Technology I |  |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Jutta Hanson   |   |  | <b>Type</b><br>Practice | <b>SWS</b><br>2              |



| <b>Module name</b><br>Electrical Engineering and Information Technology Lab I |  |                 |   |                 |                      |
|---|--|-----------------|---|-----------------|----------------------|
| <b>Module Nr.</b>   | <b>Credit Points</b>   | <b>Workload</b> | <b>Self study</b>                             | <b>Duration</b> | <b>Cycle offered</b> |
| 18-kn-1040  | 4 CP   | 120 h           | 60 h  | 2               | WiSe                 |
| <b>Language</b><br>German   |  |                 | <b>Module owner</b><br>Prof. Dr. Mario Kupnik |                 |                      |
| <b>1</b>  | <b>Content</b><br>After a safety instruction for electrical equipment, students do lab experiments covering foundations of electrical engineering by using theoretical and experimental instructions to improve basic electrical understanding. Building up a test set autonomously and performing of measurements and evaluations in the form of logs to confirm the theoretical knowledge and lead to independent work in practice.<br>The following experiments are performed: <ul style="list-style-type: none"> <li>• Investigate real behavior of ohmic resistors</li> <li>• Investigate real behavior of capacitors and inductors</li> <li>• Calculate impedances of basic two-terminal circuits using network theory</li> <li>• Measure of electrical power in AC circuits and investigate in the real behaviour of transformers</li> <li>• DC technology, capacity and inductors, AC technology - Impedances and two-terminal circuits, transformer &amp; power;</li> </ul> |                 |   |                 |                      |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>After preparing the afternoons independently and self-implementing the measurement setup and measurement tasks by active participation in the practical group and by thorough preparation of the associated measurement protocols, you should be able to: <ul style="list-style-type: none"> <li>• Perform the measurement of basic electrical parameters of DC and AC circuits, independently and in compliance with safety rules</li> <li>• measuring the frequency response of passive electrical networks and resonant circuits, and electric power measurement</li> <li>• the measurement of circuits for the determination of magnetic, electro-thermal and high-frequency. You have to be able to build and run your own measurements</li> <li>• interpretations of the measurement results in terms of its technical meaning, but also their accuracy and error sources safely.</li> </ul>                                 |                 |   |                 |                      |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Parallel attending the lectures and exercises, "Electrical Engineering I and II"  |                 |   |                 |                      |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |                 |   |                 |                      |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |                 |   |                 |                      |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT  |                 |   |                 |                      |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |                 |   |                 |                      |
| <b>8</b>  | <b>References</b><br>detailed script with instructions for the experiments; Clausert, H. / Wiesemann, G.: Grundgebiete der Elektrotechnik, Oldenbourg, 1999  |                 |   |                 |                      |
| <b>Courses</b>  |  |                 |   |                 |                      |

|  |   |  |                           |                 |
|--|---|--|---------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-kn-1040-pr          | <b>Course name</b><br>Electrical Engineering and Information Technology Lab I A                          |                           |                 |
|  | <b>Instructor</b><br>Prof. Dr. Mario Kupnik |  | <b>Type</b><br>Internship | <b>SWS</b><br>2 |
|  | <b>Course Nr.</b><br>18-kn-1041-pr          | <b>Course name</b><br>Electrical Engineering and Information Technology Lab I B                          |                           |                 |
|  | <b>Instructor</b><br>Prof. Dr. Mario Kupnik |  | <b>Type</b><br>Internship | <b>SWS</b><br>2 |
|  | <b>Course Nr.</b><br>18-kn-1040-tt          | <b>Course name</b><br>Electrical Engineering and Information Technology I, Safety instructions and rules |                           |                 |
|  | <b>Instructor</b><br>Prof. Dr. Mario Kupnik |  | <b>Type</b><br>Tutorial   | <b>SWS</b><br>0 |

|  |   |                          |  |                      |                              |
|--|---|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Electrical Engineering and Information Technology II |   |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-gt-1020  | <b>Credit Points</b><br>7 CP  | <b>Workload</b><br>210 h | <b>Self study</b><br>135 h                             | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German  |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Gerd Griepentrog |                      |                              |
| <b>1</b>   | <b>Content</b><br>Electrostatic fields; stationary electrical flow fields; stationary magnetic fields; temporally variable magnetic fields; capacitor networks, transmission lines  |                          |  |                      |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The students have detached themselves from the conception that all electrical procedures are line-bound; they have a clear idea of the field term, can read and interpret field plots and also design simple field plots themselves; they understand the difference between a curl and a divergence field, can describe this difference mathematically and are able to recognize the field type from a mathematical description, respectively; they are able to calculate field distributions for simple rotationally symmetric arrangements analytically; they can deal surely with the definitions of the electrostatic, the electrical quasi-static, the magnetostatic and the magneto-electric field; they have recognized the connection and dualism of electricity and magnetism; they control the mathematical apparatus necessary for their description and can apply it to simple examples; they can calculate with nonlinear magnetic circuits; they can compute inductance, capacity and resistance of simple geometrical arrangements and understand them now as physical characteristics of the respective arrangement; they have recognized, how different forms of energy can be transferred into each other and are thereby already able to solve simple scientific engineering problems; they have understood the underlying physical backgrounds for many applications of electrical engineering and are able to describe them mathematically, develop it further in a simple way and apply it to other examples; they are familiar with the system of Maxwell's equations and can transfer them from the integral into the differential form; they have a first idea of the importance of Maxwell's equations for all conceptual formulations of electrical engineering and they understand the propagation of electromagnetic waves in the free space and on transmission lines |                          |  |                      |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Electrical Engineering and Information Technology I  |                          |  |                      |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |  |                      |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |                          |  |                      |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc Wi-ETiT, LA Physik/Mathematik, BSc CE, BSc iST  |                          |  |                      |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b><br>Notenverbesserung entsprechend §25 (2) APB TU Darmstadt  |                          |  |                      |                              |
| <b>8</b>   | <b>References</b> <ul style="list-style-type: none"> <li>• Downloadable slides</li> <li>• Clausert, Wiesemann, Hinrichsen, Stenzel: „Grundgebiete der Elektrotechnik I und II“; ISBN 978-3-486-59719-6</li> <li>• Prechtel, A.: „Vorlesungen über die Grundlagen der Elektrotechnik – Band 2“ ISBN: 978-3-211-72455-2</li> </ul>  |                          |  |                      |                              |
| <b>Courses</b>   |   |                          |  |                      |                              |

|  |   |  |                         |                 |
|--|---|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-gt-1020-vl  | <b>Course name</b><br>Electrical Engineering and Information Technology II |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Gerd Griepentrog                        |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>3 |
|  | <b>Course Nr.</b><br>18-gt-1020-ue  | <b>Course name</b><br>Electrical Engineering and Information Technology II |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Gerd Griepentrog, M.Sc. Daniel Großmann |  | <b>Type</b><br>Practice | <b>SWS</b><br>2 |

|   |   |                          |  |                      |                              |
|---|---|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Deterministic Signals and Systems |   |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-kl-1010                         | <b>Credit Points</b><br>7 CP  | <b>Workload</b><br>210 h | <b>Self study</b><br>135 h                       | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                               |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Anja Klein |                      |                              |
| <b>1</b>  | <b>Content</b><br>Fourier Series: Motivation; Fourier series with real coefficients; Fourier series with complex coefficients; examples and applications<br>Fourier Transform: Motivation - Derivation from Fourier series - Dirichlet conditions - delta function - step function - properties of F-transform - special cases - examples and applications - transmissions systems - expansion into partial fractions<br>Convolution: Time invariant systems - convolution in frequency domain - Parseval's theorem - properties - examples and applications<br>Systems and Signals: Bandlimited and time limited systems - systems with only one energy store - examples and applications<br>Laplace Transform: Motivation - single sided L-transform - inverse L-transform - theorems of L-transform - examples and applications<br>Linear differential equations: Time invariant systems - rules - general differentiation - linear passive electrical networks - equivalent circuits for passive electrical elements - examples and applications<br>z-Transform: motivation - sampling - numerical order - definition - examples - transfer function - sampling theorem - examples and applications<br>Discrete Fourier Transform: motivation, derivation sampling, examples and applications |                          |  |                      |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>The student should understand the principles of integral transformations. He should apply them for the solution of physical problems. The techniques of this lecture are essential tools which will be needed in many follow-up lectures and exercises.   |                          |  |                      |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Elektrotechnik und Informationstechnik I und Elektrotechnik und Informationstechnik II   |                          |  |                      |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |  |                      |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |                          |  |                      |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc Wi-ETiT, LA Physik/Mathematik, BSc CE, BSc iST  |                          |  |                      |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |                          |  |                      |                              |
| <b>8</b>  | <b>References</b>   |                          |  |                      |                              |

A script of the lecture or slides respectively, will be provided in electronic form.

Basic Literature:

Wolfgang Preuss, "Funktionaltransformationen", Carl Hanser Verlag, 2002; Klaus-Eberhard Krueger "Transformationen", Vieweg Verlag, 2002;

H. Clausert, G. Wiesemann "Grundgebiete der Elektrotechnik 2", Oldenbourg, 1993; Otto Föllinger "Laplace-, Fourier- und z-Transformation", Hüthig, 2003;

T. Frey, M. Bossert, Signal- und Systemtheorie, Teubner Verlag, 2004

Further Literature:

Dieter Mueller-Wichards "Transformationen und Signale", Teubner Verlag, 1999

Exercises:

Hwei Hsu "Signals and Systems", Schaum's Outlines, 1995

#### Courses

|   |   |                         |                 |
|---|---|-------------------------|-----------------|
| <b>Course Nr.</b><br>18-kl-1010-vl  | <b>Course name</b><br>Deterministic Signals and Systems |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein, Prof. Dr.-Ing. Marius Pesavento |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3 |
| <b>Course Nr.</b><br>18-kl-1010-ue  | <b>Course name</b><br>Deterministic Signals and Systems |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein, Prof. Dr.-Ing. Marius Pesavento |   | <b>Type</b><br>Practice | <b>SWS</b><br>2 |

| <b>Module name</b>              |   |                                 |                                  |                 |                      |
|---------------------------------|---|---------------------------------|----------------------------------|-----------------|----------------------|
| Introduction to Electrodynamics |   |                                 |                                  |                 |                      |
| <b>Module Nr.</b>               | <b>Credit Points</b>  | <b>Workload</b>                 | <b>Self study</b>                | <b>Duration</b> | <b>Cycle offered</b> |
| 18-dg-1010                      | 5 CP  | 150 h                           | 90 h                             | 1               | SoSe                 |
| <b>Language</b>                 |   |                                 | <b>Module owner</b>              |                 |                      |
| German                          |   |                                 | Prof. Dr.-Ing. Herbert De Gersem |                 |                      |
| <b>1</b>                        | <b>Content</b><br>Vector calculus, orthogonal coordinate systems, Maxwell's equations, interface and boundary conditions, layered media, electrostatics, scalar potential, Coulomb integral, separation of variables, method of image charges, magnetostatics, vector potential, Biot-Savart law, stationary current fields, fields in matter, energy flow, skin effect, plane waves, polarization, TEM waves, reflection and multi-layer problems, multi conductor transmission lines (capacitance, inductance, and conductance matrix), velocity definitions, basics of rectangular waveguides. |                                 |                                  |                 |                      |
| <b>2</b>                        | <b>Learning objectives / Learning Outcomes</b><br>Students will be familiar with Maxwell's equations in integral and differential form for static and dynamic field problems. They will have a mental picture of wave phenomena in free space. They are able to recognize and interpret wave effects in the different areas of electrical engineering. They are able to derive the wave effects from Maxwell's equations and have a good understanding of the necessary mathematical tools.   |                                 |                                  |                 |                      |
| <b>3</b>                        | <b>Recommended prerequisite for participation</b><br>Lecture notes. Further literature recommendations are given in the course.   |                                 |                                  |                 |                      |
| <b>4</b>                        | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)</li> </ul>   |                                 |                                  |                 |                      |
| <b>5</b>                        | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |                                 |                                  |                 |                      |
| <b>6</b>                        | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT  |                                 |                                  |                 |                      |
| <b>7</b>                        | <b>Grade bonus compliant to §25 (2)</b><br>Improvement by up to 0.4 due to bonus points which can be acquired by means of e-learning online tests.  |                                 |                                  |                 |                      |
| <b>8</b>                        | <b>References</b><br>Lecture notes. Further literature recommendations are given in the course.   |                                 |                                  |                 |                      |
| <b>Courses</b>                  |   |                                 |                                  |                 |                      |
|                                 | <b>Course Nr.</b>   | <b>Course name</b>              |                                  |                 |                      |
|                                 | 18-dg-1010-vl   | Introduction to Electrodynamics |                                  |                 |                      |
|                                 | <b>Instructor</b>   |                                 |                                  | <b>Type</b>     | <b>SWS</b>           |
|                                 | Prof. Dr.-Ing. Herbert De Gersem  |                                 |                                  | Lecture         | 2                    |
|                                 | <b>Course Nr.</b>   | <b>Course name</b>              |                                  |                 |                      |
|                                 | 18-dg-1010-ue   | Introduction to Electrodynamics |                                  |                 |                      |
|                                 | <b>Instructor</b>   |                                 |                                  | <b>Type</b>     | <b>SWS</b>           |
|                                 | Prof. Dr.-Ing. Herbert De Gersem  |                                 |                                  | Practice        | 2                    |

|   |   |   |   |                         |                              |
|---|---|---|---|-------------------------|------------------------------|
| <b>Module name</b><br>Introduction to Electrodynamics |   |   |   |                         |                              |
| <b>Module Nr.</b><br>18-dg-1010                       | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h                              | <b>Self study</b><br>90 h                               | <b>Duration</b><br>1    | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                             |   |   | <b>Module owner</b><br>Prof. Dr.-Ing. Herbert De Gersem |                         |                              |
| <b>1</b>  | <b>Content</b><br>Vector calculus, orthogonal coordinate systems, Maxwell's equations, interface and boundary conditions, layered media, electrostatics, scalar potential, Coulomb integral, separation of variables, method of image charges, magnetostatics, vector potential, Biot-Savart law, stationary current fields, fields in matter, energy flow, skin effect, plane waves, polarization, TEM waves, reflection and multi-layer problems, multi conductor transmission lines (capacitance, inductance, and conductance matrix), velocity definitions, basics of rectangular waveguides. |   |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students will be familiar with Maxwell's equations in integral and differential form for static and dynamic field problems. They will have a mental picture of wave phenomena in free space. They are able to recognize and interpret wave effects in the different areas of electrical engineering. They are able to derive the wave effects from Maxwell's equations and have a good understanding of the necessary mathematical tools.   |   |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Lecture notes. Further literature recommendations are given in the course.   |   |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)</li> </ul>   |   |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |   |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT  |   |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b><br>Improvement by up to 0.4 due to bonus points which can be acquired by means of e-learning online tests.  |   |   |                         |                              |
| <b>8</b>  | <b>References</b><br>Lecture notes. Further literature recommendations are given in the course.   |   |   |                         |                              |
| <b>Courses</b>  |   |   |   |                         |                              |
|   | <b>Course Nr.</b><br>18-dg-1010-vl  | <b>Course name</b><br>Introduction to Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem   |   |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>2              |
|   | <b>Course Nr.</b><br>18-dg-1010-ue  | <b>Course name</b><br>Introduction to Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem   |   |   | <b>Type</b><br>Practice | <b>SWS</b><br>2              |



## 2 Fundamentals of Mathematics

|  |   |   |  |                                   |                                       |
|--|---|---|--|-----------------------------------|---------------------------------------|
| <b>Module name</b><br>Mathematics I (Electrical Engineering) |   |   |  |                                   |                                       |
| <b>Module Nr.</b><br>04-00-0108                              | <b>Credit Points</b><br>8 CP  | <b>Workload</b><br>240 h                                    | <b>Self study</b><br>150 h                                   | <b>Duration</b><br>1              | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                                    |   |   | <b>Module owner</b><br>Apl. Prof. Dr. rer. nat. Steffen Roch |                                   |                                       |
| <b>1</b>   | <b>Content</b><br>Basics, real and complex numbers, real functions, continuity, differential and integral calculus in one variable, vector spaces, linear mappings, systems of linear equations         |   |  |                                   |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b>  |   |  |                                   |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |   |  |                                   |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Technical Examination, Standard Grading System)</li> </ul> |   |  |                                   |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)</li> </ul>                    |   |  |                                   |                                       |
| <b>6</b>   | <b>Usability of this module</b>   |   |  |                                   |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |   |  |                                   |                                       |
| <b>8</b>   | <b>References</b>   |   |  |                                   |                                       |
| <b>Courses</b>   |   |   |  |                                   |                                       |
|  | <b>Course Nr.</b><br>04-00-0126-vu  | <b>Course name</b><br>Mathematics I (Electical Engineering) |  |                                   |                                       |
|  | <b>Instructor</b><br>Apl. Prof. Dr. rer. nat. Steffen Roch  |   |  | <b>Type</b><br>Lecture & Practice | <b>SWS</b><br>6                       |

|   |   |   |  |  |                                       |
|---|---|---|--|--|---------------------------------------|
| <b>Module name</b><br>Mathematics II (Electrical Engineering) |   |   |  |  |                                       |
| <b>Module Nr.</b><br>04-00-0109                               | <b>Credit Points</b><br>8 CP  | <b>Workload</b><br>240 h                                      | <b>Self study</b><br>150 h                                   | <b>Duration</b><br>1                   | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                                     |   |   | <b>Module owner</b><br>Apl. Prof. Dr. rer. nat. Steffen Roch |  |                                       |
| <b>1</b>  | <b>Content</b><br>Determinants, eigenvalues, quadratic forms, sequences and series of functions, Taylor and Fourier series, differentiala calculus in $R^n$ , extrema, inverse and implicit functions, path integrals, integration in $R^n$ |   |  |  |                                       |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b>  |   |  |  |                                       |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>   |   |  |  |                                       |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Technical Examination, Standard Grading System)</li> </ul>                                     |   |  |  |                                       |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)</li> </ul>  |   |  |  |                                       |
| <b>6</b>  | <b>Usability of this module</b>   |   |  |  |                                       |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |  |  |                                       |
| <b>8</b>  | <b>References</b>   |   |  |  |                                       |
| <b>Courses</b>  |   |   |  |  |                                       |
|   | <b>Course Nr.</b><br>04-00-0079-vu  | <b>Course name</b><br>Mathematics II (Electrical Engineering) |  |  |                                       |
|   | <b>Instructor</b><br>Apl. Prof. Dr. rer. nat. Steffen Roch  |   |  | <b>Type</b><br>Lecture & Prac-<br>tice | <b>SWS</b><br>6                       |

|  |   |  |  |                                   |                                       |
|--|---|--|--|-----------------------------------|---------------------------------------|
| <b>Module name</b><br>Mathematics III (Electrical Engineering) |   |  |  |                                   |                                       |
| <b>Module Nr.</b><br>04-00-0111                                | <b>Credit Points</b><br>8 CP  | <b>Workload</b><br>240 h                                       | <b>Self study</b><br>180 h                                   | <b>Duration</b><br>1              | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                                      |   |  | <b>Module owner</b><br>Apl. Prof. Dr. rer. nat. Steffen Roch |                                   |                                       |
| <b>1</b>   | <b>Content</b><br>integral calculus: surface integrals, integral theorems; ordinary differential equations: linear and non-linear differential equations, existence and uniqueness of solutions, elementary techniques, linear systems with constant coefficients, Laplace transform; Complex Analysis: complex functions, complex differentiation, Cauchy's integral formula, power series and Laurent series, residues, residue theorem |  |  |                                   |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b>  |  |  |                                   |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |                                   |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Technical Examination, Standard Grading System)</li> </ul>   |  |  |                                   |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)</li> </ul>  |  |  |                                   |                                       |
| <b>6</b>   | <b>Usability of this module</b>   |  |  |                                   |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |                                   |                                       |
| <b>8</b>   | <b>References</b>   |  |  |                                   |                                       |
| <b>Courses</b>   |   |  |  |                                   |                                       |
|  | <b>Course Nr.</b><br>04-00-0127-vu  | <b>Course name</b><br>Mathematics III (Electrical Engineering) |  |                                   |                                       |
|  | <b>Instructor</b><br>Apl. Prof. Dr. rer. nat. Steffen Roch  |  |  | <b>Type</b><br>Lecture & Practice | <b>SWS</b><br>4                       |

|   |  |   |   |                                   |                                       |
|---|--|---|---|-----------------------------------|---------------------------------------|
| <b>Module name</b><br>Numerical and Statistical Methods |  |   |   |                                   |                                       |
| <b>Module Nr.</b><br>04-00-0112                         | <b>Credit Points</b><br>8 CP   | <b>Workload</b><br>240 h                                | <b>Self study</b><br>150 h                                | <b>Duration</b><br>1              | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                               |  |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Stefan Ulbrich |                                   |                                       |
| <b>1</b>  | <b>Content</b><br>Numerical Analysis: linear equations, interpolation, numerical integration, systems of nonlinear equations, initial value problems for ODEs, numerical methods for eigenvalue problems<br>Statistics: basic concepts of statistics and probability theory, regression, multivariate distributions, methods of estimation, confidence intervals, tests for normally distributed random variables, robust statistics |   |   |                                   |                                       |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b>   |   |   |                                   |                                       |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>  |   |   |                                   |                                       |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Technical Examination, Standard Grading System)  |   |   |                                   |                                       |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)   |   |   |                                   |                                       |
| <b>6</b>  | <b>Usability of this module</b>  |   |   |                                   |                                       |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |   |   |                                   |                                       |
| <b>8</b>  | <b>References</b>  |   |   |                                   |                                       |
| <b>Courses</b>  |  |   |   |                                   |                                       |
|   | <b>Course Nr.</b><br>04-00-0081-vu   | <b>Course name</b><br>Numerical and Statistical Methods |   |                                   |                                       |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Stefan Ulbrich  |   |   | <b>Type</b><br>Lecture & Practice | <b>SWS</b><br>6                       |

### 3 More Fundamentals

|                                 |   |                          |   |                         |                                       |
|---------------------------------|---|--------------------------|---|-------------------------|---------------------------------------|
| <b>Module name</b><br>Physics I |   |                          |   |                         |                                       |
| <b>Module Nr.</b><br>05-91-1024 | <b>Credit Points</b><br>4 CP  | <b>Workload</b><br>120 h | <b>Self study</b><br>75 h                                 | <b>Duration</b><br>1    | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German       |   |                          | <b>Module owner</b><br>Prof. Dr. rer. nat. Joachim Enders |                         |                                       |
| 1                               | <b>Content</b>  |                          |   |                         |                                       |
| 2                               | <b>Learning objectives / Learning Outcomes</b>  |                          |   |                         |                                       |
| 3                               | <b>Recommended prerequisite for participation</b>   |                          |   |                         |                                       |
| 4                               | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul> |                          |   |                         |                                       |
| 5                               | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |                          |   |                         |                                       |
| 6                               | <b>Usability of this module</b>   |                          |   |                         |                                       |
| 7                               | <b>Grade bonus compliant to §25 (2)</b>   |                          |   |                         |                                       |
| 8                               | <b>References</b>   |                          |   |                         |                                       |
| <b>Courses</b>                  |   |                          |   |                         |                                       |
|                                 | <b>Course Nr.</b><br>05-11-0054-vl  | <b>Course name</b>       |   |                         |                                       |
|                                 | <b>Instructor</b>   |                          |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>2                       |
|                                 | <b>Course Nr.</b><br>05-13-0054-ue  | <b>Course name</b>       |   |                         |                                       |
|                                 | <b>Instructor</b>   |                          |   | <b>Type</b><br>Practice | <b>SWS</b><br>1                       |

|                                  |   |                          |   |                         |                                       |
|----------------------------------|---|--------------------------|---|-------------------------|---------------------------------------|
| <b>Module name</b><br>Physics II |   |                          |   |                         |                                       |
| <b>Module Nr.</b><br>05-91-1025  | <b>Credit Points</b><br>4 CP  | <b>Workload</b><br>120 h | <b>Self study</b><br>75 h                                 | <b>Duration</b><br>1    | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German        |   |                          | <b>Module owner</b><br>Prof. Dr. rer. nat. Joachim Enders |                         |                                       |
| 1                                | <b>Content</b>  |                          |   |                         |                                       |
| 2                                | <b>Learning objectives / Learning Outcomes</b>  |                          |   |                         |                                       |
| 3                                | <b>Recommended prerequisite for participation</b>   |                          |   |                         |                                       |
| 4                                | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul> |                          |   |                         |                                       |
| 5                                | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |                          |   |                         |                                       |
| 6                                | <b>Usability of this module</b>   |                          |   |                         |                                       |
| 7                                | <b>Grade bonus compliant to §25 (2)</b>   |                          |   |                         |                                       |
| 8                                | <b>References</b>   |                          |   |                         |                                       |
| <b>Courses</b>                   |   |                          |   |                         |                                       |
|                                  | <b>Course Nr.</b><br>05-11-0055-vl  | <b>Course name</b>       |   |                         |                                       |
|                                  | <b>Instructor</b>   |                          |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>2                       |
|                                  | <b>Course Nr.</b><br>05-13-0055-ue  | <b>Course name</b>       |   |                         |                                       |
|                                  | <b>Instructor</b>   |                          |   | <b>Type</b><br>Practice | <b>SWS</b><br>1                       |

|   |   |                          |  |                      |                              |
|---|---|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Microelectronic Devices |   |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-pr-1030               | <b>Credit Points</b><br>4 CP  | <b>Workload</b><br>120 h | <b>Self study</b><br>75 h                              | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                     |   |                          | <b>Module owner</b><br>Prof. Dr. rer. nat. Sascha Preu |                      |                              |
| <b>1</b>                                      | <b>Content</b> <ul style="list-style-type: none"> <li>• Introduction: Semiconductor Devices &amp; Microelectronic</li> <li>• Semiconductor: Materials, Physics &amp; Technology</li> <li>• PN-Junction</li> <li>• Metal-Oxide-Semiconductor Capacity</li> <li>• Schottky Contact</li> <li>• MOS-Field-Effect-Transistor (MOSFET)</li> <li>• CMOS: Digital Applications</li> <li>• MOS-Memory</li> <li>• Bipolar- Junction-Transistor</li> <li>• Outlook: Scaling Limits &amp; SET,...</li> </ul>  |                          |  |                      |                              |
| <b>2</b>                                      | <b>Learning objectives / Learning Outcomes</b> <ul style="list-style-type: none"> <li>• Understand the physical properties and processes in semiconductor devices and materials</li> <li>• the operation of basic semiconductor devices like diode, MOS-Transistor and bipolar transistor</li> <li>• Understand functionality of basic circuits like rectifier circuit , 1-transistor amplifier and inverter from the device point of view.</li> <li>• Goal: Understand state-of-the art semiconductor devices and circuits as a basis for a successful engineering career</li> </ul>                                       |                          |  |                      |                              |
| <b>3</b>                                      | <b>Recommended prerequisite for participation</b><br>Electrical Engineering and Information Technology I, Electrical Engineering and Information Technology II, Laboratory ETiT, Laboratory Electronics, Mathematics I, Mathematics II, Physics   |                          |  |                      |                              |
| <b>4</b>                                      | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>  |                          |  |                      |                              |
| <b>5</b>                                      | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |                          |  |                      |                              |
| <b>6</b>                                      | <b>Usability of this module</b><br>BSc ETiT   |                          |  |                      |                              |
| <b>7</b>                                      | <b>Grade bonus compliant to §25 (2)</b>   |                          |  |                      |                              |
| <b>8</b>                                      | <b>References</b><br>Skript: Microelectronic devices - the Basics <ul style="list-style-type: none"> <li>• Robert F. Pierret: Semiconductor Device Fundamentals, ISBN 0201543931</li> <li>• Roger T. How, Charles G. Sodini: Microelectronics - an Integrated Approach, ISBN 0135885183</li> <li>• Richard C. Jaeger: Microelectronic Circuit Design, ISBN 0071143866</li> <li>• Y. Taur, T.H. Ning, Fundamentals of Modern VLSI Devices, ISBN 0521559596</li> <li>• Thomas Tille, Doris Schmidt-Landsiedel: Mikroelektronik, ISBN 3540204229</li> <li>• Michael Reisch: Halbleiter-Bauelemente, ISBN 3540213848</li> </ul> |                          |  |                      |                              |
| <b>Courses</b>                                |   |                          |  |                      |                              |

|  |  |   |                         |                 |
|--|--|---|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-pr-1030-vl                   | <b>Course name</b><br>Microelectronic Devices |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Sascha Preu |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>2 |
|  | <b>Course Nr.</b><br>18-pr-1030-ue                   | <b>Course name</b><br>Microelectronic Devices |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Sascha Preu |   | <b>Type</b><br>Practice | <b>SWS</b><br>1 |



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|---|---|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Measuring Technique |   |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-kn-1011           | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h | <b>Self study</b><br>105 h                    | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                 |   |                          | <b>Module owner</b><br>Prof. Dr. Mario Kupnik |                      |                              |
| <b>1</b>                                  | <p><b>Content</b></p> <p>The module includes theoretical discussion and practical application of the measuring chain in detail on example the electrical variables (current, voltage, impedance, power) and selected non-electrical variables (frequency, time, force, pressure and acceleration).</p> <p>In the lecture the following chapter will be thematically treated measuring signals and measuring equipment (oscilloscope, laboratory testing equipment), static measurement error and disturbance variables (especially temperature), basic measurement circuits, AD conversion principles and filtering, measurement method non-electrical variables and the statistics of measurements (distributions, statist safe tests).</p> <p>The topics of the lecture are discussed in the exercise of the module. Examples are analyzed and their application in measurement scenarios are practiced.</p> <p>The practicum of the module consists of five experiments which are time closely matched in time to the lecture:</p> <ul style="list-style-type: none"> <li>• Measuring of signals in the time range with digital storage oscilloscope, trigger conditions</li> <li>• Measuring of signals in the frequency range with digital storage oscilloscope, error of measurement (aliasing / subsampling, leakage) and window functions</li> <li>• Measuring of mechanical dimensions with suitable primary sensors, sensor electronics / amplifier circuits</li> <li>• computer-based measuring</li> <li>• Importing of sensor signals, whose processing and the resulting automated control of a process using a programmable logic controller (PLC)</li> </ul> |                          |   |                      |                              |
| <b>2</b>                                  | <p><b>Learning objectives / Learning Outcomes</b></p> <p>The students know the structure of the measuring chain and the specific properties of the corresponding elements. They know the structure of electronic measuring instruments and basic measuring circuits for electrical and selected non-electrical variables and can apply them. They know the basics of capturing, processing, transferring and storage of measurement data and can describe error sources and quantifying their influences.</p> <p>In the practicum, the students deepen the basis of the measurements with the oscilloscope, the understanding of the relationship between time and frequency range. Methodically they are able to document and evaluate the data during laboratory measuring.</p>   |                          |   |                      |                              |
| <b>3</b>                                  | <p><b>Recommended prerequisite for participation</b></p> <p>Basics of ETiT I-III, Math I-III, Electronic</p>  |                          |   |                      |                              |
| <b>4</b>                                  | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul> <p>Module Ecompanying Examination:</p> <ul style="list-style-type: none"> <li>• [18-kn-1011-pr] (Study Achievement, Optional, Standard BWS)</li> </ul>  |                          |   |                      |                              |
| <b>5</b>                                  | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 4)</li> </ul> <p>Module Ecompanying Examination:</p> <ul style="list-style-type: none"> <li>• [18-kn-1011-pr] (Study Achievement, Optional, Weighting: 2)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>                                  | <p><b>Usability of this module</b></p> <p>BSc ETiT, BSc Wi-ETiT, BSc MEC</p>  |                          |   |                      |                              |

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|----------------|---|---|---------------------------|
| 7              | <b>Grade bonus compliant to §25 (2)</b>   |   |                           |
| 8              | <b>References</b> <ul style="list-style-type: none"> <li>• Slide set of lecture</li> <li>• Textbook and exercise book Lerch: „Elektrische Messtechnik“, Springer</li> <li>• Exercise documents</li> <li>• Practical experiment manuals</li> </ul> |   |                           |
| <b>Courses</b> |   |   |                           |
|                | <b>Course Nr.</b><br>18-kn-1011-vl  | <b>Course name</b><br>Measuring Technique     |                           |
|                | <b>Instructor</b><br>Prof. Dr. Mario Kupnik   |   | <b>Type</b><br>Lecture    |
|                | <b>SWS</b><br>2   |   |                           |
|                | <b>Course Nr.</b><br>18-kn-1011-pr  | <b>Course name</b><br>Measuring Technique Lab |                           |
|                | <b>Instructor</b><br>Prof. Dr. Mario Kupnik   |   | <b>Type</b><br>Internship |
|                | <b>SWS</b><br>2   |   |                           |
|                | <b>Course Nr.</b><br>18-kn-1011-ue  | <b>Course name</b><br>Measuring Technique     |                           |
|                | <b>Instructor</b><br>Prof. Dr. Mario Kupnik   |   | <b>Type</b><br>Practice   |
|                | <b>SWS</b><br>1   |   |                           |

|                                    |   |                                    |  |                         |                              |
|------------------------------------|---|------------------------------------|--|-------------------------|------------------------------|
| <b>Module name</b><br>Logic Design |   |                                    |  |                         |                              |
| <b>Module Nr.</b><br>18-hb-1010    | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h           | <b>Self study</b><br>120 h                                 | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German          |   |                                    | <b>Module owner</b><br>Prof. Dr.-Ing. Christian Hochberger |                         |                              |
| <b>1</b>                           | <b>Content</b><br>Boolean algebra, logic gates, hardware description languages, flipflops, sequential circuits, state-diagrams and -tables, technology mapping, programmable logic circuits   |                                    |  |                         |                              |
| <b>2</b>                           | <b>Learning objectives / Learning Outcomes</b><br>By this module, Students will be enabled to <ul style="list-style-type: none"> <li>• rewrite boolean expressions and transform them into circuits of logic gates</li> <li>• analyze and synthesize digital circuits</li> <li>• describe digital circuits in a hardware description language</li> <li>• extract finite state machines from informal descriptions and implement them with synchronous circuits</li> </ul> |                                    |  |                         |                              |
| <b>3</b>                           | <b>Recommended prerequisite for participation</b>   |                                    |  |                         |                              |
| <b>4</b>                           | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>  |                                    |  |                         |                              |
| <b>5</b>                           | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |                                    |  |                         |                              |
| <b>6</b>                           | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc Wi-ETiT   |                                    |  |                         |                              |
| <b>7</b>                           | <b>Grade bonus compliant to §25 (2)</b>   |                                    |  |                         |                              |
| <b>8</b>                           | <b>References</b><br>R.H. Katz: Contemporary Logic Design   |                                    |  |                         |                              |
| <b>Courses</b>                     |   |                                    |  |                         |                              |
|                                    | <b>Course Nr.</b><br>18-hb-1010-vl  | <b>Course name</b><br>Logic Design |  |                         |                              |
|                                    | <b>Instructor</b><br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz  |                                    |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|                                    | <b>Course Nr.</b><br>18-hb-1010-ue  | <b>Course name</b><br>Logic Design |  |                         |                              |
|                                    | <b>Instructor</b><br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz  |                                    |  | <b>Type</b><br>Practice | <b>SWS</b><br>1              |

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|--|--|--|--|-------------------------------------|---------------------------------------|
| <b>Module name</b><br>General Computer Science I |  |  |  |                                     |                                       |
| <b>Module Nr.</b><br>20-00-0304                  | <b>Credit Points</b><br>5 CP   | <b>Workload</b><br>150 h                         | <b>Self study</b><br>120 h                               | <b>Duration</b><br>1                | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                        |  |  | <b>Module owner</b><br>Prof. Dr. rer. nat. Karsten Weihe |                                     |                                       |
| <b>1</b>   | <b>Content</b>   |  |  |                                     |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b> <ul style="list-style-type: none"> <li>• Basic Knowledge of Computer Science Concepts</li> <li>• Practical Work with computers</li> <li>• Fundamental Programming Skills</li> </ul> |  |  |                                     |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>-   |  |  |                                     |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Accompanying Examination: <ul style="list-style-type: none"> <li>• [20-00-0304-iv] (Technical Examination, Written/Oral Examination, Standard BWS)</li> </ul>                                 |  |  |                                     |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Accompanying Examination: <ul style="list-style-type: none"> <li>• [20-00-0304-iv] (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>  |  |  |                                     |                                       |
| <b>6</b>   | <b>Usability of this module</b>  |  |  |                                     |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                                     |                                       |
| <b>8</b>   | <b>References</b><br>David J. Barnes und Michael Kölling, Objects First with Java: A Practical Introduction using BlueJ, Fifth edition, Prentice Hall/Pearson Education, 2012, ISBN 978-013-249266-9                               |  |  |                                     |                                       |
| <b>Courses</b>                                   |  |  |  |                                     |                                       |
|  | <b>Course Nr.</b><br>20-00-0304-iv   | <b>Course name</b><br>General Computer Science I |  |                                     |                                       |
|  | <b>Instructor</b>  |  |  | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>2                       |

|                                    |   |                                    |  |                           |                              |
|------------------------------------|---|------------------------------------|--|---------------------------|------------------------------|
| <b>Module name</b><br>Software Lab |   |                                    |  |                           |                              |
| <b>Module Nr.</b><br>18-st-1020    | <b>Credit Points</b><br>4 CP  | <b>Workload</b><br>120 h           | <b>Self study</b><br>75 h                                  | <b>Duration</b><br>1      | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German          |   |                                    | <b>Module owner</b><br>Prof. Dr. rer. nat. Florian Steinke |                           |                              |
| <b>1</b>                           | <b>Content</b><br>The lab covers the following basic software development skills: <ul style="list-style-type: none"> <li>• working together and software development in teams</li> <li>• lightweight software engineering process eXtreme Programming (XP)</li> <li>• training of advanced OO/Java programming skills and coding standards</li> <li>• software documentation using JavaDoc</li> <li>• the basics of the development tool eclipse</li> <li>• regression testing methods (test framework JUnit) to increase software quality</li> <li>• more sophisticated data structures and algorithms</li> </ul>                                |                                    |  |                           |                              |
| <b>2</b>                           | <b>Learning objectives / Learning Outcomes</b><br>Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems. |                                    |  |                           |                              |
| <b>3</b>                           | <b>Recommended prerequisite for participation</b><br>Basics in Java (as taught in Introduction to Computer Science for Engineers).<br>Windows-Account of the ETiT PC-Pool   |                                    |  |                           |                              |
| <b>4</b>                           | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>   |                                    |  |                           |                              |
| <b>5</b>                           | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>   |                                    |  |                           |                              |
| <b>6</b>                           | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT  |                                    |  |                           |                              |
| <b>7</b>                           | <b>Grade bonus compliant to §25 (2)</b>   |                                    |  |                           |                              |
| <b>8</b>                           | <b>References</b><br><a href="http://www.es.tu-darmstadt.de/lehre/sp/">www.es.tu-darmstadt.de/lehre/sp/</a>   |                                    |  |                           |                              |
| <b>Courses</b>                     |   |                                    |  |                           |                              |
|                                    | <b>Course Nr.</b><br>18-st-1020-pr  | <b>Course name</b><br>Software Lab |  |                           |                              |
|                                    | <b>Instructor</b><br>Prof. Dr. rer. nat. Florian Steinke  |                                    |  | <b>Type</b><br>Internship | <b>SWS</b><br>3              |

|                                   |   |                          |   |                      |                              |
|-----------------------------------|---|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Electronics |   |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-ho-1011   | <b>Credit Points</b><br>7 CP  | <b>Workload</b><br>210 h | <b>Self study</b><br>135 h                          | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German         |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Klaus Hofmann |                      |                              |
| <b>1</b>                          | <b>Content</b><br><b>18-ho-1011-vl bzw. -ue:</b><br>Semiconductor Elements: Diode, MOSFET, Bipolartransistor. Electronic Circuit Design; Basic Analog Circuits and their properties, Behavior and properties of operational amplifiers, circuit simulation with SPICE, small signal amplification, single stage amplifiers, frequency response; digital circuits: CMOS-logic<br><b>18-ho-1011-pr:</b><br>Practical experiments in the fields: <ul style="list-style-type: none"> <li>• digital circuits: FPGA-programming</li> <li>• analog circuits: basic building blocks, amplifiers, operational amplifiers, filters and demodulators</li> </ul>  |                          |   |                      |                              |
| <b>2</b>                          | <b>Learning objectives / Learning Outcomes</b><br>A student is after successful attending the lecture able to <ul style="list-style-type: none"> <li>• analyse the behavior of diodes, MOS- and Bipolartransistors in simple circuits,</li> <li>• assess the properties of single-transistor amplifiers (MOSFET and BJT), such as small signal behavior, input- and output-resistance;</li> <li>• design inverting and non-inverting operational amplifiers with passive components and knows the ideal and non-ideal properties;</li> <li>• calculate the frequency response of simple transistor circuits;</li> <li>• knows the different circuit techniques (CMOS, NMOS) of logical gates and knows the basic functions (inverter, NAND, NOR).</li> </ul> A student is after successful attending the lab able to <ul style="list-style-type: none"> <li>• perform measurements in time and frequency domain using an oscilloscope on simple operational amplifiers;</li> <li>• design and realize a traffic light controller based on a finite state machine using a FPGA as the target implementation;</li> <li>• mount passive and active components on a PCB (including preparation of components, soldering) and put the system to function,</li> <li>• simulate a circuit (filter) using SPICE and perform measurements on the realization.</li> </ul> |                          |   |                      |                              |
| <b>3</b>                          | <b>Recommended prerequisite for participation</b><br>Basics of Electrical Engineering   |                          |   |                      |                              |
| <b>4</b>                          | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul> Module Ecompanying Examination: <ul style="list-style-type: none"> <li>• [18-ho-1011-pr] (Study Achievement, Optional, Standard BWS)</li> </ul>  |                          |   |                      |                              |
| <b>5</b>                          | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 4)</li> </ul> Module Ecompanying Examination: <ul style="list-style-type: none"> <li>• [18-ho-1011-pr] (Study Achievement, Optional, Weighting: 3)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>                          | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc iST, BEd  |                          |   |                      |                              |

|                |  |                                       |                           |
|----------------|--|---------------------------------------|---------------------------|
| 7              | Grade bonus compliant to §25 (2)   |                                       |                           |
| 8              | References   |                                       |                           |
| <b>Courses</b> |  |                                       |                           |
|                | <b>Course Nr.</b><br>18-ho-1011-vl                                       | <b>Course name</b><br>Electronics     |                           |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann |                                       | <b>Type</b><br>Lecture    |
|                |  |                                       | <b>SWS</b><br>2           |
|                | <b>Course Nr.</b><br>18-ho-1011-pr                                       | <b>Course name</b><br>Electronics Lab |                           |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Ferdinand Keil  |                                       | <b>Type</b><br>Internship |
|                |  |                                       | <b>SWS</b><br>2           |
|                | <b>Course Nr.</b><br>18-ho-1011-ue                                       | <b>Course name</b><br>Electronics     |                           |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann |                                       | <b>Type</b><br>Practice   |
|                |  |                                       | <b>SWS</b><br>1           |

# 4 Options

## 4.1 Option Automation Systems

### 4.1.1 Fundamentals

|   |  |                          |   |                      |                              |
|---|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>System Dynamics and Automatic Control Systems I |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-ko-1010                                       | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                              | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German   |  |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Ulrich Konigorski |                      |                              |
| <b>1</b>  | <b>Content</b><br>Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization                                   |                          |   |                      |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems. |                          |   |                      |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>  |                          |   |                      |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>  |                          |   |                      |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, MSc Informatik   |                          |   |                      |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |                          |   |                      |                              |
| <b>8</b>  | <b>References</b>  |                          |   |                      |                              |



Skript Konigorski: "Systemdynamik und Regelungstechnik I", Aufgabensammlung zur Vorlesung, Lunze: "Regelungstechnik 1: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen", Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen", Unbehauen: "Regelungstechnik I: Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme, Fuzzy-Regelsysteme", Föllinger: "Laplace-, Fourier- und z-Transformation", Jörgl: "Repetitorium Regelungstechnik", Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden", Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise", Schneider: "Regelungstechnik für Maschinenbauer", Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnahe Grundlage"

#### Courses

|  |  |                         |                 |
|--|--|-------------------------|-----------------|
| <b>Course Nr.</b><br>18-ko-1010-vl   | <b>Course name</b><br>System Dynamics and Automatic Control Systems I                      |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>3 |
| <b>Course Nr.</b><br>18-ko-1010-tt   | <b>Course name</b><br>System Dynamics and Automatic Control Systems I- Auditorium Exercise |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand |  | <b>Type</b><br>Tutorial | <b>SWS</b><br>1 |

|  |  |  |  |                         |                              |
|--|--|--|--|-------------------------|------------------------------|
| <b>Module name</b><br>System Dynamics and Automatic Control Systems II |  |  |  |                         |                              |
| <b>Module Nr.</b><br>18-ad-1010  | <b>Credit Points</b><br>7 CP   | <b>Workload</b><br>210 h   | <b>Self study</b><br>135 h                         | <b>Duration</b><br>1    | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German  |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Jürgen Adamy |                         |                              |
| <b>1</b>   | <b>Content</b><br>Main topics covered are: <ul style="list-style-type: none"> <li>• Root locus method (construction and application),</li> <li>• State space representation of linear systems (representation, time solution, controllability, observability, observer- based controller design)</li> </ul>  |  |  |                         |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After attending the lecture, a student is capable of: <ul style="list-style-type: none"> <li>• constructing and evaluating the root locus of given systems</li> <li>• describing the concept and importance of the state space for linear systems</li> <li>• defining controllability and observability for linear systems and being able to test given systems with respect to these properties</li> <li>• stating controller design methods using the state space, and applying them to given systems</li> <li>• applying the method of linearization to non-linear systems with respect to a given operating point</li> </ul> |  |  |                         |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>System Dynamics and Control Systems I   |  |  |                         |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)</li> </ul>  |  |  |                         |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |  |  |                         |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik   |  |  |                         |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                         |                              |
| <b>8</b>   | <b>References</b><br>Adamy: Systemdynamik und Regelungstechnik II, Shaker Verlag (available for purchase at the FG office)   |  |  |                         |                              |
| <b>Courses</b>   |  |  |  |                         |                              |
|  | <b>Course Nr.</b><br>18-ad-1010-vl   | <b>Course name</b><br>System Dynamics and Automatic Control Systems II |  |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Jürgen Adamy   |  |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|  | <b>Course Nr.</b><br>18-ad-1010-ue   | <b>Course name</b><br>System Dynamics and Automatic Control Systems II |  |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Jürgen Adamy   |  |  | <b>Type</b><br>Practice | <b>SWS</b><br>2              |

|  |  |  |   |                        |                                       |
|--|--|--|---|------------------------|---------------------------------------|
| <b>Module name</b><br>Technical Mechanics for Electrical Engineering |  |  |   |                        |                                       |
| <b>Module Nr.</b><br>16-26-6400                                      | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h   | <b>Self study</b><br>105 h                        | <b>Duration</b><br>1   | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German  |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Tobias Melz |                        |                                       |
| <b>1</b>   | <b>Content</b><br>Statics: force, moment (torque), free body diagram, equilibrium equations, center of gravity, truss, beams, adhesion and friction.<br>Mechanics of elastic bodies: stress and deformation, tension, torsion, bending.<br>Kinematics: point and rigid body movement.<br>Kinetics: dynamic force and moment equilibrium equations, energy and work, linear oscillators, momentum and angular momentum conservation laws, impact.   |  |   |                        |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>In this course the students will learn the basic concepts of technical mechanics. They should be able to analyze the statics of simple statically determinate planar systems, to carry out elementary elastomechanical calculations of statically determinate and statically indeterminate structures, to describe and analyze movements, and to solve planar motion problems, oscillation and shock phenomena with the laws of kinetics.  |  |   |                        |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>  |  |   |                        |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Standard Grading System)  |  |   |                        |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)  |  |   |                        |                                       |
| <b>6</b>   | <b>Usability of this module</b>  |  |   |                        |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |   |                        |                                       |
| <b>8</b>   | <b>References</b><br>Markert, Norrick: Einführung in die Technische Mechanik, ISBN 978-3-8440-3228-4<br>Exercises are embodied in the book.<br>Further reading:<br>Markert: Statik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3279-6<br>Markert: Elastomechanik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3280-2<br>Markert: Dynamik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-2200-1<br>Gross, Hauger, Schröder, Wall: Technische Mechanik 1 - 3. Springer-Verlag Berlin (2012-2014).<br>Hagedorn: Technische Mechanik, Band 1 - 3. Verlag Harri Deutsch Frankfurt. |  |   |                        |                                       |
| <b>Courses</b>   |  |  |   |                        |                                       |
|  | <b>Course Nr.</b><br>16-26-6400-vl   | <b>Course name</b><br>Technical Mechanics for Electrical Engineering |   |                        |                                       |
|  | <b>Instructor</b>  |  |   | <b>Type</b><br>Lecture | <b>SWS</b><br>3                       |

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|  |                                    |  |                         |                 |
|--|------------------------------------|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>16-26-6400-ue | <b>Course name</b><br>Technical Mechanics for Electrical Engineering |                         |                 |
|  | <b>Instructor</b>                  |  | <b>Type</b><br>Practice | <b>SWS</b><br>2 |

#### 4.1.1.1 Proseminar ETiT

|  |   |  |  |   |                                   |
|--|---|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |  |   |                                   |
| <b>Module Nr.</b><br>18-ad-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                          | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Jürgen Adamy |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |  |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |  |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |  |  |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |  |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |   |                                   |
| <b>8</b>   | <b>References</b>   |  |  |   |                                   |
| <b>Courses</b>   |   |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-ad-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Jürgen Adamy  |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |   |   |                                   |
|--|---|--|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                                   |
| <b>Module Nr.</b><br>18-ko-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                               | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Ulrich Konigorski |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |   |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |   |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |   |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |   |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |   |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                                   |
| <b>8</b>   | <b>References</b>   |  |   |   |                                   |
| <b>Courses</b>   |   |  |   |   |                                   |
|  | <b>Course Nr.</b><br>18-ko-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski   |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

#### 4.1.1.2 More Fundamentals

|  |   |  |   |                         |                              |
|--|---|--|---|-------------------------|------------------------------|
| <b>Module name</b><br>Analog Integrated Circuit Design |   |  |   |                         |                              |
| <b>Module Nr.</b><br>18-ho-1020                        | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h                               | <b>Self study</b><br>120 h                          | <b>Duration</b><br>1    | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                              |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Klaus Hofmann |                         |                              |
| <b>1</b>   | <b>Content</b><br>Basic analog Building Blocks: Current Mirrors, Reference Circuits; Multi Stage Amplifier, internal Structure and Properties of Differential and Operational Amplifiers, Feedback Techniques, Frequency Response, Oscillators  |  |   |                         |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>A student is, after successful completion of this module, able to 1. derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, 2. derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties (y-Parameters, DC- and AC-properties), 3. understands simulation methods for analog circuits on transistor level using SPICE, 4. analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, 5. derive and calculate the analog properties of digital logic gates |  |   |                         |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Lecture "Electronics"  |  |   |                         |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>  |  |   |                         |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |  |   |                         |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE  |  |   |                         |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |                         |                              |
| <b>8</b>   | <b>References</b><br>Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design   |  |   |                         |                              |
| <b>Courses</b>   |   |  |   |                         |                              |
|  | <b>Course Nr.</b><br>18-ho-1020-vl  | <b>Course name</b><br>Analog Integrated Circuit Design |   |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann   |  |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|  | <b>Course Nr.</b><br>18-ho-1020-ue  | <b>Course name</b><br>Analog Integrated Circuit Design |   |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann   |  |   | <b>Type</b><br>Practice | <b>SWS</b><br>1              |

|  |  |                          |  |                      |                              |
|--|--|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Electrical Power Engineering |  |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-bi-1010                    | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                                     | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                          |  |                          | <b>Module owner</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |                      |                              |
| <b>1</b>   | <p><b>Content</b></p> <p>The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.</p> <p>First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.</p> <p>Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.</p> <p>The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications. The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.</p> |                          |  |                      |                              |
| <b>2</b>   | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.</p> <p>They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.</p> <p>They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.</p> <p>They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.</p>  |                          |  |                      |                              |
| <b>3</b>   | <p><b>Recommended prerequisite for participation</b></p> <p>Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.</p>  |                          |  |                      |                              |
| <b>4</b>   | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |  |                      |                              |
| <b>5</b>   | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |                          |  |                      |                              |



|                |   |  |                 |
|----------------|---|--|-----------------|
| <b>6</b>       | <b>Usability of this module</b><br>BSc ETiT, BSc WI-ETiT, BSc MEC, BSc iST, BSc CE, MSc ESE   |  |                 |
| <b>7</b>       | <b>Grade bonus compliant to §25 (2)</b><br>At the beginning of the semester, it will be announced whether there will be homework tests accompanying the lecture that will enable an improvement in grades.  |  |                 |
| <b>8</b>       | <b>References</b><br>Lecture notes (slides)<br>Practice documents (examples, solutions)<br>Additional and more detailed literature:<br>Grothe/Feldhusen: Dubbel-Taschenbuch für den Maschinenbau, Springer, Berlin, 2007, 22. Aufl.; besonders: Kapitel „Energietechnik und Wirtschaft“; Sterner/Stadler: Energiespeicher – Bedarf, Technologien, Integration, Springer-Vieweg, Berlin, 2011; Rummich: Energiespeicher, expert-verlag, Rellingen, 2015, 2. Aufl.; Strauß: Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, Berlin, 2006, 5. Aufl.; Hau: Windkraftanlagen –Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Springer-Vieweg, Berlin, 2014, 5. Aufl.; Heuck/Dettmann/Schulz: Elektrische Energieversorgung, Springer-Vieweg, Berlin, 2014, 9. Aufl.; Quaschnig: Regenerative Energiesystem, Hanser, München, 2001, 7. Aufl. |  |                 |
| <b>Courses</b> |   |  |                 |
|                | <b>Course Nr.</b><br>18-bi-1010-vl  | <b>Course name</b><br>Electrical Power Engineering |                 |
|                | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  | <b>Type</b><br>Lecture                             | <b>SWS</b><br>3 |
|                | <b>Course Nr.</b><br>18-bi-1010-ue  | <b>Course name</b><br>Electrical Power Engineering |                 |
|                | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  | <b>Type</b><br>Practice                            | <b>SWS</b><br>1 |

| <b>Module name</b><br>Fundamentals of Signal Processing |  |                 |                                |                 |                      |
|---|--|-----------------|--------------------------------|-----------------|----------------------|
| <b>Module Nr.</b>                                       | <b>Credit Points</b>   | <b>Workload</b> | <b>Self study</b>              | <b>Duration</b> | <b>Cycle offered</b> |
| 18-zo-1030  | 6 CP   | 180 h           | 120 h                          | 1               | SoSe                 |
| <b>Language</b>   |  |                 | <b>Module owner</b>            |                 |                      |
| German  |  |                 | Prof. Dr.-Ing. Abdelhak Zoubir |                 |                      |
| <b>1</b>  | <b>Content</b><br>The course covers the following topics: <ul style="list-style-type: none"> <li>• The basic concepts of stochastic</li> <li>• The sampling theorem</li> <li>• Discrete-time noise processes and their properties</li> <li>• Description of noise processes in the frequency domain</li> <li>• Linear time-invariant systems: FIR and IIR filters</li> <li>• Filtering of noise processes: AR, MA, and ARMA models</li> <li>• The Matched filter</li> <li>• The Wiener filter</li> <li>• Properties of estimators</li> <li>• The method of least squares</li> </ul>        |                 |                                |                 |                      |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory.   |                 |                                |                 |                      |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>  |                 |                                |                 |                      |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)</li> </ul> In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase. |                 |                                |                 |                      |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>  |                 |                                |                 |                      |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC   |                 |                                |                 |                      |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |                 |                                |                 |                      |
| <b>8</b>  | <b>References</b>  |                 |                                |                 |                      |

Lecture notes and slides can be downloaded here:

- <http://www.spg.tu-darmstadt.de>
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schafer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River, 1999.

#### Courses

|   |   |                         |                 |
|---|---|-------------------------|-----------------|
| <b>Course Nr.</b><br>18-zo-1030-vl                  | <b>Course name</b><br>Fundamentals of Signal Processing |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3 |
| <b>Course Nr.</b><br>18-zo-1030-ue                  | <b>Course name</b><br>Fundamentals of Signal Processing |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |   | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

|  |  |  |  |                        |                              |
|--|--|--|--|------------------------|------------------------------|
| <b>Module name</b><br>Communication Technology I |  |  |  |                        |                              |
| <b>Module Nr.</b><br>18-kl-1020                  | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                         | <b>Self study</b><br>120 h                       | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                        |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Anja Klein |                        |                              |
| <b>1</b>   | <b>Content</b><br>Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carrier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access  |  |  |                        |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the lecture, students possess the ability to: <ul style="list-style-type: none"> <li>• classify signals and communication systems,</li> <li>• understand, model and analyse basic components of communication systems,</li> <li>• understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,</li> <li>• model and analyse base-band communication systems,</li> <li>• describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,</li> <li>• understand, model, evaluate, compare and apply linear modulation schemes,</li> <li>• design receiver structures for different modulation schemes,</li> <li>• detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,</li> <li>• understand and model OFDM,</li> <li>• understand and model CDMA,</li> <li>• understand and compare the basic properties of multiple access schemes.</li> </ul> |  |  |                        |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV  |  |  |                        |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |  |  |                        |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>  |  |  |                        |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC   |  |  |                        |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                        |                              |
| <b>8</b>   | <b>References</b><br>Will be announced in the lecture  |  |  |                        |                              |
| <b>Courses</b>                                   |  |  |  |                        |                              |
|  | <b>Course Nr.</b><br>18-kl-1020-vl   | <b>Course name</b><br>Communication Technology I |  |                        |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein   |  |  | <b>Type</b><br>Lecture | <b>SWS</b><br>3              |

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|--|--|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-kl-1020-ue   | <b>Course name</b><br>Communication Technology I |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein, Dr. rer. nat. Sabrina Klos |  | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

|   |  |                          |   |                      |                              |
|---|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Fundamentals of Communication |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-jk-1010                     | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                        | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                           |  |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Rolf Jakoby |                      |                              |
| <b>1</b>  | <p><b>Content</b></p> <p>Part 1: Chap. 1 will be a brief introduction in “Electrical Information- and Communication Engineering”, presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.</p> <p>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.</p> <p>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.</p> <p>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited intersymbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture.</p> |                          |   |                      |                              |
| <b>2</b>  | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.</p> <p>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems.</p>   |                          |   |                      |                              |
| <b>3</b>  | <p><b>Recommended prerequisite for participation</b></p> <p>Deterministic Signals and Systems</p>  |                          |   |                      |                              |
| <b>4</b>  | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |   |                      |                              |
| <b>5</b>  | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>  | <p><b>Usability of this module</b></p> <p>BSc ETiT, Wi-ETiT</p>  |                          |   |                      |                              |
| <b>7</b>  | <p><b>Grade bonus compliant to §25 (2)</b></p>   |                          |   |                      |                              |

|          |  |
|----------|--|
| <b>8</b> | <p><b>References</b></p> <p>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addison-Wesley 1992.</p> |
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|----------------|----------------------------|--------------------------------|-------------|
| <b>Courses</b> |                            |                                |             |
|                | <b>Course Nr.</b>          | <b>Course name</b>             |             |
|                | 18-jk-1010-vl              | Fundamentals of Communications |             |
|                | <b>Instructor</b>          |                                | <b>Type</b> |
|                | Prof. Dr.-Ing. Rolf Jakoby |                                | Lecture     |
|                |                            |                                | <b>SWS</b>  |
|                |                            |                                | 3           |
|                | <b>Course Nr.</b>          | <b>Course name</b>             |             |
|                | 18-jk-1010-ue              | Fundamentals of Communications |             |
|                | <b>Instructor</b>          |                                | <b>Type</b> |
|                | Prof. Dr.-Ing. Rolf Jakoby |                                | Practice    |
|                |                            |                                | <b>SWS</b>  |
|                |                            |                                | 1           |

|   |  |   |   |                         |                              |
|---|--|---|---|-------------------------|------------------------------|
| <b>Module name</b><br>Software Engineering - Introduction |  |   |   |                         |                              |
| <b>Module Nr.</b><br>18-su-1010                           | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                                  | <b>Self study</b><br>120 h                                | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                                 |  |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Andreas Schürr |                         |                              |
| <b>1</b>  | <b>Content</b><br><p>The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's "Guide to the Software Engineering Body of Knowledge" - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of software architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).</p> <p>During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of requirements, definition of a design and eventually the implementation of executable (proof-of-concept) code.</p> |   |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br><p>This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.</p> <p>After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Furthermore, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal.</p>  |   |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>sound knowledge of an object-oriented programming language (preferably Java)  |   |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |   |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |   |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc iST, BSc Wi-ETiT  |   |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |   |   |                         |                              |
| <b>8</b>  | <b>References</b><br><a href="http://www.es.tu-darmstadt.de/lehre/se-i-v/">www.es.tu-darmstadt.de/lehre/se-i-v/</a>  |   |   |                         |                              |
| <b>Courses</b>  |  |   |   |                         |                              |
|   | <b>Course Nr.</b><br>18-su-1010-vl   | <b>Course name</b><br>Software Engineering - Introduction |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr  |   |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|   | <b>Course Nr.</b><br>18-su-1010-ue   | <b>Course name</b><br>Software Engineering - Introduction |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Fritsche   |   |   | <b>Type</b><br>Practice | <b>SWS</b><br>1              |



|   |   |   |   |                         |                              |
|---|---|---|---|-------------------------|------------------------------|
| <b>Module name</b><br>Technical Electrodynamics |   |   |   |                         |                              |
| <b>Module Nr.</b><br>18-dg-1070                 | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h                        | <b>Self study</b><br>120 h                              | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                       |   |   | <b>Module owner</b><br>Prof. Dr.-Ing. Herbert De Gersem |                         |                              |
| <b>1</b>  | <b>Content</b><br>Fields in materials, Green's functions, separation of variables in generalized orthogonal coordinates, conformal mapping, elliptic integrals and elliptic functions, electromagnetic forces, quasi-stationary fields, general waveguides, resonators, antennas.   |   |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Starting with Maxwell's equations the lecture's aim is to provide a general understanding of electromagnetic phenomena. Students will be able to apply analytical methods to simple problems. Students will exhibit the ability to deal with more complex electromagnetic formulations and tasks. |   |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Vector analysis, infinitesimal calculus, basics in differential equations. Knowledge of "Introduction to Electrodynamics"  |   |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)</li> </ul>  |   |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |   |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, MSc Wi-ETiT  |   |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                         |                              |
| <b>8</b>  | <b>References</b><br>Course notes available (including references)  |   |   |                         |                              |
| <b>Courses</b>                                  |   |   |   |                         |                              |
|   | <b>Course Nr.</b><br>18-dg-1070-vl  | <b>Course name</b><br>Technical Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann  |   |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>2              |
|   | <b>Course Nr.</b><br>18-dg-1070-ue  | <b>Course name</b><br>Technical Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann  |   |   | <b>Type</b><br>Practice | <b>SWS</b><br>2              |

## 4.1.2 Optional Modules

### 4.1.2.1 Geschlossener Wahlkatalog

|  |   |                          |  |                      |                              |
|--|---|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Electrical Machines and Drives |   |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-bi-1020                      | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h | <b>Self study</b><br>90 h                                      | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                            |   |                          | <b>Module owner</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |                      |                              |
| <b>1</b>   | <b>Content</b><br>Construction and function of induction machine, synchronous machine, direct current machine. Electromagnetic field within machines, armature windings, steady-state performance as motor/generator, application as line-fed and inverter-fed drives. Significance for electric power generation, both to the grid and in stand-alone version.   |                          |  |                      |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>With active collaboration during lectures by asking questions related to those parts, which have not been completely understood by you, as well as by independent solving of examples ahead of the tutorial (not as late as during preparation for examination) you should be able to: <ul style="list-style-type: none"> <li>• calculate and explain the stationary operation performance of the three basic types of electric machine sin motor and generator mode,</li> <li>• understand the application of electrical machines in modern drive systems and to design simple drive applications by yourself,</li> <li>• understand and explain the function and physical background of the components of electrical machines</li> <li>• understand and explain the impact of basic electromagnetic field and force theory on the basic function of electrical machines.</li> </ul> |                          |  |                      |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Mathematics I to III, Electrical Engineering I and II, Physics, Mechanical Engineering   |                          |  |                      |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Optional, Standard Grading System)</li> </ul>   |                          |  |                      |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Optional, Weighting: 100 %)</li> </ul>  |                          |  |                      |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc/MSc Wi-ETiT, BEd   |                          |  |                      |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |                          |  |                      |                              |
| <b>8</b>   | <b>References</b><br>Detailed textbook and collection of exercises; Complete set of PowerPoint presentations<br>L.Matsch: Electromagnetic and electromechanical machines, Int.Textbook, 1972<br>A.Fitzgerald et al: Electric machinery, McGraw-Hill, 1971<br>S.Nasar et al: Electromechanics and electric machines, Wiley&Sons, 1995<br>R.Fischer: Elektrische Maschinen, C.Hanser-Verlag, 2004   |                          |  |                      |                              |
| <b>Courses</b>                                       |   |                          |  |                      |                              |

|  |  |  |                         |                 |
|--|--|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-bi-1020-vl                           | <b>Course name</b><br>Electrical Machines and Drives |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>2 |
|  | <b>Course Nr.</b><br>18-bi-1020-ue                           | <b>Course name</b><br>Electrical Machines and Drives |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |  | <b>Type</b><br>Practice | <b>SWS</b><br>2 |

|  |  |  |   |                           |                                   |
|--|--|--|---|---------------------------|-----------------------------------|
| <b>Module name</b><br>Laboratory Matlab/Simulink I |  |  |   |                           |                                   |
| <b>Module Nr.</b><br>18-ko-1030                    | <b>Credit Points</b><br>3 CP   | <b>Workload</b><br>90 h                            | <b>Self study</b><br>45 h                               | <b>Duration</b><br>1      | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German                          |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Ulrich Konigorski |                           |                                   |
| <b>1</b>   | <b>Content</b><br>In this lab tutorial, an introduction to the software tool MatLab/Simulink will be given. The lab is split into two parts. First the fundamentals of programming in Matlab are introduced and their application to different problems is trained. In addition, an introduction to the Control System Toolbox will be given. In the second part, the knowledge gained in the first part is applied to solve a control engineering specific problem with the software tools. |  |   |                           |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Fundamentals in the handling of Matlab/Simulink and the application to control engineering tasks.  |  |   |                           |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>The lab should be attended in parallel or after the lecture "System Dynamics and Control Systems I"   |  |   |                           |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>   |  |   |                           |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>  |  |   |                           |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT; BSc MEC   |  |   |                           |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b><br>In case of E-Learning: Possibility to improve the grade up to 1,0   |  |   |                           |                                   |
| <b>8</b>   | <b>References</b><br>Lecture notes for the lab tutorial can be obtained at the secretariat<br>Lunze; Regelungstechnik I<br>Dorp; Bishop: Moderne Regelungssysteme<br>Moler: Numerical Computing with MATLAB  |  |   |                           |                                   |
| <b>Courses</b>                                     |  |  |   |                           |                                   |
|  | <b>Course Nr.</b><br>18-ko-1030-pr   | <b>Course name</b><br>Laboratory Matlab/Simulink I |   |                           |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Alexander Steinke   |  |   | <b>Type</b><br>Internship | <b>SWS</b><br>3                   |

|  |  |  |   |                           |                              |
|--|--|--|---|---------------------------|------------------------------|
| <b>Module name</b><br>Laboratory Control Engineering I |  |  |   |                           |                              |
| <b>Module Nr.</b><br>18-ko-1020                        | <b>Credit Points</b><br>4 CP   | <b>Workload</b><br>120 h                               | <b>Self study</b><br>60 h                               | <b>Duration</b><br>1      | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                              |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Ulrich Konigorski |                           |                              |
| <b>1</b>   | <b>Content</b> <ul style="list-style-type: none"> <li>• Control of a 2-tank system.</li> <li>• Control of pneumatic and hydraulic servo-drives.</li> <li>• Control of a 3 mass oscillator.</li> <li>• Position control of a MagLev system.</li> <li>• Control of a discrete transport process with electro-pneumatic components.</li> <li>• Microcontroller-based control of an electrically driven throttle valve.</li> <li>• Identification of a 3 mass oscillator.</li> <li>• Process control using PLC.</li> </ul> |  |   |                           |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After this lab tutorial the students will be able to practically apply the modelling and design techniques for different dynamic systems presented in the lecture "System dynamics and control systems I" to real lab experiments and to bring them into operation at the lab setup.   |  |   |                           |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>System Dynamics and Control Systems I   |  |   |                           |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |  |   |                           |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Written Examination, Weighting: 100%)</li> </ul>   |  |   |                           |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT  |  |   |                           |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |   |                           |                              |
| <b>8</b>   | <b>References</b><br>Lab handouts will be given to students  |  |   |                           |                              |
| <b>Courses</b>   |  |  |   |                           |                              |
|  | <b>Course Nr.</b><br>18-ko-1020-pr   | <b>Course name</b><br>Laboratory Control Engineering I |   |                           |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski  |  |   | <b>Type</b><br>Internship | <b>SWS</b><br>4              |

|  |  |  |  |                         |                              |
|--|--|--|--|-------------------------|------------------------------|
| <b>Module name</b><br>Programming in Automatic Control (C/C++) |  |  |  |                         |                              |
| <b>Module Nr.</b><br>18-ad-1020                                | <b>Credit Points</b><br>2 CP   | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                          | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                                      |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Jürgen Adamy |                         |                              |
| <b>1</b>   | <b>Content</b><br>Programming in LINUX, Makefiles, C - Programming (Program structures in C, pointer, developer environment and debugger), C++ (object oriented programming)   |  |  |                         |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After attending the lecture, a student is capable of:<br>1. operating LINUX computers,<br>2. assembling and using makefiles,<br>3. recalling and applying the syntax for standard C-blocks,<br>4. explaining and applying the use of pointers, 5. explaining the concept of object oriented programming in C++ |  |  |                         |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>  |  |  |                         |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)  |  |  |                         |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)  |  |  |                         |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc iST, MSc MEC, MSc Wi-ETiT   |  |  |                         |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                         |                              |
| <b>8</b>   | <b>References</b><br>Adamy: Lecture notes  |  |  |                         |                              |
| <b>Courses</b>   |  |  |  |                         |                              |
|  | <b>Course Nr.</b><br>18-ad-1020-vl   | <b>Course name</b><br>Programming in Automatic Control (C/C++) |  |                         |                              |
|  | <b>Instructor</b><br>Dr. rer. nat. Tatiana Tatarenko   |  |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>1              |
|  | <b>Course Nr.</b><br>18-ad-1020-ue   | <b>Course name</b><br>Programming in Automatic Control (C/C++) |  |                         |                              |
|  | <b>Instructor</b><br>Dr. rer. nat. Tatiana Tatarenko   |  |  | <b>Type</b><br>Practice | <b>SWS</b><br>1              |

## 4.2 Option Computer-Aided Electrodynamics

### 4.2.1 Fundamentals

|   |   |   |   |                        |                              |
|---|---|---|---|------------------------|------------------------------|
| <b>Module name</b><br>Computational Electromagnetics and Applications I |   |   |   |                        |                              |
| <b>Module Nr.</b><br>18-dg-1030   | <b>Credit Points</b><br>3 CP  | <b>Workload</b><br>90 h   | <b>Self study</b><br>60 h                               | <b>Duration</b><br>1   | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German   |   |   | <b>Module owner</b><br>Prof. Dr.-Ing. Herbert De Gersem |                        |                              |
| <b>1</b>  | <b>Content</b><br>Basics FIT, electrostatics, magnetostatics, magnetoquasistatics, high frequency simulations, convergence studies, discretisation, time- and frequency domain simulations.   |   |   |                        |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students learn the basic concepts of the Finite Integration Technique (FIT) for the numerical solution of Maxwell's equations. Students are, furthermore, introduced to the practical application of the method for numerical field problems. |   |   |                        |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Basics of Maxwell's equations, linear algebra. Recommended: Basic knowledge in knowledge in "Technical Electrodynamics"  |   |   |                        |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Oral Examination, Duration: 30 min, Standard Grading System)</li> </ul>   |   |   |                        |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Oral Examination, Weighting: 100%)</li> </ul>   |   |   |                        |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT   |   |   |                        |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                        |                              |
| <b>8</b>  | <b>References</b><br>Course notes, lecture slides.  |   |   |                        |                              |
| <b>Courses</b>  |   |   |   |                        |                              |
|   | <b>Course Nr.</b><br>18-dg-1030-vl  | <b>Course name</b><br>Computational Electromagnetics and Applications I |   |                        |                              |
|   | <b>Instructor</b><br>Dr.-Ing. Wolfgang Ackermann  |   |   | <b>Type</b><br>Lecture | <b>SWS</b><br>2              |

|  |   |  |   |                           |                              |
|--|---|--|---|---------------------------|------------------------------|
| <b>Module name</b><br>Software Lab Computational Electromagnetics and Applications I |   |  |   |                           |                              |
| <b>Module Nr.</b><br>18-sc-1010  | <b>Credit Points</b><br>8 CP  | <b>Workload</b><br>240 h   | <b>Self study</b><br>195 h                                  | <b>Duration</b><br>1      | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr. rer. nat. Sebastian Schöps |                           |                              |
| <b>1</b>   | <b>Content</b><br>Various topics are: 1. Introduction, 2. Basics of FIT I, 3. Basics of FIT II, 4. Static problems (electrical/magnetical) (scalar potential), 5. Magnetostatic problems, frequency domain, 5. Time domain integration techniques: Leapfrog I, 7. Time domain integration techniques: Leapfrog II, 8. Other physical problems: heat conduction, 9. Other discretization methods: Finite Element Method. |  |   |                           |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Students will understand basic concepts of numerical solution techniques to field problems related to different physical domains. They will exhibit the ability to write small simulation programs in Matlab.   |  |   |                           |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Recommended: "Computational Electromagnetics and Applications" (also in parallel).   |  |   |                           |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Duration: 20 min, Standard Grading System)</li> </ul>   |  |   |                           |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Weighting: 100 %)</li> </ul>  |  |   |                           |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, MSc ETiT, BSc CE   |  |   |                           |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |                           |                              |
| <b>8</b>   | <b>References</b><br>Course notes will be provided.   |  |   |                           |                              |
| <b>Courses</b>   |   |  |   |                           |                              |
|  | <b>Course Nr.</b><br>18-sc-1010-pr  | <b>Course name</b><br>Software Lab Computational Electromagnetics and Applications I |   |                           |                              |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Sebastian Schöps   |  |   | <b>Type</b><br>Internship | <b>SWS</b><br>3              |



|   |   |   |   |                                |                                   |
|---|---|---|---|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Electromagnetic CAD |   |   |   |                                |                                   |
| <b>Module Nr.</b><br>18-sc-1020                           | <b>Credit Points</b><br>8 CP  | <b>Workload</b><br>240 h                                  | <b>Self study</b><br>180 h                                  | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English                     |   |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Sebastian Schöps |                                |                                   |
| <b>1</b>  | <b>Content</b><br>Work on a more complex project in numerical field calculation using commercial tools or own software.   |   |   |                                |                                   |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students will be able to simulate complex engineering problems with numerical field simulation software. They are able to estimate modelling and numerical errors. They know how to present the results on a scientific level in talks and a paper. Students are able to organize teamwork. |   |   |                                |                                   |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Good understanding of electromagnetic fields, knowledge about numerical simulation methods.  |   |   |                                |                                   |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Duration: 20 min, Standard Grading System)</li> </ul>   |   |   |                                |                                   |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Weighting: 100 %)</li> </ul>  |   |   |                                |                                   |
| <b>6</b>  | <b>Usability of this module</b><br>MSc ETiT   |   |   |                                |                                   |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                                |                                   |
| <b>8</b>  | <b>References</b><br>Course notes “Computational Electromagnetics and Applications I-III”, further material is provided.  |   |   |                                |                                   |
| <b>Courses</b>  |   |   |   |                                |                                   |
|   | <b>Course Nr.</b><br>18-sc-1020-pj  | <b>Course name</b><br>Project Seminar Electromagnetic CAD |   |                                |                                   |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Sebastian Schöps   |   |   | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |

|   |   |   |   |                         |                              |
|---|---|---|---|-------------------------|------------------------------|
| <b>Module name</b><br>Technical Electrodynamics |   |   |   |                         |                              |
| <b>Module Nr.</b><br>18-dg-1070                 | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h                        | <b>Self study</b><br>120 h                              | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                       |   |   | <b>Module owner</b><br>Prof. Dr.-Ing. Herbert De Gersem |                         |                              |
| <b>1</b>  | <b>Content</b><br>Fields in materials, Green's functions, separation of variables in generalized orthogonal coordinates, conformal mapping, elliptic integrals and elliptic functions, electromagnetic forces, quasi-stationary fields, general waveguides, resonators, antennas.   |   |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Starting with Maxwell's equations the lecture's aim is to provide a general understanding of electromagnetic phenomena. Students will be able to apply analytical methods to simple problems. Students will exhibit the ability to deal with more complex electromagnetic formulations and tasks. |   |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Vector analysis, infinitesimal calculus, basics in differential equations. Knowledge of "Introduction to Electrodynamics"  |   |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)</li> </ul>   |   |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |   |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, MSc Wi-ETiT  |   |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                         |                              |
| <b>8</b>  | <b>References</b><br>Course notes available (including references)  |   |   |                         |                              |
| <b>Courses</b>                                  |   |   |   |                         |                              |
|   | <b>Course Nr.</b><br>18-dg-1070-vl  | <b>Course name</b><br>Technical Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann  |   |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>2              |
|   | <b>Course Nr.</b><br>18-dg-1070-ue  | <b>Course name</b><br>Technical Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann  |   |   | <b>Type</b><br>Practice | <b>SWS</b><br>2              |

|   |  |   |   |                         |                              |
|---|--|---|---|-------------------------|------------------------------|
| <b>Module name</b><br>Software Engineering - Introduction |  |   |   |                         |                              |
| <b>Module Nr.</b><br>18-su-1010                           | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                                  | <b>Self study</b><br>120 h                                | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                                 |  |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Andreas Schürr |                         |                              |
| <b>1</b>  | <b>Content</b><br><p>The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's "Guide to the Software Engineering Body of Knowledge" - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of software architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).</p> <p>During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of requirements, definition of a design and eventually the implementation of executable (proof-of-concept) code.</p> |   |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br><p>This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.</p> <p>After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Furthermore, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal.</p>  |   |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>sound knowledge of an object-oriented programming language (preferably Java)  |   |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |   |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |   |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc iST, BSc Wi-ETiT  |   |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |   |   |                         |                              |
| <b>8</b>  | <b>References</b><br><a href="http://www.es.tu-darmstadt.de/lehre/se-i-v/">www.es.tu-darmstadt.de/lehre/se-i-v/</a>  |   |   |                         |                              |
| <b>Courses</b>  |  |   |   |                         |                              |
|   | <b>Course Nr.</b><br>18-su-1010-vl   | <b>Course name</b><br>Software Engineering - Introduction |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr  |   |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|   | <b>Course Nr.</b><br>18-su-1010-ue   | <b>Course name</b><br>Software Engineering - Introduction |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Fritsche   |   |   | <b>Type</b><br>Practice | <b>SWS</b><br>1              |

#### 4.2.1.1 Proseminar ETiT

|  |   |  |   |   |                                   |
|--|---|--|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                                   |
| <b>Module Nr.</b><br>18-dg-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                               | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Herbert De Gersem |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |   |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |   |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |   |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |  |   |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |   |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                                   |
| <b>8</b>   | <b>References</b>   |  |   |   |                                   |
| <b>Courses</b>   |   |  |   |   |                                   |
|  | <b>Course Nr.</b><br>18-dg-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem   |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |   |   |                                   |
|--|---|--|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                                   |
| <b>Module Nr.</b><br>18-sc-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                                   | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr. rer. nat. Sebastian Schöps |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |   |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |   |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |   |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |   |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |   |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                                   |
| <b>8</b>   | <b>References</b>   |  |   |   |                                   |
| <b>Courses</b>   |   |  |   |   |                                   |
|  | <b>Course Nr.</b><br>18-sc-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Sebastian Schöps   |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

#### 4.2.1.2 More Fundamentals

|  |  |                          |  |                      |                              |
|--|--|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Electrical Power Engineering |  |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-bi-1010                    | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                                     | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                          |  |                          | <b>Module owner</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |                      |                              |
| <b>1</b>   | <p><b>Content</b></p> <p>The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.</p> <p>First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.</p> <p>Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.</p> <p>The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications. The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.</p> |                          |  |                      |                              |
| <b>2</b>   | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.</p> <p>They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.</p> <p>They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.</p> <p>They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.</p>  |                          |  |                      |                              |
| <b>3</b>   | <p><b>Recommended prerequisite for participation</b></p> <p>Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.</p>  |                          |  |                      |                              |
| <b>4</b>   | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |  |                      |                              |
| <b>5</b>   | <b>Grading</b>   |                          |  |                      |                              |

|                |   |  |                         |
|----------------|---|--|-------------------------|
|                | Module Final Examination:<br><ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |  |                         |
| 6              | <b>Usability of this module</b><br>BSc ETiT, BSc WI-ETiT, BSc MEC, BSc iST, BSc CE, MSc ESE   |  |                         |
| 7              | <b>Grade bonus compliant to §25 (2)</b><br>At the beginning of the semester, it will be announced whether there will be homework tests accompanying the lecture that will enable an improvement in grades.  |  |                         |
| 8              | <b>References</b><br>Lecture notes (slides)<br>Practice documents (examples, solutions)<br>Additional and more detailed literature:<br>Grothe/Feldhusen: Dubbel-Taschenbuch für den Maschinenbau, Springer, Berlin, 2007, 22. Aufl.; besonders: Kapitel „Energietechnik und Wirtschaft“; Sterner/Stadler: Energiespeicher – Bedarf, Technologien, Integration, Springer-Vieweg, Berlin, 2011; Rummich: Energiespeicher, expert-verlag, Rellingen, 2015, 2. Aufl.; Strauß: Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, Berlin, 2006, 5. Aufl.; Hau: Windkraftanlagen –Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Springer-Vieweg, Berlin, 2014, 5. Aufl.; Heuck/Dettmann/Schulz: Elektrische Energieversorgung, Springer-Vieweg, Berlin, 2014, 9. Aufl.; Quaschnig: Regenerative Energiesystem, Hanser, München, 2001, 7. Aufl. |  |                         |
| <b>Courses</b> |   |  |                         |
|                | <b>Course Nr.</b><br>18-bi-1010-vl  | <b>Course name</b><br>Electrical Power Engineering |                         |
|                | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  |  | <b>Type</b><br>Lecture  |
|                |   |  | <b>SWS</b><br>3         |
|                | <b>Course Nr.</b><br>18-bi-1010-ue  | <b>Course name</b><br>Electrical Power Engineering |                         |
|                | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  |  | <b>Type</b><br>Practice |
|                |   |  | <b>SWS</b><br>1         |

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|--|--|--|--|------------------------|------------------------------|
| <b>Module name</b><br>Communication Technology I |  |  |  |                        |                              |
| <b>Module Nr.</b><br>18-kl-1020                  | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                         | <b>Self study</b><br>120 h                       | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                        |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Anja Klein |                        |                              |
| <b>1</b>   | <b>Content</b><br>Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carrier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access  |  |  |                        |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the lecture, students possess the ability to: <ul style="list-style-type: none"> <li>• classify signals and communication systems,</li> <li>• understand, model and analyse basic components of communication systems,</li> <li>• understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,</li> <li>• model and analyse base-band communication systems,</li> <li>• describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,</li> <li>• understand, model, evaluate, compare and apply linear modulation schemes,</li> <li>• design receiver structures for different modulation schemes,</li> <li>• detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,</li> <li>• understand and model OFDM,</li> <li>• understand and model CDMA,</li> <li>• understand and compare the basic properties of multiple access schemes.</li> </ul> |  |  |                        |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV  |  |  |                        |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |  |  |                        |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>  |  |  |                        |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC   |  |  |                        |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                        |                              |
| <b>8</b>   | <b>References</b><br>Will be announced in the lecture  |  |  |                        |                              |
| <b>Courses</b>                                   |  |  |  |                        |                              |
|  | <b>Course Nr.</b><br>18-kl-1020-vl   | <b>Course name</b><br>Communication Technology I |  |                        |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein   |  |  | <b>Type</b><br>Lecture | <b>SWS</b><br>3              |



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|--|--|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-kl-1020-ue   | <b>Course name</b><br>Communication Technology I |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein, Dr. rer. nat. Sabrina Klos |  | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

|   |  |                          |   |                      |                              |
|---|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Fundamentals of Communication |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-jk-1010                     | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                        | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                           |  |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Rolf Jakoby |                      |                              |
| <b>1</b>  | <p><b>Content</b></p> <p>Part 1: Chap. 1 will be a brief introduction in “Electrical Information- and Communication Engineering”, presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.</p> <p>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.</p> <p>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.</p> <p>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited intersymbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture.</p> |                          |   |                      |                              |
| <b>2</b>  | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.</p> <p>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems.</p>   |                          |   |                      |                              |
| <b>3</b>  | <p><b>Recommended prerequisite for participation</b></p> <p>Deterministic Signals and Systems</p>  |                          |   |                      |                              |
| <b>4</b>  | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |   |                      |                              |
| <b>5</b>  | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>  | <p><b>Usability of this module</b></p> <p>BSc ETiT, Wi-ETiT</p>  |                          |   |                      |                              |
| <b>7</b>  | <p><b>Grade bonus compliant to §25 (2)</b></p>   |                          |   |                      |                              |

|          |   |
|----------|---|
| <b>8</b> | <b>References</b><br>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addison-Wesley 1992. |
|----------|---|

| <b>Courses</b> |                            |                                |             |
|----------------|----------------------------|--------------------------------|-------------|
|                | <b>Course Nr.</b>          | <b>Course name</b>             |             |
|                | 18-jk-1010-vl              | Fundamentals of Communications |             |
|                | <b>Instructor</b>          |                                | <b>Type</b> |
|                | Prof. Dr.-Ing. Rolf Jakoby |                                | Lecture     |
|                | <b>SWS</b>                 | 3                              |             |
|                | <b>Course Nr.</b>          | <b>Course name</b>             |             |
|                | 18-jk-1010-ue              | Fundamentals of Communications |             |
|                | <b>Instructor</b>          |                                | <b>Type</b> |
|                | Prof. Dr.-Ing. Rolf Jakoby |                                | Practice    |
|                | <b>SWS</b>                 | 1                              |             |

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|---|---|--|---|-------------------------|------------------------------|
| <b>Module name</b><br>System Dynamics and Automatic Control Systems I |   |  |   |                         |                              |
| <b>Module Nr.</b><br>18-ko-1010                                       | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h   | <b>Self study</b><br>120 h                              | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German   |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Ulrich Konigorski |                         |                              |
| <b>1</b>  | <b>Content</b><br>Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization  |  |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems.  |  |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>   |  |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |  |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |  |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, MSc Informatik  |  |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |  |   |                         |                              |
| <b>8</b>  | <b>References</b><br>Skript Konigorski: "Systemdynamik und Regelungstechnik I", Aufgabensammlung zur Vorlesung, Lunze: "Regelungstechnik 1: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen", Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen", Unbehauen: "Regelungstechnik I:Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme, Fuzzy-Regelsysteme", Föllinger: "Laplace-, Fourier- und z-Transformation", Jörgl: "Repetitorium Regelungstechnik", Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden", Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise", Schneider: "Regelungstechnik für Maschinenbauer", Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnaher Grundlage" |  |   |                         |                              |
| <b>Courses</b>  |   |  |   |                         |                              |
|   | <b>Course Nr.</b><br>18-ko-1010-vl  | <b>Course name</b><br>System Dynamics and Automatic Control Systems I                      |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand  |  |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|   | <b>Course Nr.</b><br>18-ko-1010-tt  | <b>Course name</b><br>System Dynamics and Automatic Control Systems I- Auditorium Exercise |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand  |  |   | <b>Type</b><br>Tutorial | <b>SWS</b><br>1              |

## 4.2.2 Optional Modules

### 4.2.2.1 Wahlkatalog

|  |  |  |  |                                   |                                       |
|--|--|--|--|-----------------------------------|---------------------------------------|
| <b>Module name</b><br>Introduction to Numerical Analysis |  |  |  |                                   |                                       |
| <b>Module Nr.</b><br>04-10-0013/de                       | <b>Credit Points</b><br>9 CP   | <b>Workload</b><br>270 h                                 | <b>Self study</b><br>180 h                           | <b>Duration</b><br>1              | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                                |  |  | <b>Module owner</b><br>Prof. Dr. rer. nat. Jens Lang |                                   |                                       |
| <b>1</b>   | <b>Content</b><br>Condition, systems of linear and nonlinear equations, least squares minimization, interpolation, integration and differentiation, differential equations, difference schemes, programming exercises.   |  |  |                                   |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The students are able to describe, explain and apply basic elementary numerical methods. They should have the ability to compare, modify and combine them.   |  |  |                                   |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>recommended: Analysis and Linear Algebra, Introduction to Scientific Programming  |  |  |                                   |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Special Form, Pass/Fail Grading System)</li> <li>• Module Examination (Technical Examination, Optional, Standard Grading System)</li> </ul> Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.<br>Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture. |  |  |                                   |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Special Form, Weighting: 0%)</li> <li>• Module Examination (Technical Examination, Optional, Weighting: 100%)</li> </ul>   |  |  |                                   |                                       |
| <b>6</b>   | <b>Usability of this module</b><br>B.Sc. Mathematik, LaG Mathematik  |  |  |                                   |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                                   |                                       |
| <b>8</b>   | <b>References</b><br>Deuflhard, Hohmann: Numerical Analysis in Modern Scientific Computing: An Introduction; Texts in Applied Mathematics 43, Springer 2003.<br>Stoer, Bulirsch: Introduction to Numerical Analysis; Texts in Applied Mathematics 12, Springer 2002<br>Matlab User Guide   |  |  |                                   |                                       |
| <b>Courses</b>   |  |  |  |                                   |                                       |
|  | <b>Course Nr.</b><br>04-00-0056-vu   | <b>Course name</b><br>Introduction to Numerical Analysis |  |                                   |                                       |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Jens Lang   |  |  | <b>Type</b><br>Lecture & Practice | <b>SWS</b><br>6                       |

|   |   |                          |  |                                   |                                       |
|---|---|--------------------------|--|-----------------------------------|---------------------------------------|
| <b>Module name</b><br>Numerical Methods for Ordinary Differential Equations for Engineers |   |                          |  |                                   |                                       |
| <b>Module Nr.</b><br>04-10-0042/de  | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h | <b>Self study</b><br>105 h                           | <b>Duration</b><br>1              | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German   |   |                          | <b>Module owner</b><br>Prof. Dr. rer. nat. Jens Lang |                                   |                                       |
| <b>1</b>  | <b>Content</b><br>initial value problems: one-step methods, multi-step methods; convergence analysis, notions of stability; boundary-value problems: Shooting methods, finite difference methods, stability and convergence;  |                          |  |                                   |                                       |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students know the basic numerical solution concepts for ordinary differential equations and they are able to analyze, compare, and apply them.  |                          |  |                                   |                                       |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>recommended: Analysis, Linear Algebra, Ordinary Differential Equations, Introduction to Numerical Analysis or similar knowledge as taught in an engineering programme.   |                          |  |                                   |                                       |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Technical Examination, Standard Grading System)</li> <li>• Module Examination (Study Achievement, Special Form, Pass/Fail Grading System)</li> </ul> Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.<br>Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture. |                          |  |                                   |                                       |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)</li> <li>• Module Examination (Study Achievement, Special Form, Weighting: 0 %)</li> </ul>   |                          |  |                                   |                                       |
| <b>6</b>  | <b>Usability of this module</b><br>B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics   |                          |  |                                   |                                       |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |                          |  |                                   |                                       |
| <b>8</b>  | <b>References</b><br>Deuffhard, Bornemann: Numerische Mathematik 2<br>Stoer, Bulirsch: Numerische Mathematik 2  |                          |  |                                   |                                       |
| <b>Courses</b>  |   |                          |  |                                   |                                       |
|   | <b>Course Nr.</b><br>04-10-0134-vu  | <b>Course name</b>       |  |                                   |                                       |
|   | <b>Instructor</b><br>Prof. Dr. techn. Herbert Egger   |                          |  | <b>Type</b><br>Lecture & Practice | <b>SWS</b><br>3                       |

|  |   |  |  |                                   |                                       |
|--|---|--|--|-----------------------------------|---------------------------------------|
| <b>Module name</b><br>Numerical Linear Algebra |   |  |  |                                   |                                       |
| <b>Module Nr.</b><br>04-10-0043/de             | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h                       | <b>Self study</b><br>105 h                       | <b>Duration</b><br>1              | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                      |   |  | <b>Module owner</b><br>Dr. rer. nat. Alf Gerisch |                                   |                                       |
| <b>1</b>                                       | <b>Content</b><br>Systems of linear equations: iterative methods, singular value decomposition, eigenvalue problems.  |  |  |                                   |                                       |
| <b>2</b>                                       | <b>Learning objectives / Learning Outcomes</b><br>Students know about the most important numerical methods of linear algebra and they are able to explain, classify, and apply them.  |  |  |                                   |                                       |
| <b>3</b>                                       | <b>Recommended prerequisite for participation</b><br>recommended: Linear Algebra, Introduction to Numerical Analysis or similar knowledge   |  |  |                                   |                                       |
| <b>4</b>                                       | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Technical Examination, Standard Grading System)</li> <li>• Module Examination (Study Achievement, Special Form, Pass/Fail Grading System)</li> </ul> Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.<br>Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture. |  |  |                                   |                                       |
| <b>5</b>                                       | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)</li> <li>• Module Examination (Study Achievement, Special Form, Weighting: 0 %)</li> </ul>   |  |  |                                   |                                       |
| <b>6</b>                                       | <b>Usability of this module</b><br>B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics   |  |  |                                   |                                       |
| <b>7</b>                                       | <b>Grade bonus compliant to §25 (2)</b>   |  |  |                                   |                                       |
| <b>8</b>                                       | <b>References</b><br>Trefethen/Bau: Numerical Linear Algebra, SIAM<br>Demmel: Applied Numerical Linear Algebra, SIAM<br>Stoer/Bulirsch: Numerische Mathematik 2, Springer   |  |  |                                   |                                       |
| <b>Courses</b>                                 |   |  |  |                                   |                                       |
|  | <b>Course Nr.</b><br>04-00-0139-vu  | <b>Course name</b><br>Numerical Linear Algebra |  |                                   |                                       |
|  | <b>Instructor</b><br>Dr. rer. nat. Alf Gerisch  |  |  | <b>Type</b><br>Lecture & Practice | <b>SWS</b><br>3                       |

|   |   |   |  |                                |                                   |
|---|---|---|--|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Particle Accelerator Technology |   |   |  |                                |                                   |
| <b>Module Nr.</b><br>18-kb-1020                                       | <b>Credit Points</b><br>9 CP  | <b>Workload</b><br>270 h  | <b>Self study</b><br>210 h                             | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English                                 |   |   | <b>Module owner</b><br>Prof. Dr.-Ing. Harald Klingbeil |                                |                                   |
| <b>1</b>  | <b>Content</b><br>Work on a more complex project in the field of particle accelerator technology. Depending on the specific problem, measurement aspects, analytical aspects, and simulation aspects will be included.  |   |  |                                |                                   |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students will be able to solve complex engineering problems with different measurement techniques, analytical approaches or simulation methods. They are able to estimate measurement errors and modeling and simulation errors. They know how to present the results on a scientific level in talks and a paper. Students are able to organize teamwork. |   |  |                                |                                   |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Good understanding of electromagnetic fields, broad knowledge of different electrical engineering disciplines.   |   |  |                                |                                   |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Duration: 20 min, Standard Grading System)</li> </ul>   |   |  |                                |                                   |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Weighting: 100 %)</li> </ul>  |   |  |                                |                                   |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT   |   |  |                                |                                   |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |  |                                |                                   |
| <b>8</b>  | <b>References</b><br>Suitable material is provided based on specific problem.   |   |  |                                |                                   |
| <b>Courses</b>  |   |   |  |                                |                                   |
|   | <b>Course Nr.</b><br>18-kb-1020-pj  | <b>Course name</b><br>Project Seminar Particle Accelerator Technology |  |                                |                                   |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Harald Klingbeil  |   |  | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |



|  |  |                          |   |                      |                              |
|--|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Modelling and simulation of circuits |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-sc-2010                            | <b>Credit Points</b><br>4 CP   | <b>Workload</b><br>120 h | <b>Self study</b><br>75 h                                   | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German and English                      |  |                          | <b>Module owner</b><br>Prof. Dr. rer. nat. Sebastian Schöps |                      |                              |
| <b>1</b>   | <b>Content</b><br>The content of this course is the following: <ul style="list-style-type: none"> <li>• Circuit interpretation as directed graphs</li> <li>• Modified nodal and loop analysis</li> <li>• Flux and charge oriented formulations</li> <li>• Differential algebraic equations</li> <li>• Linear system solver</li> <li>• Numerical solution of nonlinear systems</li> <li>• Time-domain methods</li> <li>• Frequency-domain solution</li> <li>• Implementation of the numerical methods</li> </ul>  |                          |   |                      |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Students understand the theoretical and numerical fundamentals of circuit simulation and how the equations can be derived from Maxwell's equations. Circuit properties can be expressed in terms of graph theory. The sparse systems of equations such as the flux/charge oriented modified nodal analysis can be assembled. In order to solve the obtained systems, different numerical methods for the simulation of circuits are relevant. This includes methods for the solution of linear systems (direct and iterative solvers), root-finding algorithms for nonlinear systems and implicit time integration methods. Mathematical concepts such as stability, convergence order or complexity are known and can be employed to judge the advantages and disadvantages of the various methods. Eventually, the students are able to program their own circuit simulator, that can return both frequency as well as time domain solutions of electric networks. |                          |   |                      |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>18-hs-1070 Elektrotechnik und Informationstechnik I<br>18-gt-1020 Elektrotechnik und Informationstechnik II<br>20-00-0304 Allgemeine Informatik I<br>04-00-0112 Mathematik IV   |                          |   |                      |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Oral Examination, Duration: 20 min, Standard Grading System)</li> </ul>  |                          |   |                      |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Oral Examination, Weighting: 100%)</li> </ul>  |                          |   |                      |                              |
| <b>6</b>   | <b>Usability of this module</b>  |                          |   |                      |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b><br>Grade bonus of 0,4 if correctly implemented programs are submitted  |                          |   |                      |                              |
| <b>8</b>   | <b>References</b>  |                          |   |                      |                              |

- L. W. Nagel, "SPICE2: A computer program to simulate semiconductor circuits", University of Berkeley, Tech. Rep., 1975.
- C.-W. Ho, A. E. Ruehli, and P. A. Brennan, "The modified nodal approach to network analysis", IEEE Trans. Circ. Syst., vol. 22, no. 6, pp. 504–509, Jun. 1975.
- J. Vlach, K. Singhal, Computer methods for circuit analysis and design. New York : Van Nostrand Reinold, 1983.

**Courses**

|                                    |  |  |                         |                 |
|------------------------------------|--|--|-------------------------|-----------------|
| <b>Course Nr.</b><br>18-sc-2010-v1 | <b>Course name</b><br>Modelling and simulation of circuits |  |                         |                 |
| <b>Instructor</b>                  |  |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>2 |
| <b>Course Nr.</b><br>18-sc-2010-ue | <b>Course name</b><br>Modelling and simulation of circuits |  |                         |                 |
| <b>Instructor</b>                  |  |  | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

## 4.3 Option Computer Engineering

### 4.3.1 Fundamentals

|   |   |                         |  |                      |                                       |
|---|---|-------------------------|--|----------------------|---------------------------------------|
| <b>Module name</b><br>General Computer Science II |   |                         |  |                      |                                       |
| <b>Module Nr.</b><br>20-00-0290                   | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150h | <b>Self study</b><br>90 h                                | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                         |   |                         | <b>Module owner</b><br>Prof. Dr. rer. nat. Karsten Weihe |                      |                                       |
| <b>1</b>  | <b>Content</b><br>In this course, students learn fundamental algorithms and data structures using advanced concepts of the programming language Java.<br>Recapitulation Basic Java:<br>* Variables, Types, Classes, Program Flow<br>* Inheritance, Abstract Classes, Interfaces<br>* Arrays and Collections<br>Advanced Programming Concepts<br>* Graphical User Interfaces<br>* Input/Output<br>* Error Handling and Exceptions<br>Algorithms and Data Structures<br>* Recursion<br>* Sorting algorithms<br>* Stacks, Lists, Queues,<br>* Search<br>* Trees and Graphs |                         |  |                      |                                       |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>After completion of this course, students are able to<br>- write larger programs in Java<br>- use fundamental algorithms and data structures of computer science<br>- estimate and compare the quality of elementary algorithms with respect to complexity and run-time   |                         |  |                      |                                       |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>General Computer Science I or<br>- elementary programming skills in Java<br>- basic knowledge in computer science<br>- working with computers  |                         |  |                      |                                       |
| <b>4</b>  | <b>Form of examination</b><br>Module Accompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Standard BWS)   |                         |  |                      |                                       |
| <b>5</b>  | <b>Grading</b><br>Module Accompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)   |                         |  |                      |                                       |
| <b>6</b>  | <b>Usability of this module</b>   |                         |  |                      |                                       |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |                         |  |                      |                                       |
| <b>8</b>  | <b>References</b>   |                         |  |                      |                                       |

Java lernen mit BlueJ: Eine Einführung in die objektorientierte Programmierung David J. Barnes, Michael Kölling Pearson Studium 4., aktualisierte Auflage, 2009  
 ISBN-13: 978-3-8689-4001-5  
 Algorithmen in Java  
 Robert Sedgewick  
 Pearson Studium  
 3. überarbeitete Auflage, 2003  
 ISBN-13: 978-3-8273-7072-3  
 Einführung in die Programmierung mit Java Robert Sedgewick, Kevin Wayne Pearson Studium 1. Auflage, 2011  
 ISBN-13: 978-3-8689-4076-3

**Courses**

|                                    |   |                                     |                 |
|------------------------------------|---|-------------------------------------|-----------------|
| <b>Course Nr.</b><br>20-00-0290-iv | <b>Course name</b><br>General Computer Science II |                                     |                 |
| <b>Instructor</b>                  |   | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>4 |

|  |   |                          |  |                      |                              |
|--|---|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Communication Networks I |   |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-sm-1010                | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                           | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>English                     |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Ralf Steinmetz |                      |                              |
| <b>1</b>                                       | <p><b>Content</b></p> <p>In this class the technologies that make today's communication networks work are introduced and discussed.</p> <p>This lecture covers basic knowledge about communication networks and discusses in detail the physical layer, the data link layer, the network layer and parts of the transport layer.</p> <p>The physical layer, which is responsible for an adequate transmission across a channel, is discussed briefly. Next, error control, flow control and medium access mechanisms of the data link layer are presented. Then the network layer is discussed. It comprises mainly routing and congestion control algorithms. After that basic functionalities of the transport layer are discussed. This includes UDP and TCP. The Internet is thoroughly studied throughout the class.</p> <p>Detailed Topics are:</p> <ul style="list-style-type: none"> <li>• ISO-OSI and TCP/IP layer models</li> <li>• Tasks and properties of the physical layer</li> <li>• Physical layer coding techniques</li> <li>• Services and protocols of the data link layer</li> <li>• Flow control (sliding window)</li> <li>• Applications: LAN, MAN, High-Speed LAN, WAN</li> <li>• Services of the network layer</li> <li>• Routing algorithms</li> <li>• Broadcast and Multicast routing</li> <li>• Congestion Control</li> <li>• Addressing</li> <li>• Internet protocol (IP)</li> <li>• Internetworking</li> <li>• Mobile networking</li> <li>• Services and protocols of the transport layer</li> <li>• TCP, UDP</li> </ul> |                          |  |                      |                              |
| <b>2</b>                                       | <p><b>Learning objectives / Learning Outcomes</b></p> <p>This lecture teaches about basic functionalities, services, protocols, algorithms and standards of network communication systems. Competencies acquired are basic knowledge about the lower four ISO-OSI layers: physical layer, datalink layer, network layer and transport layer; Furthermore, basic knowledge about communication networks is taught. Attendants will learn about the functionality of today's network technologies and the Internet.</p>   |                          |  |                      |                              |
| <b>3</b>                                       | <b>Recommended prerequisite for participation</b>   |                          |  |                      |                              |
| <b>4</b>                                       | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>  |                          |  |                      |                              |
| <b>5</b>                                       | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>  |                          |  |                      |                              |
| <b>6</b>                                       | <p><b>Usability of this module</b></p> <p>Wi-CS, Wi-ETiT, BSc CS, BSc ETiT, BSc iST</p>   |                          |  |                      |                              |

|                |  |  |                         |
|----------------|--|--|-------------------------|
| <b>7</b>       | <p><b>Grade bonus compliant to §25 (2)</b><br/> A bonus of 0.3 or 0.7 can be obtained.<br/> For 0.3 bonus: 7 out of 9 exercises are to be solved to the best of your knowledge. That is, every question needs to be answered. However, not every question needs to be answered correctly. Additionally, at least one wiki article or applet concerning a topic of the lecture has to be provided (written).<br/> For the 0.7 bonus: Additionally, present one exercise and write at least three wiki articles, or write at least 5 wiki articles.<br/> An oral exam (“Fachgespräch”) is mandatory in order to receive the bonus. The bonus can only be applied if the exam grade is 4.0 or better.</p>   |  |                         |
| <b>8</b>       | <p><b>References</b></p> <ul style="list-style-type: none"> <li>• Andrew S. Tanenbaum: Computer Networks, 5th Edition, Prentice Hall, 2010</li> <li>• Andrew S. Tanenbaum: Computernetzwerke, 3. Auflage, Prentice Hall, 1998</li> <li>• Larry L. Peterson, Bruce S. Davie: Computer Networks: A System Approach, 2nd Edition, Morgan Kaufmann Publishers, 1999</li> <li>• Larry L. Peterson, Bruce S. Davie: Computernetze, Ein modernes Lehrbuch, 2. Auflage, Dpunkt Verlag, 2000</li> <li>• James F. Kurose, Keith W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet, 2nd Edition, Addison Wesley-Longman, 2002</li> <li>• Jean Walrand: Communication Networks: A First Course, 2nd Edition, McGraw-Hill, 1998</li> </ul> |  |                         |
| <b>Courses</b> |  |  |                         |
|                | <b>Course Nr.</b><br>18-sm-1010-vl   | <b>Course name</b><br>Communication Networks I |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Ralf Steinmetz   |  | <b>Type</b><br>Lecture  |
|                |  |  | <b>SWS</b><br>3         |
|                | <b>Course Nr.</b><br>18-sm-1010-ue   | <b>Course name</b><br>Communication Networks I |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Ralf Steinmetz   |  | <b>Type</b><br>Practice |
|                |  |  | <b>SWS</b><br>1         |

|  |  |  |  |                         |                              |
|--|--|--|--|-------------------------|------------------------------|
| <b>Module name</b><br>Computer Systems I |  |  |  |                         |                              |
| <b>Module Nr.</b><br>18-hb-1020          | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                 | <b>Self study</b><br>120 h                                 | <b>Duration</b><br>1    | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Christian Hochberger |                         |                              |
| <b>1</b>                                 | <b>Content</b><br>Types of instruction sets, memory organization and its impact on the runtime, pipelining, instruction level parallelism, superscalar processors, VLIW processors, floating point numbers and operations, memory subsystem, cache types, virtual address spaces, benchmarking and performance prediction, system architecture and bus systems, peripheral devices   |  |  |                         |                              |
| <b>2</b>                                 | <b>Learning objectives / Learning Outcomes</b><br>Successful students can analyze and evaluate processors, memory systems and bus systems. They can transform structures of high-level programming languages like subroutine calls into sequences of machine instructions. They are able to measure the performance of computers. They know how instructions are executed in modern processors and thus, they can predict the influence of a specific memory hierarchy onto the execution time of a given program. They know how internal and external bus systems work and can define the essential parameters for their dimension and operation. |  |  |                         |                              |
| <b>3</b>                                 | <b>Recommended prerequisite for participation</b><br>Basic knowledge of digital design as it can be obtained by the lecture "Logic Design".  |  |  |                         |                              |
| <b>4</b>                                 | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |  |  |                         |                              |
| <b>5</b>                                 | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |  |  |                         |                              |
| <b>6</b>                                 | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT   |  |  |                         |                              |
| <b>7</b>                                 | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                         |                              |
| <b>8</b>                                 | <b>References</b><br>Harris & Harris: Digital Design and Computer Architecture<br>Hennessy/Patterson: Computer architecture - a quantitative approach  |  |  |                         |                              |
| <b>Courses</b>                           |  |  |  |                         |                              |
|  | <b>Course Nr.</b><br>18-hb-1020-vl   | <b>Course name</b><br>Computer Systems I |  |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Christian Hochberger   |  |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|  | <b>Course Nr.</b><br>18-hb-1020-ue   | <b>Course name</b><br>Computer Systems I |  |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Christian Hochberger   |  |  | <b>Type</b><br>Practice | <b>SWS</b><br>1              |

|  |   |  |   |                         |                              |
|--|---|--|---|-------------------------|------------------------------|
| <b>Module name</b><br>Analog Integrated Circuit Design |   |  |   |                         |                              |
| <b>Module Nr.</b><br>18-ho-1020                        | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h                               | <b>Self study</b><br>120 h                          | <b>Duration</b><br>1    | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                              |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Klaus Hofmann |                         |                              |
| <b>1</b>   | <b>Content</b><br>Basic analog Building Blocks: Current Mirrors, Reference Circuits; Multi Stage Amplifier, internal Structure and Properties of Differential and Operational Amplifiers, Feedback Techniques, Frequency Response, Oscillators  |  |   |                         |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>A student is, after successful completion of this module, able to 1. derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, 2. derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties ( $y$ -Parameters, DC- and AC-properties), 3. understands simulation methods for analog circuits on transistor level using SPICE, 4. analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, 5. derive and calculate the analog properties of digital logic gates |  |   |                         |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Lecture "Electronics"  |  |   |                         |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>  |  |   |                         |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |  |   |                         |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE  |  |   |                         |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |                         |                              |
| <b>8</b>   | <b>References</b><br>Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design   |  |   |                         |                              |
| <b>Courses</b>   |   |  |   |                         |                              |
|  | <b>Course Nr.</b><br>18-ho-1020-vl  | <b>Course name</b><br>Analog Integrated Circuit Design |   |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann   |  |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|  | <b>Course Nr.</b><br>18-ho-1020-ue  | <b>Course name</b><br>Analog Integrated Circuit Design |   |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann   |  |   | <b>Type</b><br>Practice | <b>SWS</b><br>1              |



|   |  |   |   |                         |                              |
|---|--|---|---|-------------------------|------------------------------|
| <b>Module name</b><br>Software Engineering - Introduction |  |   |   |                         |                              |
| <b>Module Nr.</b><br>18-su-1010                           | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                                  | <b>Self study</b><br>120 h                                | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                                 |  |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Andreas Schürr |                         |                              |
| <b>1</b>  | <b>Content</b><br><p>The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's "Guide to the Software Engineering Body of Knowledge" - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of software architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).</p> <p>During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of requirements, definition of a design and eventually the implementation of executable (proof-of-concept) code.</p> |   |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br><p>This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.</p> <p>After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Furthermore, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal.</p>  |   |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>sound knowledge of an object-oriented programming language (preferably Java)  |   |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |   |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |   |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc iST, BSc Wi-ETiT  |   |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |   |   |                         |                              |
| <b>8</b>  | <b>References</b><br><a href="http://www.es.tu-darmstadt.de/lehre/se-i-v/">www.es.tu-darmstadt.de/lehre/se-i-v/</a>  |   |   |                         |                              |
| <b>Courses</b>  |  |   |   |                         |                              |
|   | <b>Course Nr.</b><br>18-su-1010-vl   | <b>Course name</b><br>Software Engineering - Introduction |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr  |   |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|   | <b>Course Nr.</b><br>18-su-1010-ue   | <b>Course name</b><br>Software Engineering - Introduction |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Fritsche   |   |   | <b>Type</b><br>Practice | <b>SWS</b><br>1              |

#### 4.3.1.1 Proseminar ETiT

|  |   |  |  |   |                                   |
|--|---|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |  |   |                                   |
| <b>Module Nr.</b><br>18-hb-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                                  | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Christian Hochberger |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |  |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |  |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |  |  |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |  |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |   |                                   |
| <b>8</b>   | <b>References</b>   |  |  |   |                                   |
| <b>Courses</b>   |   |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-hb-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Christian Hochberger  |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |   |   |                                   |
|--|---|--|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                                   |
| <b>Module Nr.</b><br>18-ho-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                           | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Klaus Hofmann |   |                                   |
| <b>1</b>   | <b>Content</b><br>Analysis of basic electronic circuits and presentation of selected examples   |  |   |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After attending the seminar, a student is capable of analysing basic electronic circuits and preparing didactical materials and presentations |  |   |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Electronics  |  |   |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>          |  |   |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>                             |  |   |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT   |  |   |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                                   |
| <b>8</b>   | <b>References</b><br>Will be provided at the begin of the seminar   |  |   |   |                                   |
| <b>Courses</b>   |   |  |   |   |                                   |
|  | <b>Course Nr.</b><br>18-ho-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann   |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |  |   |                                   |
|--|---|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |  |   |                                   |
| <b>Module Nr.</b><br>18-sm-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                            | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Ralf Steinmetz |   |                                   |
| <b>1</b>   | <p><b>Content</b><br/>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.<br/>This seminar addresses students of Electrical Engineering disciplines and covers various topics from the fields of computer science and electrical engineering. It is usually the first seminar that students take during their studies. Therefore, the focus lies on the process of finding, reading, and understanding scientific publications (conference papers, articles) related to a given topics and on categorizing and summarizing the results in oral form (presentation) and written form (short paper). Some potential topics are:</p> <ul style="list-style-type: none"> <li>• Knowledge &amp; Educational Technologies</li> <li>• Adaptive Communication Systems</li> <li>• Multimedia Technologies &amp; Serious Games</li> </ul> <p>For more information please refer to the webpage: <a href="https://www.kom.tu-darmstadt.de/en/teaching/current-courses/11/proseminar-etit/">https://www.kom.tu-darmstadt.de/en/teaching/current-courses/11/proseminar-etit/</a></p> |  |  |   |                                   |
| <b>2</b>   | <p><b>Learning objectives / Learning Outcomes</b><br/>The students will be able to understand and analyse scientific papers, as well as to present technical facts in a proper and well structured manner. They know how to summarize and present publications from a given topic area.</p>   |  |  |   |                                   |
| <b>3</b>   | <p><b>Recommended prerequisite for participation</b><br/>Solid knowledge in computer communication networks. Lectures in Communication Networks I and II are recommended</p>  |  |  |   |                                   |
| <b>4</b>   | <p><b>Form of examination</b><br/>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>   |  |  |   |                                   |
| <b>5</b>   | <p><b>Grading</b><br/>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>  |  |  |   |                                   |
| <b>6</b>   | <p><b>Usability of this module</b><br/>BSc ETiT, BSc MEC, BSc iST</p>   |  |  |   |                                   |
| <b>7</b>   | <p><b>Grade bonus compliant to §25 (2)</b></p>  |  |  |   |                                   |
| <b>8</b>   | <p><b>References</b><br/>Depending on specific topic (selected articles of journals, magazines, and conferences).</p>   |  |  |   |                                   |
| <b>Courses</b>   |   |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-sm-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Ralf Steinmetz  |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |   |   |                              |
|--|---|--|---|---|------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                              |
| <b>Module Nr.</b><br>18-su-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                                 | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr. rer. nat. Andreas Schürr |   |                              |
| <b>1</b>   | <b>Content</b><br>In this course, the students produce scientific reports from changing subject areas. Each student has to explore a subject related to IT system development and produce a written report as well as a final talk with a presentation. A list of the subjects of the current semester is available at <a href="http://www.es.tu-darmstadt.de/lehre/sst">www.es.tu-darmstadt.de/lehre/sst</a> . |  |   |   |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After a successful participation, the students will be able to explore an unknown topic under scientific aspects. The students learn to support the exploration by a literature research and to analyze the subject critically. They achieve the skills to present a definite subject in a written report as well as in an oral presentation.                 |  |   |   |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Introduction to Computer Science for Engineers, Software Lab; Software Engineering I or comparable skills  |  |   |   |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |   |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |  |   |   |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, Informatik, iST, Wi-ETiT   |  |   |   |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                              |
| <b>8</b>   | <b>References</b><br><a href="http://www.es.tu-darmstadt.de/lehre/proseminar-etit/">http://www.es.tu-darmstadt.de/lehre/proseminar-etit/</a>  |  |   |   |                              |
| <b>Courses</b>   |   |  |   |   |                              |
|  | <b>Course Nr.</b><br>18-su-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                              |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr   |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2              |

#### 4.3.1.2 More Fundamentals

|  |  |                          |  |                      |                              |
|--|--|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Electrical Power Engineering |  |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-bi-1010                    | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                                     | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                          |  |                          | <b>Module owner</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |                      |                              |
| <b>1</b>   | <p><b>Content</b></p> <p>The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.</p> <p>First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.</p> <p>Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.</p> <p>The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications. The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.</p> |                          |  |                      |                              |
| <b>2</b>   | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.</p> <p>They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.</p> <p>They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.</p> <p>They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.</p>  |                          |  |                      |                              |
| <b>3</b>   | <p><b>Recommended prerequisite for participation</b></p> <p>Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.</p>  |                          |  |                      |                              |
| <b>4</b>   | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |  |                      |                              |
| <b>5</b>   | <b>Grading</b>   |                          |  |                      |                              |

|                |   |  |                 |
|----------------|---|--|-----------------|
|                | Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)   |  |                 |
| 6              | <b>Usability of this module</b><br>BSc ETiT, BSc WI-ETiT, BSc MEC, BSc iST, BSc CE, MSc ESE   |  |                 |
| 7              | <b>Grade bonus compliant to §25 (2)</b><br>At the beginning of the semester, it will be announced whether there will be homework tests accompanying the lecture that will enable an improvement in grades.  |  |                 |
| 8              | <b>References</b><br>Lecture notes (slides)<br>Practice documents (examples, solutions)<br>Additional and more detailed literature:<br>Grothe/Feldhusen: Dubbel-Taschenbuch für den Maschinenbau, Springer, Berlin, 2007, 22. Aufl.; besonders: Kapitel „Energietechnik und Wirtschaft“; Sterner/Stadler: Energiespeicher – Bedarf, Technologien, Integration, Springer-Vieweg, Berlin, 2011; Rummich: Energiespeicher, expert-verlag, Rellingen, 2015, 2. Aufl.; Strauß: Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, Berlin, 2006, 5. Aufl.; Hau: Windkraftanlagen –Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Springer-Vieweg, Berlin, 2014, 5. Aufl.; Heuck/Dettmann/Schulz: Elektrische Energieversorgung, Springer-Vieweg, Berlin, 2014, 9. Aufl.; Quaschnig: Regenerative Energiesystem, Hanser, München, 2001, 7. Aufl. |  |                 |
| <b>Courses</b> |   |  |                 |
|                | <b>Course Nr.</b><br>18-bi-1010-vl  | <b>Course name</b><br>Electrical Power Engineering |                 |
|                | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  | <b>Type</b><br>Lecture                             | <b>SWS</b><br>3 |
|                | <b>Course Nr.</b><br>18-bi-1010-ue  | <b>Course name</b><br>Electrical Power Engineering |                 |
|                | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  | <b>Type</b><br>Practice                            | <b>SWS</b><br>1 |

| <b>Module name</b><br>Fundamentals of Signal Processing |  |                 |                                |                 |                      |
|---|--|-----------------|--------------------------------|-----------------|----------------------|
| <b>Module Nr.</b>                                       | <b>Credit Points</b>   | <b>Workload</b> | <b>Self study</b>              | <b>Duration</b> | <b>Cycle offered</b> |
| 18-zo-1030  | 6 CP   | 180 h           | 120 h                          | 1               | SoSe                 |
| <b>Language</b>   |  |                 | <b>Module owner</b>            |                 |                      |
| German  |  |                 | Prof. Dr.-Ing. Abdelhak Zoubir |                 |                      |
| <b>1</b>  | <b>Content</b><br>The course covers the following topics: <ul style="list-style-type: none"> <li>• The basic concepts of stochastic</li> <li>• The sampling theorem</li> <li>• Discrete-time noise processes and their properties</li> <li>• Description of noise processes in the frequency domain</li> <li>• Linear time-invariant systems: FIR and IIR filters</li> <li>• Filtering of noise processes: AR, MA, and ARMA models</li> <li>• The Matched filter</li> <li>• The Wiener filter</li> <li>• Properties of estimators</li> <li>• The method of least squares</li> </ul>        |                 |                                |                 |                      |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory.   |                 |                                |                 |                      |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>  |                 |                                |                 |                      |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)</li> </ul> In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase. |                 |                                |                 |                      |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>  |                 |                                |                 |                      |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC   |                 |                                |                 |                      |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |                 |                                |                 |                      |
| <b>8</b>  | <b>References</b>  |                 |                                |                 |                      |



Lecture notes and slides can be downloaded here:

- <http://www.spg.tu-darmstadt.de>
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schafer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River, 1999.

#### Courses

|   |   |                         |                 |
|---|---|-------------------------|-----------------|
| <b>Course Nr.</b><br>18-zo-1030-vl                  | <b>Course name</b><br>Fundamentals of Signal Processing |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3 |
| <b>Course Nr.</b><br>18-zo-1030-ue                  | <b>Course name</b><br>Fundamentals of Signal Processing |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |   | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

|  |  |  |  |                        |                              |
|--|--|--|--|------------------------|------------------------------|
| <b>Module name</b><br>Communication Technology I |  |  |  |                        |                              |
| <b>Module Nr.</b><br>18-kl-1020                  | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                         | <b>Self study</b><br>120 h                       | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                        |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Anja Klein |                        |                              |
| <b>1</b>   | <b>Content</b><br>Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access   |  |  |                        |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the lecture, students possess the ability to: <ul style="list-style-type: none"> <li>• classify signals and communication systems,</li> <li>• understand, model and analyse basic components of communication systems,</li> <li>• understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,</li> <li>• model and analyse base-band communication systems,</li> <li>• describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,</li> <li>• understand, model, evaluate, compare and apply linear modulation schemes,</li> <li>• design receiver structures for different modulation schemes,</li> <li>• detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,</li> <li>• understand and model OFDM,</li> <li>• understand and model CDMA,</li> <li>• understand and compare the basic properties of multiple access schemes.</li> </ul> |  |  |                        |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV  |  |  |                        |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |  |  |                        |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |  |  |                        |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC   |  |  |                        |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                        |                              |
| <b>8</b>   | <b>References</b><br>Will be announced in the lecture  |  |  |                        |                              |
| <b>Courses</b>                                   |  |  |  |                        |                              |
|  | <b>Course Nr.</b><br>18-kl-1020-vl   | <b>Course name</b><br>Communication Technology I |  |                        |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein   |  |  | <b>Type</b><br>Lecture | <b>SWS</b><br>3              |

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|--|--|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-kl-1020-ue   | <b>Course name</b><br>Communication Technology I |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein, Dr. rer. nat. Sabrina Klos |  | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

|   |  |                          |   |                      |                              |
|---|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Fundamentals of Communication |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-jk-1010                     | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                        | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                           |  |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Rolf Jakoby |                      |                              |
| <b>1</b>  | <p><b>Content</b></p> <p>Part 1: Chap. 1 will be a brief introduction in “Electrical Information- and Communication Engineering”, presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.</p> <p>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.</p> <p>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.</p> <p>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited intersymbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture.</p> |                          |   |                      |                              |
| <b>2</b>  | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.</p> <p>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems.</p>   |                          |   |                      |                              |
| <b>3</b>  | <p><b>Recommended prerequisite for participation</b></p> <p>Deterministic Signals and Systems</p>  |                          |   |                      |                              |
| <b>4</b>  | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |   |                      |                              |
| <b>5</b>  | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>  | <p><b>Usability of this module</b></p> <p>BSc ETiT, Wi-ETiT</p>  |                          |   |                      |                              |
| <b>7</b>  | <p><b>Grade bonus compliant to §25 (2)</b></p>   |                          |   |                      |                              |

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| <b>8</b> | <p><b>References</b></p> <p>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addison-Wesley 1992.</p> |
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|----------------|----------------------------|--------------------------------|-------------|
| <b>Courses</b> |                            |                                |             |
|                | <b>Course Nr.</b>          | <b>Course name</b>             |             |
|                | 18-jk-1010-vl              | Fundamentals of Communications |             |
|                | <b>Instructor</b>          |                                | <b>Type</b> |
|                | Prof. Dr.-Ing. Rolf Jakoby |                                | Lecture     |
|                | <b>SWS</b>                 | 3                              |             |
|                | <b>Course Nr.</b>          | <b>Course name</b>             |             |
|                | 18-jk-1010-ue              | Fundamentals of Communications |             |
|                | <b>Instructor</b>          |                                | <b>Type</b> |
|                | Prof. Dr.-Ing. Rolf Jakoby |                                | Practice    |
|                | <b>SWS</b>                 | 1                              |             |

|   |   |  |   |                         |                              |
|---|---|--|---|-------------------------|------------------------------|
| <b>Module name</b><br>System Dynamics and Automatic Control Systems I |   |  |   |                         |                              |
| <b>Module Nr.</b><br>18-ko-1010                                       | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h   | <b>Self study</b><br>120 h                              | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German   |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Ulrich Konigorski |                         |                              |
| <b>1</b>  | <b>Content</b><br>Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization  |  |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems.  |  |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>   |  |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |  |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |  |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, MSc Informatik  |  |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |  |   |                         |                              |
| <b>8</b>  | <b>References</b><br>Skript Konigorski: "Systemdynamik und Regelungstechnik I", Aufgabensammlung zur Vorlesung, Lunze: "Regelungstechnik 1: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen", Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen", Unbehauen: "Regelungstechnik I:Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme, Fuzzy-Regelsysteme", Föllinger: "Laplace-, Fourier- und z-Transformation", Jörgl: "Repetitorium Regelungstechnik", Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden", Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise", Schneider: "Regelungstechnik für Maschinenbauer", Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnaher Grundlage" |  |   |                         |                              |
| <b>Courses</b>  |   |  |   |                         |                              |
|   | <b>Course Nr.</b><br>18-ko-1010-vl  | <b>Course name</b><br>System Dynamics and Automatic Control Systems I                      |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand  |  |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|   | <b>Course Nr.</b><br>18-ko-1010-tt  | <b>Course name</b><br>System Dynamics and Automatic Control Systems I- Auditorium Exercise |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand  |  |   | <b>Type</b><br>Tutorial | <b>SWS</b><br>1              |

|   |   |   |   |                         |                              |
|---|---|---|---|-------------------------|------------------------------|
| <b>Module name</b><br>Technical Electrodynamics |   |   |   |                         |                              |
| <b>Module Nr.</b><br>18-dg-1070                 | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h                        | <b>Self study</b><br>120 h                              | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                       |   |   | <b>Module owner</b><br>Prof. Dr.-Ing. Herbert De Gersem |                         |                              |
| <b>1</b>  | <b>Content</b><br>Fields in materials, Green's functions, separation of variables in generalized orthogonal coordinates, conformal mapping, elliptic integrals and elliptic functions, electromagnetic forces, quasi-stationary fields, general waveguides, resonators, antennas.   |   |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Starting with Maxwell's equations the lecture's aim is to provide a general understanding of electromagnetic phenomena. Students will be able to apply analytical methods to simple problems. Students will exhibit the ability to deal with more complex electromagnetic formulations and tasks. |   |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Vector analysis, infinitesimal calculus, basics in differential equations. Knowledge of "Introduction to Electrodynamics"  |   |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)</li> </ul>   |   |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |   |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, MSc Wi-ETiT  |   |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                         |                              |
| <b>8</b>  | <b>References</b><br>Course notes available (including references)  |   |   |                         |                              |
| <b>Courses</b>                                  |   |   |   |                         |                              |
|   | <b>Course Nr.</b><br>18-dg-1070-vl  | <b>Course name</b><br>Technical Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann  |   |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>2              |
|   | <b>Course Nr.</b><br>18-dg-1070-ue  | <b>Course name</b><br>Technical Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann  |   |   | <b>Type</b><br>Practice | <b>SWS</b><br>2              |

|  |  |                          |   |                      |                              |
|--|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Modelling and simulation of circuits |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-sc-2010                            | <b>Credit Points</b><br>4 CP   | <b>Workload</b><br>120 h | <b>Self study</b><br>75 h                                   | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German and English                      |  |                          | <b>Module owner</b><br>Prof. Dr. rer. nat. Sebastian Schöps |                      |                              |
| <b>1</b>   | <b>Content</b><br>The content of this course is the following: <ul style="list-style-type: none"> <li>• Circuit interpretation as directed graphs</li> <li>• Modified nodal and loop analysis</li> <li>• Flux and charge oriented formulations</li> <li>• Differential algebraic equations</li> <li>• Linear system solver</li> <li>• Numerical solution of nonlinear systems</li> <li>• Time-domain methods</li> <li>• Frequency-domain solution</li> <li>• Implementation of the numerical methods</li> </ul>  |                          |   |                      |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Students understand the theoretical and numerical fundamentals of circuit simulation and how the equations can be derived from Maxwell's equations. Circuit properties can be expressed in terms of graph theory. The sparse systems of equations such as the flux/charge oriented modified nodal analysis can be assembled. In order to solve the obtained systems, different numerical methods for the simulation of circuits are relevant. This includes methods for the solution of linear systems (direct and iterative solvers), root-finding algorithms for nonlinear systems and implicit time integration methods. Mathematical concepts such as stability, convergence order or complexity are known and can be employed to judge the advantages and disadvantages of the various methods. Eventually, the students are able to program their own circuit simulator, that can return both frequency as well as time domain solutions of electric networks. |                          |   |                      |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>18-hs-1070 Elektrotechnik und Informationstechnik I<br>18-gt-1020 Elektrotechnik und Informationstechnik II<br>20-00-0304 Allgemeine Informatik I<br>04-00-0112 Mathematik IV   |                          |   |                      |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Oral Examination, Duration: 20 min, Standard Grading System)</li> </ul>  |                          |   |                      |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Oral Examination, Weighting: 100%)</li> </ul>  |                          |   |                      |                              |
| <b>6</b>   | <b>Usability of this module</b>  |                          |   |                      |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b><br>Grade bonus of 0,4 if correctly implemented programs are submitted  |                          |   |                      |                              |
| <b>8</b>   | <b>References</b>  |                          |   |                      |                              |



- L. W. Nagel, “SPICE2: A computer program to simulate semiconductor circuits”, University of Berkeley, Tech. Rep., 1975.
- C.-W. Ho, A. E. Ruehli, and P. A. Brennan, “The modified nodal approach to network analysis”, IEEE Trans. Circ. Syst., vol. 22, no. 6, pp. 504–509, Jun. 1975.
- J. Vlach, K. Singhal, Computer methods for circuit analysis and design. New York : Van Nostrand Reinold, 1983.

**Courses**

|                                    |  |  |                         |                 |
|------------------------------------|--|--|-------------------------|-----------------|
| <b>Course Nr.</b><br>18-sc-2010-v1 | <b>Course name</b><br>Modelling and simulation of circuits |  |                         |                 |
| <b>Instructor</b>                  |  |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>2 |
| <b>Course Nr.</b><br>18-sc-2010-ue | <b>Course name</b><br>Modelling and simulation of circuits |  |                         |                 |
| <b>Instructor</b>                  |  |  | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

## 4.3.2 Optional Modules

### 4.3.2.1 Informatik-Kanoniken

|   |   |                         |   |                      |                                       |
|---|---|-------------------------|---|----------------------|---------------------------------------|
| <b>Module name</b><br>Architecture and Design of Computer Systems |   |                         |   |                      |                                       |
| <b>Module Nr.</b><br>20-00-0012                                   | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150h | <b>Self study</b><br>105 h                                | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German   |   |                         | <b>Module owner</b><br>Prof. Dr. phil. nat. Marc Fischlin |                      |                                       |
| <b>1</b>  | <b>Content</b> <ul style="list-style-type: none"> <li>- Technological foundations and trends in micro electronics</li> <li>- Design flows for microelectronic systems</li> <li>- Description of hardware systems</li> <li>- Characteristics of computing systems</li> <li>- Architectural support for parallel execution</li> <li>- Memory systems</li> <li>- Heterogeneous systems-on-chip</li> <li>- On-chip and off-chip communication structures</li> <li>- Embedded systems, including in context of cyber-physical systems</li> </ul> |                         |   |                      |                                       |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>After successfully attending the course, students are familiar with functional and non-functional requirements for heterogeneous discrete and integrated computing systems. They understand the techniques for realizing such systems and can use design methods and tools to apply the techniques to independently implement computing systems (or components thereof) that fulfill the given requirements. They are able to evaluate computing systems in a number of quality metrics.  |                         |   |                      |                                       |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Recommended:<br>Pass of lecture „Digitaltechnik“ and „Rechnerorganisation“, respectively according knowledge.  |                         |   |                      |                                       |
| <b>4</b>  | <b>Form of examination</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>• [20-00-0012-iv] (Technical Examination, Written/Oral Examination, Standard BWS)</li> </ul>   |                         |   |                      |                                       |
| <b>5</b>  | <b>Grading</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>• [20-00-0012-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)</li> </ul>   |                         |   |                      |                                       |
| <b>6</b>  | <b>Usability of this module</b><br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs.  |                         |   |                      |                                       |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |                         |   |                      |                                       |
| <b>8</b>  | <b>References</b>   |                         |   |                      |                                       |

Literature recommendations will be updated regularly, an example might be:  
 Nikhil/Czeck: Bluespec by Example  
 Arvind/Nikhil/Emer/Vijayaraghavan: Computer Architecture: A Constructive Approach  
 Hennessy/Patterson: Computer Architecture – A Quantitative Approach  
 Crockett/Elliott/Enderwitz/Stewart: The Zynq Book  
 Flynn/Luk: Computer System Design  
 Sass/Schmidt: Embedded Systems Design

**Courses**

|                                    |   |                                     |                 |
|------------------------------------|---|-------------------------------------|-----------------|
| <b>Course Nr.</b><br>20-00-0012-iv | <b>Course name</b><br>Architecture and Design of Computer Systems |                                     |                 |
| <b>Instructor</b>                  |   | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>3 |

|  |   |                          |   |                      |                                       |
|--|---|--------------------------|---|----------------------|---------------------------------------|
| <b>Module name</b><br>Computational Engineering and Robotics |   |                          |   |                      |                                       |
| <b>Module Nr.</b><br>20-00-0011                              | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h | <b>Self study</b><br>105 h                                | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                                    |   |                          | <b>Module owner</b><br>Prof. Dr. phil. nat. Marc Fischlin |                      |                                       |
| <b>1</b>   | <b>Content</b><br>- Foundations of modelling and simulation<br>- Problem specification and system description for computational engineering<br>- Model generation for the example of mechanical systems<br>- Model analysis for the example of mechanical systems<br>- Implementations of simulations for the example of robots and other systems<br>- Interpretation and validation using measurement data<br>- Applications in simulation and control of robots as well as in physically based animation and computer games |                          |   |                      |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Upon successful completion of this class, students will be able to develop first models and simulations and can perform first simulation studies within robotics. They know the necessary key steps needed to construct simulations (problem specification, model generation, model analysis, implementation, and validation) and can use them to construct first simulations to meet the specification requirements.   |                          |   |                      |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |                          |   |                      |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>[20-00-0011-iv] (Technical Examination, Written/Oral Examination, Standard BWS)</li> </ul>   |                          |   |                      |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>[20-00-0011-iv] (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>  |                          |   |                      |                                       |
| <b>6</b>   | <b>Usability of this module</b><br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Computational Engineering<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs.   |                          |   |                      |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b><br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.  |                          |   |                      |                                       |
| <b>8</b>   | <b>References</b><br>F Föllinger: Einführung in die Zustandsbeschreibung dynamischer Systeme (Oldenbourg, 1982)<br>P Corke: Robotics, Vision & Control, Springer, 2011<br>EL. Severance: System Modeling and Simulation: An Introduction, J. Wiley & Sons, 2001   |                          |   |                      |                                       |
| <b>Courses</b>   |   |                          |   |                      |                                       |

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|--|------------------------------------|--|-------------------------------------|-----------------|
|  | <b>Course Nr.</b><br>20-00-0011-iv | <b>Course name</b><br>Computational Engineering and Robotics |                                     |                 |
|  | <b>Instructor</b>                  |  | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>3 |

| <b>Module name</b><br>Computer Networks and Distributed Systems |   |                 |   |                 |                      |
|---|---|-----------------|---|-----------------|----------------------|
| <b>Module Nr.</b>   | <b>Credit Points</b>  | <b>Workload</b> | <b>Self study</b>   | <b>Duration</b> | <b>Cycle offered</b> |
| 20-00-0016  | 5 CP  | 150 h           | 105 h   | 1               | Every 2. Sem.        |
| <b>Language</b><br>German                                       |   |                 | <b>Module owner</b><br>Prof. Dr. phil. nat. Marc Fischlin |                 |                      |
| <b>1</b>  | <b>Content</b><br>Overview of Net-Centric Computing (NCC), a basic element of modern computer science. Fundamental network concepts of modeling, planning and evaluating net-centric systems<br>- Foundations: Service, protocols, connection, layer model<br>- protocol mechanisms for media access, routing, broad-/multicast<br>- Multimedia Data Handling<br>- Aspects of continuous data streams and their processing<br>- Quality of service: definition and mechanisms<br>- Multimedia - Synchronisation: Basics<br>- Compression procedures;  |                 |   |                 |                      |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>- Overview knowledge of relevant areas and basic problems of net-centric computing (NCC)<br>- Reproducible comprehension of selected, elementary algorithms, protocols and procedures used in the internet<br>- Applicable methodological knowledge of widely applied elements of the modeling and engineering of NCC-systems<br>NCC is, in this context, understood as "internet technology in the broadcast sense". It covers, in particular, themes of the "classical areas" constituted by computer networks, distributed systems, multimedia and mobile communication/ mobile computing, as those from "modern areas", such as ubiquitous/pervasive computing, peer-to-peer-computing or ambient intelligence. The canonical lecture "Introduction to NCS" focusses on the area of computer networks, the understanding of which is fundamental for all other listed areas; the latter will be the subject matter of advanced lectures in the area of NCS. |                 |   |                 |                      |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Recommended:<br>Funktionale und objektorientierte Programmierkonzepte“, „Algorithmen und Datenstrukturen“, „Betriebssysteme“, „Einführung in den Compilerbau“, „Rechnerorganisation“ und „Systemnahe and parallele Programmierung“.  |                 |   |                 |                      |
| <b>4</b>  | <b>Form of examination</b><br>Module Ecompanying Examination:<br>• [20-00-0016-iv] (Technical Examination, Written/Oral Examination, Standard BWS)  |                 |   |                 |                      |
| <b>5</b>  | <b>Grading</b><br>Module Ecompanying Examination:<br>• [20-00-0016-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)  |                 |   |                 |                      |
| <b>6</b>  | <b>Usability of this module</b><br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs.  |                 |   |                 |                      |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |                 |   |                 |                      |

In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.

**8 References**  
 Main literature:  
 - A. Tanenbaum, D. Wetherall: Computernetzwerke, 5te Aufl., Pearson Studium 2012  
 - (englisch: Computer Networks, 5th Ed., Prentics Hall 2010)  
 - J. Kurose, K. Ross: Computernetzwerke; Pearson Studium 2012 (also in english by Prentice Hall)  
 Selected chapters of:  
 - G. Coulouris, J. Dollimore, T. Kindberg: Distributed Systems – Concept and Design, Pearson Studium  
 - G. Krüger, D. Reschke: „Lehr- und Übungsbuch Telematik“  
 - L. Kleinrock: Queueing Systems, vol. 1 (Wiley)  
 - W.R. Stevens: Unix Network Programming, Volume 1: The Sockets Networking API (Addison Wesley)

**Courses**

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|------------------------------------|---|-------------------------------------|-----------------|
| <b>Course Nr.</b><br>20-00-0016-iv | <b>Course name</b><br>Computer Networks and distributed Systems |                                     |                 |
| <b>Instructor</b>                  |   | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>3 |

|   |   |                          |   |                      |                                       |
|---|---|--------------------------|---|----------------------|---------------------------------------|
| <b>Module name</b><br>Computer Security |   |                          |   |                      |                                       |
| <b>Module Nr.</b><br>20-00-0018         | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h | <b>Self study</b><br>105 h                                | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German               |   |                          | <b>Module owner</b><br>Prof. Dr. phil. nat. Marc Fischlin |                      |                                       |
| <b>1</b>                                | <b>Content</b><br>Part I: Cryptography<br>- Background in Mathematics for cryptography<br>- Security objectives: Confidentiality, Integrity, Authenticity<br>- Symmetric and Asymmetric Cryptography<br>- Hash functions and digital signatures<br>- Protocols for key distribution<br>Part II: IT-Security and Dependability<br>- Basic concepts of IT security<br>- Authentication and biometrics<br>- Access control models and mechanisms<br>- Basic concepts of network security<br>- Basic concepts of software security<br>- Dependable systems: error tolerance, redundancy, availability |                          |   |                      |                                       |
| <b>2</b>                                | <b>Learning objectives / Learning Outcomes</b><br>After successfully attending the course, students are familiar with the basic concepts, methods and models in the areas of cryptography and computer security. They understand the most important methods that allow to secure software and hardware systems against attackers and are able to apply this knowledge to concrete application scenarios.  |                          |   |                      |                                       |
| <b>3</b>                                | <b>Recommended prerequisite for participation</b>   |                          |   |                      |                                       |
| <b>4</b>                                | <b>Form of examination</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>[20-00-0018-iv] (Technical Examination, Written/Oral Examination, Standard BWS)</li> </ul>   |                          |   |                      |                                       |
| <b>5</b>                                | <b>Grading</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>[20-00-0018-iv] (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>  |                          |   |                      |                                       |
| <b>6</b>                                | <b>Usability of this module</b><br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs.  |                          |   |                      |                                       |
| <b>7</b>                                | <b>Grade bonus compliant to §25 (2)</b><br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.  |                          |   |                      |                                       |
| <b>8</b>                                | <b>References</b><br>- J. Buchmann, Einführung in die Kryptographie, Springer-Verlag, 2010<br>- C. Eckert, IT-Sicherheit, Oldenbourg Verlag, 2013<br>- M. Bishop, Computer Security: Art and Science, Addison Wesley, 2004  |                          |   |                      |                                       |
| <b>Courses</b>                          |   |                          |   |                      |                                       |



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|--|------------------------------------|---|-------------------------------------|-----------------|
|  | <b>Course Nr.</b><br>20-00-0018-iv | <b>Course name</b><br>Computer Security |                                     |                 |
|  | <b>Instructor</b>                  |   | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>3 |

|  |  |                          |   |                      |                                       |
|--|--|--------------------------|---|----------------------|---------------------------------------|
| <b>Module name</b><br>Information Management |  |                          |   |                      |                                       |
| <b>Module Nr.</b><br>20-00-0015              | <b>Credit Points</b><br>5 CP   | <b>Workload</b><br>150 h | <b>Self study</b><br>105 h                                | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                    |  |                          | <b>Module owner</b><br>Prof. Dr. phil. nat. Marc Fischlin |                      |                                       |
| <b>1</b>                                     | <p><b>Content</b></p> <p>Information Management Concepts:<br/> Information systems concepts<br/> Information storage/retrieval, searching, browsing, navigational vs. declarative access<br/> Quality issues: consistency, scalability, availability, reliability<br/> Data Modeling:<br/> Conceptual data models (ER/UML structure diagr.)<br/> Conceptual design<br/> Operational models (relational model)<br/> Mapping from conceptual to operational model<br/> Relational Model:<br/> Operators<br/> Relational algebra<br/> Relational calculus<br/> Implications on query languages derived from RA and RC<br/> Design theory, normalization<br/> Query Languages<br/> SQL (in detail)<br/> QBE, Xpath, rdf (high level)<br/> Storage media<br/> RAID, SSDs<br/> Buffering, caching<br/> Implementation of relational operators:<br/> Implementation algorithms<br/> Cost functions<br/> Query optimization:<br/> Heuristic query optimization<br/> Cost based query optimization<br/> Transaction processing (concurrency control and recovery):<br/> Flat transactions<br/> Concurrency control, correctness criteria: serializability, recoverability, ACA, strictness<br/> Isolation levels<br/> Lock-based schedulers, 2PL<br/> Multiversion concurrency control<br/> Optimistic schedulers<br/> Logging<br/> Checkpointing<br/> Recovery/restart<br/> New trends in data management<br/> Main memory databases<br/> Column stores<br/> NoSQL</p> |                          |   |                      |                                       |
| <b>2</b>                                     | <b>Learning objectives / Learning Outcomes</b>   |                          |   |                      |                                       |

|          |  |
|----------|--|
|          | After successfully attending the course, students are familiar with the fundamental concepts of information management. They understand the techniques for realizing information management systems and can apply the models, algorithms and languages to independently use and (partially) implement information management systems that fulfill the given requirements. They are able to evaluate such systems in a number of quality metrics. |
| <b>3</b> | <b>Recommended prerequisite for participation</b><br>Recommended:<br>Participation of lecture „Funktionale und Objektorientierte Programmierkonzepte“ and „Algorithmen und Datenstrukturen“, respective according knowledge.   |
| <b>4</b> | <b>Form of examination</b><br>Module Accompanying Examination:<br><ul style="list-style-type: none"> <li>[20-00-0015-iv] (Technical Examination, Written/Oral Examination, Standard BWS)</li> </ul>  |
| <b>5</b> | <b>Grading</b><br>Module Accompanying Examination:<br><ul style="list-style-type: none"> <li>[20-00-0015-iv] (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>   |
| <b>6</b> | <b>Usability of this module</b><br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>May be used in other degree programs.  |
| <b>7</b> | <b>Grade bonus compliant to §25 (2)</b><br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.   |
| <b>8</b> | <b>References</b><br>Will be updated regularly, an example might be:<br>Haerder, Rahm, "Datenbanksysteme - Konzepte und Techniken der Implementierung", Springer 1999<br>Elmasri, R., Navathe, S. B.: Fundamentals of Database Systems, 3rd. ed., Redwood City, CA: Benjamin/Cummings<br>Ullman, J. D.: Principles of Database and Knowledge-Base Systems, Vol. 1 Computer Science   |

**Courses**

|                                    |  |                                     |                 |
|------------------------------------|--|-------------------------------------|-----------------|
| <b>Course Nr.</b><br>20-00-0015-iv | <b>Course name</b><br>Information Management |                                     |                 |
| <b>Instructor</b>                  |  | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>3 |

|   |   |                          |   |                      |                                       |
|---|---|--------------------------|---|----------------------|---------------------------------------|
| <b>Module name</b><br>Modeling, Specification and Semantics |   |                          |   |                      |                                       |
| <b>Module Nr.</b><br>20-00-0013                             | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h | <b>Self study</b><br>105 h                                | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                                   |   |                          | <b>Module owner</b><br>Prof. Dr. phil. nat. Marc Fischlin |                      |                                       |
| <b>1</b>  | <b>Content</b> <ul style="list-style-type: none"> <li>- introduction to modeling using predicate logic and algebraic concepts</li> <li>- interpretation and faithfulness of formal models</li> <li>- systematic construction of models and making of design decisions</li> <li>- abstraction, refinement, composition, and decomposition of models</li> <li>- syntax and operational semantics of programming languages</li> <li>- elementary proof techniques and their use</li> <li>- introduction to specification languages</li> <li>- syntax and denotational semantics of specification languages</li> <li>- modeling communication and coordination in concurrent systems</li> <li>- taxonomy of system properties</li> </ul>  |                          |   |                      |                                       |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>After successfully participating in this course, students know basic concepts in the areas modeling, specification, and semantics. They are able to use predicate logic and algebraic concepts to formalize given, informally described scenarios. They are able to develop formal models in a systematic fashion, to make necessary design decisions, and to employ informal notation and graphics to facilitate the construction of formal models. They know selected formal specification languages and are able to apply at least one such language. They understand the distinction between the syntax and semantics of formal languages and are able to prove propositions about expressions as well as simple meta-properties about the languages themselves. They are able to formalize basic system requirements as predicates and can assess the faithfulness of such formalizations. |                          |   |                      |                                       |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Recommended:<br>Participation of lecture “Automaten, formale Sprachen und Entscheidbarkeit” and “Aussagen- und Prädikatenlogik”, respective according knowledge.   |                          |   |                      |                                       |
| <b>4</b>  | <b>Form of examination</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>• [20-00-0013-iv] (Technical Examination, Written/Oral Examination, Standard BWS)</li> </ul>   |                          |   |                      |                                       |
| <b>5</b>  | <b>Grading</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>• [20-00-0013-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)</li> </ul>   |                          |   |                      |                                       |
| <b>6</b>  | <b>Usability of this module</b><br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>May be used in other degree programs.   |                          |   |                      |                                       |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b><br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.  |                          |   |                      |                                       |
| <b>8</b>  | <b>References</b>   |                          |   |                      |                                       |

U. Kastens, H. Kleine Büning: Modellierung - Grundlagen und formale Methoden, Hanser  
 G. Winskel: The Formal Semantics of Programming Languages, MIT Press  
 C. A. R. Hoare: Communicating Sequential Processes, Prentice-Hall  
 Literature recommendations will be updated regularly.

**Courses**

|                                    |  |                                     |                 |
|------------------------------------|--|-------------------------------------|-----------------|
| <b>Course Nr.</b><br>20-00-0013-iv | <b>Course name</b><br>Modellierung, Spezifikation und Semantik |                                     |                 |
| <b>Instructor</b>                  |  | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>3 |

|  |  |                          |   |                      |                                       |
|--|--|--------------------------|---|----------------------|---------------------------------------|
| <b>Module name</b><br>Visual Computing |  |                          |   |                      |                                       |
| <b>Module Nr.</b><br>20-00-0014        | <b>Credit Points</b><br>5 CP   | <b>Workload</b><br>150 h | <b>Self study</b><br>105 h                                | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German              |  |                          | <b>Module owner</b><br>Prof. Dr. phil. nat. Marc Fischlin |                      |                                       |
| <b>1</b>                               | <b>Content</b><br>- Basics of perception<br>- Basic Fourier transformation<br>- Images, filtering, compression & processing<br>- Basic object recognition<br>- Geometric transformations<br>- Basic 3D reconstruction<br>- Surface and scene representations<br>- Rendering algorithms<br>- Color: Perception, spaces & models<br>- Basic visualization  |                          |   |                      |                                       |
| <b>2</b>                               | <b>Learning objectives / Learning Outcomes</b><br>After successful participation in the course students are able to describe the foundational concepts as well as the basic models and methods of visual computing. They explain important approaches for image synthesis (computer graphics & visualization) and analysis (computer vision) and can solve basic image synthesis and analysis tasks. |                          |   |                      |                                       |
| <b>3</b>                               | <b>Recommended prerequisite for participation</b><br>Recommended:<br>Participation of lecture "Mathematik I/II/III".   |                          |   |                      |                                       |
| <b>4</b>                               | <b>Form of examination</b><br>Module Ecompanying Examination:<br>• [20-00-0014-iv] (Technical Examination, Written/Oral Examination, Standard BWS)   |                          |   |                      |                                       |
| <b>5</b>                               | <b>Grading</b><br>Module Ecompanying Examination:<br>• [20-00-0014-iv] (Technical Examination, Written/Oral Examination, Weighting: 100%)  |                          |   |                      |                                       |
| <b>6</b>                               | <b>Usability of this module</b><br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>B.Sc. Computational Engineering<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs.  |                          |   |                      |                                       |
| <b>7</b>                               | <b>Grade bonus compliant to §25 (2)</b><br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.   |                          |   |                      |                                       |
| <b>8</b>                               | <b>References</b><br>Literature recommendations will be updated regularly, an example might be:<br>- R. Szeliski, "Computer Vision: Algorithms and Applications", Springer 2011<br>- B. Blundell, "An Introduction to Computer Graphics and Creative 3D Environments", Springer 2008   |                          |   |                      |                                       |
| <b>Courses</b>                         |  |                          |   |                      |                                       |

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|--|------------------------------------|--|-------------------------------------|-----------------|
|  | <b>Course Nr.</b><br>20-00-0014-iv | <b>Course name</b><br>Visual Computing |                                     |                 |
|  | <b>Instructor</b>                  |  | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>3 |

### 4.3.2.2 Praktikum

|   |   |   |   |                           |                              |
|---|---|---|---|---------------------------|------------------------------|
| <b>Module name</b><br>C/C++ Programming Lab |   |   |   |                           |                              |
| <b>Module Nr.</b><br>18-su-1030             | <b>Credit Points</b><br>3 CP  | <b>Workload</b><br>90 h                     | <b>Self study</b><br>45 h                                 | <b>Duration</b><br>1      | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                   |   |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Andreas Schürr |                           |                              |
| <b>1</b>                                    | <b>Content</b><br>The six-day programming lab is divided into two sections.<br>In the first four days, the programming languages C and C++ are taught with practical tasks and lectures. All covered aspects are extensively practiced under supervision. Based on the fundamental basics of C++, manual memory management and dynamic data structures are handled from a procedural as well as from an object-oriented perspective. Object orientation with C++ is extensively addressed by treating multiple inheritance, polymorphism and parametric polymorphism.<br>The last two days are dedicated to microcontroller programming in C including the opportunity of programming of a distributed application (via a CAN-bus). |   |   |                           |                              |
| <b>2</b>                                    | <b>Learning objectives / Learning Outcomes</b><br>During the lab, the students acquire a fundamental understanding of the programming languages C and C++ with emphasis not only on procedural but also on object-oriented characteristics. The students gain hands-on experience with applying C++ and discover the challenges of using C++ safely and properly especially in the context of embedded system software development.   |   |   |                           |                              |
| <b>3</b>                                    | <b>Recommended prerequisite for participation</b><br>Java skills  |   |   |                           |                              |
| <b>4</b>                                    | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>   |   |   |                           |                              |
| <b>5</b>                                    | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>   |   |   |                           |                              |
| <b>6</b>                                    | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST, BSc Wi-ETiT  |   |   |                           |                              |
| <b>7</b>                                    | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                           |                              |
| <b>8</b>                                    | <b>References</b><br><a href="http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/c-und-c-p">http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/c-und-c-p</a>  |   |   |                           |                              |
| <b>Courses</b>                              |   |   |   |                           |                              |
|   | <b>Course Nr.</b><br>18-su-1030-pr  | <b>Course name</b><br>C/C++ Programming Lab |   |                           |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr   |   |   | <b>Type</b><br>Internship | <b>SWS</b><br>3              |



|  |  |  |  |                           |                              |
|--|--|--|--|---------------------------|------------------------------|
| <b>Module name</b><br>Digital Design Lab |  |  |  |                           |                              |
| <b>Module Nr.</b><br>18-hb-1030          | <b>Credit Points</b><br>3 CP   | <b>Workload</b><br>90 h                  | <b>Self study</b><br>45 h                                  | <b>Duration</b><br>1      | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Christian Hochberger |                           |                              |
| <b>1</b>                                 | <b>Content</b> <ul style="list-style-type: none"> <li>• Introduction to the MP3 encoding standard for audio signals</li> <li>• Analysis of the individual steps of the decoding process wrt. the used algorithms</li> <li>• Analysis of the individual steps of the decoding process wrt. the storage of in-intermediate results</li> <li>• Design and configuration of the datapath to realize the individual process steps</li> <li>• Simulation on functional level and with timing annotation</li> <li>• Check, whether the design meets all restrictions</li> <li>• Test of the final HW design with all relevant MP3 variants (short and long frames)</li> </ul> |  |  |                           |                              |
| <b>2</b>                                 | <b>Learning objectives / Learning Outcomes</b><br>Students are able to manually map complex problems onto a digital target architecture. They are proficient in using the design tools to implement their solution on FPGAs. They know strategies to systematically find errors in their design. They can explore designs by simulation.   |  |  |                           |                              |
| <b>3</b>                                 | <b>Recommended prerequisite for participation</b><br>Basic knowledge of digital design   |  |  |                           |                              |
| <b>4</b>                                 | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Duration: 30 min, Standard Grading System)</li> </ul>  |  |  |                           |                              |
| <b>5</b>                                 | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Weighting: 100%)</li> </ul>  |  |  |                           |                              |
| <b>6</b>                                 | <b>Usability of this module</b><br>BSc ETiT, BSc iST   |  |  |                           |                              |
| <b>7</b>                                 | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                           |                              |
| <b>8</b>                                 | <b>References</b>  |  |  |                           |                              |
| <b>Courses</b>                           |  |  |  |                           |                              |
|  | <b>Course Nr.</b><br>18-hb-1030-pr   | <b>Course name</b><br>Digital Design Lab |  |                           |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Christian Hochberger   |  |  | <b>Type</b><br>Internship | <b>SWS</b><br>3              |

| <b>Module name</b><br>Multimedia Communications Lab I |  |                 |  |                 |                      |
|---|--|-----------------|--|-----------------|----------------------|
| <b>Module Nr.</b>                                     | <b>Credit Points</b>   | <b>Workload</b> | <b>Self study</b>                                    | <b>Duration</b> | <b>Cycle offered</b> |
| 18-sm-1020  | 3 CP   | 90 h            | 45 h   | 1               | WiSe/SoSe            |
| <b>Language</b><br>German and English                 |  |                 | <b>Module owner</b><br>Prof. Dr.-Ing. Ralf Steinmetz |                 |                      |
| <b>1</b>  | <b>Content</b><br>The course deals with cutting edge development topics in the area of multimedia communication systems. Beside a general overview it provides a deep insight into a special development topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and basic scientific competences in one or more of the following topics: <ul style="list-style-type: none"> <li>• Network planning and traffic analysis</li> <li>• Performance evaluation of network applications</li> <li>• Discrete event simulation for network services</li> <li>• Protocols for mobile ad hoc networks / sensor networks</li> <li>• Infrastructure networks for mobile communication / mesh networks</li> <li>• Context-aware communication and services</li> <li>• Peer-to-peer systems and architectures</li> <li>• Content distribution and management systems for multimedia/e-learning</li> <li>• Multimedia authoring and re-authoring tools</li> <li>• Web service technologies and service-oriented architectures</li> <li>• Applications for distributed workflows</li> <li>• Resource-based Learning</li> </ul> |                 |  |                 |                      |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>The ability to solve simple problems in the area of multimedia communication shall be acquired. Acquired competences are: <ul style="list-style-type: none"> <li>• Design of simple communication applications and protocols</li> <li>• Implementing and testing of software components for distributed systems</li> <li>• Application of object-oriented analysis and design techniques</li> <li>• Presentation of project advances and outcomes</li> </ul>   |                 |  |                 |                      |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Keen interest to explore basic topics of cutting edge communication and multimedia technologies. Further we expect: <ul style="list-style-type: none"> <li>• Basic experience in programming Java/C# (C/C++).</li> <li>• Knowledge in computer communication networks. Lectures in Communication Networks I and/or Net Centric Systems are recommended.</li> </ul>  |                 |  |                 |                      |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |                 |  |                 |                      |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |                 |  |                 |                      |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc/MSc iST, MSc MEC, Wi-CS, Wi-ETiT, BSc/MSc CS  |                 |  |                 |                      |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |                 |  |                 |                      |
| <b>8</b>  | <b>References</b>  |                 |  |                 |                      |

Each topic is covered by a selection of papers and articles. In addition we recommend reading of selected chapters from following books:

- Andrew Tanenbaum: "Computer Networks". Prentice Hall PTR (ISBN 0130384887)
- Christian Ullenboom: "Java ist auch eine Insel: Programmieren mit der Java Standard Edition Version 5 / 6" (ISBN-13: 978-3898428385)
- Kent Beck: "Extreme Programming Explained - Embrace Changes" (ISBN-13: 978-0321278654)

**Courses**

|  |   |   |                           |                 |
|--|---|---|---------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-sm-1020-pr  | <b>Course name</b><br>Multimedia Communications Lab I |                           |                 |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Ralf Steinmetz, M.Sc. Daniel Bischoff, M.Sc. Tim Steuer |   | <b>Type</b><br>Internship | <b>SWS</b><br>3 |

### 4.3.2.3 Projektseminar

|   |  |   |   |                                |                                   |
|---|--|---|---|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Integrated Electronic Systems |  |   |   |                                |                                   |
| <b>Module Nr.</b><br>18-ho-1060                                     | <b>Credit Points</b><br>9 CP   | <b>Workload</b><br>270 h  | <b>Self study</b><br>210 h                          | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German   |  |   | <b>Module owner</b><br>Prof. Dr.-Ing. Klaus Hofmann |                                |                                   |
| <b>1</b>  | <b>Content</b><br>Research-oriented project in the domain of Integrated Electronic Systems or Microelectronic System Design, Final Report and Presentation of Results in a Team  |   |   |                                |                                   |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>After attending this projectseminar, a student is able to fulfill/implement a given task or project in the domain of Integrated Electronic System design (optionally in a group of students), write a final report and present the results to an audience. |   |   |                                |                                   |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Lecture Analog Integrated Circuit Design  |   |   |                                |                                   |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Duration: 30 min, Standard Grading System)</li> </ul>  |   |   |                                |                                   |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Weighting: 100 %)</li> </ul>   |   |   |                                |                                   |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, Wi ETiT   |   |   |                                |                                   |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |   |   |                                |                                   |
| <b>8</b>  | <b>References</b><br>Material on the subject will be handed out  |   |   |                                |                                   |
| <b>Courses</b>  |  |   |   |                                |                                   |
|   | <b>Course Nr.</b><br>18-ho-1060-pj   | <b>Course name</b><br>Project Seminar Integrated Electronic Systems |   |                                |                                   |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann  |   |   | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |

| <b>Module name</b><br>Multimedia Communications Project I |  |                 |  |                 |                      |
|---|--|-----------------|--|-----------------|----------------------|
| <b>Module Nr.</b>   | <b>Credit Points</b>   | <b>Workload</b> | <b>Self study</b>                                    | <b>Duration</b> | <b>Cycle offered</b> |
| 18-sm-1030  | 9 CP   | 270 h           | 210 h  | 1               | WiSe/SoSe            |
| <b>Language</b><br>German and English                     |  |                 | <b>Module owner</b><br>Prof. Dr.-Ing. Ralf Steinmetz |                 |                      |
| <b>1</b>  | <b>Content</b><br>The course deals with cutting edge scientific and development topics in the area of multimedia communication systems. Besides a general overview, it provides a deep insight into a special scientific topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and scientific competences in one or more of the following topics: <ul style="list-style-type: none"> <li>• Network planning and traffic analysis</li> <li>• Performance evaluation of network applications</li> <li>• Discrete event simulation for network services</li> <li>• Protocols for mobile ad hoc networks / sensor networks</li> <li>• Infrastructure networks for mobile communication / mesh networks</li> <li>• Context-aware communication and services</li> <li>• Peer-to-peer systems and architectures</li> <li>• Content distribution and management systems for multimedia/e-learning</li> <li>• Multimedia authoring and re-authoring tools</li> <li>• Web service technologies and service-oriented architectures</li> <li>• Applications for distributed workflows</li> <li>• Resource-based Learning</li> </ul> |                 |  |                 |                      |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>The ability to solve and evaluate technical problems in the area of design and development of future multimedia communication networks and applications using state of the art scientific methods. Acquired competences are among the following: <ul style="list-style-type: none"> <li>• Searching and reading of project relevant literature</li> <li>• Design of communication applications and protocols</li> <li>• Implementing and testing of software components</li> <li>• Application of object-orient analysis and design techniques</li> <li>• Acquisition of project management techniques for small development teams</li> <li>• Evaluation and analyzing of technical scientific experiments</li> <li>• Writing of software documentation and project reports</li> <li>• Presentation of project advances and outcomes</li> </ul>  |                 |  |                 |                      |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Keen interest to develop and explore challenging solutions and applications in cutting edge multimedia communication systems. Further we expect: <ul style="list-style-type: none"> <li>• Basic experience in programming Java/C# (C/C++).</li> <li>• Basic knowledge in Object oriented analysis and design.</li> <li>• Knowledge in computer communication networks. Lectures in Communication Networks I and/or Net Centric Systems are recommended.</li> </ul>  |                 |  |                 |                      |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |                 |  |                 |                      |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |                 |  |                 |                      |

|                |   |   |                 |
|----------------|---|---|-----------------|
| <b>6</b>       | <b>Usability of this module</b><br>BSc ETiT, BSc/MSc iST, MSc MEC, Wi-CS, Wi-ETiT, BSc/MSc CS   |   |                 |
| <b>7</b>       | <b>Grade bonus compliant to §25 (2)</b>   |   |                 |
| <b>8</b>       | <b>References</b><br>Each topic is covered by a selection of papers and articles. In addition we recommend reading of selected chapters from following books: <ul style="list-style-type: none"> <li>• Andrew Tanenbaum: "Computer Networks". Prentice Hall PTR (ISBN 0130384887)</li> <li>• Raj Jain: "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling" (ISBN 0-471-50336-3)</li> <li>• Erich Gamma, Richard Helm, Ralph E. Johnson: "Design Patterns: Objects of Reusable Object Oriented Software" (ISBN 0-201-63361-2)</li> <li>• Kent Beck: "Extreme Programming Explained - Embrace Changes" (ISBN-13: 978-0321278654)</li> </ul> |   |                 |
| <b>Courses</b> |   |   |                 |
|                | <b>Course Nr.</b><br>18-sm-1030-pj  | <b>Course name</b><br>Multimedia Communications Project I |                 |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Ralf Steinmetz, M.Sc. Julian Zobel, M.Sc. Daniel Bischoff, M.Sc. Tim Steuer   | <b>Type</b><br>Project Seminar                            | <b>SWS</b><br>4 |

|  |  |  |  |                                |                                   |
|--|--|--|--|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Computer Systems |  |  |  |                                |                                   |
| <b>Module Nr.</b><br>18-hb-1040                        | <b>Credit Points</b><br>9 CP   | <b>Workload</b><br>270 h                               | <b>Self study</b><br>210 h                                 | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German                              |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Christian Hochberger |                                |                                   |
| <b>1</b>   | <b>Content</b><br>Students elaborate on a research-oriented subject in the area of computer-systems. They present a written documentation and a presentation of the acquired advanced knowledge. They provide a set of alternative solutions to a given problem. |  |  |                                |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Students are able to systematically develop design alternatives to a given problem. They learn to acquire the necessary fundamental knowledge in terms of references and terminology.                          |  |  |                                |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Basic knowledge of digital design   |  |  |                                |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>   |  |  |                                |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>   |  |  |                                |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc/MSc iST   |  |  |                                |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                                |                                   |
| <b>8</b>   | <b>References</b>  |  |  |                                |                                   |
| <b>Courses</b>   |  |  |  |                                |                                   |
|  | <b>Course Nr.</b><br>18-hb-1040-pj   | <b>Course name</b><br>Project Seminar Computer Systems |  |                                |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Christian Hochberger   |  |  | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |

|   |  |                          |   |                      |                                   |
|---|--|--------------------------|---|----------------------|-----------------------------------|
| <b>Module name</b><br>Projektseminar Software Systems |  |                          |   |                      |                                   |
| <b>Module Nr.</b><br>18-su-1060                       | <b>Credit Points</b><br>9 CP   | <b>Workload</b><br>270 h | <b>Self study</b><br>210 h                                | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German                             |  |                          | <b>Module owner</b><br>Prof. Dr. rer. nat. Andreas Schürr |                      |                                   |
| <b>1</b>  | <b>Content</b><br><p>The course deals with various development and research topics in the area of model-driven engineering and object-oriented software engineering. Besides a general overview, it provides a deep insight into a special scientific topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and scientific competences in one or more of the following topics:</p> <ul style="list-style-type: none"> <li>• Model-Driven Engineering and Model Synchronization</li> <li>• Model Transformation</li> <li>• Object-Oriented Refactorings</li> <li>• Program Variability (Software Product Lines)</li> <li>• Feature Model Analysis</li> </ul> <p>Additional information and topic description for the current semester: <a href="http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/projektseminar-softwareysteme/">http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/projektseminar-softwareysteme/</a></p>   |                          |   |                      |                                   |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br><p>The student gains practical experience in development (reengineering and maintenance) of complex software systems. He/She learns to work and function in a team, and to analyze and solve a non-trivial task. Moreover, students exercise using theoretical knowledge in the group (e.g. from lectures like software engineering – introduction / Design / Maintenance &amp; Quality Assurance) to solve a concrete and practical problem.</p> <p>Students that have successfully completed this seminar are able to independently organize and set-up a non-trivial software project and function to analyze and solve a certain task. Attendees gain the following skills in detail:</p> <ul style="list-style-type: none"> <li>• realistic time and resource management (project management)</li> <li>• experience with tools for version control and change management</li> <li>• usage of CASE tools for model-based software development</li> <li>• planning and execution of quality assurance measures</li> </ul> |                          |   |                      |                                   |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Mandatory: Basic software technology knowledge and advanced knowledge of object-oriented programming languages  |                          |   |                      |                                   |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |                          |   |                      |                                   |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |                          |   |                      |                                   |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, MSc ETiT, BSc iST   |                          |   |                      |                                   |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |                          |   |                      |                                   |
| <b>8</b>  | <b>References</b><br>Each topic is covered by a specific selection of papers and articles.   |                          |   |                      |                                   |
| <b>Courses</b>  |  |                          |   |                      |                                   |



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|--|--|---|--------------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-su-1060-pj   | <b>Course name</b><br>Projektseminar Software Systems |                                |                 |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Luthmann |   | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4 |

|  |   |  |  |                                |                                   |
|--|---|--|--|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Energy Information Systems |   |  |  |                                |                                   |
| <b>Module Nr.</b><br>18-st-1010                                  | <b>Credit Points</b><br>9 CP  | <b>Workload</b><br>270 h   | <b>Self study</b><br>210 h                                 | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr. rer. nat. Florian Steinke |                                |                                   |
| <b>1</b>   | <b>Content</b><br>Students elaborate on a research-oriented subject in the area of computer-systems. They present a written documentation and/or a presentation of the acquired advanced knowledge. They provide a set of alternative solutions to a given problem. |  |  |                                |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Students are able to systematically develop design alternatives to a given problem. They learn to acquire the necessary fundamental knowledge in terms of references and terminology.                             |  |  |                                |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |                                |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |                                |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |  |                                |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT   |  |  |                                |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |                                |                                   |
| <b>8</b>   | <b>References</b>   |  |  |                                |                                   |
| <b>Courses</b>   |   |  |  |                                |                                   |
|  | <b>Course Nr.</b><br>18-st-1010-pj  | <b>Course name</b><br>Project Seminar Energy Information Systems |  |                                |                                   |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Florian Steinke  |  |  | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |

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|--|---|--------------------------|--|----------------------|---------------------------------------|
| <b>Module name</b><br>Advanced Topics in Embedded Systems and Applications |   |                          |  |                      |                                       |
| <b>Module Nr.</b><br>20-00-1001  | <b>Credit Points</b><br>9 CP  | <b>Workload</b><br>270 h | <b>Self study</b><br>180 h                         | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German and English                                      |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Andreas Koch |                      |                                       |
| <b>1</b>   | <b>Content</b><br>The course covers current topics in research and development of computing systems and programming tools, including focused ones in the areas of embedded and application-specific architectures. The subjects are determined by current research efforts in the ESA group and are intended to guide students towards acquiring technical as well as introductory scientific skills, for example, including one or more of the following domains:<br>- Computing systems architecture at the processor and systems-level<br>- Design of digital electronic circuits and hardware systems<br>- Use of Field-Programmable Gate Arrays<br>Hardware/Software design and programming tools<br>- Operating systems and low-level programming<br>Hardware/Software Co-Design<br>Application-specific architectures and techniques<br>- Design and/or programming of compute accelerators<br>- Debugging and analysis techniques for hardware/software-systems |                          |  |                      |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Participants are intended to acquire the skills necessary to quickly become familiar with a new domain and then solve a complex practical problem within that domain. These skills can include studies of scientific literature, surveying existing code-bases from the hardware/software domains, and the practical implementation of hardware and/or software systems. The final talk should show proficiency with basic presentation techniques.   |                          |  |                      |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>An interest to develop high-quality solutions in the assigned problem domain. For different domains, different pre-requisites will be required. These can include digital design, compiler construction, system-level and parallel programming. Such skills can be acquired by successfully completing the appropriate lectures.   |                          |  |                      |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Ecompanying Examination:<br>• [20-00-1001-pp] (Study Achievement, Written/Oral Examination, Standard BWS)  |                          |  |                      |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Ecompanying Examination:<br>• [20-00-1001-pp] (Study Achievement, Written/Oral Examination, Weighting: 100 %)  |                          |  |                      |                                       |
| <b>6</b>   | <b>Usability of this module</b><br>B.Sc. Informatjk<br>M.Sc Informatik<br>May be used in other degree programs.   |                          |  |                      |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |                          |  |                      |                                       |
| <b>8</b>   | <b>References</b>   |                          |  |                      |                                       |
| <b>Courses</b>   |   |                          |  |                      |                                       |

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|--|--|--|------------------------|-----------------|
|  | <b>Course Nr.</b><br>20-00-1001-pp               | <b>Course name</b><br>Advanced Topics in Embedded Systems and Applications |                        |                 |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Andreas Koch |  | <b>Type</b><br>Project | <b>SWS</b><br>6 |

## 4.4 Option Electrical Power Engineering

### 4.4.1 Fundamentals

|  |  |                         |  |                      |                              |
|--|--|-------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Electrical Power Engineering |  |                         |  |                      |                              |
| <b>Module Nr.</b><br>18-bi-1010                    | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180h | <b>Self study</b><br>120 h                                     | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                          |  |                         | <b>Module owner</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |                      |                              |
| <b>1</b>   | <p><b>Content</b></p> <p>The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.</p> <p>First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.</p> <p>Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.</p> <p>The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications. The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.</p> |                         |  |                      |                              |
| <b>2</b>   | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.</p> <p>They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.</p> <p>They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.</p> <p>They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.</p>  |                         |  |                      |                              |
| <b>3</b>   | <p><b>Recommended prerequisite for participation</b></p> <p>Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.</p>  |                         |  |                      |                              |
| <b>4</b>   | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                         |  |                      |                              |

|                |   |  |                         |
|----------------|---|--|-------------------------|
| 5              | <b>Grading</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)   |  |                         |
| 6              | <b>Usability of this module</b><br>BSc ETiT, BSc WI-ETiT, BSc MEC, BSc iST, BSc CE, MSc ESE   |  |                         |
| 7              | <b>Grade bonus compliant to §25 (2)</b><br>At the beginning of the semester, it will be announced whether there will be homework tests accompanying the lecture that will enable an improvement in grades.  |  |                         |
| 8              | <b>References</b><br>Lecture notes (slides)<br>Practice documents (examples, solutions)<br>Additional and more detailed literature:<br>Grothe/Feldhusen: Dubbel-Taschenbuch für den Maschinenbau, Springer, Berlin, 2007, 22. Aufl.; besonders: Kapitel „Energietechnik und Wirtschaft“; Sterner/Stadler: Energiespeicher – Bedarf, Technologien, Integration, Springer-Vieweg, Berlin, 2011; Rummich: Energiespeicher, expert-verlag, Rellingen, 2015, 2. Aufl.; Strauß: Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, Berlin, 2006, 5. Aufl.; Hau: Windkraftanlagen –Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Springer-Vieweg, Berlin, 2014, 5. Aufl.; Heuck/Dettmann/Schulz: Elektrische Energieversorgung, Springer-Vieweg, Berlin, 2014, 9. Aufl.; Quaschnig: Regenerative Energiesystem, Hanser, München, 2001, 7. Aufl. |  |                         |
| <b>Courses</b> |   |  |                         |
|                | <b>Course Nr.</b><br>18-bi-1010-vl  | <b>Course name</b><br>Electrical Power Engineering |                         |
|                | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  |  | <b>Type</b><br>Lecture  |
|                |   |  | <b>SWS</b><br>3         |
|                | <b>Course Nr.</b><br>18-bi-1010-ue  | <b>Course name</b><br>Electrical Power Engineering |                         |
|                | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  |  | <b>Type</b><br>Practice |
|                |   |  | <b>SWS</b><br>1         |

|   |  |   |   |                        |                                       |
|---|--|---|---|------------------------|---------------------------------------|
| <b>Module name</b><br>Materials of Electrical Engineering |  |   |   |                        |                                       |
| <b>Module Nr.</b><br>11-01-6410                           | <b>Credit Points</b><br>3 CP   | <b>Workload</b><br>90 h                                   | <b>Self study</b><br>60 h                               | <b>Duration</b><br>1   | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                                 |  |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Lambert Alff |                        |                                       |
| 1   | <b>Content</b>   |   |   |                        |                                       |
| 2   | <b>Learning objectives / Learning Outcomes</b>   |   |   |                        |                                       |
| 3   | <b>Recommended prerequisite for participation</b>  |   |   |                        |                                       |
| 4   | <b>Form of examination</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>[11-01-6410-vl] (Technical Examination, Technical Examination, Standard BWS)</li> </ul> |   |   |                        |                                       |
| 5   | <b>Grading</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>[11-01-6410-vl] (Technical Examination, Technical Examination, Weighting: 100 %)</li> </ul>         |   |   |                        |                                       |
| 6   | <b>Usability of this module</b>  |   |   |                        |                                       |
| 7   | <b>Grade bonus compliant to §25 (2)</b>  |   |   |                        |                                       |
| 8   | <b>References</b>  |   |   |                        |                                       |
| <b>Courses</b>  |  |   |   |                        |                                       |
|   | <b>Course Nr.</b><br>11-01-6410-vl   | <b>Course name</b><br>Materials of Electrical Engineering |   |                        |                                       |
|   | <b>Instructor</b>  |   |   | <b>Type</b><br>Lecture | <b>SWS</b><br>2                       |

|   |  |                          |   |                      |                              |
|---|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Fundamentals of Communication |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-jk-1010                     | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                        | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                           |  |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Rolf Jakoby |                      |                              |
| <b>1</b>  | <p><b>Content</b></p> <p>Part 1: Chap. 1 will be a brief introduction in “Electrical Information- and Communication Engineering”, presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.</p> <p>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.</p> <p>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.</p> <p>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited intersymbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture.</p> |                          |   |                      |                              |
| <b>2</b>  | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.</p> <p>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems.</p>   |                          |   |                      |                              |
| <b>3</b>  | <p><b>Recommended prerequisite for participation</b></p> <p>Deterministic Signals and Systems</p>  |                          |   |                      |                              |
| <b>4</b>  | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |   |                      |                              |
| <b>5</b>  | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>  | <p><b>Usability of this module</b></p> <p>BSc ETiT, Wi-ETiT</p>  |                          |   |                      |                              |
| <b>7</b>  | <p><b>Grade bonus compliant to §25 (2)</b></p>   |                          |   |                      |                              |



|          |  |
|----------|--|
| <b>8</b> | <p><b>References</b><br/> Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addison-Wesley 1992.</p> |
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| <b>Courses</b> |   |  |                 |
|----------------|---|--|-----------------|
|                | <b>Course Nr.</b><br>18-jk-1010-vl              | <b>Course name</b><br>Fundamentals of Communications |                 |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Rolf Jakoby | <b>Type</b><br>Lecture                               | <b>SWS</b><br>3 |
|                | <b>Course Nr.</b><br>18-jk-1010-ue              | <b>Course name</b><br>Fundamentals of Communications |                 |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Rolf Jakoby | <b>Type</b><br>Practice                              | <b>SWS</b><br>1 |

|                                       |   |                                       |  |                         |                              |
|---------------------------------------|---|---------------------------------------|--|-------------------------|------------------------------|
| <b>Module name</b><br>Power Systems I |   |                                       |  |                         |                              |
| <b>Module Nr.</b><br>18-hs-1010       | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h              | <b>Self study</b><br>90 h                          | <b>Duration</b><br>1    | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German             |   |                                       | <b>Module owner</b><br>Prof. Dr.-Ing. Jutta Hanson |                         |                              |
| <b>1</b>                              | <b>Content</b><br>Three-phase network and symmetrical components; overhead lines; cables; transformers; calculation of short-circuit currents; switch equipment; switchgears  |                                       |  |                         |                              |
| <b>2</b>                              | <b>Learning objectives / Learning Outcomes</b><br>The education goals are <ul style="list-style-type: none"> <li>• Presentation of components of power system</li> <li>• Functional elaboration of equipment</li> <li>• Calculation of the component rating</li> <li>• Impact on the electrical power system</li> </ul> |                                       |  |                         |                              |
| <b>3</b>                              | <b>Recommended prerequisite for participation</b><br>Contents of the lecture Electrical Power Engineering   |                                       |  |                         |                              |
| <b>4</b>                              | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Optional, Standard Grading System)</li> </ul>   |                                       |  |                         |                              |
| <b>5</b>                              | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Optional, Weighting: 100 %)</li> </ul>  |                                       |  |                         |                              |
| <b>6</b>                              | <b>Usability of this module</b><br>BSc ETiT, BSc/MSc WI-ET, BSc EPE, BSc/MSc CE, BSc/MSc iST, MSc Informatik  |                                       |  |                         |                              |
| <b>7</b>                              | <b>Grade bonus compliant to §25 (2)</b>   |                                       |  |                         |                              |
| <b>8</b>                              | <b>References</b><br>Script, lecture slides, guiding questions, excercises  |                                       |  |                         |                              |
| <b>Courses</b>                        |   |                                       |  |                         |                              |
|                                       | <b>Course Nr.</b><br>18-hs-1010-vl  | <b>Course name</b><br>Power Systems I |  |                         |                              |
|                                       | <b>Instructor</b><br>Prof. Dr.-Ing. Jutta Hanson  |                                       |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>2              |
|                                       | <b>Course Nr.</b><br>18-hs-1010-ue  | <b>Course name</b><br>Power Systems I |  |                         |                              |
|                                       | <b>Instructor</b><br>Prof. Dr.-Ing. Jutta Hanson  |                                       |  | <b>Type</b><br>Practice | <b>SWS</b><br>2              |

|  |   |  |  |                        |                              |
|--|---|--|--|------------------------|------------------------------|
| <b>Module name</b><br>Electrical Machines and Drives |   |  |  |                        |                              |
| <b>Module Nr.</b><br>18-bi-1020                      | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h                             | <b>Self study</b><br>90 h                                      | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                            |   |  | <b>Module owner</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |                        |                              |
| <b>1</b>   | <b>Content</b><br>Construction and function of induction machine, synchronous machine, direct current machine. Electro-magnetic field within machines, armature windings, steady-state performance as motor/generator, application as line-fed and inverter-fed drives. Significance for electric power generation, both to the grid and in stand-alone version.  |  |  |                        |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>With active collaboration during lectures by asking questions related to those parts, which have not been completely understood by you, as well as by independent solving of examples ahead of the tutorial (not as late as during preparation for examination) you should be able to: <ul style="list-style-type: none"> <li>• calculate and explain the stationary operation performance of the three basic types of electric machine sin motor and generator mode,</li> <li>• understand the application of electrical machines in modern drive systems and to design simple drive applications by yourself,</li> <li>• understand and explain the function and physical background of the components of electrical machines</li> <li>• understand and explain the impact of basic electromagnetic field and force theory on the basic function of electrical machines.</li> </ul> |  |  |                        |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Mathematics I to III, Electrical Engineering I and II, Physics, Mechanical Engineering   |  |  |                        |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Optional, Standard Grading System)</li> </ul>   |  |  |                        |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Optional, Weighting: 100 %)</li> </ul>  |  |  |                        |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc/MSc Wi-ETiT, BEd   |  |  |                        |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |                        |                              |
| <b>8</b>   | <b>References</b><br>Detailed textbook and collection of exercises; Complete set of PowerPoint presentations<br>L.Matsch: Electromagnetic and electromechanical machines, Int.Textbook, 1972<br>A.Fitzgerald et al: Electric machinery, McGraw-Hill, 1971<br>S.Nasar et al: Electromechanics and electric machines, Wiley&Sons, 1995<br>R.Fischer: Elektrische Maschinen, C.Hanser-Verlag, 2004   |  |  |                        |                              |
| <b>Courses</b>                                       |   |  |  |                        |                              |
|  | <b>Course Nr.</b><br>18-bi-1020-vl  | <b>Course name</b><br>Electrical Machines and Drives |  |                        |                              |
|  | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  |  |  | <b>Type</b><br>Lecture | <b>SWS</b><br>2              |

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|--|--|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-bi-1020-ue                           | <b>Course name</b><br>Electrical Machines and Drives |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |  | <b>Type</b><br>Practice | <b>SWS</b><br>2 |

|   |   |                          |  |                      |                              |
|---|---|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Power Electronics |   |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-gt-1010         | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h | <b>Self study</b><br>90 h                              | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German               |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Gerd Griepentrog |                      |                              |
| <b>1</b>                                | <b>Content</b><br>Power electronic devices convert the energy from the distribution network to the form required by the load. This conversion does not wear out, can be controlled very fast and has a high efficiency. In lecture "Power Electronics" the most important circuits required for the energy conversion are treated, using ideal switches.<br>The main chapters are<br>I.) Line commutated converters in order to understand the basic concepts of power electronic systems.<br>II.) Self- commutated converters (one, two and four quadrant converters, 3-phase- VSI)  |                          |  |                      |                              |
| <b>2</b>                                | <b>Learning objectives / Learning Outcomes</b><br>After an active participation in the lecture, as well as by solving all exercises prior to the respective tutorial students should be able to: <ul style="list-style-type: none"> <li>• Understand the ideal concept of power semiconductors</li> <li>• Calculate and sketch the time-characteristics of all currents and voltages in a line-commutated converter using defined simplifications as well as represent the behavior of currents and voltages during commutation in line-commutated converters for center –tapped as well as for bridge circuits.</li> <li>• Specify the basic circuit diagrams for one, two and four quadrant DC/DC converters and calculate the characteristics of voltages and currents in these circuits.</li> <li>• Explain the function of single-phase and three-phase voltage source inverters and calculate the currents and voltages in these circuits using defined simplifications.</li> <li>• Understand the concept and operation of HVDC converter</li> </ul> |                          |  |                      |                              |
| <b>3</b>                                | <b>Recommended prerequisite for participation</b><br>Mathe I und II, ETiT I und II, Energietechnik  |                          |  |                      |                              |
| <b>4</b>                                | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>  |                          |  |                      |                              |
| <b>5</b>                                | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |                          |  |                      |                              |
| <b>6</b>                                | <b>Usability of this module</b><br>MSc ETiT, MSc MEC, Wi-ETiT   |                          |  |                      |                              |
| <b>7</b>                                | <b>Grade bonus compliant to §25 (2)</b>   |                          |  |                      |                              |
| <b>8</b>                                | <b>References</b><br>Lecture notes, instructions for exercises are available for download in Moodle.<br>Literature:<br>Probst U.: „Leistungselektronik für Bachelors: Grundlagen und praktische Anwendungen“, Carl Hanser Verlag GmbH & Co. KG, 2011<br>Jäger, R.: „Leistungselektronik: Grundlagen und Anwendungen“, VDE-Verlag; Auflage 2011<br>Heumann, K.: „Grundlagen der Leistungselektronik“; Teubner; Stuttgart; 1985<br>Lappe, R.: „Leistungselektronik“; Springer-Verlag; 1988<br>Mohan, Undeland, Robbins: Power Electronics: Converters, Applications and Design; John Wiley Verlag; New York; 2003   |                          |  |                      |                              |

| <b>Courses</b> |   |   |                         |
|----------------|---|---|-------------------------|
|                | <b>Course Nr.</b><br>18-gt-1010-vl                                      | <b>Course name</b><br>Power Electronics |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Gerd Griepentrog                    |   | <b>Type</b><br>Lecture  |
|                |   |   | <b>SWS</b><br>2         |
|                | <b>Course Nr.</b><br>18-gt-1010-ue                                      | <b>Course name</b><br>Power Electronics |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Gerd Griepentrog, M.Sc. Milad Khani |   | <b>Type</b><br>Practice |
|                |   |   | <b>SWS</b><br>2         |

|   |   |  |   |                         |                              |
|---|---|--|---|-------------------------|------------------------------|
| <b>Module name</b><br>System Dynamics and Automatic Control Systems I |   |  |   |                         |                              |
| <b>Module Nr.</b><br>18-ko-1010                                       | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h   | <b>Self study</b><br>120 h                              | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German   |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Ulrich Konigorski |                         |                              |
| <b>1</b>  | <b>Content</b><br>Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization  |  |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems.  |  |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>   |  |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |  |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |  |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, MSc Informatik  |  |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |  |   |                         |                              |
| <b>8</b>  | <b>References</b><br>Skript Konigorski: "Systemdynamik und Regelungstechnik I", Aufgabensammlung zur Vorlesung, Lunze: "Regelungstechnik 1: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen", Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen", Unbehauen: "Regelungstechnik I:Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme, Fuzzy-Regelsysteme", Föllinger: "Laplace-, Fourier- und z-Transformation", Jörgl: "Repetitorium Regelungstechnik", Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden", Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise", Schneider: "Regelungstechnik für Maschinenbauer", Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnaher Grundlage" |  |   |                         |                              |
| <b>Courses</b>  |   |  |   |                         |                              |
|   | <b>Course Nr.</b><br>18-ko-1010-vl  | <b>Course name</b><br>System Dynamics and Automatic Control Systems I                      |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand  |  |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|   | <b>Course Nr.</b><br>18-ko-1010-tt  | <b>Course name</b><br>System Dynamics and Automatic Control Systems I- Auditorium Exercise |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand  |  |   | <b>Type</b><br>Tutorial | <b>SWS</b><br>1              |

|  |  |  |   |                        |                                       |
|--|--|--|---|------------------------|---------------------------------------|
| <b>Module name</b><br>Technical Mechanics for Electrical Engineering |  |  |   |                        |                                       |
| <b>Module Nr.</b><br>16-26-6400                                      | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h   | <b>Self study</b><br>105 h                        | <b>Duration</b><br>1   | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German  |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Tobias Melz |                        |                                       |
| <b>1</b>   | <b>Content</b><br>Statics: force, moment (torque), free body diagram, equilibrium equations, center of gravity, truss, beams, adhesion and friction.<br>Mechanics of elastic bodies: stress and deformation, tension, torsion, bending.<br>Kinematics: point and rigid body movement.<br>Kinetics: dynamic force and moment equilibrium equations, energy and work, linear oscillators, momentum and angular momentum conservation laws, impact.   |  |   |                        |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>In this course the students will learn the basic concepts of technical mechanics. They should be able to analyze the statics of simple statically determinate planar systems, to carry out elementary elastomechanical calculations of statically determinate and statically indeterminate structures, to describe and analyze movements, and to solve planar motion problems, oscillation and shock phenomena with the laws of kinetics.  |  |   |                        |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>  |  |   |                        |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Standard Grading System)  |  |   |                        |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)  |  |   |                        |                                       |
| <b>6</b>   | <b>Usability of this module</b>  |  |   |                        |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |   |                        |                                       |
| <b>8</b>   | <b>References</b><br>Markert, Norrick: Einführung in die Technische Mechanik, ISBN 978-3-8440-3228-4<br>Exercises are embodied in the book.<br>Further reading:<br>Markert: Statik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3279-6<br>Markert: Elastomechanik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3280-2<br>Markert: Dynamik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-2200-1<br>Gross, Hauger, Schröder, Wall: Technische Mechanik 1 - 3. Springer-Verlag Berlin (2012-2014).<br>Hagedorn: Technische Mechanik, Band 1 - 3. Verlag Harri Deutsch Frankfurt. |  |   |                        |                                       |
| <b>Courses</b>   |  |  |   |                        |                                       |
|  | <b>Course Nr.</b><br>16-26-6400-vl   | <b>Course name</b><br>Technical Mechanics for Electrical Engineering |   |                        |                                       |
|  | <b>Instructor</b>  |  |   | <b>Type</b><br>Lecture | <b>SWS</b><br>3                       |



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|  |                                    |  |                         |                 |
|--|------------------------------------|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>16-26-6400-ue | <b>Course name</b><br>Technical Mechanics for Electrical Engineering |                         |                 |
|  | <b>Instructor</b>                  |  | <b>Type</b><br>Practice | <b>SWS</b><br>2 |

#### 4.4.1.1 Proseminar ETiT

|  |   |  |  |   |                                   |
|--|---|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |  |   |                                   |
| <b>Module Nr.</b><br>18-bi-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                                      | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |  |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |  |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |  |  |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |  |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |   |                                   |
| <b>8</b>   | <b>References</b>   |  |  |   |                                   |
| <b>Courses</b>   |   |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-bi-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |   |   |                                   |
|--|---|--|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                                   |
| <b>Module Nr.</b><br>18-hi-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                               | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Volker Hinrichsen |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. Additional information can be found here.        |  |   |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |   |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |   |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |  |   |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |   |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                                   |
| <b>8</b>   | <b>References</b>   |  |   |   |                                   |
| <b>Courses</b>   |   |  |   |   |                                   |
|  | <b>Course Nr.</b><br>18-hi-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Volker Hinrichsen, M.Sc. Johannes Wiener  |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |  |   |                                   |
|--|---|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |  |   |                                   |
| <b>Module Nr.</b><br>18-hs-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                          | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Jutta Hanson |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |  |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |  |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |  |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |  |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |   |                                   |
| <b>8</b>   | <b>References</b>   |  |  |   |                                   |
| <b>Courses</b>   |   |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-hs-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Jutta Hanson  |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |  |   |                                   |
|--|---|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |  |   |                                   |
| <b>Module Nr.</b><br>18-gt-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                              | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Gerd Griepentrog |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |  |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |  |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |  |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |  |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |   |                                   |
| <b>8</b>   | <b>References</b>   |  |  |   |                                   |
| <b>Courses</b>   |   |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-gt-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Gerd Griepentrog  |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |  |   |                                   |
|--|---|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |  |   |                                   |
| <b>Module Nr.</b><br>18-st-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                                  | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr. rer. nat. Florian Steinke |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. Additional information can be found here.        |  |  |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |  |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |  |  |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |  |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |   |                                   |
| <b>8</b>   | <b>References</b>   |  |  |   |                                   |
| <b>Courses</b>   |   |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-st-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Florian Steinke, M.Sc. Christopher Thomas Peter Ripp   |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

## 4.4.2 Optional Modules

### 4.4.2.1 Offener Wahlkatalog

Gesamtkatalog aller Module FB 18 Elektro- und Informationstechnik

## 4.5 Option Communication and Sensor Systems

### 4.5.1 Fundamentals

|   |   |                          |   |                      |                              |
|---|---|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Microwave Engineering I |   |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-jk-1020               | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                        | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                     |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Rolf Jakoby |                      |                              |
| <b>1</b>                                      | <b>Content</b><br>Electromagnetic spectrum, kinds of transmission media, frequency ranges, bit rates, applications; Radio-Frequency (RF) and Microwave Circuits, Components and Modules, Passive RF Circuits with R-, L- and C-Lumped Elements: Resonant and Equivalent RLC Circuits, Graphical Representation of RF Circuits with the Smith Chart, Lumped-Element Impedance Matching; Theory and Applications of Transmission Lines: General Transmission-Line Equations, Lossless Transmission Lines as Circuit Elements, Line Terminations, Transmission-Line devices; Scattering-Matrix Formulation of N-Port RF Devices: Characterization of Microwave Networks, Concatenation of Two S-Matrixes, Applications of S-Parameters; Passive microwave components: waveguide splitter, circulator, directional coupler, filter, attenuator, matching network; Antennas: Antenna performance parameter, Ideal dipole with uniform current distribution, Antenna arrays of ideal dipoles, Image theory, Antenna modelling, Transmission Factor and Power Budget of Radio Links: Friis transmission equation, Gain and effective aperture of antennas, Radar equation, System noise temperature, Antenna noise temperature, Power budget of radio links, Basic propagation effects: reflection, transmission, scattering, diffraction; The radio channel: The two-ray propagation model, Doppler shift Multipath propagation, Stochastic behaviour of the mobile radio channel |                          |   |                      |                              |
| <b>2</b>                                      | <b>Learning objectives / Learning Outcomes</b>  |                          |   |                      |                              |
| <b>3</b>                                      | <b>Recommended prerequisite for participation</b><br>Nachrichtentechnik, Grundlagen der Technischen Elektrodynamik  |                          |   |                      |                              |
| <b>4</b>                                      | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"><li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li></ul>  |                          |   |                      |                              |
| <b>5</b>                                      | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"><li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li></ul>   |                          |   |                      |                              |
| <b>6</b>                                      | <b>Usability of this module</b><br>BSc ETiT, Wi-ETiT  |                          |   |                      |                              |
| <b>7</b>                                      | <b>Grade bonus compliant to §25 (2)</b>   |                          |   |                      |                              |
| <b>8</b>                                      | <b>References</b><br>Script will be hand out; Literature will be recommended in first lecture   |                          |   |                      |                              |

| <b>Courses</b> |   |   |                         |
|----------------|---|---|-------------------------|
|                | <b>Course Nr.</b><br>18-jk-1020-vl              | <b>Course name</b><br>Microwave Engineering I |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Rolf Jakoby |   | <b>Type</b><br>Lecture  |
|                |   |   | <b>SWS</b><br>3         |
|                | <b>Course Nr.</b><br>18-jk-1020-ue              | <b>Course name</b><br>Microwave Engineering I |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Rolf Jakoby |   | <b>Type</b><br>Practice |
|                |   |   | <b>SWS</b><br>1         |



|  |  |  |   |                         |                              |
|--|--|--|---|-------------------------|------------------------------|
| <b>Module name</b><br>Information Theory I |  |  |   |                         |                              |
| <b>Module Nr.</b><br>18-kp-1010            | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                   | <b>Self study</b><br>120 h                          | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>English                 |  |  | <b>Module owner</b><br>Prof. Dr. techn. Heinz Köppl |                         |                              |
| <b>1</b>                                   | <b>Content</b><br>This lecture course introduces the fundamentals of information and network information theory.<br>Outline:<br>information, uncertainty, entropy, mutual information, capacity, differential entropy, typical sequences, Gaussian channels, basics of source and channel coding, linear block codes, Shannon's source coding theorem, Shannon's channel coding theorem, capacity of Gaussian channels, capacity of bandlimited channels, Shannon's bound, bandwidth efficiency, capacity of multiple parallel channels and waterfilling, Gaussian vector channel, Multiple Access Channel, Broadcast Channel, rate region.. |  |   |                         |                              |
| <b>2</b>                                   | <b>Learning objectives / Learning Outcomes</b><br>Students will understand the fundamentals of classic information theory.   |  |   |                         |                              |
| <b>3</b>                                   | <b>Recommended prerequisite for participation</b><br>Knowledge of basic communication theory und probability theory  |  |   |                         |                              |
| <b>4</b>                                   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |  |   |                         |                              |
| <b>5</b>                                   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |  |   |                         |                              |
| <b>6</b>                                   | <b>Usability of this module</b><br>BSc ETiT, BSc iST, MSc iCE, BSc Wi-ETiT, BSc/MSc CE   |  |   |                         |                              |
| <b>7</b>                                   | <b>Grade bonus compliant to §25 (2)</b>  |  |   |                         |                              |
| <b>8</b>                                   | <b>References</b><br>1. T.M. Cover and J.A. Thomas, Elements of Information Theory, Wiley & Sons, 1991.<br>2. Abbas El Gamal and Young-Han Kim, Network Information Theory, Cambridge, 2011.<br>3. S. Haykin, Communication Systems, Wiley & Sons, 2001.   |  |   |                         |                              |
| <b>Courses</b>                             |  |  |   |                         |                              |
|  | <b>Course Nr.</b><br>18-kp-1010-vl   | <b>Course name</b><br>Information Theory I |   |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr. techn. Heinz Köppl, M.Sc. Anam Tahir  |  |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|  | <b>Course Nr.</b><br>18-kp-1010-ue   | <b>Course name</b><br>Information Theory I |   |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr. techn. Heinz Köppl, M.Sc. Anam Tahir  |  |   | <b>Type</b><br>Practice | <b>SWS</b><br>1              |

| <b>Module name</b><br>Optical Communications – Components |   |                 |  |                 |                      |
|---|---|-----------------|--|-----------------|----------------------|
| <b>Module Nr.</b>   | <b>Credit Points</b>  | <b>Workload</b> | <b>Self study</b>                                      | <b>Duration</b> | <b>Cycle offered</b> |
| 18-pr-1050  | 6 CP  | 180 h           | 120 h  | 1               | SoSe                 |
| <b>Language</b><br>English                                |   |                 | <b>Module owner</b><br>Prof. Dr. rer. nat. Sascha Preu |                 |                      |
| <b>1</b>  | <p><b>Content</b></p> <p>The lecture discusses the working principle of the most important devices and components of modern telecommunication networks and optical data transmission systems. The starting point will be basic physical principles:</p> <p>The nature of light</p> <ul style="list-style-type: none"> <li>• Wave equation</li> <li>• Polarization</li> <li>• Absorption, transmission, reflection, refraction</li> <li>• Mirrors, HR-/AR coatings</li> </ul> <p>Waveguides</p> <ul style="list-style-type: none"> <li>• Fiber-optic waveguides</li> <li>• Attenuation, modes, dispersion</li> <li>• Fiber types</li> <li>• Connectors and splices</li> <li>• Dispersion and dispersion compensation</li> <li>• Kerr nonlinearity and self-phase modulation</li> </ul> <p>Components, e.g.:</p> <ul style="list-style-type: none"> <li>• Optical filters</li> <li>• Wavelength division multiplexers</li> <li>• Magneto-optical effect / optical isolator / circulator</li> <li>• Electro-optic modulator</li> </ul> <p>Lasers</p> <ul style="list-style-type: none"> <li>• Basics, concepts, types</li> <li>• Erbium-doped fiber lasers / amplifiers (EDFL / EDFA)</li> <li>• Optical semiconductor laser / amplifier (laser diode)</li> </ul> <p>Other selected components and devices</p> |                 |  |                 |                      |
| <b>2</b>  | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Students understand concepts, basics of physics, design criteria and system requirements (component specifications) of the most important passive and active components of optical communications.</p>   |                 |  |                 |                      |
| <b>3</b>  | <p><b>Recommended prerequisite for participation</b></p> <p>ET 1-4, Physics</p>   |                 |  |                 |                      |
| <b>4</b>  | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |                 |  |                 |                      |
| <b>5</b>  | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>  |                 |  |                 |                      |
| <b>6</b>  | <p><b>Usability of this module</b></p> <p>BSc ETiT, MSc ETiT, MSc iCE</p>   |                 |  |                 |                      |

|                |  |   |                         |
|----------------|--|---|-------------------------|
| 7              | <b>Grade bonus compliant to §25 (2)</b>  |   |                         |
| 8              | <b>References</b><br>Lecture slides<br>Textbook (M. Cvijetic, I. B. Djordjevic: „Advanced Optical Communication Systems and Networks“) |   |                         |
| <b>Courses</b> |  |   |                         |
|                | <b>Course Nr.</b><br>18-pr-1050-vl   | <b>Course name</b><br>Optical Communications – Components |                         |
|                | <b>Instructor</b><br>Prof. Dr. rer. nat. Sascha Preu   |   | <b>Type</b><br>Lecture  |
|                |  |   | <b>SWS</b><br>3         |
|                | <b>Course Nr.</b><br>18-pr-1050-ue   | <b>Course name</b><br>Optical Communications – Components |                         |
|                | <b>Instructor</b><br>Prof. Dr. rer. nat. Sascha Preu   |   | <b>Type</b><br>Practice |
|                |  |   | <b>SWS</b><br>1         |

#### 4.5.1.1 Proseminar

|  |   |  |  |   |                                   |
|--|---|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |  |   |                                   |
| <b>Module Nr.</b><br>18-pe-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                              | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Marius Pesavento |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |  |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |  |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |  |  |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |  |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |   |                                   |
| <b>8</b>   | <b>References</b>   |  |  |   |                                   |
| <b>Courses</b>   |   |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-pe-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Marius Pesavento, M.Sc. Wassim Suleiman   |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |   |   |                                   |
|--|---|--|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                                   |
| <b>Module Nr.</b><br>18-jk-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                         | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Rolf Jakoby |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |   |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |   |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |   |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |   |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |   |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                                   |
| <b>8</b>   | <b>References</b>   |  |   |   |                                   |
| <b>Courses</b>   |   |  |   |   |                                   |
|  | <b>Course Nr.</b><br>18-jk-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Rolf Jakoby, Dr.-Ing. Martin Schüßler   |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |  |   |                                   |
|--|---|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |  |   |                                   |
| <b>Module Nr.</b><br>18-kl-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                        | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Anja Klein |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |  |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |  |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Basic knowledge from the first four semesters  |  |  |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |  |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST, BSc Wi-ETiT  |  |  |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |   |                                   |
| <b>8</b>   | <b>References</b>   |  |  |   |                                   |
| <b>Courses</b>   |   |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-kl-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein, M.Sc. Sumedh Dongare  |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |   |   |                                   |
|--|---|--|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                                   |
| <b>Module Nr.</b><br>18-zo-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                             | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.  |  |   |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |   |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |   |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |   |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST   |  |   |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                                   |
| <b>8</b>   | <b>References</b>   |  |   |   |                                   |
| <b>Courses</b>   |   |  |   |   |                                   |
|  | <b>Course Nr.</b><br>18-zo-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir   |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |  |  |  |   |                                   |
|--|--|--|--|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |  |  |  |   |                                   |
| <b>Module Nr.</b><br>18-pr-1000  | <b>Credit Points</b><br>2 CP   | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                              | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |  |  | <b>Module owner</b><br>Prof. Dr. rer. nat. Sascha Preu |   |                                   |
| <b>1</b>   | <b>Content</b><br>Literature seminar: Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. Interested students please directly contact Prof. Sascha Preu for definition of a topic: sascha.preu@tu-darmstadt.de<br>Link to TSYs-website. |  |  |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic.  |  |  |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>  |  |  |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>   |  |  |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>  |  |  |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST  |  |  |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |   |                                   |
| <b>8</b>   | <b>References</b>  |  |  |   |                                   |
| <b>Courses</b>   |  |  |  |   |                                   |
|  | <b>Course Nr.</b><br>18-pr-1000-ps   | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |  |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Sascha Preu   |  |  | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |



#### 4.5.1.2 More Fundamentals

|   |  |                          |   |                      |                              |
|---|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Fundamentals of Signal Processing |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-zo-1030                         | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                            | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                               |  |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |                      |                              |
| <b>1</b>  | <b>Content</b><br>The course covers the following topics: <ul style="list-style-type: none"> <li>• The basic concepts of stochastic</li> <li>• The sampling theorem</li> <li>• Discrete-time noise processes and their properties</li> <li>• Description of noise processes in the frequency domain</li> <li>• Linear time-invariant systems: FIR and IIR filters</li> <li>• Filtering of noise processes: AR, MA, and ARMA models</li> <li>• The Matched filter</li> <li>• The Wiener filter</li> <li>• Properties of estimators</li> <li>• The method of least squares</li> </ul>        |                          |   |                      |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory.   |                          |   |                      |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>  |                          |   |                      |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)</li> </ul> In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase. |                          |   |                      |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>  |                          |   |                      |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC   |                          |   |                      |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |                          |   |                      |                              |
| <b>8</b>  | <b>References</b>  |                          |   |                      |                              |

Lecture notes and slides can be downloaded here:

- <http://www.spg.tu-darmstadt.de>
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schaffer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River, 1999.

#### Courses

|   |   |                         |                 |
|---|---|-------------------------|-----------------|
| <b>Course Nr.</b><br>18-zo-1030-vl                  | <b>Course name</b><br>Fundamentals of Signal Processing |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3 |
| <b>Course Nr.</b><br>18-zo-1030-ue                  | <b>Course name</b><br>Fundamentals of Signal Processing |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |   | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

|  |  |  |  |                        |                              |
|--|--|--|--|------------------------|------------------------------|
| <b>Module name</b><br>Communication Technology I |  |  |  |                        |                              |
| <b>Module Nr.</b><br>18-kl-1020                  | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                         | <b>Self study</b><br>120 h                       | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                        |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Anja Klein |                        |                              |
| <b>1</b>   | <b>Content</b><br>Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access   |  |  |                        |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the lecture, students possess the ability to: <ul style="list-style-type: none"> <li>• classify signals and communication systems,</li> <li>• understand, model and analyse basic components of communication systems,</li> <li>• understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,</li> <li>• model and analyse base-band communication systems,</li> <li>• describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,</li> <li>• understand, model, evaluate, compare and apply linear modulation schemes,</li> <li>• design receiver structures for different modulation schemes,</li> <li>• detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,</li> <li>• understand and model OFDM,</li> <li>• understand and model CDMA,</li> <li>• understand and compare the basic properties of multiple access schemes.</li> </ul> |  |  |                        |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV  |  |  |                        |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>   |  |  |                        |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>  |  |  |                        |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC   |  |  |                        |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                        |                              |
| <b>8</b>   | <b>References</b><br>Will be announced in the lecture  |  |  |                        |                              |
| <b>Courses</b>                                   |  |  |  |                        |                              |
|  | <b>Course Nr.</b><br>18-kl-1020-vl   | <b>Course name</b><br>Communication Technology I |  |                        |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein   |  |  | <b>Type</b><br>Lecture | <b>SWS</b><br>3              |

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|  |  |  |                         |                 |
|--|--|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-kl-1020-ue   | <b>Course name</b><br>Communication Technology I |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein, Dr. rer. nat. Sabrina Klos |  | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

|   |  |                          |   |                      |                              |
|---|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Fundamentals of Communication |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-jk-1010                     | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                        | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                           |  |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Rolf Jakoby |                      |                              |
| <b>1</b>  | <p><b>Content</b></p> <p>Part 1: Chap. 1 will be a brief introduction in “Electrical Information- and Communication Engineering”, presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.</p> <p>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.</p> <p>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.</p> <p>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited intersymbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture.</p> |                          |   |                      |                              |
| <b>2</b>  | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.</p> <p>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems.</p>   |                          |   |                      |                              |
| <b>3</b>  | <p><b>Recommended prerequisite for participation</b></p> <p>Deterministic Signals and Systems</p>  |                          |   |                      |                              |
| <b>4</b>  | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |                          |   |                      |                              |
| <b>5</b>  | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>  | <p><b>Usability of this module</b></p> <p>BSc ETiT, Wi-ETiT</p>  |                          |   |                      |                              |
| <b>7</b>  | <p><b>Grade bonus compliant to §25 (2)</b></p>   |                          |   |                      |                              |

|          |  |
|----------|--|
| <b>8</b> | <p><b>References</b></p> <p>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addison-Wesley 1992.</p> |
|----------|--|

|                |                            |                                |             |
|----------------|----------------------------|--------------------------------|-------------|
| <b>Courses</b> |                            |                                |             |
|                | <b>Course Nr.</b>          | <b>Course name</b>             |             |
|                | 18-jk-1010-vl              | Fundamentals of Communications |             |
|                | <b>Instructor</b>          |                                | <b>Type</b> |
|                | Prof. Dr.-Ing. Rolf Jakoby |                                | Lecture     |
|                | <b>SWS</b>                 | 3                              |             |
|                | <b>Course Nr.</b>          | <b>Course name</b>             |             |
|                | 18-jk-1010-ue              | Fundamentals of Communications |             |
|                | <b>Instructor</b>          |                                | <b>Type</b> |
|                | Prof. Dr.-Ing. Rolf Jakoby |                                | Practice    |
|                | <b>SWS</b>                 | 1                              |             |

## 4.5.2 Optional Modules

### 4.5.2.1 Projektseminar

|  |  |  |   |                                |                                   |
|--|--|--|---|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Communication and Sensor Systems |  |  |   |                                |                                   |
| <b>Module Nr.</b><br>18-jk-1041  | <b>Credit Points</b><br>8 CP   | <b>Workload</b><br>240 h   | <b>Self study</b><br>180 h                        | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English                                  |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Rolf Jakoby |                                |                                   |
| <b>1</b>   | <b>Content</b><br>Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.  |  |   |                                |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the course, students possess: <ul style="list-style-type: none"> <li>• the ability to apply methods of communication and sensor systems to practical problems</li> <li>• deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks</li> <li>• the skills to find, analyze and evaluate scientific reference papers for a particular topic</li> <li>• the capability to summarize the achieved scientific findings in the form of a concise report</li> <li>• the ability to present and discuss achieved results in the form of a presentation in front of an audience</li> </ul> |  |   |                                |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks  |  |   |                                |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |                                |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |  |   |                                |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC   |  |   |                                |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |   |                                |                                   |
| <b>8</b>   | <b>References</b><br>Will be announced in the lecture  |  |   |                                |                                   |
| <b>Courses</b>   |  |  |   |                                |                                   |
|  | <b>Course Nr.</b><br>18-jk-1041-pj   | <b>Course name</b><br>Project Seminar Communication and Sensor Systems |   |                                |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Rolf Jakoby, Dr.-Ing. Martin Schüßler  |  |   | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |

|  |  |  |  |                                |                                   |
|--|--|--|--|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Communication and Sensor Systems |  |  |  |                                |                                   |
| <b>Module Nr.</b><br>18-kl-1041  | <b>Credit Points</b><br>8 CP   | <b>Workload</b><br>240 h   | <b>Self study</b><br>180 h                       | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English                                  |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Anja Klein |                                |                                   |
| <b>1</b>   | <b>Content</b><br>Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.  |  |  |                                |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the course, students possess: <ul style="list-style-type: none"> <li>• the ability to apply methods of communication and sensor systems to practical problems</li> <li>• deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks</li> <li>• the skills to find, analyze and evaluate scientific reference papers for a particular topic</li> <li>• the capability to summarize the achieved scientific findings in the form of a concise report</li> <li>• the ability to present and discuss achieved results in the form of a presentation in front of an audience</li> </ul> |  |  |                                |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks  |  |  |                                |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |                                |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |  |                                |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC   |  |  |                                |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                                |                                   |
| <b>8</b>   | <b>References</b><br>Will be announced in the lecture  |  |  |                                |                                   |
| <b>Courses</b>   |  |  |  |                                |                                   |
|  | <b>Course Nr.</b><br>18-kl-1041-pj   | <b>Course name</b><br>Project Seminar Communication and Sensor Systems |  |                                |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Anja Klein, M.Sc. Sumedh Dongare   |  |  | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |



|  |  |  |  |                                |                                   |
|--|--|--|--|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Communication and Sensor Systems |  |  |  |                                |                                   |
| <b>Module Nr.</b><br>18-pe-1041  | <b>Credit Points</b><br>8 CP   | <b>Workload</b><br>240 h   | <b>Self study</b><br>180 h                             | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English                                  |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Marius Pesavento |                                |                                   |
| <b>1</b>   | <b>Content</b><br>Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.  |  |  |                                |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the course, students possess: <ul style="list-style-type: none"> <li>• the ability to apply methods of communication and sensor systems to practical problems</li> <li>• deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks</li> <li>• the skills to find, analyze and evaluate scientific reference papers for a particular topic</li> <li>• the capability to summarize the achieved scientific findings in the form of a concise report</li> <li>• the ability to present and discuss achieved results in the form of a presentation in front of an audience</li> </ul> |  |  |                                |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks  |  |  |                                |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |  |                                |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |  |                                |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC   |  |  |                                |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                                |                                   |
| <b>8</b>   | <b>References</b><br>Will be announced in the lecture  |  |  |                                |                                   |
| <b>Courses</b>   |  |  |  |                                |                                   |
|  | <b>Course Nr.</b><br>18-pe-1041-pj   | <b>Course name</b><br>Project Seminar Communication and Sensor Systems |  |                                |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Marius Pesavento, M.Sc. Yufan Fan  |  |  | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |

|  |  |  |   |                                |                                   |
|--|--|--|---|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Communication and Sensor Systems |  |  |   |                                |                                   |
| <b>Module Nr.</b><br>18-zo-1041  | <b>Credit Points</b><br>8 CP   | <b>Workload</b><br>240 h   | <b>Self study</b><br>180 h                            | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English                                  |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |                                |                                   |
| <b>1</b>   | <b>Content</b><br>Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.  |  |   |                                |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the course, students possess: <ul style="list-style-type: none"> <li>• the ability to apply methods of communication and sensor systems to practical problems</li> <li>• deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks</li> <li>• the skills to find, analyze and evaluate scientific reference papers for a particular topic</li> <li>• the capability to summarize the achieved scientific findings in the form of a concise report</li> <li>• the ability to present and discuss achieved results in the form of a presentation in front of an audience</li> </ul> |  |   |                                |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks  |  |   |                                |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |                                |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |   |                                |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC   |  |   |                                |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |   |                                |                                   |
| <b>8</b>   | <b>References</b><br>Will be announced in the lecture  |  |   |                                |                                   |
| <b>Courses</b>   |  |  |   |                                |                                   |
|  | <b>Course Nr.</b><br>18-zo-1041-pj   | <b>Course name</b><br>Project Seminar Communication and Sensor Systems |   |                                |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir  |  |   | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |

|  |   |  |  |                                |                                   |
|--|---|--|--|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Communication and Sensor Systems |   |  |  |                                |                                   |
| <b>Module Nr.</b><br>18-pr-1041  | <b>Credit Points</b><br>8 CP  | <b>Workload</b><br>240 h   | <b>Self study</b><br>180 h                             | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English                                  |   |  | <b>Module owner</b><br>Prof. Dr. rer. nat. Sascha Preu |                                |                                   |
| <b>1</b>   | <b>Content</b><br>Investigating and solving specific problems concerning the development of Terahertz sensors and -systems as well as of applications of THz technology. The specific task will be defined based on current research topics. The project seminar includes working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. Topics include, e.g.: <ul style="list-style-type: none"> <li>• Optics on chip</li> <li>• Semiconductor devicesLight-matter interaction</li> </ul> |  |  |                                |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the course, students possess: <ul style="list-style-type: none"> <li>• the ability to apply theoretical models to practical problems</li> <li>• deep and special knowledge in a particular field related to THz science, optics or semiconductor physics</li> <li>• the skills to find, analyze and evaluate scientific reference papers for a particular topic</li> <li>• the capability to summarize the achieved scientific findings in the form of a concise reportthe ability to present and discuss achieved results in the form of a presentation in front of an audience</li> </ul>   |  |  |                                |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Previous knowledge one of the following disciplines: Optics, semiconductor physics, or THz technology  |  |  |                                |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>   |  |  |                                |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>   |  |  |                                |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC  |  |  |                                |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |                                |                                   |
| <b>8</b>   | <b>References</b><br>Will be announced once the topic is defined.   |  |  |                                |                                   |
| <b>Courses</b>   |   |  |  |                                |                                   |
|  | <b>Course Nr.</b><br>18-pr-1041-pj  | <b>Course name</b><br>Project Seminar Communication and Sensor Systems |  |                                |                                   |
|  | <b>Instructor</b><br>Prof. Dr. rer. nat. Sascha Preu  |  |  | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |

|  |  |  |   |                                |                                   |
|--|--|--|---|--------------------------------|-----------------------------------|
| <b>Module name</b><br>Project Seminar Communication and Sensor Systems |  |  |   |                                |                                   |
| <b>Module Nr.</b><br>18-kp-1041  | <b>Credit Points</b><br>8 CP   | <b>Workload</b><br>240 h   | <b>Self study</b><br>180 h                          | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English                                  |  |  | <b>Module owner</b><br>Prof. Dr. techn. Heinz Köppl |                                |                                   |
| <b>1</b>   | <b>Content</b><br>Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience.  |  |   |                                |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After completion of the course, students possess: <ul style="list-style-type: none"> <li>• the ability to apply methods of communication and sensor systems to practical problems</li> <li>• deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks</li> <li>• the skills to find, analyze and evaluate scientific reference papers for a particular topic</li> <li>• the capability to summarize the achieved scientific findings in the form of a concise report</li> <li>• the ability to present and discuss achieved results in the form of a presentation in front of an audience</li> </ul> |  |   |                                |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks  |  |   |                                |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |                                |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |   |                                |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC   |  |   |                                |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |   |                                |                                   |
| <b>8</b>   | <b>References</b><br>Will be announced in the lecture  |  |   |                                |                                   |
| <b>Courses</b>   |  |  |   |                                |                                   |
|  | <b>Course Nr.</b><br>18-kp-1041-pj   | <b>Course name</b><br>Project Seminar Communication and Sensor Systems |   |                                |                                   |
|  | <b>Instructor</b><br>Prof. Dr. techn. Heinz Köppl  |  |   | <b>Type</b><br>Project Seminar | <b>SWS</b><br>4                   |

#### 4.5.2.2 Offener Wahlkatalog

Complete Catalogue of all modules FB 18 Electrical Engineering and Information Technology

### 4.6 Option Sensors, Actuators and Electronics

#### 4.6.1 Fundamentals

|   |   |   |   |                        |                              |
|---|---|---|---|------------------------|------------------------------|
| <b>Module name</b><br>Electromechanical Systems I |   |   |   |                        |                              |
| <b>Module Nr.</b><br>18-kn-1050                   | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h                          | <b>Self study</b><br>90 h                     | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                         |   |   | <b>Module owner</b><br>Prof. Dr. Mario Kupnik |                        |                              |
| <b>1</b>  | <b>Content</b><br>Structure and design methods of elektromechanical systems, mechanical, acoustical and thermal networks, transducers between mechanical and acoustical networks. Design and devices of electromechanical transducers.  |   |   |                        |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Comprehension, description, calculation and application of the most relevant electromechanical transducers, comprising electrostatic transducer (e.g. microphone and accelerometer), piezoelectric transducers (e.g. micro motors, micro sensors), electrodynamic transducer (loudspeaker, shaker), piezomagnetic transducer (e.g. ultrasonic source). Design of complex electromechanical systems like sensors and actuators and their applications by applying the discrete element network method. |   |   |                        |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Electrical Engineering and Information Technology I  |   |   |                        |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Optional, Standard Grading System)</li> </ul>  |   |   |                        |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Optional, Weighting: 100 %)</li> </ul>   |   |   |                        |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc WI-ETiT, MSc MEC   |   |   |                        |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                        |                              |
| <b>8</b>  | <b>References</b><br>Book: Electromechanical Systems in Microtechnic und Mechatronic, Springer 2012, Script for lecture Electromechanical Systems I, Workbook   |   |   |                        |                              |
| <b>Courses</b>                                    |   |   |   |                        |                              |
|   | <b>Course Nr.</b><br>18-kn-1050-vl  | <b>Course name</b><br>Electromechanical Systems I |   |                        |                              |
|   | <b>Instructor</b><br>Prof. Dr. Mario Kupnik, Prof. Dr. techn. Dr.h.c. Andreas Binder, M.Sc. Omar Ben Dali   |   |   | <b>Type</b><br>Lecture | <b>SWS</b><br>2              |

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|  |   |   |                         |                 |
|--|---|---|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-kn-1050-ue  | <b>Course name</b><br>Electromechanical Systems I |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr. Mario Kupnik, Prof. Dr. techn. Dr.h.c. Andreas Binder, M.Sc. Omar Ben Dali |   | <b>Type</b><br>Practice | <b>SWS</b><br>2 |

|  |   |  |   |                         |                              |
|--|---|--|---|-------------------------|------------------------------|
| <b>Module name</b><br>Analog Integrated Circuit Design |   |  |   |                         |                              |
| <b>Module Nr.</b><br>18-ho-1020                        | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h                               | <b>Self study</b><br>120 h                          | <b>Duration</b><br>1    | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                              |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Klaus Hofmann |                         |                              |
| <b>1</b>   | <b>Content</b><br>Basic analog Building Blocks: Current Mirrors, Reference Circuits; Multi Stage Amplifier, internal Structure and Properties of Differential and Operational Amplifiers, Feedback Techniques, Frequency Response, Oscillators  |  |   |                         |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>A student is, after successful completion of this module, able to 1. derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, 2. derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties ( $y$ -Parameters, DC- and AC-properties), 3. understands simulation methods for analog circuits on transistor level using SPICE, 4. analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, 5. derive and calculate the analog properties of digital logic gates |  |   |                         |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Lecture "Electronics"  |  |   |                         |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>  |  |   |                         |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |  |   |                         |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE  |  |   |                         |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |                         |                              |
| <b>8</b>   | <b>References</b><br>Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design   |  |   |                         |                              |
| <b>Courses</b>   |   |  |   |                         |                              |
|  | <b>Course Nr.</b><br>18-ho-1020-vl  | <b>Course name</b><br>Analog Integrated Circuit Design |   |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann   |  |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|  | <b>Course Nr.</b><br>18-ho-1020-ue  | <b>Course name</b><br>Analog Integrated Circuit Design |   |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann   |  |   | <b>Type</b><br>Practice | <b>SWS</b><br>1              |

|  |   |  |  |                         |                              |
|--|---|--|--|-------------------------|------------------------------|
| <b>Module name</b><br>Technology of Micro- and Precision Engineering |   |  |  |                         |                              |
| <b>Module Nr.</b><br>18-bu-1010                                      | <b>Credit Points</b><br>4 CP  | <b>Workload</b><br>120 h   | <b>Self study</b><br>75 h                            | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Ph.D. Thomas Peter Burg |                         |                              |
| <b>1</b>   | <b>Content</b><br>To explain production processes of parts like: casting, sintering of metal and ceramic parts, injection moulding, metal injection moulding, rapid prototyping, to describe manufacturing processes of parts like: forming processes, compression moulding, shaping, deep-drawing, fine cutting machines, ultrasonic treatment, laser manufacturing, machining by etching, to classify the joining of materials by: welding, bonding, soldering, sticking, to discuss modification of material properties by: tempering, annealing, composite materials. |  |  |                         |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Provide insights into the various production and processing methods in micro- and precision engineering and the influence of these methods on the development of devices and components.  |  |  |                         |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |  |                         |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Optional, Standard Grading System)</li> </ul>  |  |  |                         |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Optional, Weighting: 100 %)</li> </ul>   |  |  |                         |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, MSc MEC, MSc WI-ETiT   |  |  |                         |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |                         |                              |
| <b>8</b>   | <b>References</b><br>Script for lecture: Technology of Micro- and Precision Engineering   |  |  |                         |                              |
| <b>Courses</b>   |   |  |  |                         |                              |
|  | <b>Course Nr.</b><br>18-bu-1010-vl  | <b>Course name</b><br>Technology of Micro- and Precision Engineering |  |                         |                              |
|  | <b>Instructor</b><br>Prof. Ph.D. Thomas Peter Burg, M.Sc. Niko Alexander Faul   |  |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>2              |
|  | <b>Course Nr.</b><br>18-bu-1010-ue  | <b>Course name</b><br>Technology of Micro- and Precision Engineering |  |                         |                              |
|  | <b>Instructor</b><br>Prof. Ph.D. Thomas Peter Burg, M.Sc. Niko Alexander Faul   |  |  | <b>Type</b><br>Practice | <b>SWS</b><br>1              |



|   |   |   |   |                                |                              |
|---|---|---|---|--------------------------------|------------------------------|
| <b>Module name</b><br>Product Development Methodology I |   |   |   |                                |                              |
| <b>Module Nr.</b><br>18-kn-1025                         | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h                                | <b>Self study</b><br>105 h                    | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                               |   |   | <b>Module owner</b><br>Prof. Dr. Mario Kupnik |                                |                              |
| <b>1</b>  | <b>Content</b><br>Practical experience in the methods used for the development of technical products. Work in a project team.   |   |   |                                |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Applying the development methodology to a specific development project in a team. To do this, students can create a schedule, can analyze the state of the art, can compose a list of requirements, can abstract the task, can work out the sub-problems, can seek solutions with different methods, can work out optimal solutions using valuation methods, can set up a final concept, can derive the parameters needed by computation and modeling, can create the production documentation with all necessary documents such as part lists, technical drawings and circuit diagrams, can build up and investigate a laboratory prototype and can reflect their development in retrospect. |   |   |                                |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Parallel attendance of Proseminar ETiT Option MPE  |   |   |                                |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>   |   |   |                                |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>  |   |   |                                |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc WI-ETiT  |   |   |                                |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                                |                              |
| <b>8</b>  | <b>References</b><br>Script: Development Methodology (PEM)  |   |   |                                |                              |
| <b>Courses</b>  |   |   |   |                                |                              |
|   | <b>Course Nr.</b><br>18-kn-1025-pj  | <b>Course name</b><br>Product Development Methodology I |   |                                |                              |
|   | <b>Instructor</b><br>Prof. Dr. Mario Kupnik, Prof. Dr.-Ing. Khanh Quoc Tran, Prof. Dr.-Ing. Klaus Hofmann, Prof. Ph.D. Thomas Peter Burg  |   |   | <b>Type</b><br>Project Seminar | <b>SWS</b><br>3              |

|   |   |  |   |                         |                              |
|---|---|--|---|-------------------------|------------------------------|
| <b>Module name</b><br>System Dynamics and Automatic Control Systems I |   |  |   |                         |                              |
| <b>Module Nr.</b><br>18-ko-1010                                       | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h   | <b>Self study</b><br>120 h                              | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German   |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Ulrich Konigorski |                         |                              |
| <b>1</b>  | <b>Content</b><br>Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization  |  |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems.  |  |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>   |  |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>   |  |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |  |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, MSc Informatik  |  |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |  |   |                         |                              |
| <b>8</b>  | <b>References</b><br>Skript Konigorski: "Systemdynamik und Regelungstechnik I", Aufgabensammlung zur Vorlesung, Lunze: "Regelungstechnik 1: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen", Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen", Unbehauen: "Regelungstechnik I:Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme, Fuzzy-Regelsysteme", Föllinger: "Laplace-, Fourier- und z-Transformation", Jörgl: "Repetitorium Regelungstechnik", Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden", Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise", Schneider: "Regelungstechnik für Maschinenbauer", Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnaher Grundlage" |  |   |                         |                              |
| <b>Courses</b>  |   |  |   |                         |                              |
|   | <b>Course Nr.</b><br>18-ko-1010-vl  | <b>Course name</b><br>System Dynamics and Automatic Control Systems I                      |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand  |  |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|   | <b>Course Nr.</b><br>18-ko-1010-tt  | <b>Course name</b><br>System Dynamics and Automatic Control Systems I- Auditorium Exercise |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand  |  |   | <b>Type</b><br>Tutorial | <b>SWS</b><br>1              |

|                                     |   |                                     |   |                           |                              |
|-------------------------------------|---|-------------------------------------|---|---------------------------|------------------------------|
| <b>Module name</b><br>Excursion SAE |   |                                     |   |                           |                              |
| <b>Module Nr.</b><br>18-kn-1060     | <b>Credit Points</b><br>1 CP  | <b>Workload</b><br>30 h             | <b>Self study</b><br>30 h                     | <b>Duration</b><br>1      | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German           |   |                                     | <b>Module owner</b><br>Prof. Dr. Mario Kupnik |                           |                              |
| <b>1</b>                            | <b>Content</b><br>During the excursion SAE (duration 5 days) several companies working on electrical engineering and information technology and other fields will be visited. Students can become acquainted with close-to-reality examples. Working fields of an electrical engineer can be assessed, with technical- or organizational aspects and conditions of work as the main target. By the attendance of several companies in successive days, a comparison becomes possible. During the excursion the group is accommodated in e.g. hostels. |                                     |   |                           |                              |
| <b>2</b>                            | <b>Learning objectives / Learning Outcomes</b><br>Students should be able to understand products and the associated production processes and be able to concisely summarize this in a report.   |                                     |   |                           |                              |
| <b>3</b>                            | <b>Recommended prerequisite for participation</b>   |                                     |   |                           |                              |
| <b>4</b>                            | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Pass/Fail Grading System)</li> </ul>   |                                     |   |                           |                              |
| <b>5</b>                            | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>   |                                     |   |                           |                              |
| <b>6</b>                            | <b>Usability of this module</b><br>BSc ETiT, BSc WI-ETiT  |                                     |   |                           |                              |
| <b>7</b>                            | <b>Grade bonus compliant to §25 (2)</b>   |                                     |   |                           |                              |
| <b>8</b>                            | <b>References</b>   |                                     |   |                           |                              |
| <b>Courses</b>                      |   |                                     |   |                           |                              |
|                                     | <b>Course Nr.</b><br>18-kn-1060-ek  | <b>Course name</b><br>Excursion SAE |   |                           |                              |
|                                     | <b>Instructor</b><br>Prof. Dr. Mario Kupnik, Prof. Dr.-Ing. Khanh Quoc Tran, Prof. Dr.-Ing. Klaus Hofmann, Prof. Ph.D. Thomas Peter Burg  |                                     |   | <b>Type</b><br>Field Trip | <b>SWS</b><br>0              |

#### 4.6.1.1 Proseminar ETiT

|  |   |  |   |   |                                   |
|--|---|--|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                                   |
| <b>Module Nr.</b><br>18-ho-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                           | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Klaus Hofmann |   |                                   |
| <b>1</b>   | <b>Content</b><br>Analysis of basic electronic circuits and presentation of selected examples   |  |   |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After attending the seminar, a student is capable of analysing basic electronic circuits and preparing didactical materials and presentations |  |   |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Electronics  |  |   |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>          |  |   |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>                             |  |   |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT   |  |   |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                                   |
| <b>8</b>   | <b>References</b><br>Will be provided at the begin of the seminar   |  |   |   |                                   |
| <b>Courses</b>   |   |  |   |   |                                   |
|  | <b>Course Nr.</b><br>18-ho-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann   |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|  |   |  |   |   |                                   |
|--|---|--|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar Electrical Engineering and Information Technology |   |  |   |   |                                   |
| <b>Module Nr.</b><br>18-kh-1000  | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h  | <b>Self study</b><br>30 h                             | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German  |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Khanh Quoc Tran |   |                                   |
| <b>1</b>   | <b>Content</b><br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. Additional information can be found here.        |  |   |   |                                   |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |  |   |   |                                   |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |  |   |   |                                   |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |   |                                   |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |   |   |                                   |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT   |  |   |   |                                   |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |   |                                   |
| <b>8</b>   | <b>References</b>   |  |   |   |                                   |
| <b>Courses</b>   |   |  |   |   |                                   |
|  | <b>Course Nr.</b><br>18-kh-1000-ps  | <b>Course name</b><br>Proseminar Electrical Engineering and Information Technology |   |   |                                   |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Khanh Quoc Tran   |  |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

|                                       |   |                                       |   |   |                                   |
|---------------------------------------|---|---------------------------------------|---|---|-----------------------------------|
| <b>Module name</b><br>Proseminar ETiT |   |                                       |   |   |                                   |
| <b>Module Nr.</b><br>18-kn-1000       | <b>Credit Points</b><br>2 CP  | <b>Workload</b><br>60 h               | <b>Self study</b><br>30 h                     | <b>Duration</b><br>1                          | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German             |   |                                       | <b>Module owner</b><br>Prof. Dr. Mario Kupnik |   |                                   |
| 1                                     | <b>Content</b>  |                                       |   |   |                                   |
| 2                                     | <b>Learning objectives / Learning Outcomes</b>  |                                       |   |   |                                   |
| 3                                     | <b>Recommended prerequisite for participation</b>   |                                       |   |   |                                   |
| 4                                     | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul> |                                       |   |   |                                   |
| 5                                     | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100 %)</li> </ul>                    |                                       |   |   |                                   |
| 6                                     | <b>Usability of this module</b>   |                                       |   |   |                                   |
| 7                                     | <b>Grade bonus compliant to §25 (2)</b>   |                                       |   |   |                                   |
| 8                                     | <b>References</b>   |                                       |   |   |                                   |
| <b>Courses</b>                        |   |                                       |   |   |                                   |
|                                       | <b>Course Nr.</b><br>18-kn-1000-ps  | <b>Course name</b><br>Proseminar ETiT |   |   |                                   |
|                                       | <b>Instructor</b><br>Prof. Dr. Mario Kupnik   |                                       |   | <b>Type</b><br>Introductory<br>Seminar Course | <b>SWS</b><br>2                   |

## 4.6.2 Advanced Fundamentals

|   |   |                          |   |                      |                              |
|---|---|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Fundamentals of Communication |   |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-jk-1010                     | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                        | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                           |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Rolf Jakoby |                      |                              |
| <b>1</b>  | <p><b>Content</b></p> <p>Part 1: Chap. 1 will be a brief introduction in “Electrical Information- and Communication Engineering”, presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.</p> <p>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.</p> <p>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.</p> <p>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited inter-symbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture.</p> |                          |   |                      |                              |
| <b>2</b>  | <p><b>Learning objectives / Learning Outcomes</b></p> <p>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.</p> <p>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems.</p>  |                          |   |                      |                              |
| <b>3</b>  | <p><b>Recommended prerequisite for participation</b></p> <p>Deterministic Signals and Systems</p>   |                          |   |                      |                              |
| <b>4</b>  | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>  |                          |   |                      |                              |
| <b>5</b>  | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>  | <p><b>Usability of this module</b></p> <p>BSc ETiT, Wi-ETiT</p>   |                          |   |                      |                              |

|                |   |  |                         |
|----------------|---|--|-------------------------|
| 7              | <b>Grade bonus compliant to §25 (2)</b>   |  |                         |
| 8              | <b>References</b><br>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addison-Wesley 1992. |  |                         |
| <b>Courses</b> |   |  |                         |
|                | <b>Course Nr.</b><br>18-jk-1010-vl  | <b>Course name</b><br>Fundamentals of Communications |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Rolf Jakoby   |  | <b>Type</b><br>Lecture  |
|                |   |  | <b>SWS</b><br>3         |
|                | <b>Course Nr.</b><br>18-jk-1010-ue  | <b>Course name</b><br>Fundamentals of Communications |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Rolf Jakoby   |  | <b>Type</b><br>Practice |
|                |   |  | <b>SWS</b><br>1         |



|   |  |                          |   |                      |                              |
|---|--|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Fundamentals of Signal Processing |  |                          |   |                      |                              |
| <b>Module Nr.</b><br>18-zo-1030                         | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                            | <b>Duration</b><br>1 | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                               |  |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |                      |                              |
| <b>1</b>  | <b>Content</b><br>The course covers the following topics: <ul style="list-style-type: none"> <li>• The basic concepts of stochastic</li> <li>• The sampling theorem</li> <li>• Discrete-time noise processes and their properties</li> <li>• Description of noise processes in the frequency domain</li> <li>• Linear time-invariant systems: FIR and IIR filters</li> <li>• Filtering of noise processes: AR, MA, and ARMA models</li> <li>• The Matched filter</li> <li>• The Wiener filter</li> <li>• Properties of estimators</li> <li>• The method of least squares</li> </ul>        |                          |   |                      |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory.   |                          |   |                      |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b>  |                          |   |                      |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)</li> </ul> In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase. |                          |   |                      |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>  |                          |   |                      |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc MEC   |                          |   |                      |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |                          |   |                      |                              |
| <b>8</b>  | <b>References</b>  |                          |   |                      |                              |

Lecture notes and slides can be downloaded here:

- <http://www.spg.tu-darmstadt.de>
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schafer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River, 1999.

#### Courses

|   |   |                         |                 |
|---|---|-------------------------|-----------------|
| <b>Course Nr.</b><br>18-zo-1030-vl                  | <b>Course name</b><br>Fundamentals of Signal Processing |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>3 |
| <b>Course Nr.</b><br>18-zo-1030-ue                  | <b>Course name</b><br>Fundamentals of Signal Processing |                         |                 |
| <b>Instructor</b><br>Prof. Dr.-Ing. Abdelhak Zoubir |   | <b>Type</b><br>Practice | <b>SWS</b><br>1 |

|   |   |                          |  |                      |                              |
|---|---|--------------------------|--|----------------------|------------------------------|
| <b>Module name</b><br>Power Electronics |   |                          |  |                      |                              |
| <b>Module Nr.</b><br>18-gt-1010         | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h | <b>Self study</b><br>90 h                              | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German               |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Gerd Griepentrog |                      |                              |
| <b>1</b>                                | <b>Content</b><br>Power electronic devices convert the energy from the distribution network to the form required by the load. This conversion does not wear out, can be controlled very fast and has a high efficiency. In lecture "Power Electronics" the most important circuits required for the energy conversion are treated, using ideal switches.<br>The main chapters are<br>I.) Line commutated converters in order to understand the basic concepts of power electronic systems.<br>II.) Self- commutated converters (one, two and four quadrant converters, 3-phase- VSI)  |                          |  |                      |                              |
| <b>2</b>                                | <b>Learning objectives / Learning Outcomes</b><br>After an active participation in the lecture, as well as by solving all exercises prior to the respective tutorial students should be able to: <ul style="list-style-type: none"> <li>• Understand the ideal concept of power semiconductors</li> <li>• Calculate and sketch the time-characteristics of all currents and voltages in a line-commutated converter using defined simplifications as well as represent the behavior of currents and voltages during commutation in line-commutated converters for center –tapped as well as for bridge circuits.</li> <li>• Specify the basic circuit diagrams for one, two and four quadrant DC/DC converters and calculate the characteristics of voltages and currents in these circuits.</li> <li>• Explain the function of single-phase and three-phase voltage source inverters and calculate the currents and voltages in these circuits using defined simplifications.</li> <li>• Understand the concept und operation of HVDC converter</li> </ul> |                          |  |                      |                              |
| <b>3</b>                                | <b>Recommended prerequisite for participation</b><br>Mathe I und II, ETiT I und II, Energietechnik  |                          |  |                      |                              |
| <b>4</b>                                | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)</li> </ul>  |                          |  |                      |                              |
| <b>5</b>                                | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>   |                          |  |                      |                              |
| <b>6</b>                                | <b>Usability of this module</b><br>MSc ETiT, MSc MEC, Wi-ETiT   |                          |  |                      |                              |
| <b>7</b>                                | <b>Grade bonus compliant to §25 (2)</b>   |                          |  |                      |                              |
| <b>8</b>                                | <b>References</b><br>Lecture notes, instructions for exercises are available for download in Moodle.<br>Literature:<br>Probst U.: „Leistungselektronik für Bachelors: Grundlagen und praktische Anwendungen“, Carl Hanser Verlag GmbH & Co. KG, 2011<br>Jäger, R.: „Leistungselektronik: Grundlagen und Anwendungen“, VDE-Verlag; Auflage 2011<br>Heumann, K.: „Grundlagen der Leistungselektronik“; Teubner; Stuttgart; 1985<br>Lappe, R.: „Leistungselektronik“; Springer-Verlag; 1988<br>Mohan, Undeland, Robbins: Power Electronics: Converters, Applications and Design; John Wiley Verlag; New York; 2003   |                          |  |                      |                              |

| <b>Courses</b> |   |   |                         |
|----------------|---|---|-------------------------|
|                | <b>Course Nr.</b><br>18-gt-1010-vl                                      | <b>Course name</b><br>Power Electronics |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Gerd Griepentrog                    |   | <b>Type</b><br>Lecture  |
|                |   |   | <b>SWS</b><br>2         |
|                | <b>Course Nr.</b><br>18-gt-1010-ue                                      | <b>Course name</b><br>Power Electronics |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Gerd Griepentrog, M.Sc. Milad Khani |   | <b>Type</b><br>Practice |
|                |   |   | <b>SWS</b><br>2         |

|  |   |  |  |                        |                              |
|--|---|--|--|------------------------|------------------------------|
| <b>Module name</b><br>Electrical Machines and Drives |   |  |  |                        |                              |
| <b>Module Nr.</b><br>18-bi-1020                      | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h                             | <b>Self study</b><br>90 h                                      | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                            |   |  | <b>Module owner</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |                        |                              |
| <b>1</b>   | <b>Content</b><br>Construction and function of induction machine, synchronous machine, direct current machine. Electro-magnetic field within machines, armature windings, steady-state performance as motor/generator, application as line-fed and inverter-fed drives. Significance for electric power generation, both to the grid and in stand-alone version.  |  |  |                        |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>With active collaboration during lectures by asking questions related to those parts, which have not been completely understood by you, as well as by independent solving of examples ahead of the tutorial (not as late as during preparation for examination) you should be able to: <ul style="list-style-type: none"> <li>• calculate and explain the stationary operation performance of the three basic types of electric machine sin motor and generator mode,</li> <li>• understand the application of electrical machines in modern drive systems and to design simple drive applications by yourself,</li> <li>• understand and explain the function and physical background of the components of electrical machines</li> <li>• understand and explain the impact of basic electromagnetic field and force theory on the basic function of electrical machines.</li> </ul> |  |  |                        |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Mathematics I to III, Electrical Engineering I and II, Physics, Mechanical Engineering   |  |  |                        |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Optional, Standard Grading System)</li> </ul>   |  |  |                        |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Optional, Weighting: 100 %)</li> </ul>  |  |  |                        |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc/MSc Wi-ETiT, BEd   |  |  |                        |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |  |                        |                              |
| <b>8</b>   | <b>References</b><br>Detailed textbook and collection of exercises; Complete set of PowerPoint presentations<br>L.Matsch: Electromagnetic and electromechanical machines, Int.Textbook, 1972<br>A.Fitzgerald et al: Electric machinery, McGraw-Hill, 1971<br>S.Nasar et al: Electromechanics and electric machines, Wiley&Sons, 1995<br>R.Fischer: Elektrische Maschinen, C.Hanser-Verlag, 2004   |  |  |                        |                              |
| <b>Courses</b>                                       |   |  |  |                        |                              |
|  | <b>Course Nr.</b><br>18-bi-1020-vl  | <b>Course name</b><br>Electrical Machines and Drives |  |                        |                              |
|  | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder  |  |  | <b>Type</b><br>Lecture | <b>SWS</b><br>2              |

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|--|--|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>18-bi-1020-ue                           | <b>Course name</b><br>Electrical Machines and Drives |                         |                 |
|  | <b>Instructor</b><br>Prof. Dr. techn. Dr.h.c. Andreas Binder |  | <b>Type</b><br>Practice | <b>SWS</b><br>2 |

|  |  |  |   |                        |                                       |
|--|--|--|---|------------------------|---------------------------------------|
| <b>Module name</b><br>Technical Mechanics for Electrical Engineering |  |  |   |                        |                                       |
| <b>Module Nr.</b><br>16-26-6400                                      | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h   | <b>Self study</b><br>105 h                        | <b>Duration</b><br>1   | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German  |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Tobias Melz |                        |                                       |
| <b>1</b>   | <b>Content</b><br>Statics: force, moment (torque), free body diagram, equilibrium equations, center of gravity, truss, beams, adhesion and friction.<br>Mechanics of elastic bodies: stress and deformation, tension, torsion, bending.<br>Kinematics: point and rigid body movement.<br>Kinetics: dynamic force and moment equilibrium equations, energy and work, linear oscillators, momentum and angular momentum conservation laws, impact.   |  |   |                        |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>In this course the students will learn the basic concepts of technical mechanics. They should be able to analyze the statics of simple statically determinate planar systems, to carry out elementary elastomechanical calculations of statically determinate and statically indeterminate structures, to describe and analyze movements, and to solve planar motion problems, oscillation and shock phenomena with the laws of kinetics.  |  |   |                        |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>  |  |   |                        |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Standard Grading System)  |  |   |                        |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)  |  |   |                        |                                       |
| <b>6</b>   | <b>Usability of this module</b>  |  |   |                        |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |   |                        |                                       |
| <b>8</b>   | <b>References</b><br>Markert, Norrick: Einführung in die Technische Mechanik, ISBN 978-3-8440-3228-4<br>Exercises are embodied in the book.<br>Further reading:<br>Markert: Statik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3279-6<br>Markert: Elastomechanik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3280-2<br>Markert: Dynamik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-2200-1<br>Gross, Hauger, Schröder, Wall: Technische Mechanik 1 - 3. Springer-Verlag Berlin (2012-2014).<br>Hagedorn: Technische Mechanik, Band 1 - 3. Verlag Harri Deutsch Frankfurt. |  |   |                        |                                       |
| <b>Courses</b>   |  |  |   |                        |                                       |
|  | <b>Course Nr.</b><br>16-26-6400-vl   | <b>Course name</b><br>Technical Mechanics for Electrical Engineering |   |                        |                                       |
|  | <b>Instructor</b>  |  |   | <b>Type</b><br>Lecture | <b>SWS</b><br>3                       |

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|--|------------------------------------|--|-------------------------|-----------------|
|  | <b>Course Nr.</b><br>16-26-6400-ue | <b>Course name</b><br>Technical Mechanics for Electrical Engineering |                         |                 |
|  | <b>Instructor</b>                  |  | <b>Type</b><br>Practice | <b>SWS</b><br>2 |



|  |   |                          |   |                      |                              |
|--|---|--------------------------|---|----------------------|------------------------------|
| <b>Module name</b><br>Technical Thermodynamics I |   |                          |   |                      |                              |
| <b>Module Nr.</b><br>16-14-5010                  | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h | <b>Self study</b><br>105 h                                    | <b>Duration</b><br>1 | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                        |   |                          | <b>Module owner</b><br>Prof. Dr.-Ing. Peter Christian Stephan |                      |                              |
| <b>1</b>   | <b>Content</b><br>Fundamental terms of thermodynamics; thermodynamic equilibrium and temperature; different forms of energy (internal energy, heat, work, enthalpy); properties and equations of state for gases and incompressible substances; first law of thermodynamics and energy balances for technical systems; second law of thermodynamics and entropy balances for technical systems; exergy analysis; thermodynamic behaviour during phase change; the carnot cycle for power generation or refrigeration; energy efficiency and coefficient of performance; cyclic processes for gas turbines, combustion engines, power plants, refrigerators and heat pumps.  |                          |   |                      |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>On successful completion of this module, students should be able to: <ul style="list-style-type: none"> <li>• Explain the relationships between thermodynamic properties and the thermodynamic state of a system and apply them within calculations of thermal system behaviour.</li> <li>• Distinguish between different types of energy (e.g. work, heat, internal energy, enthalpy) and define them.</li> <li>• Analyse technical systems and processes using energy balances and equations of state.</li> <li>• Assess energy conversion processes by means of an entropy balance or an exergy analysis.</li> <li>• Characterise the thermal behaviour of gases, liquids and solids and corresponding phase change processes.</li> <li>• Apply this basic knowledge (1.-5.) to examine machines (turbines, pumps etc.) and processes for energy conversion (combustion engine, power plants, refrigerators, heat pumps).</li> </ul> |                          |   |                      |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>None   |                          |   |                      |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Technical Examination, Standard Grading System)</li> </ul> Written exam 150 min   |                          |   |                      |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)</li> </ul>   |                          |   |                      |                              |
| <b>6</b>   | <b>Usability of this module</b><br>Bachelor MPE Pflicht<br>Bachelor WI-MB<br>Master ETiT MFT, Bachelor Mechatronik  |                          |   |                      |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |                          |   |                      |                              |
| <b>8</b>   | <b>References</b><br>P Stephan; K. Schaber; K. Stephan; F. Mayinger: Thermodynamik, Band 1: Einstoffsysteme, Springer Verlag.<br>Further material (slides, collection of exercises, table of formulas etc.) is available through the Moodle system of TU Darmstadt.   |                          |   |                      |                              |
| <b>Courses</b>                                   |   |                          |   |                      |                              |

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|--|------------------------------------|---|--|-----------------|
|  | <b>Course Nr.</b><br>16-14-5010-vl | <b>Course name</b><br>Technical Thermodynamics I                  |  |                 |
|  | <b>Instructor</b>                  |   | <b>Type</b><br>Lecture                       | <b>SWS</b><br>3 |
|  | <b>Course Nr.</b><br>16-14-5010-hü | <b>Course name</b><br>Technical Thermodynamics I                  |  |                 |
|  | <b>Instructor</b>                  |   | <b>Type</b><br>Lecture      Hall<br>Practice | <b>SWS</b><br>1 |
|  | <b>Course Nr.</b><br>16-14-5010-gü | <b>Course name</b><br>Technical Thermodynamics I - Group Exercise |  |                 |
|  | <b>Instructor</b>                  |   | <b>Type</b><br>Group Practice                | <b>SWS</b><br>1 |

|   |   |   |   |                         |                              |
|---|---|---|---|-------------------------|------------------------------|
| <b>Module name</b><br>Technical Electrodynamics |   |   |   |                         |                              |
| <b>Module Nr.</b><br>18-dg-1070                 | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h                        | <b>Self study</b><br>120 h                              | <b>Duration</b><br>1    | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                       |   |   | <b>Module owner</b><br>Prof. Dr.-Ing. Herbert De Gersem |                         |                              |
| <b>1</b>  | <b>Content</b><br>Fields in materials, Green's functions, separation of variables in generalized orthogonal coordinates, conformal mapping, elliptic integrals and elliptic functions, electromagnetic forces, quasi-stationary fields, general waveguides, resonators, antennas.   |   |   |                         |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Starting with Maxwell's equations the lecture's aim is to provide a general understanding of electromagnetic phenomena. Students will be able to apply analytical methods to simple problems. Students will exhibit the ability to deal with more complex electromagnetic formulations and tasks. |   |   |                         |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Vector analysis, infinitesimal calculus, basics in differential equations. Knowledge of "Introduction to Electrodynamics"  |   |   |                         |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)</li> </ul>   |   |   |                         |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>  |   |   |                         |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, MSc Wi-ETiT  |   |   |                         |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                         |                              |
| <b>8</b>  | <b>References</b><br>Course notes available (including references)  |   |   |                         |                              |
| <b>Courses</b>                                  |   |   |   |                         |                              |
|   | <b>Course Nr.</b><br>18-dg-1070-vl  | <b>Course name</b><br>Technical Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann  |   |   | <b>Type</b><br>Lecture  | <b>SWS</b><br>2              |
|   | <b>Course Nr.</b><br>18-dg-1070-ue  | <b>Course name</b><br>Technical Electrodynamics |   |                         |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann  |   |   | <b>Type</b><br>Practice | <b>SWS</b><br>2              |

### 4.6.3 Lectures

|   |   |   |   |                        |                              |
|---|---|---|---|------------------------|------------------------------|
| <b>Module name</b><br>Printed Electronics |   |   |   |                        |                              |
| <b>Module Nr.</b><br>16-17-5110           | <b>Credit Points</b><br>4 CP  | <b>Workload</b><br>120 h                  | <b>Self study</b><br>90 h                     | <b>Duration</b><br>1   | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                 |   |   | <b>Module owner</b><br>Prof. Dr. Edgar Dörsam |                        |                              |
| <b>1</b>                                  | <b>Content</b><br>Printing technologies for functional printing (printing methods and systems); Design and materials for printed electronics (aerial, OFET, RFID); Activities for quality assurance; Examples of application (aerial, RFID, OFET, photovoltaic, batteries, lab on a chip).  |   |   |                        |                              |
| <b>2</b>                                  | <b>Learning objectives / Learning Outcomes</b><br>On successful completion of this module, students should be able to: <ul style="list-style-type: none"> <li>• Describe the printing technologies that are applicable for “Printed Electronics”.</li> <li>• Name materials that are appropriate to printing processes and to describe the impact of the materials on the design e.g. of antennas and OFETs.</li> <li>• Classify and rate different activities for quality assurance.</li> <li>• Explain basic functions, configurations, materials, and specific properties of printed antennas, RFIDs, photovoltaics and batteries.</li> <li>• Describe “Printed Electronics” as a multidisciplinary task that consists of electrical engineering, material science, and mechanical engineering.</li> </ul> |   |   |                        |                              |
| <b>3</b>                                  | <b>Recommended prerequisite for participation</b><br>Mechanical components and Mechatronics I and II recommended  |   |   |                        |                              |
| <b>4</b>                                  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Technical Examination, Standard Grading System)</li> </ul> Oral exam 30 min   |   |   |                        |                              |
| <b>5</b>                                  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)</li> </ul>   |   |   |                        |                              |
| <b>6</b>                                  | <b>Usability of this module</b><br>WPB Master MPE III (Wahlfächer aus Natur- und Ingenieurwissenschaft)<br>WPB Master PST III (Fächer aus Natur- und Ingenieurwissenschaft für Papiertechnik)<br>Master ETiT IMNT; Master Mechatronik   |   |   |                        |                              |
| <b>7</b>                                  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                        |                              |
| <b>8</b>                                  | <b>References</b><br>The current lecture notes can be downloaded from the web pages of the institute while the semester is in session.  |   |   |                        |                              |
| <b>Courses</b>                            |   |   |   |                        |                              |
|   | <b>Course Nr.</b><br>16-17-5110-vl  | <b>Course name</b><br>Printed Electronics |   |                        |                              |
|   | <b>Instructor</b>   |   |   | <b>Type</b><br>Lecture | <b>SWS</b><br>2              |

|  |  |  |  |                         |                                       |
|--|--|--|--|-------------------------|---------------------------------------|
| <b>Module name</b><br>Basic Principles of Design |  |  |  |                         |                                       |
| <b>Module Nr.</b><br>16-17-6400                  | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h                         | <b>Self study</b><br>120 h                         | <b>Duration</b><br>1    | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                        |  |  | <b>Module owner</b><br>Dr.-Ing. Hermann Kloberdanz |                         |                                       |
| <b>1</b>   | <b>Content</b><br>Illustration in draft, sectional drawing, dimensioning; Functions of technical parts, screw joints, bearings, tolerances and fits; Mechanical basics of machine parts.   |  |  |                         |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>The students are able to recognise and describe position, shape and function of a mechanical component from a draft. They have the capability to prepare sketches of their own ideas applying standardised rules. Furthermore, they are able to explain the basic mechanical principles of machine components. |  |  |                         |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>  |  |  |                         |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Technical Examination, Standard Grading System)</li> </ul>  |  |  |                         |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Technical Examination, Weighting: 100 %)</li> </ul>   |  |  |                         |                                       |
| <b>6</b>   | <b>Usability of this module</b>  |  |  |                         |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                         |                                       |
| <b>8</b>   | <b>References</b><br>Lecture notes can be downloaded from the web pages of the institute.  |  |  |                         |                                       |
| <b>Courses</b>                                   |  |  |  |                         |                                       |
|  | <b>Course Nr.</b><br>16-17-6400-vl   | <b>Course name</b><br>Basic Principles of Design |  |                         |                                       |
|  | <b>Instructor</b>  |  |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>2                       |
|  | <b>Course Nr.</b><br>16-17-6400-ue   | <b>Course name</b><br>Basic Principles of Design |  |                         |                                       |
|  | <b>Instructor</b>  |  |  | <b>Type</b><br>Practice | <b>SWS</b><br>2                       |

|   |   |   |   |                                |                              |
|---|---|---|---|--------------------------------|------------------------------|
| <b>Module name</b><br>Introduction into the numerical computation of electromagnetic fields |   |   |   |                                |                              |
| <b>Module Nr.</b><br>18-sc-3010   | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h  | <b>Self study</b><br>75 h                                   | <b>Duration</b><br>1           | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German   |   |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Sebastian Schöps |                                |                              |
| <b>1</b>  | <b>Content</b><br>Maxwell's equations, basics of numerical calculation of electromagnetic fields, knowledge about different types of possible errors  |   |   |                                |                              |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>Starting from basic electromagnetic problems in terms of electric and magnetic circuits the field aspect inherent to these models is accentuated. After attending the lecture, the student is capable of modeling given geometric structures and devices using the methods of Computational Engineering. Furthermore, the student is able to solve the related task numerically using appropriate software. The student should understand the basics of the numerical calculation of electromagnetic fields as well as become acquainted with the related procedures in practical applications. The gathered solution methods will be applied practically during the laboratory courses. Moreover basic programming skills related to specific simulation tasks as well as for the purpose of postprocessing the results of the numerical simulations are taught. |   |   |                                |                              |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Elektrotechnik und Informationstechnik I und II  |   |   |                                |                              |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Optional, Standard Grading System)</li> </ul>  |   |   |                                |                              |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Optional, Weighting: 100%)</li> </ul>  |   |   |                                |                              |
| <b>6</b>  | <b>Usability of this module</b><br>BSc CE   |   |   |                                |                              |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                                |                              |
| <b>8</b>  | <b>References</b><br>Will be handed out during the lecture and is provided at <a href="http://www.temf.de">www.temf.de</a>  |   |   |                                |                              |
| <b>Courses</b>  |   |   |   |                                |                              |
|   | <b>Course Nr.</b><br>18-sc-3010-vl  | <b>Course name</b><br>Introduction into the numerical computation of electromagnetic fields |   |                                |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Sebastian Schöps   |   |   | <b>Type</b><br>Lecture         | <b>SWS</b><br>2              |
|   | <b>Course Nr.</b><br>18-sc-3010-pj  | <b>Course name</b><br>Introduction into the numerical computation of electromagnetic fields |   |                                |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Sebastian Schöps   |   |   | <b>Type</b><br>Project Seminar | <b>SWS</b><br>3              |

| <b>Module name</b><br>Communication Networks I |   |                 |  |                 |                      |
|--|---|-----------------|--|-----------------|----------------------|
| <b>Module Nr.</b>                              | <b>Credit Points</b>  | <b>Workload</b> | <b>Self study</b>                                    | <b>Duration</b> | <b>Cycle offered</b> |
| 18-sm-1010                                     | 6 CP  | 180 h           | 120 h  | 1               | SoSe                 |
| <b>Language</b><br>English                     |   |                 | <b>Module owner</b><br>Prof. Dr.-Ing. Ralf Steinmetz |                 |                      |
| <b>1</b>                                       | <p><b>Content</b></p> <p>In this class the technologies that make today's communication networks work are introduced and discussed.</p> <p>This lecture covers basic knowledge about communication networks and discusses in detail the physical layer, the data link layer, the network layer and parts of the transport layer.</p> <p>The physical layer, which is responsible for an adequate transmission across a channel, is discussed briefly. Next, error control, flow control and medium access mechanisms of the data link layer are presented. Then the network layer is discussed. It comprises mainly routing and congestion control algorithms. After that basic functionalities of the transport layer are discussed. This includes UDP and TCP. The Internet is thoroughly studied throughout the class.</p> <p>Detailed Topics are:</p> <ul style="list-style-type: none"> <li>• ISO-OSI and TCP/IP layer models</li> <li>• Tasks and properties of the physical layer</li> <li>• Physical layer coding techniques</li> <li>• Services and protocols of the data link layer</li> <li>• Flow control (sliding window)</li> <li>• Applications: LAN, MAN, High-Speed LAN, WAN</li> <li>• Services of the network layer</li> <li>• Routing algorithms</li> <li>• Broadcast and Multicast routing</li> <li>• Congestion Control</li> <li>• Addressing</li> <li>• Internet protocol (IP)</li> <li>• Internetworking</li> <li>• Mobile networking</li> <li>• Services and protocols of the transport layer</li> <li>• TCP, UDP</li> </ul> |                 |  |                 |                      |
| <b>2</b>                                       | <p><b>Learning objectives / Learning Outcomes</b></p> <p>This lecture teaches about basic functionalities, services, protocols, algorithms and standards of network communication systems. Competencies acquired are basic knowledge about the lower four ISO-OSI layers: physical layer, datalink layer, network layer and transport layer; Furthermore, basic knowledge about communication networks is taught. Attendants will learn about the functionality of today's network technologies and the Internet.</p>   |                 |  |                 |                      |
| <b>3</b>                                       | <b>Recommended prerequisite for participation</b>   |                 |  |                 |                      |
| <b>4</b>                                       | <p><b>Form of examination</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)</li> </ul>  |                 |  |                 |                      |
| <b>5</b>                                       | <p><b>Grading</b></p> <p>Module Final Examination:</p> <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %)</li> </ul>  |                 |  |                 |                      |
| <b>6</b>                                       | <p><b>Usability of this module</b></p> <p>Wi-CS, Wi-ETiT, BSc CS, BSc ETiT, BSc iST</p>   |                 |  |                 |                      |

|                |  |  |                         |
|----------------|--|--|-------------------------|
| <b>7</b>       | <p><b>Grade bonus compliant to §25 (2)</b><br/> A bonus of 0.3 or 0.7 can be obtained.<br/> For 0.3 bonus: 7 out of 9 exercises are to be solved to the best of your knowledge. That is, every question needs to be answered. However, not every question needs to be answered correctly. Additionally, at least one wiki article or applet concerning a topic of the lecture has to be provided (written).<br/> For the 0.7 bonus: Additionally, present one exercise and write at least three wiki articles, or write at least 5 wiki articles.<br/> An oral exam (“Fachgespräch”) is mandatory in order to receive the bonus. The bonus can only be applied if the exam grade is 4.0 or better.</p>   |  |                         |
| <b>8</b>       | <p><b>References</b></p> <ul style="list-style-type: none"> <li>• Andrew S. Tanenbaum: Computer Networks, 5th Edition, Prentice Hall, 2010</li> <li>• Andrew S. Tanenbaum: Computernetzwerke, 3. Auflage, Prentice Hall, 1998</li> <li>• Larry L. Peterson, Bruce S. Davie: Computer Networks: A System Approach, 2nd Edition, Morgan Kaufmann Publishers, 1999</li> <li>• Larry L. Peterson, Bruce S. Davie: Computernetze, Ein modernes Lehrbuch, 2. Auflage, Dpunkt Verlag, 2000</li> <li>• James F. Kurose, Keith W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet, 2nd Edition, Addison Wesley-Longman, 2002</li> <li>• Jean Walrand: Communication Networks: A First Course, 2nd Edition, McGraw-Hill, 1998</li> </ul> |  |                         |
| <b>Courses</b> |  |  |                         |
|                | <b>Course Nr.</b><br>18-sm-1010-vl   | <b>Course name</b><br>Communication Networks I |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Ralf Steinmetz   |  | <b>Type</b><br>Lecture  |
|                |  |  | <b>SWS</b><br>3         |
|                | <b>Course Nr.</b><br>18-sm-1010-ue   | <b>Course name</b><br>Communication Networks I |                         |
|                | <b>Instructor</b><br>Prof. Dr.-Ing. Ralf Steinmetz   |  | <b>Type</b><br>Practice |
|                |  |  | <b>SWS</b><br>1         |



|   |   |                          |  |                      |                                       |
|---|---|--------------------------|--|----------------------|---------------------------------------|
| <b>Module name</b><br>General Computer Science II |   |                          |  |                      |                                       |
| <b>Module Nr.</b><br>20-00-0290                   | <b>Credit Points</b><br>6 CP  | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h                               | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                         |   |                          | <b>Module owner</b><br>Prof. Dr. rer. nat. Karsten Weihe |                      |                                       |
| <b>1</b>  | <b>Content</b><br>In this course, students learn fundamental algorithms and data structures using advanced concepts of the programming language Java.<br>Recapitulation Basic Java:<br>* Variables, Types, Classes, Program Flow<br>* Inheritance, Abstract Classes, Interfaces<br>* Arrays and Collections<br>Advanced Programming Concepts<br>* Graphical User Interfaces<br>* Input/Output<br>* Error Handling and Exceptions<br>Algorithms and Data Structures<br>* Recursion<br>* Sorting algorithms<br>* Stacks, Lists, Queues,<br>* Search<br>* Trees and Graphs |                          |  |                      |                                       |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>After completion of this course, students are able to<br>- write larger programs in Java<br>- use fundamental algorithms and data structures of computer science<br>- estimate and compare the quality of elementary algorithms with respect to complexity and run-time   |                          |  |                      |                                       |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>General Computer Science I or<br>- elementary programming skills in Java<br>- basic knowledge in computer science<br>- working with computers  |                          |  |                      |                                       |
| <b>4</b>  | <b>Form of examination</b><br>Module Ecompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Standard BWS)  |                          |  |                      |                                       |
| <b>5</b>  | <b>Grading</b><br>Module Ecompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %)  |                          |  |                      |                                       |
| <b>6</b>  | <b>Usability of this module</b>   |                          |  |                      |                                       |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |                          |  |                      |                                       |
| <b>8</b>  | <b>References</b>   |                          |  |                      |                                       |

Java lernen mit BlueJ: Eine Einführung in die objektorientierte Programmierung David J. Barnes, Michael Kölling Pearson Studium 4., aktualisierte Auflage, 2009  
 ISBN-13: 978-3-8689-4001-5  
 Algorithmen in Java  
 Robert Sedgewick  
 Pearson Studium  
 3. überarbeitete Auflage, 2003  
 ISBN-13: 978-3-8273-7072-3  
 Einführung in die Programmierung mit Java Robert Sedgewick, Kevin Wayne Pearson Studium 1. Auflage, 2011  
 ISBN-13: 978-3-8689-4076-3

**Courses**

|                                    |   |                                     |                 |
|------------------------------------|---|-------------------------------------|-----------------|
| <b>Course Nr.</b><br>20-00-0290-iv | <b>Course name</b><br>General Computer Science II |                                     |                 |
| <b>Instructor</b>                  |   | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>4 |

|   |  |   |   |                           |                              |
|---|--|---|---|---------------------------|------------------------------|
| <b>Module name</b><br>Lighting Technology I |  |   |   |                           |                              |
| <b>Module Nr.</b><br>18-kh-2010             | <b>Credit Points</b><br>5 CP   | <b>Workload</b><br>150 h                    | <b>Self study</b><br>90 h                             | <b>Duration</b><br>1      | <b>Cycle offered</b><br>WiSe |
| <b>Language</b><br>German                   |  |   | <b>Module owner</b><br>Prof. Dr.-Ing. Khanh Quoc Tran |                           |                              |
| <b>1</b>                                    | <b>Content</b><br>Structure and functionality of the human eye, terms and unit in lighting technology, photometry, radiometric and photometric properties of materials, filters, physiology of vision, colour theory, lighting, light sources.<br>Measurement of luminous flux, luminous intensity, illuminance, luminance, determination of the spectral responsivity function of the human eye, colorimetry colour rendering, colour as traffic signals, measuring of optical material characteristics, LED properties           |   |   |                           |                              |
| <b>2</b>                                    | <b>Learning objectives / Learning Outcomes</b><br>To list and connect terms, units and radiometric and photometric properties of materials in lighting technology, to describe and understand structure and functionality of the human eye and the physiology of vision, to illustrate basics of lighting, measuring methods and application.<br>Being able to measure base items in lighting technology, applying knowlegde of lighting and enhance them with experiments. Developing a better understanding for light and color. |   |   |                           |                              |
| <b>3</b>                                    | <b>Recommended prerequisite for participation</b><br>MSc ETiT, MSc Wi-ETiT, MSc MEC  |   |   |                           |                              |
| <b>4</b>                                    | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Oral Examination, Duration: 30 min, Standard Grading System)</li> </ul>  |   |   |                           |                              |
| <b>5</b>                                    | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Technical Examination, Oral Examination, Weighting: 100 %)</li> </ul>   |   |   |                           |                              |
| <b>6</b>                                    | <b>Usability of this module</b><br>MSc ETiT, MSc Wi-ETiT, MSc MEC  |   |   |                           |                              |
| <b>7</b>                                    | <b>Grade bonus compliant to §25 (2)</b>  |   |   |                           |                              |
| <b>8</b>                                    | <b>References</b><br>Script for lecture: Lighting Technology I<br>Excercisebook: laboratory: lighting technology I   |   |   |                           |                              |
| <b>Courses</b>                              |  |   |   |                           |                              |
|   | <b>Course Nr.</b><br>18-kh-2010-vl   | <b>Course name</b><br>Lighting Technology I |   |                           |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Khanh Quoc Tran  |   |   | <b>Type</b><br>Lecture    | <b>SWS</b><br>2              |
|   | <b>Course Nr.</b><br>18-kh-2010-pr   | <b>Course name</b><br>Lighting Technology I |   |                           |                              |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Khanh Quoc Tran  |   |   | <b>Type</b><br>Internship | <b>SWS</b><br>2              |

|  |  |  |  |                         |                              |
|--|--|--|--|-------------------------|------------------------------|
| <b>Module name</b><br>System Dynamics and Automatic Control Systems II |  |  |  |                         |                              |
| <b>Module Nr.</b><br>18-ad-1010  | <b>Credit Points</b><br>7 CP   | <b>Workload</b><br>210 h   | <b>Self study</b><br>135 h                         | <b>Duration</b><br>1    | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German  |  |  | <b>Module owner</b><br>Prof. Dr.-Ing. Jürgen Adamy |                         |                              |
| <b>1</b>   | <b>Content</b><br>Main topics covered are: <ul style="list-style-type: none"> <li>• Root locus method (construction and application),</li> <li>• State space representation of linear systems (representation, time solution, controllability, observability, observer- based controller design)</li> </ul>  |  |  |                         |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>After attending the lecture, a student is capable of: <ul style="list-style-type: none"> <li>• constructing and evaluating the root locus of given systems</li> <li>• describing the concept and importance of the state space for linear systems</li> <li>• defining controllability and observability for linear systems and being able to test given systems with respect to these properties</li> <li>• stating controller design methods using the state space, and applying them to given systems</li> <li>• applying the method of linearization to non-linear systems with respect to a given operating point</li> </ul> |  |  |                         |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>System Dynamics and Control Systems I   |  |  |                         |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)</li> </ul>  |  |  |                         |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Technical Examination, Written Examination, Weighting: 100%)</li> </ul>   |  |  |                         |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik   |  |  |                         |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>  |  |  |                         |                              |
| <b>8</b>   | <b>References</b><br>Adamy: Systemdynamik und Regelungstechnik II, Shaker Verlag (available for purchase at the FG office)   |  |  |                         |                              |
| <b>Courses</b>   |  |  |  |                         |                              |
|  | <b>Course Nr.</b><br>18-ad-1010-vl   | <b>Course name</b><br>System Dynamics and Automatic Control Systems II |  |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Jürgen Adamy   |  |  | <b>Type</b><br>Lecture  | <b>SWS</b><br>3              |
|  | <b>Course Nr.</b><br>18-ad-1010-ue   | <b>Course name</b><br>System Dynamics and Automatic Control Systems II |  |                         |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Jürgen Adamy   |  |  | <b>Type</b><br>Practice | <b>SWS</b><br>2              |

|  |   |                          |   |                      |                                       |
|--|---|--------------------------|---|----------------------|---------------------------------------|
| <b>Module name</b><br>Computational Engineering and Robotics |   |                          |   |                      |                                       |
| <b>Module Nr.</b><br>20-00-0011                              | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h | <b>Self study</b><br>105 h                                | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>German                                    |   |                          | <b>Module owner</b><br>Prof. Dr. phil. nat. Marc Fischlin |                      |                                       |
| <b>1</b>   | <b>Content</b><br>- Foundations of modelling and simulation<br>- Problem specification and system description for computational engineering<br>- Model generation for the example of mechanical systems<br>- Model analysis for the example of mechanical systems<br>- Implementations of simulations for the example of robots and other systems<br>- Interpretation and validation using measurement data<br>- Applications in simulation and control of robots as well as in physically based animation and computer games |                          |   |                      |                                       |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Upon successful completion of this class, students will be able to develop first models and simulations and can perform first simulation studies within robotics. They know the necessary key steps needed to construct simulations (problem specification, model generation, model analysis, implementation, and validation) and can use them to construct first simulations to meet the specification requirements.   |                          |   |                      |                                       |
| <b>3</b>   | <b>Recommended prerequisite for participation</b>   |                          |   |                      |                                       |
| <b>4</b>   | <b>Form of examination</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>[20-00-0011-iv] (Technical Examination, Written/Oral Examination, Standard BWS)</li> </ul>   |                          |   |                      |                                       |
| <b>5</b>   | <b>Grading</b><br>Module Ecompanying Examination: <ul style="list-style-type: none"> <li>[20-00-0011-iv] (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>  |                          |   |                      |                                       |
| <b>6</b>   | <b>Usability of this module</b><br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Computational Engineering<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs.   |                          |   |                      |                                       |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b><br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.  |                          |   |                      |                                       |
| <b>8</b>   | <b>References</b><br>F Föllinger: Einführung in die Zustandsbeschreibung dynamischer Systeme (Oldenbourg, 1982)<br>P Corke: Robotics, Vision & Control, Springer, 2011<br>EL. Severance: System Modeling and Simulation: An Introduction, J. Wiley & Sons, 2001   |                          |   |                      |                                       |
| <b>Courses</b>   |   |                          |   |                      |                                       |

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|  |                                    |  |                                     |                 |
|--|------------------------------------|--|-------------------------------------|-----------------|
|  | <b>Course Nr.</b><br>20-00-0011-iv | <b>Course name</b><br>Computational Engineering and Robotics |                                     |                 |
|  | <b>Instructor</b>                  |  | <b>Type</b><br>Integrated<br>Course | <b>SWS</b><br>3 |

|                                      |  |                          |                            |                      |                                       |
|--------------------------------------|--|--------------------------|----------------------------|----------------------|---------------------------------------|
| <b>Module name</b><br>Robot Learning |  |                          |                            |                      |                                       |
| <b>Module Nr.</b><br>20-00-0629      | <b>Credit Points</b><br>6 CP   | <b>Workload</b><br>180 h | <b>Self study</b><br>120 h | <b>Duration</b><br>1 | <b>Cycle offered</b><br>Every 2. Sem. |
| <b>Language</b><br>English           |  |                          | <b>Module owner</b>        |                      |                                       |
| <b>1</b>                             | <b>Content</b><br>- Foundations from robotics and machine learning for robot learning<br>- Learning of forward models<br>- Representation of a policy, hierarchical abstraction with movement primitives<br>- Imitation learning<br>- Optimal control with learned forward models<br>- Reinforcement learning and policy search<br>- Inverse reinforcement learning  |                          |                            |                      |                                       |
| <b>2</b>                             | <b>Learning objectives / Learning Outcomes</b><br>Upon successful completion of this course, students are able to understand the relevant foundations of machine learning and robotics. They will be able to use machine learning approaches to empower robots to learn new tasks. They will understand the foundations of optimal decision making and reinforcement learning and can apply reinforcement learning algorithms to let a robot learn from interaction with its environment. Students will understand the difference between Imitation Learning, Reinforcement Learning, Policy Search and Inverse Reinforcement Learning and can apply each of these approaches in the appropriate scenario. |                          |                            |                      |                                       |
| <b>3</b>                             | <b>Recommended prerequisite for participation</b><br>Good programming in Matlab<br>Lecture Machine Learning 1 - Statistical Approaches is helpful but not mandatory.   |                          |                            |                      |                                       |
| <b>4</b>                             | <b>Form of examination</b><br>Module Accompanying Examination: <ul style="list-style-type: none"> <li>[20-00-0629-vl] (Technical Examination, Written/Oral Examination, Standard BWS)</li> </ul>   |                          |                            |                      |                                       |
| <b>5</b>                             | <b>Grading</b><br>Module Accompanying Examination: <ul style="list-style-type: none"> <li>[20-00-0629-vl] (Technical Examination, Written/Oral Examination, Weighting: 100%)</li> </ul>  |                          |                            |                      |                                       |
| <b>6</b>                             | <b>Usability of this module</b><br>B.Sc. Informatik<br>M.Sc. Informatik<br>B.Sc. Computational Engineering<br>M.Sc. Computational Engineering<br>M.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>Can be used in other degree programs.  |                          |                            |                      |                                       |
| <b>7</b>                             | <b>Grade bonus compliant to §25 (2)</b><br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann.   |                          |                            |                      |                                       |
| <b>8</b>                             | <b>References</b>  |                          |                            |                      |                                       |

Deisenroth, M. P; Neumann, G.; Peters, J. (2013). A Survey on Policy Search for Robotics, Foundations and Trends in Robotics  
 Kober, J; Bagnell, D.; Peters, J. (2013). Reinforcement Learning in Robotics: A Survey, International Journal of Robotics Research  
 C.M. Bishop, Pattern Recognition and Machine Learning (2006),  
 R. Sutton, A. Barto. Reinforcement Learning - an Introduction  
 Nguyen-Tuong, D.; Peters, J. (2011). Model Learning in Robotics: a Survey

| <b>Courses</b>                     |                                      |                        |                 |
|------------------------------------|--------------------------------------|------------------------|-----------------|
| <b>Course Nr.</b><br>20-00-0629-v1 | <b>Course name</b><br>Robot Learning |                        |                 |
| <b>Instructor</b>                  |                                      | <b>Type</b><br>Lecture | <b>SWS</b><br>4 |



#### 4.6.4 (Projekt-)Seminare und Praktika

|  |   |  |   |                                |                              |
|--|---|--|---|--------------------------------|------------------------------|
| <b>Module name</b><br>Product Development Methodology II |   |  |   |                                |                              |
| <b>Module Nr.</b><br>18-ho-1025                          | <b>Credit Points</b><br>5 CP  | <b>Workload</b><br>150 h                                 | <b>Self study</b><br>105 h                          | <b>Duration</b><br>1           | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                                |   |  | <b>Module owner</b><br>Prof. Dr.-Ing. Klaus Hofmann |                                |                              |
| <b>1</b>   | <b>Content</b><br>Practical experiences by using methodical procedures in the development of technical products. In addition teamwork, verbal and written representation of results and the organization of development. Work in a project team and organize the development process independently.   |  |   |                                |                              |
| <b>2</b>   | <b>Learning objectives / Learning Outcomes</b><br>Applying the development methodology to a specific development project in a team. To do this, students can create a schedule, can analyze the state of the art, can compose a list of requirements, can abstract the task, can work out the sub-problems, can seek solutions with different methods, can work out optimal solutions using valuation methods, can set up a final concept, can derive the parameters needed by computation and modeling, can create the production documentation with all necessary documents such as bills of materials, technical drawings and circuit diagrams, can build up and investigate a laboratory prototype and can reflect their development in retrospect. |  |   |                                |                              |
| <b>3</b>   | <b>Recommended prerequisite for participation</b><br>Product Development Methodology I  |  |   |                                |                              |
| <b>4</b>   | <b>Form of examination</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |  |   |                                |                              |
| <b>5</b>   | <b>Grading</b><br>Module Final Examination:<br><ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |  |   |                                |                              |
| <b>6</b>   | <b>Usability of this module</b><br>BSc ETiT, BSc WI-ETiT, MSc MEC   |  |   |                                |                              |
| <b>7</b>   | <b>Grade bonus compliant to §25 (2)</b>   |  |   |                                |                              |
| <b>8</b>   | <b>References</b><br>Script: Development Methodology (PEM)  |  |   |                                |                              |
| <b>Courses</b>   |   |  |   |                                |                              |
|  | <b>Course Nr.</b><br>18-ho-1025-pj  | <b>Course name</b><br>Product Development Methodology II |   |                                |                              |
|  | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann, Prof. Dr.-Ing. Khanh Quoc Tran, Prof. Dr. Mario Kupnik, Prof. Ph.D. Thomas Peter Burg  |  |   | <b>Type</b><br>Project Seminar | <b>SWS</b><br>3              |

|   |  |   |  |                        |                                   |
|---|--|---|--|------------------------|-----------------------------------|
| <b>Module name</b><br>Seminar Terahertz Components & Applications |  |   |  |                        |                                   |
| <b>Module Nr.</b><br>18-pr-1010                                   | <b>Credit Points</b><br>4 CP   | <b>Workload</b><br>120 h  | <b>Self study</b><br>90 h                              | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German and English                             |  |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Sascha Preu |                        |                                   |
| <b>1</b>  | <b>Content</b><br>Investigating and solving specific problems concerning the development of Terahertz devices as well as of applications of THz technology. The specific task will be defined based on current research topics. The project seminar includes working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. Topics include, e.g.: <ul style="list-style-type: none"> <li>• Optics on chip</li> <li>• Semiconductor devicesLight-matter interaction</li> </ul> |   |  |                        |                                   |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>After completion of the course, students possess: <ul style="list-style-type: none"> <li>• the ability to apply theoretical models to practical problems</li> <li>• deep and special knowledge in a particular field related to THz science, optics or semiconductor physics</li> <li>• the skills to find, analyze and evaluate scientific reference papers for a particular topic</li> <li>• the capability to summarize the achieved scientific findings in the form of a concise reportthe ability to present and discuss achieved results in the form of a presentation in front of an audience</li> </ul>  |   |  |                        |                                   |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Previous knowledge one of the following disciplines: Optics, semiconductor physics, or THz technology   |   |  |                        |                                   |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>  |   |  |                        |                                   |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>  |   |  |                        |                                   |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT, BSc Wi-ETiT, BSc/MSc iST  |   |  |                        |                                   |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>  |   |  |                        |                                   |
| <b>8</b>  | <b>References</b><br>Will be announced once the topic is defined.  |   |  |                        |                                   |
| <b>Courses</b>  |  |   |  |                        |                                   |
|   | <b>Course Nr.</b><br>18-pr-1010-se   | <b>Course name</b><br>Seminar Terahertz Components & Applications |  |                        |                                   |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Sascha Preu   |   |  | <b>Type</b><br>Seminar | <b>SWS</b><br>2                   |

|   |   |   |   |                           |                              |
|---|---|---|---|---------------------------|------------------------------|
| <b>Module name</b><br>C/C++ Programming Lab |   |   |   |                           |                              |
| <b>Module Nr.</b><br>18-su-1030             | <b>Credit Points</b><br>3 CP  | <b>Workload</b><br>90 h                     | <b>Self study</b><br>45 h                                 | <b>Duration</b><br>1      | <b>Cycle offered</b><br>SoSe |
| <b>Language</b><br>German                   |   |   | <b>Module owner</b><br>Prof. Dr. rer. nat. Andreas Schürr |                           |                              |
| <b>1</b>                                    | <b>Content</b><br>The six-day programming lab is divided into two sections.<br>In the first four days, the programming languages C and C++ are taught with practical tasks and lectures. All covered aspects are extensively practiced under supervision. Based on the fundamental basics of C++, manual memory management and dynamic data structures are handled from a procedural as well as from an object-oriented perspective. Object orientation with C++ is extensively addressed by treating multiple inheritance, polymorphism and parametric polymorphism.<br>The last two days are dedicated to microcontroller programming in C including the opportunity of programming of a distributed application (via a CAN-bus). |   |   |                           |                              |
| <b>2</b>                                    | <b>Learning objectives / Learning Outcomes</b><br>During the lab, the students acquire a fundamental understanding of the programming languages C and C++ with emphasis not only on procedural but also on object-oriented characteristics. The students gain hands-on experience with applying C++ and discover the challenges of using C++ safely and properly especially in the context of embedded system software development.   |   |   |                           |                              |
| <b>3</b>                                    | <b>Recommended prerequisite for participation</b><br>Java skills  |   |   |                           |                              |
| <b>4</b>                                    | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Standard Grading System)</li> </ul>   |   |   |                           |                              |
| <b>5</b>                                    | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>Module Examination (Study Achievement, Optional, Weighting: 100%)</li> </ul>   |   |   |                           |                              |
| <b>6</b>                                    | <b>Usability of this module</b><br>BSc ETiT, BSc MEC, BSc iST, BSc Wi-ETiT  |   |   |                           |                              |
| <b>7</b>                                    | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                           |                              |
| <b>8</b>                                    | <b>References</b><br><a href="http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/c-und-c-p">http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/c-und-c-p</a>  |   |   |                           |                              |
| <b>Courses</b>                              |   |   |   |                           |                              |
|   | <b>Course Nr.</b><br>18-su-1030-pr  | <b>Course name</b><br>C/C++ Programming Lab |   |                           |                              |
|   | <b>Instructor</b><br>Prof. Dr. rer. nat. Andreas Schürr   |   |   | <b>Type</b><br>Internship | <b>SWS</b><br>3              |

|   |   |   |   |                        |                                   |
|---|---|---|---|------------------------|-----------------------------------|
| <b>Module name</b><br>Seminar Electronic Circuits |   |   |   |                        |                                   |
| <b>Module Nr.</b><br>18-ho-1070                   | <b>Credit Points</b><br>4 CP  | <b>Workload</b><br>120 h                          | <b>Self study</b><br>90 h                           | <b>Duration</b><br>1   | <b>Cycle offered</b><br>WiSe/SoSe |
| <b>Language</b><br>German                         |   |   | <b>Module owner</b><br>Prof. Dr.-Ing. Klaus Hofmann |                        |                                   |
| <b>1</b>  | <b>Content</b><br>Analysis of state-of-the-art circuit concepts and presentation of selected examples   |   |   |                        |                                   |
| <b>2</b>  | <b>Learning objectives / Learning Outcomes</b><br>After attending the seminar, a student is capable of analysing of state-of-the-art circuit concepts and preparing didactical materials and presentations, based on the know-how gained in the lectures “Electronics” and “Analog Integrated Circuit Design” |   |   |                        |                                   |
| <b>3</b>  | <b>Recommended prerequisite for participation</b><br>Electronics, Analog Integrated Circuit Design  |   |   |                        |                                   |
| <b>4</b>  | <b>Form of examination</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Duration: 30 min, Standard Grading System)</li> </ul>   |   |   |                        |                                   |
| <b>5</b>  | <b>Grading</b><br>Module Final Examination: <ul style="list-style-type: none"> <li>• Module Examination (Study Achievement, Oral Examination, Weighting: 100 %)</li> </ul>  |   |   |                        |                                   |
| <b>6</b>  | <b>Usability of this module</b><br>BSc ETiT   |   |   |                        |                                   |
| <b>7</b>  | <b>Grade bonus compliant to §25 (2)</b>   |   |   |                        |                                   |
| <b>8</b>  | <b>References</b><br>Will be provided at the begin of the seminar   |   |   |                        |                                   |
| <b>Courses</b>                                    |   |   |   |                        |                                   |
|   | <b>Course Nr.</b><br>18-ho-1070-se  | <b>Course name</b><br>Seminar Electronic Circuits |   |                        |                                   |
|   | <b>Instructor</b><br>Prof. Dr.-Ing. Klaus Hofmann   |   |   | <b>Type</b><br>Seminar | <b>SWS</b><br>2                   |