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**Modulhandbuch**  
**Engineering Physics - Bachelor's Programme**  
im Wintersemester 2021/2022  
erstellt am 07/12/21

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## Basismodule

### phy509 - Mechanics

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|--|---|---------------------|
| <b>Module label</b>                              | Mechanics   |                     |
| <b>Module code</b>                               | phy509  |                     |
| <b>Credit points</b>                             | 6.0 KP  |                     |
| <b>Workload</b>                                  | 180 h<br>(<br>Attendance: 84 hrs Self study: 96 hrs<br>)  |                     |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Basismodule</li> </ul>  |                     |
| <b>Responsible persons</b>                       | Kittel, Achim (Authorized examiners)<br>Kühn, Martin (Authorized examiners)<br>Lienau, Christoph (Authorized examiners)<br>Nilius, Niklas (Authorized examiners)<br>Peinke, Joachim (Authorized examiners)<br>Schäfer, Sascha (Authorized examiners)<br>Uppenkamp, Stefan (Authorized examiners)<br>Wollenhaupt, Matthias (Authorized examiners)  |                     |
| <b>Prerequisites</b>                             | Basic knowledge of mathematics acc. the pre-course of mathematics   |                     |
| <b>Skills to be acquired in this module</b>      | Introduction into scientific reasoning; understanding the basic physical principles that govern physical behaviour in the real world, application of these principles to solve practical problems. General introduction to the fundamentals of experimental mechanics.  |                     |
| <b>Module contents</b>                           | <ul style="list-style-type: none"> <li>Scientific reasoning</li> <li>Space and Time</li> <li>Kinematics</li> <li>Dynamics</li> <li>Motion in accelerated frames</li> <li>Work and Energy</li> <li>Laws of Conservation</li> <li>Physics of rigid bodies</li> <li>Deformable bodies and fluid media</li> <li>Oscillations</li> <li>Waves</li> </ul>  |                     |
| <b>Reader's advisory</b>                         | D. Halliday, R. Resnick, J. Walker, S. W. Koch: Fundamentals of physics / Physik. Wiley-VCH, Weinheim, 2003<br>P. A. Tipler, G. Mosca, D. Pelté, M. Basler: Physics/Physik. Spektrum Akademischer Verlag, 2004<br>W. Demtröder: Experimentalphysik, Band 1: Mechanik und Wärme. Springer, Berlin, 2004<br>L. Bergmann, C. Schäfer, H. Gobrecht: Lehrbuch der Experimentalphysik, Band 1: Mechanik, Relativität, Wärme. De Gruyter, Berlin, 1998 |                     |
| <b>Links</b>                                     |   |                     |
| <b>Language of instruction</b>                   | English   |                     |
| <b>Duration (semesters)</b>                      | 1 Semester  |                     |
| <b>Module frequency</b>                          | jährlich  |                     |
| <b>Module capacity</b>                           | unlimited   |                     |
| <b>Modullevel / module level</b>                 | ---   |                     |
| <b>Modular / typ of module</b>                   | je nach Studiengang Pflicht oder Wahlpflicht  |                     |
| <b>Lehr-/Lernform / Teaching/Learning method</b> |   |                     |
| <b>Vorkenntnisse / Previous knowledge</b>        |   |                     |
| Examination                                      | Time of examination   | Type of examination |

| Examination                                    | Time of examination | Type of examination   |           |                                   |
|--|---------------------|---|-----------|-----------------------------------|
| <b>Final exam of module</b>                    |                     | weekly exercises, 2 hrs written exam or 45 min oral exam and assignment. Here you will find information about the consideration of bonus points for module marks. |           |                                   |
| Course type                                    | Comment             | SWS   | Frequency | Workload of compulsory attendance |
| Lecture  |                     | 2   | WiSe      | 28                                |
| Exercises                                      |                     | 2   | WiSe      | 28                                |
| <b>Total time of attendance for the module</b> |                     |   |           | <b>56 h</b>                       |

## phy513 - Basic Laboratory

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|--|--|
| <b>Module label</b>                              | Basic Laboratory   |
| <b>Module code</b>                               | phy513   |
| <b>Credit points</b>                             | 9.0 KP   |
| <b>Workload</b>                                  | 270 h<br>(<br>270 h (Präsenzzeit 140h, Selbststudium: 130h)<br>)   |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"><li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Basismodule</li></ul>   |
| <b>Responsible persons</b>                       | Krüger, Michael (Module responsibility)<br>Koch, Sandra (Module responsibility)<br>Brückner, Hans Josef (Authorized examiners)<br>Schüning, Thomas (Authorized examiners)<br>Koch, Sandra (Authorized examiners)<br>Krüger, Michael (Authorized examiners)<br>Neu, Walter (Authorized examiners)<br>Reck, Martin (Authorized examiners)<br>Schellenberg, Markus (Authorized examiners)<br>Struve, Bert (Authorized examiners)<br>Teubner, Ulrich (Authorized examiners)<br>Huke, Philipp (Authorized examiners)<br>Hölling, Michael (Authorized examiners) |
| <b>Prerequisites</b>                             | - Simultaneous hearing of Mechanics & Electrodynamics and Optics lectures - Course I is a prerequisite for course II   |
| <b>Skills to be acquired in this module</b>      | Students will learn the basics of physical experimentation, the use of modern instrumentation, data collection and analysis using appropriate hardware and software. They deepen lecture material through their own experiments. They acquire the skills for planning, implementation, evaluation, analysis, and reporting of physical experiments and presenting of results using multimedia tools. By working in groups, they gain competencies in the areas of teamwork and communication.  |
| <b>Module contents</b>                           | Introduction to software for scientific data analysis, analysis and assessment of measurement uncertainties, analysis and verification of measured data, fitting of functions to measured data, dealing with modern measurement techniques, carrying out experiments in the fields of mechanics, electricity, optics, nuclear radiation, electronics, signal acquisition, signal processing.   |
| <b>Reader's advisory</b>                         | See <a href="http://www.physik.uni-oldenburg.de/Docs/praktika/45394.html">http://www.physik.uni-oldenburg.de/Docs/praktika/45394.html</a> for the first semester and will be provided via Stud-IP for the second semester.   |
| <b>Links</b>                                     |  |
| <b>Language of instruction</b>                   | English  |
| <b>Duration (semesters)</b>                      | 2 Semester   |
| <b>Module frequency</b>                          | jährlich   |
| <b>Module capacity</b>                           | unlimited  |
| <b>Reference text</b>                            | The first part will take place in Oldenburg (Winter Semester)<br>The second part will take place in Emden (Summer Semester)  |
| <b>Modullevel / module level</b>                 | BM (Basismodul / Base)   |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Laborpraktikum: 8 SWS<br>Seminar: 2 SWS<br><br>Praktikum: 4 WiSe 70 h  |

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Seminar: 1 WiSe 14 h  
Praktikum: HS EL 4 SoSe 56

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|---|---------------------|--|
| <b>Vorkenntnisse / Previous knowledge</b> |                     |  |
| Examination                               | Time of examination | Type of examination  |
| <b>Final exam of module</b>               |                     | Successful execution and record keeping of the experiments, presentation of the results in lectures. |
| <b>Course type</b>                        | Practical training  |  |
| <b>SWS</b>                                | 8                   |  |
| <b>Frequency</b>                          |                     |  |
| <b>Workload attendance</b>                | 112 h               |  |

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## phy520 - Electrodynamics and Optics

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|---|---|
| <b>Module label</b>                         | Electrodynamics and Optics  |
| <b>Module code</b>                          | phy520  |
| <b>Credit points</b>                        | 9.0 KP  |
| <b>Workload</b>                             | 270 h<br>(<br>Attendance 112 hrs Self study: 158 hrs<br>)   |
| <b>Applicability of the module</b>          | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Basismodule</li> </ul>  |
| <b>Responsible persons</b>                  | <p>Groß, Petra (Authorized examiners)</p> <p>Kittel, Achim (Authorized examiners)</p> <p>Lienau, Christoph (Authorized examiners)</p> <p>Nilius, Niklas (Authorized examiners)</p> <p>Peinke, Joachim (Authorized examiners)</p> <p>Schäfer, Sascha (Authorized examiners)</p> <p>Schellenberg, Markus (Authorized examiners)</p> <p>Uppenkamp, Stefan (Authorized examiners)</p> <p>van de Par, Steven (Authorized examiners)</p> <p>Wollenhaupt, Matthias (Authorized examiners)</p>  |
| <b>Prerequisites</b>                        | Mechanics   |
| <b>Skills to be acquired in this module</b> | <p>Electrodynamics and optics:<br/>Students will be able to understand the electric and magnetic phenomena and their treatment by an electromagnetic field including electromagnetic waves - with special emphasis on light.</p> <p>Optical systems:<br/>The students should be able with the help of optics basics to apply the optics to solve questions of informatics and measurement technology illumination technology materials processing with laser beams and the development of optical mechanical instruments and systems to implement the field of optics and to solve engineering questions.</p>   |
| <b>Module contents</b>                      | <p>Electrodynamics and optics:<br/>Basics of Electrostatics, matter in an electric field, the magnetic field, motion of charges in electric and magnetic fields, magnetism in matter, induction, electromagnetic waves, light as electromagnetic wave</p> <p>Optical systems:<br/>Summary of optical basics, technical optics as basics, optical rays, behaviour and properties of electromagnetic waves, application of wave optic properties, area of validity and law of geometric optics, application of ray optic laws, optical image, imaging construction elements, ray bundle, bundle limitation, physics of rays and light, colours, optical systems, set-up and function of selected optical systems of the illumination technology, measurement technology, material processing with laser beams, Communication technology</p>   |
| <b>Reader's advisory</b>                    | <p>Electrodynamics and optics:<br/>D. Meschede: Gerthsen, Physik. Springer, Berlin, 2005 (available in English)<br/>P. A. Tipler, G. Mosca, D. Pelté, M. Basler: Physik. Spektrum Akademischer Verlag, 2004<br/>W. Demtröder: Experimentalphysik, Band 2: Elektrizität und Optik. Springer, Berlin, 2004 (available in English)<br/>H. Hänsel, W. Neumann: Physik. Elektrizität, Optik, Raum und Zeit. Spektrum Akademischer Verlag, Heidelberg, 2003<br/>S. Brandt, H. D. Dahmen: Elektrodynamik. Eine Einführung in Experiment und Theorie. Springer, Berlin, 2005<br/>W. Greiner: Klassische Elektrodynamik. Harri Deutsch, Frankfurt, 2002<br/>E. Hecht: Optik. Oldenbourg, München, 2005</p> <p>Optical systems:<br/>Waren J. Smith: Modern Optical Engineering, Mc Graw Hill, 4th edition, 2008<br/>G. Schröder: Technische Optik, Vogel Verlag Würzburg, 2007<br/>Scriptum</p> |
| <b>Links</b>                                |   |
| <b>Language of instruction</b>              | English   |
| <b>Duration (semesters)</b>                 | 1 Semester  |
| <b>Module frequency</b>                     | jährlich  |
| <b>Module capacity</b>                      | unlimited   |



|  |   |     |                     |                                   |
|--|---|-----|---------------------|-----------------------------------|
| <b>Modullevel / module level</b>                 | ---   |     |                     |                                   |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht  |     |                     |                                   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Lecture: 6 hrs/week<br>Exercise: 2 hrs/week   |     |                     |                                   |
| <b>Vorkenntnisse / Previous knowledge</b>        |   |     |                     |                                   |
| Examination                                      | Time of examination   |     | Type of examination |                                   |
| <b>Final exam of module</b>                      | 2 exams: 180 min written exam or 60 min oral exam. Here , you will find information about the consideration of bonus points for module marks. |     |                     |                                   |
| Course type                                      | Comment   | SWS | Frequency           | Workload of compulsory attendance |
| Lecture  |   | 6   | SuSe                | 84                                |
| Exercises  |   | 2   | SuSe                | 28                                |
| <b>Total time of attendance for the module</b>   |   |     |                     | 112 h                             |

## phy540 - Mathematical Methods for Physics and Engineering I

|  |   |                     |           |                                   |
|--|---|---------------------|-----------|-----------------------------------|
| <b>Module label</b>                              | Mathematical Methods for Physics and Engineering I  |                     |           |                                   |
| <b>Module code</b>                               | phy540  |                     |           |                                   |
| <b>Credit points</b>                             | 9.0 KP  |                     |           |                                   |
| <b>Workload</b>                                  | 270 h<br>(<br>Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden<br>)   |                     |           |                                   |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>• Bachelor's Programme Engineering Physics (Bachelor) &gt; Basismodule</li> <li>• Bachelor's Programme Physics, Engineering and Medicine (Bachelor) &gt; Basismodule</li> </ul>  |                     |           |                                   |
| <b>Responsible persons</b>                       | <p>Uppenkamp, Stefan (Module responsibility)</p> <p>Doclo, Simon (Authorized examiners)</p> <p>Hohmann, Volker (Authorized examiners)</p> <p>Uppenkamp, Stefan (Authorized examiners)</p> <p>van de Par, Steven (Authorized examiners)</p>  |                     |           |                                   |
| <b>Prerequisites</b>                             | Abiturwissen Mathematik   |                     |           |                                   |
| <b>Skills to be acquired in this module</b>      | To obtain basic knowledge in application of mathematical methods to solve problems in physics and engineering   |                     |           |                                   |
| <b>Module contents</b>                           | <p>Vector algebra (vectors in 2- and 3-space, vector products, planes, lines, cylindrical and spherical coordinates)</p> <p>Preliminary calculus (elementary functions, limits, series, differentiation, integration)</p> <p>Preliminary complex analysis</p> <p>Introduction to ordinary differential equations</p> <p>Partial differentiation</p> <p>Vector calculus (scalar and vector fields, vector operators, line, surface and volume integrals, divergence and Stokes' theorem)</p> |                     |           |                                   |
| <b>Reader's advisory</b>                         | K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006   |                     |           |                                   |
| <b>Links</b>                                     |   |                     |           |                                   |
| <b>Language of instruction</b>                   | English   |                     |           |                                   |
| <b>Duration (semesters)</b>                      | 1 Semester  |                     |           |                                   |
| <b>Module frequency</b>                          | jährlich  |                     |           |                                   |
| <b>Module capacity</b>                           | unlimited   |                     |           |                                   |
| <b>Modullevel / module level</b>                 | BM (Basismodul / Base)  |                     |           |                                   |
| <b>Modulart / typ of module</b>                  | Wahlpflicht / Elective  |                     |           |                                   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Vorlesung: 4 SWS,<br>Übungen: 2 SWS   |                     |           |                                   |
| <b>Vorkenntnisse / Previous knowledge</b>        |   |                     |           |                                   |
| Examination                                      | Time of examination   | Type of examination |           |                                   |
| <b>Final exam of module</b>                      | Max. 180 min written exam or 30 min oral exam.<br>Here , you will find information about the consideration of bonus points for module marks.  |                     |           |                                   |
| Course type                                      | Comment   | SWS                 | Frequency | Workload of compulsory attendance |
| Lecture  |   | 4                   |           | 56                                |
| Exercises  |   | 2                   |           | 28                                |
| <b>Total time of attendance for the module</b>   |   |                     |           | 84 h                              |

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# Aufbaumodule

## phy031 - Atomic and Molecular Physics

|   |  |
|---|--|
| <b>Module label</b>                         | Atomic and Molecular Physics   |
| <b>Module code</b>                          | phy031   |
| <b>Credit points</b>                        | 6.0 KP   |
| <b>Workload</b>                             | 180 h<br>(<br>Präsenzzeit 84h, Selbststudium: 96h<br>)   |
| <b>Applicability of the module</b>          | <ul style="list-style-type: none"><li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>  |
| <b>Responsible persons</b>                  | Neu, Walter (Module responsibility)<br><br>Bayer, Tim-Daniel (Authorized examiners)<br><br>Englert, Lars (Authorized examiners)<br><br>Groß, Petra (Authorized examiners)<br><br>Kittel, Achim (Authorized examiners)<br><br>Lienau, Christoph (Authorized examiners)<br><br>Neu, Walter (Authorized examiners)<br><br>Nilius, Niklas (Authorized examiners)<br><br>Pengel, Dominik (Authorized examiners)<br><br>Schäfer, Sascha (Authorized examiners)<br><br>Wollenhaupt, Matthias (Authorized examiners)   |
| <b>Prerequisites</b>                        | Courses in Experimental Physics I and II and Mathematics I & II  |
| <b>Skills to be acquired in this module</b> | The students are competent on the fundamental principles of atomic and molecular physics. They are familiar to classical description and have established a quantum mechanical understanding. The exercises and tutorials deepen the knowledge by assigning appropriate homework.  |
| <b>Module contents</b>                      | <ul style="list-style-type: none"><li>concepts of atomic models</li><li>angular momentum, spin, and magnetic properties of the electrons</li><li>interaction with electric and magnetic fields</li><li>wave-particle dualism of electrons and photons</li><li>introduction to quantum mechanics: wave packets, Schrodinger equation, Heisenberg uncertainty principle</li><li>relativity and Dirac equation</li><li>coupling schemes and atomic spectra</li><li>Bosons and fermions</li><li>periodic system of the elements</li><li>introduction to molecular physics</li><li>molecular spectra</li><li>applications: the electron in the box, the harmonic oscillator, the hydrogen atom, fine and hyperfine structure, line shapes, spectroscopy and modern experimental methods</li></ul> |
| <b>Reader's advisory</b>                    | W. Demtröder: Experimentalphysik, Band 3: Atome, Moleküle, Festkörper. Springer, Berlin, 2000. (available in English)<br>H. Haken, H. C. Wolf: Atom- und Quantenphysik. Springer, Berlin 2004.<br>H. Haken, H. C. Wolf: Molekülphysik und Quantenchemie. Springer, Berlin, 2004. (available in English)<br>H.-J. Leisi: Quantenphysik. Springer, Berlin, 2004.<br>G. Otter, R. Honecker: Atome, Moleküle, Kerne. Teubner, Stuttgart, 1998.<br>B. Thaller: Visual Quantum Mechanics – Selected topics with computer generated movies of quantum mechanical phenomena. Springer, Berlin, 2002.   |
| <b>Links</b>                                |  |
| <b>Languages of instruction</b>             | German, English  |
| <b>Duration (semesters)</b>                 | 1 Semester   |
| <b>Module frequency</b>                     | jährlich   |

|  |  |                     |           |                                   |
|--|--|---------------------|-----------|-----------------------------------|
| <b>Module capacity</b>                           | unlimited  |                     |           |                                   |
| <b>Reference text</b>                            |  |                     |           |                                   |
| <b>Modullevel / module level</b>                 | AC (Aufbaucurriculum / Composition)  |                     |           |                                   |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |                     |           |                                   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Vorlesung: 4 SWS, Übung: 2 SWS   |                     |           |                                   |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |                     |           |                                   |
| Examination                                      | Time of examination  | Type of examination |           |                                   |
| <b>Final exam of module</b>                      | Successful attendance of the weekly exercises, 45 min oral exam.<br>Here , you will find information about the consideration of bonus points for module marks. |                     |           |                                   |
| Course type                                      | Comment  | SWS                 | Frequency | Workload of compulsory attendance |
| Lecture  |  | 4                   |           | 56                                |
| Exercises  |  | 2                   |           | 28                                |
| <b>Total time of attendance for the module</b>   |  |                     |           | 84 h                              |

## phy041 - Thermodynamics and Statistics

|  |  |     |           |                                   |      |
|--|--|-----|-----------|-----------------------------------|------|
| <b>Module label</b>                              | Thermodynamics and Statistics  |     |           |                                   |      |
| <b>Module code</b>                               | phy041   |     |           |                                   |      |
| <b>Credit points</b>                             | 6.0 KP   |     |           |                                   |      |
| <b>Workload</b>                                  | 180 h<br>(<br>attendance: 84 hrs self study: 96 hrs<br>)   |     |           |                                   |      |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |     |           |                                   |      |
| <b>Responsible persons</b>                       | Kittel, Achim (Authorized examiners)<br><br>Lienau, Christoph (Authorized examiners)<br><br>Nilius, Niklas (Authorized examiners)<br><br>Peinke, Joachim (Authorized examiners)<br><br>Schäfer, Sascha (Authorized examiners)<br><br>Wollenhaupt, Matthias (Authorized examiners)  |     |           |                                   |      |
| <b>Prerequisites</b>                             | courses experimental physics 1, 2, 3   |     |           |                                   |      |
| <b>Skills to be acquired in this module</b>      | Procurement of fundamental principles of thermodynamics and statistical physics to enable students to understand and analyze formulation of relations for particle ensembles with appropriate magnitudes.  |     |           |                                   |      |
| <b>Module contents</b>                           | I. PHENOMENOLOGICAL THERMODYNAMICS A) Fundamental Concepts Temperature, thermal equilibrium, 0. law, heat, internal energy, work from a system, first law, thermodynamic states and processes, thermodynamic cycles, B) Application of Fundamental Concepts Carnot and Stirling cycle, second law, entropy, Legendre Transform and potential functions (Free Energy, Enthalpy, Gibbs Potential), irreversible processes and change in entropy, C) Open Systems, real Gases, phase transitions II. STATISTICS Isotropic particle distribution in space Diffusion (1-dim) via particle hopping entropy changes with volume alteration energy distribution for distinguishable particles (Boltzmann- and Maxwell-distribution) energy distribution for non-distinguishable Particles (Fermi-Dirac-, and Bose-Einstein-distribution) Black Body Radiator (Plancks law) Saha-Equation |     |           |                                   |      |
| <b>Reader's advisory</b>                         | M. W. Zemansky, R. H. Dittman: Heat and Thermodynamics. McGraw-Hill, New York, 1997; Van P. Carey: Statistical thermodynamics and microscale thermophysics, Cambridge University Press, Cambridge (UK) 1999; H. B. Callen: Thermodynamics. John Wiley, New York, 1978; C. Kittel, H. Krömer: Physik der Wärme. Oldenbourg, München, 1993; D. K. Kondepudi, I. Prigogine: Modern thermodynamics. John Wiley, New York, 1998;  |     |           |                                   |      |
| <b>Links</b>                                     |  |     |           |                                   |      |
| <b>Language of instruction</b>                   | German   |     |           |                                   |      |
| <b>Duration (semesters)</b>                      | 1 Semester   |     |           |                                   |      |
| <b>Module frequency</b>                          | jährlich   |     |           |                                   |      |
| <b>Module capacity</b>                           | unlimited  |     |           |                                   |      |
| <b>Modullevel / module level</b>                 | ---  |     |           |                                   |      |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |     |           |                                   |      |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Lecture: 4 hrs/week<br>Exercise: 2 hrs/week  |     |           |                                   |      |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |     |           |                                   |      |
| Examination                                      | Time of examination  |     |           | Type of examination               |      |
| <b>Final exam of module</b>                      |  |     |           | KL                                |      |
| Course type                                      | Comment  | SWS | Frequency | Workload of compulsory attendance |      |
| Lecture  |  | 4   |           | 56                                |      |
| Exercises  |  | 2   |           | 28                                |      |
| <b>Total time of attendance for the module</b>   |  |     |           |                                   | 84 h |

## phy050 - Experimental Physics V:Solid State Physics

|  |   |
|--|---|
| <b>Module label</b>                              | Experimental Physics V:Solid State Physics  |
| <b>Module code</b>                               | phy050  |
| <b>Credit points</b>                             | 6.0 KP  |
| <b>Workload</b>                                  | 180 h<br>(<br>Präsenzzeit: 84 Stunden<br>Selbststudium: 96 Stunden<br>)   |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>• Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> <li>• Bachelor's Programme Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |
| <b>Responsible persons</b>                       | <p>Borchert, Holger (Authorized examiners)</p> <p>Kittel, Achim (Authorized examiners)</p> <p>Lienau, Christoph (Authorized examiners)</p> <p>Nilius, Niklas (Authorized examiners)</p> <p>Schäfer, Sascha (Authorized examiners)</p> <p>Wollenhaupt, Matthias (Authorized examiners)</p>   |
| <b>Prerequisites</b>                             | Experimentalphysik I-IV, Theoretische Physik I und II   |
| <b>Skills to be acquired in this module</b>      | Die Studierenden erwerben Kenntnisse über Phänomene der Festkörperphysik und ausgewählter Spezialgebiete (Halbleiterphysik, Photovoltaik, Tieftemperaturphysik, Supraleitung). Sie erlangen Fertigkeiten zur Anwendung grundlegender Methoden und Prinzipien der Beschreibung von Festkörperphänomenen (Symmetrien, reziproker Raum, Modenspektren, Bloch Gleichungen, Wechselwirkungen, Extrembetrachtungen wie starke und schwache Elektronenbindung, makroskopische Quantenphänomene, Beschreibung der Störung der periodischen Gitterstruktur). Sie erwerben Kompetenzen zur Erfassung der Funktion von technisch relevanten Bauteilen, zur vertiefenden Einarbeitung in weitergehende Bereiche und zur Entwicklung neuartiger Bauelemente aufgrund des erlernten Wissens. Außerdem erlangen sie Kompetenzen zur gesellschaftspolitischen Einordnung der Konsequenzen von physikalischer Forschung.   |
| <b>Module contents</b>                           | Kristallstrukturen und Symmetrien, Bravais-Gitter, Translationssymmetrie und reziprokes Gitter, Brillouin-Zone, Bindungstypen und -energien (kovalente, ionische, van der Waals, metallische und Wasserstoffbrücken-Bindung), Dynamik der Kristallgitter, Phononen, nichtlineare und anharmonische Effekte, spez. Wärme, Wärmeleitung und Umklapp-Prozesse, Elektronen in Festkörpern, quasifreies Elektronengas, Zustandsdichten und Fermi-niveau, Transportgleichung, Elektronen im periodischen Potential, Blochtheorem, Bänderschema, effektive Masse, Zustandsdichten und Besetzung, Metalle/Isolatoren, Grundlagen der Halbleiter, dielektrische Eigenschaften, komplexe Brechungsindices für Metalle und Isolatoren, 1-Oszillatormodell, Kramers-Kronig-Relation, lokales Feld, Meta-Materialien, Grundlagen der Supraleitung, magnetische Eigenschaften, Dia-, Para-, Ferromagnetismus, Austauschwechselwirkung, Spinwellen, Spingläser   |
| <b>Reader's advisory</b>                         | <p>1. N. W. Ashcroft, N. D. Mermin: Solid State Physics. Saunders College, Philadelphia, [BIS]<a href="http://www.bis.uni-oldenburg.de/katalogsuche/freitext=ashcroft+solid+state">http://www.bis.uni-oldenburg.de/katalogsuche/freitext=ashcroft+solid+state</a></p> <p>2. N. W. Ashcroft, N. D. Mermin: Festkörperphysik. Oldenbourg, München, [BIS]<a href="http://www.bis.uni-oldenburg.de/katalogsuche/freitext=ashcroft+festkoerperphysik">http://www.bis.uni-oldenburg.de/katalogsuche/freitext=ashcroft+festkoerperphysik</a></p> <p>3. S. Elliott: The Physics and Chemistry of Solids. John Wiley &amp; Sons, West Sussex (UK), [BIS]<a href="http://www.bis.uni-oldenburg.de/katalogsuche/freitext=elliott+physics+solids">http://www.bis.uni-oldenburg.de/katalogsuche/freitext=elliott+physics+solids</a></p> <p>4. H. Ibach, H. Lüth: Festkörperphysik. Springer, Berlin, [BIS]<a href="http://www.bis.uni-oldenburg.de/katalogsuche/freitext=ibach+festkoerperphysik">http://www.bis.uni-oldenburg.de/katalogsuche/freitext=ibach+festkoerperphysik</a></p> <p>5. Siegfried Hunklinger: Festkörperphysik, Oldenbourg, München, [BIS]<a href="http://www.bis.uni-oldenburg.de/katalogsuche/freitext=hunklinger+festkoerperphysik">http://www.bis.uni-oldenburg.de/katalogsuche/freitext=hunklinger+festkoerperphysik</a></p> <p>6. K. Kopitzki : Einführung in die Festkörperphysik. Teubner, Stuttgart, [BIS]<a href="http://www.bis.uni-oldenburg.de/katalogsuche/freitext=kopitzki+einfuehrung++festkoerperphysik">http://www.bis.uni-oldenburg.de/katalogsuche/freitext=kopitzki+einfuehrung++festkoerperphysik</a></p> |
| <b>Links</b>                                     |   |
| <b>Language of instruction</b>                   | German  |
| <b>Duration (semesters)</b>                      | 1 Semester  |
| <b>Module frequency</b>                          | jährlich  |
| <b>Module capacity</b>                           | unlimited   |
| <b>Reference text</b>                            | Studienleistungen: wöchentliche Übungen   |
| <b>Modullevel / module level</b>                 |   |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht  |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | VL, Ü   |
| <b>Vorkenntnisse / Previous knowledge</b>        |   |

| Examination                                    |         | Time of examination | Type of examination |                                   |
|--|---------|---------------------|---------------------|-----------------------------------|
| <b>Final exam of module</b>                    |         |                     | KL                  |                                   |
| Course type                                    | Comment | SWS                 | Frequency           | Workload of compulsory attendance |
| Lecture  |         |                     | --                  | 0                                 |
| Exercises                                      |         | 2                   | SoSe oder WiSe      | 28                                |
| <b>Total time of attendance for the module</b> |         |                     |                     | <b>28 h</b>                       |

## phy150 - Numerical Methods of Physics

|  |  |                     |           |                                   |
|--|--|---------------------|-----------|-----------------------------------|
| <b>Module label</b>                              | Numerical Methods of Physics   |                     |           |                                   |
| <b>Module code</b>                               | phy150   |                     |           |                                   |
| <b>Credit points</b>                             | 6.0 KP   |                     |           |                                   |
| <b>Workload</b>                                  | 180 h<br>(<br>Attendance: 56 hrs<br>Self study: 124hrs<br>)  |                     |           |                                   |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>• Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> <li>• Bachelor's Programme Physics (Bachelor) &gt; Aufbaumodule</li> <li>• Bachelor's Programme Physics, Engineering and Medicine (Bachelor) &gt; Aufbaumodule</li> </ul>  |                     |           |                                   |
| <b>Responsible persons</b>                       | <p>Anemüller, Jörn (Authorized examiners)</p> <p>Brand, Thomas (Authorized examiners)</p> <p>Hartmann, Alexander (Authorized examiners)</p> <p>Hohmann, Volker (Authorized examiners)</p> <p>Lücke, Jörg (Authorized examiners)</p> <p>Petrovic, Cornelia (Authorized examiners)</p>   |                     |           |                                   |
| <b>Prerequisites</b>                             | Grundlegende Computerkenntnisse, Kenntnisse aus dem Grundstudium PTM Basic computer knowledge; knowledge in undergraduate physics<br>Basistmodul der entsprechenden Studiengänge   |                     |           |                                   |
| <b>Skills to be acquired in this module</b>      | Students acquire theoretical knowledge of basic numerical methods and practical skills to apply these methods on physical problems within all areas of experimental, theoretical and applied physics.  |                     |           |                                   |
| <b>Module contents</b>                           | <p>Basic concepts of numerical mathematics are introduced and applied to physics problems. Topics include: Finite number representation and numerical errors linear and nonlinear systems of equations numerical differentiation and integration function minimization and model fitting discrete Fourier analysis ordinary and partial differential equations.</p> <p>The learned numerical methods will be partly implemented (programmed) and applied to basic problems from mechanics, electrodynamics, etc. in the exercises. The problems are chosen so that analytical solutions are available in most cases. In this way, the quality of the numerical methods can be assessed by comparing numerical and analytical solutions. Programming will be done in Matlab, which is a powerful package for numerical computing. It offers easy, portable programming, comfortable visualization tools and already implements most of the numerical methods introduced in this course. These built-in functions can be compared to own implementations or used in the exercises in some cases when own implementations are too costly. An introduction to Matlab will be given at the beginning of the tutorial.</p> |                     |           |                                   |
| <b>Reader's advisory</b>                         | <p>V. Hohmann: Computerphysik: Numerische Methoden (lecture script). Universität Oldenburg, <a href="http://medi.uni-oldenburg.de/16750.html">http://medi.uni-oldenburg.de/16750.html</a></p> <p>W. H. Press et al.: Numerical Recipes in C - The Art of Scientific Computing. Cambridge University Press, Cambridge, 1992</p> <p>A. L. Garcia: Numerical Methods for Physics. Prentice Hall, Englewood Cliffs (NJ), 1994</p> <p>J. H. Mathews: Numerical Methods for Mathematics, Science and Engineering. Prentice Hall, Englewood Cliffs (NJ), 1992</p> <p>B.W. Kernigham und D. Ritchie: The C Programming Language, Prentice Hall International, Englewood Cliffs (NJ), 1988</p>  |                     |           |                                   |
| <b>Links</b>                                     |  |                     |           |                                   |
| <b>Language of instruction</b>                   | German   |                     |           |                                   |
| <b>Duration (semesters)</b>                      | 1 Semester   |                     |           |                                   |
| <b>Module frequency</b>                          | jährlich   |                     |           |                                   |
| <b>Module capacity</b>                           | unlimited  |                     |           |                                   |
| <b>Modullevel / module level</b>                 |  |                     |           |                                   |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |                     |           |                                   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Vorlesung: 2 SWS<br>Übungen: 2 SWS   |                     |           |                                   |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |                     |           |                                   |
| Examination                                      | Time of examination  | Type of examination |           |                                   |
| <b>Final exam of module</b>                      | weekly graded programming exercises  |                     |           |                                   |
| Course type                                      | Comment  | SWS                 | Frequency | Workload of compulsory attendance |



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| Course type                                    | Comment | SWS | Frequency | Workload of compulsory attendance |
|--|---------|-----|-----------|-----------------------------------|
| Lecture  |         | 2   |           | 28                                |
| Exercises                                      |         | 2   |           | 28                                |
| <b>Total time of attendance for the module</b> |         |     |           | <b>56 h</b>                       |

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## phy505 - Lab Project I

|                                    |   |
|------------------------------------|---|
| <b>Module label</b>                | Lab Project I   |
| <b>Module code</b>                 | phy505  |
| <b>Credit points</b>               | 9.0 KP  |
| <b>Workload</b>                    | 270 h<br>(<br>Attendance: 70 hrs Self-study: 200 hrs<br>)   |
| <b>Applicability of the module</b> | <ul style="list-style-type: none"><li>• Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>   |
| <b>Responsible persons</b>         | Agert, Carsten (Authorized examiners)<br>Anemüller, Jörn (Authorized examiners)<br>Brückner, Hans Josef (Authorized examiners)<br>Heinemann, Detlev (Authorized examiners)<br>Doclo, Simon (Authorized examiners)<br>Ewert, Stephan (Authorized examiners)<br>Groß, Petra (Authorized examiners)<br>Gütay, Levent (Authorized examiners)<br>Hartmann, Alexander (Authorized examiners)<br>Hein, Andreas (Authorized examiners)<br>Hölling, Michael (Authorized examiners)<br>Hohmann, Volker (Authorized examiners)<br>Kittel, Achim (Authorized examiners)<br>Kollmeier, Birger (Authorized examiners)<br>Jürgens, Tim (Authorized examiners)<br>Schellenberg, Markus (Authorized examiners)<br>Koch, Sandra (Authorized examiners)<br>Schmidt, Andreas Hermann (Authorized examiners)<br>Krüger, Michael (Authorized examiners)<br>Kühn, Martin (Authorized examiners)<br>Lienau, Christoph (Authorized examiners)<br>Meyer, Bernd (Authorized examiners)<br>Neu, Walter (Authorized examiners)<br>Poppe, Björn (Authorized examiners)<br>Nilius, Niklas (Authorized examiners)<br>Peinke, Joachim (Authorized examiners)<br>Schüning, Thomas (Authorized examiners)<br>Reck, Martin (Authorized examiners)<br>Schäfer, Sascha (Authorized examiners)<br>van de Par, Steven (Authorized examiners)<br>Struve, Bert (Authorized examiners)<br>Teubner, Ulrich (Authorized examiners) |

Uppenkamp, Stefan (Authorized examiners)

Vogelgesang, Ralf (Authorized examiners)

Wollenhaupt, Matthias (Authorized examiners)

|  |  |   |           |                                   |
|--|--|---|-----------|-----------------------------------|
| <b>Prerequisites</b>                             | Lecture "Electronics"  |   |           |                                   |
| <b>Skills to be acquired in this module</b>      | Laboratory:<br>Knowledge and experience about experimental work, managing experimental work and evaluating results.<br><br>Design Fundamentals:<br>Achieving basic knowledge in reading, understanding and production of technical drawings, getting and overview about the features of CAD-Software, knowing about the basic principles of designing and dimensioning of machine elements.  |   |           |                                   |
| <b>Module contents</b>                           | Laboratory:<br>Experiments in the field of electronics and measurement technique<br><br>Design Fundamentals:<br>Rules and Standards for Technical Drawings,<br><br>Design Phases: <ul style="list-style-type: none"><li>• Functional requirements, performance specifications</li><li>• Design methodology</li><li>• Decision processes</li><li>• Detailing</li><li>• Manufacturing Drawings</li><li>• Grouping of parts</li></ul><br>Basic Machine Elements: <ul style="list-style-type: none"><li>• Frames</li><li>• Joints</li><li>• Bearings</li><li>• Sealing</li></ul> |   |           |                                   |
| <b>Reader's advisory</b>                         | Laboratory:<br>Specific project descriptions<br><br>Design Fundamentals:<br>ISO- and EN- Standards,<br>Childs: Mechanical Design,<br>Ulrich/Eppinger: Product Design and Development,<br>Matousek: Engineering Design  |   |           |                                   |
| <b>Links</b>                                     |  |   |           |                                   |
| <b>Language of instruction</b>                   | English  |   |           |                                   |
| <b>Duration (semesters)</b>                      | 1 Semester   |   |           |                                   |
| <b>Module frequency</b>                          | jährlich   |   |           |                                   |
| <b>Module capacity</b>                           | unlimited  |   |           |                                   |
| <b>Modullevel / module level</b>                 | AC (Aufbaucurriculum / Composition)  |   |           |                                   |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |   |           |                                   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Laboratory: 3 hrs/week<br>Lecture: 2 hrs/week  |   |           |                                   |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |   |           |                                   |
| Examination                                      | Time of examination  | Type of examination   |           |                                   |
| <b>Final exam of module</b>                      |  | Report and project presentation; assignment (Design Fundamentals) |           |                                   |
| Course type                                      | Comment  | SWS   | Frequency | Workload of compulsory attendance |
| Lecture  |  | 2   |           | 28                                |
| Practical training                               |  | 3   |           | 42                                |
| <b>Total time of attendance for the module</b>   |  |   |           | 70 h                              |

## phy530 - Metrology

|  |  |                     |           |                                   |
|--|--|---------------------|-----------|-----------------------------------|
| <b>Module label</b>                              | Metrology  |                     |           |                                   |
| <b>Module code</b>                               | phy530   |                     |           |                                   |
| <b>Credit points</b>                             | 6.0 KP   |                     |           |                                   |
| <b>Workload</b>                                  | 180 h<br>(<br>Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden<br>)  |                     |           |                                   |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>• Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> <li>• Bachelor's Programme Physics, Engineering and Medicine (Bachelor) &gt; Aufbaumodule</li> </ul>   |                     |           |                                   |
| <b>Responsible persons</b>                       | <p>Ewert, Stephan (Authorized examiners)</p> <p>Kittel, Achim (Authorized examiners)</p> <p>Kollmeier, Birger (Authorized examiners)</p> <p>Meyer, Bernd (Authorized examiners)</p> <p>van de Par, Steven (Authorized examiners)</p>   |                     |           |                                   |
| <b>Prerequisites</b>                             |  |                     |           |                                   |
| <b>Skills to be acquired in this module</b>      | Procurement of fundamental principles of metrology to enable the student to analyze, understand and solve the principle problems of measurement techniques.  |                     |           |                                   |
| <b>Module contents</b>                           | Sensors for measurements of the different physical quantities, data logging and processing, measuring systems  |                     |           |                                   |
| <b>Reader's advisory</b>                         | <p>H.-R. Tränkler, E. Obermeier: Sensortechnik. Springer, Berlin, 1998</p> <p>J. Niebuhr, G. Lindner: Physikalische Messtechnik mit Sensoren. Oldenbourg, München, 2001</p> <p>J. F. Keithley: Low /Level Measurements Handbook. Keithley Instruments Inc., 1998</p> <p>J.-R. Ohm, H. D. Lüke: Signalübertragung. Springer, Berlin, 2005</p> <p>K.-D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung: Filterung und Spektralanalyse mit MATLAB-Übungen. Teubner, Stuttgart, 2002</p> <p>Fourieranalyse</p> |                     |           |                                   |
| <b>Links</b>                                     |  |                     |           |                                   |
| <b>Language of instruction</b>                   | German   |                     |           |                                   |
| <b>Duration (semesters)</b>                      | 1 Semester   |                     |           |                                   |
| <b>Module frequency</b>                          | jährlich   |                     |           |                                   |
| <b>Module capacity</b>                           | unlimited  |                     |           |                                   |
| <b>Modullevel / module level</b>                 | ---  |                     |           |                                   |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |                     |           |                                   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Vorlesung: 3 SWS, Übungen: 1 SWS   |                     |           |                                   |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |                     |           |                                   |
| Examination                                      | Time of examination  | Type of examination |           |                                   |
| <b>Final exam of module</b>                      | 90 min written exam or 45 min oral exam (Signalverarbeitung) and assignment (Phys. Messtechnik).<br>Here , you will find information about the consideration of bonus points for module marks.   |                     |           |                                   |
| Course type                                      | Comment  | SWS                 | Frequency | Workload of compulsory attendance |
| Lecture  |  | 3                   |           | 42                                |
| Exercises  |  | 1                   |           | 14                                |
| <b>Total time of attendance for the module</b>   |  |                     |           | 56 h                              |

## phy541 - Mathematical Methods for Physics and Engineering II

|  |   |            |                     |  |
|--|---|------------|---------------------|--|
| <b>Module label</b>                              | Mathematical Methods for Physics and Engineering II   |            |                     |  |
| <b>Module code</b>                               | phy541  |            |                     |  |
| <b>Credit points</b>                             | 6.0 KP  |            |                     |  |
| <b>Workload</b>                                  | 180 h<br>(<br>attendance: 56 hrs self study: 124 hrs<br>)   |            |                     |  |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>• Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> <li>• Bachelor's Programme Physics, Engineering and Medicine (Bachelor) &gt; Basismodule</li> </ul>   |            |                     |  |
| <b>Responsible persons</b>                       | <p>Doclo, Simon (Module responsibility)</p> <p>Doclo, Simon (Authorized examiners)</p> <p>Hohmann, Volker (Authorized examiners)</p> <p>Uppenkamp, Stefan (Authorized examiners)</p> <p>van de Par, Steven (Authorized examiners)</p>   |            |                     |  |
| <b>Prerequisites</b>                             | Contents of the lecture "Mathematical Methods for Physics and Engineering I"  |            |                     |  |
| <b>Skills to be acquired in this module</b>      | To obtain advanced knowledge in application of mathematical methods to solve problems in physics and engineering.   |            |                     |  |
| <b>Module contents</b>                           | <ul style="list-style-type: none"> <li>• Matrices and vector spaces (linear vector spaces, basis, norm, matrices, matrix operations, determinant, inverse matrix, eigenvalue decomposition)</li> <li>• Quadratic forms</li> <li>• Linear equations (Gauss elimination, least-squares solution)</li> <li>• Functions of multiple variables (stationary points, constrained optimisation using Lagrange multipliers)</li> <li>• Fourier series</li> </ul> |            |                     |  |
| <b>Reader's advisory</b>                         | K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006   |            |                     |  |
| <b>Links</b>                                     |   |            |                     |  |
| <b>Language of instruction</b>                   | English   |            |                     |  |
| <b>Duration (semesters)</b>                      | 1 Semester  |            |                     |  |
| <b>Module frequency</b>                          | jährlich  |            |                     |  |
| <b>Module capacity</b>                           | unlimited   |            |                     |  |
| <b>Modullevel / module level</b>                 |   |            |                     |  |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht  |            |                     |  |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Lecture: 2 hrs/week<br>Exercise: 2 hrs/week   |            |                     |  |
| <b>Vorkenntnisse / Previous knowledge</b>        |   |            |                     |  |
| <b>Examination</b>                               | Time of examination   |            | Type of examination |  |
| <b>Final exam of module</b>                      | Max. 180 min written exam or 30 min oral exam.<br>Here , you will find information about the consideration of bonus points for module marks.  |            |                     |  |
| <b>Course type</b>                               | <b>Comment</b>  | <b>SWS</b> | <b>Frequency</b>    | <b>Workload of compulsory attendance</b> |
| Lecture  |   | 2          |                     | 28                                       |
| Exercises  |   | 2          |                     | 28                                       |
| <b>Total time of attendance for the module</b>   |   |            |                     | 56 h                                     |

## phy542 - Mathematical Methods for Physics and Engineering III

|  |   |  |                  |  |
|--|---|--|------------------|--|
| <b>Module label</b>                              | Mathematical Methods for Physics and Engineering III  |  |                  |  |
| <b>Module code</b>                               | phy542  |  |                  |  |
| <b>Credit points</b>                             | 6.0 KP  |  |                  |  |
| <b>Workload</b>                                  | 180 h<br>(<br>180h (attendance: 56h; self-study: 124h)<br>)   |  |                  |  |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>• Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> <li>• Bachelor's Programme Physics, Engineering and Medicine (Bachelor) &gt; Aufbaumodule</li> </ul>  |  |                  |  |
| <b>Responsible persons</b>                       | <p>Doclo, Simon (Authorized examiners)</p> <p>Hohmann, Volker (Authorized examiners)</p> <p>Uppenkamp, Stefan (Authorized examiners)</p> <p>van de Par, Steven (Authorized examiners)</p> <p>Hohmann, Volker (Module responsibility)</p>  |  |                  |  |
| <b>Prerequisites</b>                             |   |  |                  |  |
| <b>Skills to be acquired in this module</b>      | To obtain advanced knowledge in application of mathematical methods to solve problems in physics and engineering.   |  |                  |  |
| <b>Module contents</b>                           | <ul style="list-style-type: none"> <li>• Complex analysis</li> <li>• Partial differential equations</li> <li>• Special functions in physics and engineering</li> <li>• Special integral transform in physics and engineering</li> <li>• Special linear and nonlinear differential equations in physics and engineering</li> <li>• Statistics</li> </ul> |  |                  |  |
| <b>Reader's advisory</b>                         | K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006   |  |                  |  |
| <b>Links</b>                                     |   |  |                  |  |
| <b>Language of instruction</b>                   | English   |  |                  |  |
| <b>Duration (semesters)</b>                      | 1 Semester  |  |                  |  |
| <b>Module frequency</b>                          | jährlich  |  |                  |  |
| <b>Module capacity</b>                           | unlimited   |  |                  |  |
| <b>Modullevel / module level</b>                 |   |  |                  |  |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht  |  |                  |  |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Lecture: 2 hrs/week, Tutorial: 2 hrs/week   |  |                  |  |
| <b>Vorkenntnisse / Previous knowledge</b>        | Contents of the lectures "Mathematical Methods for Physics and Engineering I and II"  |  |                  |  |
| <b>Examination</b>                               | Time of examination   | Type of examination  |                  |  |
| <b>Final exam of module</b>                      |   | 2 hrs written exam or 45 min oral exam. Here , you will find information about the consideration of bonus points for module marks. |                  |  |
| <b>Course type</b>                               | <b>Comment</b>  | <b>SWS</b>   | <b>Frequency</b> | <b>Workload of compulsory attendance</b> |
| Lecture  |   | 2  |                  | 28                                       |
| Exercises  |   | 2  |                  | 28                                       |
| <b>Total time of attendance for the module</b>   |   |  |                  | 56 h                                     |

## phy551 - Quantum Structure of Matter

|  |  |
|--|--|
| <b>Module label</b>                              | Quantum Structure of Matter  |
| <b>Module code</b>                               | phy551   |
| <b>Credit points</b>                             | 6.0 KP   |
| <b>Workload</b>                                  | 180 h<br>(<br>Attendance: 56 hrs<br>Self study: 124 hrs<br>)   |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |
| <b>Responsible persons</b>                       | <p>Cocchi, Caterina (Module responsibility)</p> <p>Cocchi, Caterina (Authorized examiners)</p> <p>Biehs, Svend-Age (Authorized examiners)</p> <p>Lienau, Christoph (Authorized examiners)</p> <p>Vogelgesang, Ralf (Authorized examiners)</p>  |
| <b>Prerequisites</b>                             | Mechanics, Electrodynamics and Optics, Atomic and Molecular Physics, Mathematical Methods for Physics and Engineering I-III. These courses are mandatory prerequisites.  |
| <b>Skills to be acquired in this module</b>      | The students will gain knowledge of the fundamental principles of quantum mechanics and their application to the modelling of the equilibrium structure of different atomic, molecular and solid state material systems. The course will enhance their competence to understand and apply basic theoretical concepts in quantum mechanics. The students will learn how to rationalize quantum effects and wave phenomena in a variety of material systems and will become acquainted with strategies how to explain the equilibrium steady-state structure of different types of matter. The students will also be introduced into the nonequilibrium dynamics of selected quantum systems.  |
| <b>Module contents</b>                           | <p>The course aims at providing a modern introduction into quantum mechanical foundations of the structure of atomic, molecular and solid state systems. It will bridge the gap between „Atomic and Molecular Physics“ and „Solid State Physics.“ The following content will be covered:</p> <ol style="list-style-type: none"> <li>1. Introduction into quantum mechanics</li> <li>2. Quantum theory: techniques and applications</li> <li>3. Atomic and molecular structure</li> <li>4. Light-matter interaction</li> <li>5. Molecular spectroscopy</li> <li>6. Introduction into quantum dynamics</li> <li>7. Molecular reaction dynamics</li> <li>8. Macromolecules and Aggregates</li> <li>9. Solid State Materials</li> </ol> <p>The course will be held at the level of an advanced course in physical chemistry and requires basic knowledge of quantum mechanics as introduced in "Atomic and Molecular Physics".</p> |
| <b>Reader's advisory</b>                         | <ul style="list-style-type: none"> <li>P. W. Atkins, J. de Paulo, Physical Chemistry, 9th Edition, W. H. Freeman (2009)</li> <li>W. Demtröder, Atoms, Molecules and Photons, 2nd Edition, Springer (2010)</li> <li>W. Demtröder, Molecular Physics, Wiley-VCH (2005)</li> <li>C. Cohen-Tannoudji, B. Diu, F. Laloe, Quantum Mechanics, Vol. I and II, 1st Edition, Wiley (1991)</li> <li>N. W. Ashcroft, N. D. Mermin, Solid State Physics, 2nd Edition, Cengage Learning (1976).</li> <li>S. H. Simon, The Oxford Solid State Basics, Oxford University Press (2013).</li> <li>S. Haroche, J. M. Raimond, Exploring the Quantum: Atoms, Cavities and Photons, Oxford University Press (2006)</li> <li>L. Susskind, Quantum Mechanics - The Theoretical Minimum, Basics Books (2014)</li> </ul>  |
| <b>Links</b>                                     |  |
| <b>Language of instruction</b>                   | English  |
| <b>Duration (semesters)</b>                      | 1 Semester   |
| <b>Module frequency</b>                          | jährlich   |
| <b>Module capacity</b>                           | unlimited  |
| <b>Modullevel / module level</b>                 | AC (Aufbaucurriculum / Composition)  |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Vorlesung: 4 SWS / lecture: 4 SWS<br>Tutorium: 2 SWS / tutorials 2 SWS   |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |

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| Examination                 | Time of examination | Type of examination                      |
|-----------------------------|---------------------|--|
| <b>Final exam of module</b> |                     | 180 min written exam or 45 min oral exam |
| <b>Course type</b>          | Lecture             |  |
| <b>SWS</b>                  |                     |  |
| <b>Frequency</b>            | --                  |  |
| <b>Workload attendance</b>  | 0 h                 |  |

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## phy555 - Basic Engineering

|  |  |   |           |                                   |
|--|--|---|-----------|-----------------------------------|
| <b>Module label</b>                              | Basic Engineering  |   |           |                                   |
| <b>Module code</b>                               | phy555   |   |           |                                   |
| <b>Credit points</b>                             | 6.0 KP   |   |           |                                   |
| <b>Workload</b>                                  | 180 h<br>(<br>Attendance: 64 hrs Self study: 116 hrs<br>)  |   |           |                                   |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |   |           |                                   |
| <b>Responsible persons</b>                       | Schmidt, Florian (Authorized examiners)  |   |           |                                   |
| <b>Prerequisites</b>                             | Basic Math (Algebra, Derivation, Integration) Basic knowledge in Physics (Mechanics, Thermodynamics, esp. Heat transfer)   |   |           |                                   |
| <b>Skills to be acquired in this module</b>      | Achieving basic knowledge in applied mechanics, especially in statics and elasticity theory. Achieving basic knowledge on how to produce objects with defined geometry and properties in an effective and economic way.  |   |           |                                   |
| <b>Module contents</b>                           | <p>Applied Mechanics:</p> <ul style="list-style-type: none"> <li>Static equilibrium (mainly 2D)</li> <li>frame works</li> <li>friction (Coulomb)</li> <li>Hooke's law (3D including lateral contraction and thermal expansion)</li> <li>bending and torsion with planar cross sections</li> <li>Mohr's theory</li> </ul> <p>Production Engineering:</p> <ul style="list-style-type: none"> <li>Overview on manufacturing technologies, like</li> <li>Casting and other primary shaping processes</li> <li>Plastic deformation processes</li> <li>Cutting and separating processes</li> <li>Joining processes</li> <li>Coating processes</li> <li>Changing material properties</li> </ul> |   |           |                                   |
| <b>Reader's advisory</b>                         | <p>Applied Mechanics:<br/>Assmann: Technische Mechanik (in German);<br/>Meriam, Kraige: Engineering Mechanics,<br/>Beer, Russell, Johnston: Vector Mechanics for Engineers</p> <p>Production Engineering:<br/>Groover: Fundamentals of Modern Manufacturing<br/>DeGarmo: Materials and Processes in Manufacturing<br/>König: Fertigungsverfahren (in German)</p>   |   |           |                                   |
| <b>Links</b>                                     |  |   |           |                                   |
| <b>Language of instruction</b>                   | English  |   |           |                                   |
| <b>Duration (semesters)</b>                      | 2 Semester   |   |           |                                   |
| <b>Module frequency</b>                          | halbjährlich   |   |           |                                   |
| <b>Module capacity</b>                           | unlimited  |   |           |                                   |
| <b>Modullevel / module level</b>                 | BC (Basiscurriculum / Base curriculum)   |   |           |                                   |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |   |           |                                   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Lecture with integrated sample problems and exercises  |   |           |                                   |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |   |           |                                   |
| Examination                                      | Time of examination  | Type of examination   |           |                                   |
| <b>Final exam of module</b>                      |  | 2 exams: 180 min written exam or 60 min oral exam. Here , you will find information about the consideration of bonus points for module marks. |           |                                   |
| Course type                                      | Comment  | SWS   | Frequency | Workload of compulsory attendance |
| Lecture  |  | 4   | WiSe      | 56                                |

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| Course type                                    | Comment | SWS | Frequency      | Workload of compulsory attendance |
|--|---------|-----|----------------|-----------------------------------|
| Exercises                                      |         | 2   | SoSe oder WiSe | 28                                |
| <b>Total time of attendance for the module</b> |         |     |                | <b>84 h</b>                       |

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## phy563 - Specialization

|  |  |                     |
|--|--|---------------------|
| <b>Module label</b>                              | Specialization   |                     |
| <b>Module code</b>                               | phy563   |                     |
| <b>Credit points</b>                             | 6.0 KP   |                     |
| <b>Workload</b>                                  | 180 h<br>(<br>Attendance: 56 hrs Self study: 124 hrs<br>)  |                     |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |                     |
| <b>Responsible persons</b>                       | <p>Brudler, Evelyn (Authorized examiners)</p> <p>Brückner, Hans Josef (Authorized examiners)</p> <p>Heinemann, Detlev (Authorized examiners)</p> <p>Doclo, Simon (Authorized examiners)</p> <p>Koch, Sandra (Authorized examiners)</p> <p>Kollmeier, Birger (Authorized examiners)</p> <p>Kühn, Martin (Authorized examiners)</p> <p>Neu, Walter (Authorized examiners)</p> <p>Schüning, Thomas (Authorized examiners)</p> <p>Poppe, Björn (Authorized examiners)</p> <p>Struve, Bert (Authorized examiners)</p> <p>Teubner, Ulrich (Authorized examiners)</p>   |                     |
| <b>Prerequisites</b>                             |  |                     |
| <b>Skills to be acquired in this module</b>      | The students are enabled to establish an overview on principles and applications of engineering physics. The introduction to a specific field of specialization yields a basic knowledge on theoretical and experimental concepts and deepens on selected applications.  |                     |
| <b>Module contents</b>                           | <p>Specialization</p> <p>Laser and Optics:<br/>Introduction to relevant research fields in Laser and Optics. Knowledge of the characteristics of waves, optical radiation, design und function of optical elements and instruments, basic design of photonic systems and optical metrology.</p> <p>Biomedical Physics &amp; Acoustics:<br/>Overview of the research fields in Oldenburg related to biomedical physics and acoustics (acoustical signal processing, audiology, biomedical signal processing, neuro-sensory science and systems, medical radiation physics, medical imaging, noise control and vibration)</p> <p>Renewable Energies:<br/>Introduction into the areas of renewable energies, with special emphasis on energy conversion and utilization, based on complex physical models. The student will be able to understand the fundamental principles of the field renewable energies.</p> |                     |
| <b>Reader's advisory</b>                         | Acc. selected lecture  |                     |
| <b>Links</b>                                     |  |                     |
| <b>Language of instruction</b>                   | English  |                     |
| <b>Duration (semesters)</b>                      | 2 Semester   |                     |
| <b>Module frequency</b>                          | halbjährlich   |                     |
| <b>Module capacity</b>                           | unlimited  |                     |
| <b>Modullevel / module level</b>                 | ---  |                     |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |                     |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Lecture: 4 hrs/week  |                     |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |                     |
| Examination                                      | Time of examination  | Type of examination |

| Examination                                    | Time of examination | Type of examination   |           |                                   |
|--|---------------------|---|-----------|-----------------------------------|
| <b>Final exam of module</b>                    |                     | Max. 2 hrs written exam or 30 min oral exam. Here you will find information about the consideration of bonus points for module marks.<br>1 Klausur (max. 180 Min.) oder 1 mündliche Prüfung (max. 45 Min.) oder 1 Hausarbeit (max. 30 Seiten) |           |                                   |
| Course type                                    | Comment             | SWS   | Frequency | Workload of compulsory attendance |
| Lecture  |                     | 4   |           | 56                                |
| Seminar  |                     |   |           |                                   |
| <b>Total time of attendance for the module</b> |                     |   |           | <b>56 h</b>                       |

## phy570 - Electronics

|  |  |                           |           |                                   |
|--|--|---------------------------|-----------|-----------------------------------|
| <b>Module label</b>                              | Electronics  |                           |           |                                   |
| <b>Module code</b>                               | phy570   |                           |           |                                   |
| <b>Credit points</b>                             | 6.0 KP   |                           |           |                                   |
| <b>Workload</b>                                  | 180 h<br>(<br>Attendance: 70 hrs Self study: 110 hrs<br>)  |                           |           |                                   |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |                           |           |                                   |
| <b>Responsible persons</b>                       | Brückner, Hans Josef (Authorized examiners)<br><br>Haja, Andreas (Authorized examiners)<br><br>Haja, Andreas (Module responsibility)   |                           |           |                                   |
| <b>Prerequisites</b>                             | Basic Lab. I, Math. Methods for Physics and Engineering I  |                           |           |                                   |
| <b>Skills to be acquired in this module</b>      | The students acquire basic competences to set-up and analyze digital and analog electronic circuits; furthermore basic knowledge for measurement methods as well as for handling measurement systems are imparted  |                           |           |                                   |
| <b>Module contents</b>                           | logic functions and gates, digital circuit analysis and synthesis, flip-flops, digital counters and memories, A/D- and D/A converters, programmable logic devices , impedances, inductances and capacitances, complex alternating electric quantities, RCL-filter circuits, semiconductor circuits, rectifier circuits, operational amplifier circuits |                           |           |                                   |
| <b>Reader's advisory</b>                         | Excerpts from lecture script<br>Weddigen, Jüngst: Elektronik, Springer Verlag<br>Böhmer: Elemente der angewandten Elektronik, Vieweg Verlag<br>Hering, Bressler, Gutekunst: Elektronik für Ingenieure und Naturwissenschaftler, Springer Verlag, 2005<br>Hill: The Art of Electronics, Cambridge University Press, 1989                                |                           |           |                                   |
| <b>Links</b>                                     |  |                           |           |                                   |
| <b>Language of instruction</b>                   | English  |                           |           |                                   |
| <b>Duration (semesters)</b>                      | 1 Semester   |                           |           |                                   |
| <b>Module frequency</b>                          | jährlich   |                           |           |                                   |
| <b>Module capacity</b>                           | unlimited  |                           |           |                                   |
| <b>Modullevel / module level</b>                 |  |                           |           |                                   |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |                           |           |                                   |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Lecture: 4 hrs/week<br>Exercise/Practical Work: 1 week, block course   |                           |           |                                   |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |                           |           |                                   |
| Examination                                      | Time of examination  | Type of examination       |           |                                   |
| <b>Final exam of module</b>                      |  | 2 hrs written examination |           |                                   |
| Course type                                      | Comment  | SWS                       | Frequency | Workload of compulsory attendance |
| Lecture  |  | 4                         |           | 56                                |
| Exercises  |  | 1                         |           | 14                                |
| <b>Total time of attendance for the module</b>   |  |                           |           | 70 h                              |

## phy581 - Materials Sciences

|  |  |                     |
|--|--|---------------------|
| <b>Module label</b>                              | Materials Sciences   |                     |
| <b>Module code</b>                               | phy581   |                     |
| <b>Credit points</b>                             | 6.0 KP   |                     |
| <b>Workload</b>                                  | 180 h<br>(<br>Attendance: 56 hrs Self study: 124 hrs<br>)  |                     |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |                     |
| <b>Responsible persons</b>                       | <p>Helms, Olaf (Authorized examiners)</p> <p>Lünemann, Martin (Authorized examiners)</p> <p>Helms, Olaf (Module responsibility)</p>  |                     |
| <b>Prerequisites</b>                             |  |                     |
| <b>Skills to be acquired in this module</b>      | The students are able - outgoing from the microscopic structure of engineering materials - to understand its macroscopic properties, so that they are able to involve the behaviour of engineering materials into engineering requirements independently.  |                     |
| <b>Module contents</b>                           | <p>Introduction</p> <p>Classification of engineering materials in groups</p> <p>Constitution of engineering materials (microscopic structure, macroscopic properties)</p> <p>Physical basics of constitution:</p> <p>Constitution of single phase solids (crystals, amorphous materials, real materials)</p> <p>Constitution of multi-phase materials</p> <p>Basic diagrams of constitution of binary alloys</p> <p>Crystallisation</p> <p>Diffusion</p> <p>Properties of materials</p> <p>Physical properties</p> <p>Mechanical properties (plastic deformation, crack growth, friction, wear)</p> <p>Groups of materials (metals, ceramics, polymers)</p> <p>Selected materials (iron, aluminium, copper)</p> <p>Testing of materials (an overview of methods)</p> |                     |
| <b>Reader's advisory</b>                         | <p>E. Hornbogen: Werkstoffe, Springer Verlag Berlin u. a.</p> <p>W. Bergmann: Werkstofftechnik Teil 1, Grundlagen; Carl Hanser Verlag München Wien</p> <p>Bargel, Schulze: Werkstoffkunde, VDI-Springer</p> <p>W. D. Callister, Jr.: Materials Science and Engineering, An Introduction; John Wiley-VCH Verlag GmbH Weinheim</p>   |                     |
| <b>Links</b>                                     |  |                     |
| <b>Language of instruction</b>                   | English  |                     |
| <b>Duration (semesters)</b>                      | 1 Semester   |                     |
| <b>Module frequency</b>                          | halbjährlich   |                     |
| <b>Module capacity</b>                           | unlimited  |                     |
| <b>Modullevel / module level</b>                 |  |                     |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |                     |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Lecture with integrated exercises  |                     |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |                     |
| <b>Examination</b>                               | Time of examination  | Type of examination |
| <b>Final exam of module</b>                      | 1 hour written examination or 30 min oral exam   |                     |
| <b>Course type</b>                               | Lecture  |                     |
| <b>SWS</b>                                       | 4  |                     |
| <b>Frequency</b>                                 |  |                     |
| <b>Workload attendance</b>                       | 56 h   |                     |

## phy590 - Control Systems

|  |  |   |                  |  |
|--|--|---|------------------|--|
| <b>Module label</b>                              | Control Systems  |   |                  |  |
| <b>Module code</b>                               | phy590   |   |                  |  |
| <b>Credit points</b>                             | 6.0 KP   |   |                  |  |
| <b>Workload</b>                                  | 180 h<br>(<br>120 h<br>)   |   |                  |  |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |   |                  |  |
| <b>Responsible persons</b>                       | <p>Huke, Philipp (Authorized examiners)</p> <p>Huke, Philipp (Module responsibility)</p> <p>Huke, Philipp (Module counselling)</p>   |   |                  |  |
| <b>Prerequisites</b>                             |  |   |                  |  |
| <b>Skills to be acquired in this module</b>      | <p>Understanding of basic open- and closed-loop control systems. Basic concepts for modelling of systems, design and development of controllers. Description of controller design using differential equations. Understanding the response function of a control-loop and testing the control structure with respect to instabilities.</p> <p>The students will achieve the competence to work into technical realization of controlled systems and to develop approaches for optimization.</p>                              |   |                  |  |
| <b>Module contents</b>                           | <p>The module contains: Design procedures for controllers, Basic description of components, development, understanding and working with functional diagrams, simulation and modelling, root locus, stability, controller types, linear control systems with reference- and disturbance response function.</p>  |   |                  |  |
| <b>Reader's advisory</b>                         | <p>Hans-Werner Philippsen - Einstieg in die Regelungstechnik mit Python; <i>München Carl Hanser Verlag GmbH &amp; Co. KG, 20190805</i> (OPAC)</p> <p>Karl Johan Åström und Richard M. Murray - Feedback Systems: An Introduction for Scientists and Engineers; <i>New Jersey: Princeton University Press, 2010</i> (OPAC)</p> <p>Lutz, H. und Wendt, W.: Taschenbuch der Regelungstechnik Unbehauen;</p> <p>H.: Regelungstechnik I, Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme</p> |   |                  |  |
| <b>Links</b>                                     |  |   |                  |  |
| <b>Language of instruction</b>                   | English  |   |                  |  |
| <b>Duration (semesters)</b>                      | 1 Semester   |   |                  |  |
| <b>Module frequency</b>                          | every year   |   |                  |  |
| <b>Module capacity</b>                           | unlimited  |   |                  |  |
| <b>Modullevel / module level</b>                 | AC (Aufbaucurriculum / Composition)  |   |                  |  |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |   |                  |  |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Online presentation / online methods   |   |                  |  |
| <b>Vorkenntnisse / Previous knowledge</b>        | <ul style="list-style-type: none"> <li>– Complex numbers</li> <li>– Ordinary differential equation</li> <li>– Laplace Transformation</li> </ul>  |   |                  |  |
| <b>Examination</b>                               | Time of examination  | Type of examination   |                  |  |
| <b>Final exam of module</b>                      |  | 30 - 45 minutes oral exam. [Here] <a href="http://www.uni-oldenburg.de/en/physics/studies/bonus-points">http://www.uni-oldenburg.de/en/physics/studies/bonus-points</a> , you will find information about the consideration of bonus points for module marks. |                  |  |
| <b>Course type</b>                               | <b>Comment</b>   | <b>SWS</b>  | <b>Frequency</b> | <b>Workload of compulsory attendance</b> |
| Lecture  |  | 4   |                  | 56                                       |
| Exercises  |  | 1   |                  | 14                                       |
| <b>Total time of attendance for the module</b>   |  |   |                  | 70 h                                     |

## phy501 - Numerical Methods

|   |   |
|---|---|
| <b>Module label</b>                         | Numerical Methods   |
| <b>Module code</b>                          | phy501  |
| <b>Credit points</b>                        | 6.0 KP  |
| <b>Workload</b>                             | 180 h<br>(<br>180h (attendance: 56h; self-study: 124h)<br>)   |
| <b>Applicability of the module</b>          | <ul style="list-style-type: none"><li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>   |
| <b>Responsible persons</b>                  | Anemüller, Jörn (Authorized examiners)<br>Brand, Thomas (Authorized examiners)<br>Dietz, Mathias (Authorized examiners)<br>Hartmann, Alexander (Authorized examiners)<br>Hohmann, Volker (Authorized examiners)<br>Lücke, Jörg (Authorized examiners)<br>Meyer, Bernd (Authorized examiners)<br>Petrovic, Cornelia (Authorized examiners)<br>Hohmann, Volker (Module responsibility)  |
| <b>Prerequisites</b>                        | Course Mathematical Methods II passed with a grade of at least 4.0.   |
| <b>Skills to be acquired in this module</b> | Students acquire theoretical knowledge of basic numerical methods and practical skills to apply these methods to physical problems within all areas of experimental, theoretical and applied physics.   |
| <b>Module contents</b>                      | Basic concepts of numerical Mathematics are introduced and applied to Physics problems. Topics include: Finite number representation and numerical errors, linear and nonlinear systems of equations, numerical differentiation and integration, function minimization and model fitting, discrete Fourier analysis, ordinary and partial differential equations. The learned numerical methods will be partly implemented (programmed) and applied to basic problems from mechanics, electrodynamics, etc. in the exercises. The problems are chosen so that analytical solutions are available in most cases. In this way, the quality of the numerical methods can be assessed by comparing numerical and analytical solutions. Programming will be done in C or, preferably, in Matlab, which is a powerful package for numerical computing. Matlab offers easy, portable programming, comfortable visualization tools and already implements most of the numerical methods introduced in this course. These built-in functions can be compared to own implementations or used in the exercises in some cases when own implementations are too costly. The tutorials provide basic programming support.   |
| <b>Reader's advisory</b>                    | <ol style="list-style-type: none"><li>V. Hohmann: Numerical Methods for Physicists, Universität Oldenburg (lecture script; will be provided with the course material)</li><li>W. H. Press et al.: Numerical Recipes in C - The Art of Scientific Computing. Cambridge University Press, Cambridge, [BIS]<a href="http://www.bis.uni-oldenburg.de/katalogsuche/freitext=press+numerical+recipes+art">http://www.bis.uni-oldenburg.de/katalogsuche/freitext=press+numerical+recipes+art</a></li><li>A. L. Garcia: Numerical Methods for Physics. Prentice Hall, Englewood Cliffs (NJ), [BIS]<a href="http://www.bis.uni-oldenburg.de/katalogsuche/freitext=garcia+numerical+methods">http://www.bis.uni-oldenburg.de/katalogsuche/freitext=garcia+numerical+methods</a></li><li>J. H. Mathews: Numerical Methods for Mathematics, Science and Engineering. Prentice Hall, Englewood Cliffs (NJ), [BIS]<a href="http://www.bis.uni-oldenburg.de/katalogsuche/freitext=mathews+numerical+methods+science">http://www.bis.uni-oldenburg.de/katalogsuche/freitext=mathews+numerical+methods+science</a></li><li>B.W. Kernighan und D. Ritchie: The C Programming Language. Prentice Hall International, Englewood Cliffs (NJ) (in case Matlab is not used for the course)</li></ol> |
| <b>Links</b>                                |   |
| <b>Language of instruction</b>              | English   |
| <b>Duration (semesters)</b>                 | 1 Semester  |
| <b>Module frequency</b>                     | Annual, summer semester   |
| <b>Module capacity</b>                      | unlimited   |
| <b>Modullevel / module level</b>            | AC (Aufbaucurriculum / Composition)   |
| <b>Modulart / typ of module</b>             | Pflicht / Mandatory   |



|  |   |     |                     |                                   |
|--|---|-----|---------------------|-----------------------------------|
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Lecture: 2 hrs/week, Tutorial: 2 hrs/week   |     |                     |                                   |
| <b>Vorkenntnisse / Previous knowledge</b>        | Basic computer knowledge; Basic programming skills, in particular Matlab; Knowledge in undergraduate Physics; Courses Mathematical Methods I-III. |     |                     |                                   |
| Examination                                      | Time of examination   |     | Type of examination |                                   |
| <b>Final exam of module</b>                      | Ü   |     |                     |                                   |
| Course type                                      | Comment   | SWS | Frequency           | Workload of compulsory attendance |
| Lecture  |   | 2   | SoSe und WiSe       | 28                                |
| Exercises  |   | 2   | SoSe und WiSe       | 28                                |
| <b>Total time of attendance for the module</b>   |   |     |                     | 56 h                              |

## phy502 - Solid State Physics

|  |  |            |                     |  |
|--|--|------------|---------------------|--|
| <b>Module label</b>                              | Solid State Physics  |            |                     |  |
| <b>Module code</b>                               | phy502   |            |                     |  |
| <b>Credit points</b>                             | 6.0 KP   |            |                     |  |
| <b>Workload</b>                                  | 180 h<br>(<br>180 h (Präsenzzeit 84h, Selbststudium: 96h)<br>)   |            |                     |  |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |            |                     |  |
| <b>Responsible persons</b>                       | <p>Nilius, Niklas (Module responsibility)</p> <p>Lienau, Christoph (Authorized examiners)</p> <p>Nilius, Niklas (Authorized examiners)</p> <p>Schäfer, Sascha (Authorized examiners)</p> <p>Wollenhaupt, Matthias (Authorized examiners)</p> <p>Kittel, Achim (Authorized examiners)</p>   |            |                     |  |
| <b>Prerequisites</b>                             | Experimental Physics I-IV, Quantum structure of Matter   |            |                     |  |
| <b>Skills to be acquired in this module</b>      | The students gain comprehensive insights into solid state physics and associated phenomena. They learn how symmetry operations are interconnected with structural parameters of solids. From the chemical interaction between atoms, the binding properties and thermodynamic stability of solids are derived. The oscillatory motion of atoms in simple 1D chain models is extended towards the dynamic response of crystals, while a statistical analysis leads to the concept of heat capacity and heat conductance of solids. The quantum mechanical description of particles in a box is exploited to develop the model of free and quasi-free electrons as well as the band structure of solids. The students are made familiar with the economically relevant fields of semiconductor and low temperature physics as well as magnetism. |            |                     |  |
| <b>Module contents</b>                           | Crystal structures and symmetries, Bravais lattices, Reciprocal lattice and translational symmetry, Brillouin zone, Binding principles in solids (covalent, ionic, metallic, van-der Waals and hydrogen bonding), Dynamic properties of solids, Phonons, Atomic chain models, Dispersion relation, Specific heat, Heat conductance, Electrons in solids, Model of free and quasi-free electrons, State density, Fermi energy, Electrons in periodic potentials, Bloch theorem, Band model of electrons, Effective mass, Band gap, Occupation numbers, Semiconductors, Doping, Dielectric properties, Magnetic properties, Dia-, para- and ferro magnetism, Superconductivity   |            |                     |  |
| <b>Reader's advisory</b>                         | <ol style="list-style-type: none"> <li>N. W. Ashcroft, N. D. Mermin: Solid State Physics. Saunders College, Philadelphia,</li> <li>Introduction to Solid State Physics   Kittel, Charles   ISBN: 9780471415268</li> <li>S. Elliott: The Physics and Chemistry of Solids. John Wiley &amp; Sons, West Sussex (UK),</li> <li>H. Ibach, H. Lüth: Festkörperphysik. Springer, Berlin</li> </ol>  |            |                     |  |
| <b>Links</b>                                     |  |            |                     |  |
| <b>Language of instruction</b>                   | English  |            |                     |  |
| <b>Duration (semesters)</b>                      | 1 Semester   |            |                     |  |
| <b>Module frequency</b>                          | jährlich   |            |                     |  |
| <b>Module capacity</b>                           | unlimited  |            |                     |  |
| <b>Modullevel / module level</b>                 | AC (Aufbaucurriculum / Composition)  |            |                     |  |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |            |                     |  |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Vorlesung: 4 SWS, Übung: 2 SWS   |            |                     |  |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |            |                     |  |
| <b>Examination</b>                               | Time of examination  |            | Type of examination |  |
| <b>Final exam of module</b>                      |  |            | KL                  |  |
| <b>Course type</b>                               | <b>Comment</b>   | <b>SWS</b> | <b>Frequency</b>    | <b>Workload of compulsory attendance</b> |
| Lecture  |  | 2          | SoSe und WiSe       | 28                                       |

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| Course type                                    | Comment | SWS | Frequency     | Workload of compulsory attendance |
|--|---------|-----|---------------|-----------------------------------|
| Exercises                                      |         | 2   | SoSe und WiSe | 28                                |
| <b>Total time of attendance for the module</b> |         |     |               | <b>56 h</b>                       |

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## phy533 - Metrology

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|---|---|
| <b>Module label</b>                         | Metrology   |
| <b>Module code</b>                          | phy533  |
| <b>Credit points</b>                        | 6.0 KP  |
| <b>Workload</b>                             | 180 h<br>(<br>180 h (Präsenzzeit 56h, Selbststudium: 124h)<br>)   |
| <b>Applicability of the module</b>          | <ul style="list-style-type: none"><li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>   |
| <b>Responsible persons</b>                  | Meyer, Bernd (Authorized examiners)<br><br>Meyer, Bernd (Module responsibility)<br><br>Meyer, Bernd (Module counselling)  |
| <b>Prerequisites</b>                        |   |
| <b>Skills to be acquired in this module</b> | The students will learn basic principles of measurement technology and signal processing as well as the application of complex measurement methods to extract the measurement information. They will acquire skills to carry out advanced internships and experimental work in research laboratories. Further, they will develop the competence for analytical thinking in the evaluation of measurement situations, which will enable them to solve measurement problems such as those encountered in different branches of industry (e.g. automotive and semiconductor industries; analytical, pharmaceutical and medical industries).  |
| <b>Module contents</b>                      | <p>Lecture Measurement Technology:</p> <p>Sensors for measuring different physical quantities (e.g. force, temperature, charge, electric and magnetic fields, energies of particles and radiation), high-resolution measurements of small signals, influence of interfering signals, linearization and reduction of interfering variables through compensation methods, noise reduction, phase-sensitive detector, complex measurement systems such as nuclear magnetic resonance, electron resonance, laser measurement technology (including pump / probe systems), spatially resolved measurement methods such as magnetic resonance tomography, electron and scanning probe microscopy.</p> <p>Lecture Signal Processing:</p> <p>Characterization and processing of measurement signals (linear signal analysis, filtering), characterization and elimination of interferences (empirical statistics, noise in physical systems, correlation analysis, phase-sensitive amplifiers, methods of averaging), signal digitization, digital signal processing</p> <p>Signal processing (including time-variant filtering, complex processing algorithms)</p> <p>Filterung, komplexe Verarbeitungsalgorithmen</p> |
| <b>Reader's advisory</b>                    | <p>SE Physikalische Messtechnik:</p> <p>Elmar Schrüfer, Elektrische Messtechnik: Messung elektrischer und nichtelektrischer Größen. Hanser Fachbuchverlag</p> <p>H.-R. Tränkler, E. Obermeier: Sensortechnik. Springer, Berlin;</p> <p>J. Niebuhr, G. Lindner: Physikalische Messtechnik mit Sensoren. Oldenbourg, München;</p> <p>J. F. Keithley [Ed.]: Low /Level Measurements Handbook. Keithley Instruments Inc; VL Signalverarbeitung:</p> <p>K.-D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung: Filterung<br/>und Spektralanalyse mit MATLAB-Übungen. Teubner, Stuttgart;</p> <p>J.-R. Ohm, H.D. Lüke: Signalübertragung. Springer, Berlin; B. Kollmeier;</p> <p>Skript zur Signalverarbeitung und Messtechnik</p>   |
| <b>Links</b>                                |   |
| <b>Language of instruction</b>              | English   |
| <b>Duration (semesters)</b>                 | 1 Semester  |
| <b>Module frequency</b>                     | jährlich  |
| <b>Module capacity</b>                      | unlimited   |

|  |   |                     |                  |  |
|--|---|---------------------|------------------|--|
| <b>Modullevel / module level</b>                 | AC (Aufbaucurriculum / Composition)   |                     |                  |  |
| <b>Modulart / typ of module</b>                  | Pflicht / Mandatory   |                     |                  |  |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Vorlesung: 3 SWS; SoSe 42h<br>Übung: 1SWS; SoSe 14h<br><br>Online presentation / online methods |                     |                  |  |
| <b>Vorkenntnisse / Previous knowledge</b>        |   |                     |                  |  |
| Examination                                      | Time of examination   | Type of examination |                  |  |
| <b>Final exam of module</b>                      | G   |                     |                  |  |
|  | Max. 90 min. Klausur oder 30 min. mündliche Prüfung (Gewichtung 1/2)                            |                     |                  |  |
|  | und   |                     |                  |  |
|  | 1 Referat oder 1 Hausarbeit (Gewichtung 1/2)  |                     |                  |  |
| <b>Course type</b>                               | <b>Comment</b>  | <b>SWS</b>          | <b>Frequency</b> | <b>Workload of compulsory attendance</b> |
| Lecture and tutorial                             |   | 2                   | SoSe und WiSe    | 28                                       |
| Seminar  |   | 2                   | SoSe und WiSe    | 28                                       |
| <b>Total time of attendance for the module</b>   |   |                     |                  | <b>56 h</b>                              |

## phy563 - Specialization

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|--|--|--|
| <b>Module label</b>                              | Specialization   |  |
| <b>Module code</b>                               | phy563   |  |
| <b>Credit points</b>                             | 6.0 KP   |  |
| <b>Workload</b>                                  | 180 h<br>(<br>180 h (Präsenzzeit 56h, Selbststudium: 124h)<br>)  |  |
| <b>Applicability of the module</b>               | <ul style="list-style-type: none"> <li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>  |  |
| <b>Responsible persons</b>                       | <p>Neu, Walter (Module responsibility)</p> <p>Doclo, Simon (Authorized examiners)</p> <p>Kühn, Martin (Authorized examiners)</p> <p>Neu, Walter (Authorized examiners)</p> <p>Poppe, Björn (Authorized examiners)</p>  |  |
| <b>Prerequisites</b>                             | Mandatory courses of the semesters before  |  |
| <b>Skills to be acquired in this module</b>      | The students are enabled to establish an overview on principles and applications of engineering physics. The introduction to a specific field of specialization yields a basic knowledge on theoretical and experimental concepts and deepens on selected applications.  |  |
| <b>Module contents</b>                           | <p>Laser and Optics:</p> <p>Introduction to relevant research fields in Laser and Optics. Knowledge of the characteristics of waves, optical radiation, design and function of optical elements and instruments, basic design of photonic systems and optical metrology.</p> <p>Biomedical Physics and Acoustics:</p> <p>Overview of the research fields in Oldenburg related to biomedical physics and acoustics (acoustical signal processing, audiology, biomedical signal processing, neuro-sensory science and systems, medical radiation physics, medical imaging, noise control and vibration)</p> <p>Renewable Energies:</p> <p>Introduction into the areas of renewable energies, with special emphasis on energy conversion and utilization, based on complex physical models. The student will be able to understand the fundamental principles of the field renewable energies</p> |  |
| <b>Reader's advisory</b>                         | Acc. selected lectures   |  |
| <b>Links</b>                                     |  |  |
| <b>Language of instruction</b>                   | English  |  |
| <b>Duration (semesters)</b>                      | 1 Semester   |  |
| <b>Module frequency</b>                          | jährlich   |  |
| <b>Module capacity</b>                           | unlimited  |  |
| <b>Modullevel / module level</b>                 | AC (Aufbaucurriculum / Composition)  |  |
| <b>Modulart / typ of module</b>                  | je nach Studiengang Pflicht oder Wahlpflicht   |  |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Vorlesung: 4 SWS, Übung: 2 SWS   |  |
| <b>Vorkenntnisse / Previous knowledge</b>        |  |  |
| Examination                                      | Time of examination  | Type of examination  |
| <b>Final exam of module</b>                      |  | 2 examinations: Exam (30 - 60 minutes) or oral exam (15 - 30 min-utes) or home work (5 - 15 pages) or presentation (15-30 minutes) |
| <b>Course type</b>                               | Seminar  |  |
| <b>SWS</b>                                       | 4  |  |
| <b>Frequency</b>                                 | SoSe oder WiSe   |  |

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**Workload attendance**

56 h

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# Abschlussmodul

## bam - Bachelor's Thesis Module

|                                    |   |
|------------------------------------|---|
| <b>Module label</b>                | Bachelor's Thesis Module  |
| <b>Module code</b>                 | bam   |
| <b>Credit points</b>               | 15.0 KP   |
| <b>Workload</b>                    | 450 h<br>(<br>Attendance: 28 hrs Self study: 422 hrs<br>)   |
| <b>Applicability of the module</b> | <ul style="list-style-type: none"><li>Bachelor's Programme Engineering Physics (Bachelor) &gt; Abschlussmodul</li></ul>   |
| <b>Responsible persons</b>         | Agert, Carsten (Authorized examiners)<br>Biehs, Svend-Age (Authorized examiners)<br>Brand, Thomas (Authorized examiners)<br>Doclo, Simon (Authorized examiners)<br>Brückner, Hans Josef (Authorized examiners)<br>Ewert, Stephan (Authorized examiners)<br>Hein, Andreas (Authorized examiners)<br>Gütay, Levent (Authorized examiners)<br>Hartmann, Alexander (Authorized examiners)<br>Heinemann, Detlev (Authorized examiners)<br>Kittel, Achim (Authorized examiners)<br>Hohmann, Volker (Authorized examiners)<br>Kollmeier, Birger (Authorized examiners)<br>Kühn, Martin (Authorized examiners)<br>Neu, Walter (Authorized examiners)<br>Schädler, Marc René (Authorized examiners)<br>Lienau, Christoph (Authorized examiners)<br>Meyer, Bernd (Authorized examiners)<br>Nilius, Niklas (Authorized examiners)<br>Peinke, Joachim (Authorized examiners)<br>van de Par, Steven (Authorized examiners)<br>Petrovic, Cornelia (Authorized examiners)<br>Poppe, Björn (Authorized examiners)<br>Schäfer, Sascha (Authorized examiners)<br>Schüning, Thomas (Authorized examiners)<br>Struve, Bert (Authorized examiners)<br>Teubner, Ulrich (Authorized examiners)<br>Uppenkamp, Stefan (Authorized examiners)<br>Vogelgesang, Ralf (Authorized examiners)<br>Wollenhaupt, Matthias (Authorized examiners) |

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**Prerequisites**

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|--|---|---------------------|
| <b>Skills to be acquired in this module</b>      | Students will apply their diversified scientific and professional skills to plan, prepare, organize and produce single-handed a research study. |                     |
| <b>Module contents</b>                           | The thesis comprises empirical, theoretical or experimental research and development according to the field of specialization                   |                     |
| <b>Reader's advisory</b>                         | as required   |                     |
| <b>Links</b>                                     |   |                     |
| <b>Languages of instruction</b>                  | German, English   |                     |
| <b>Duration (semesters)</b>                      | 1 Semester  |                     |
| <b>Module frequency</b>                          |   |                     |
| <b>Module capacity</b>                           | unlimited   |                     |
| <b>Modullevel / module level</b>                 | ---   |                     |
| <b>Modulart / typ of module</b>                  | Pflicht / Mandatory   |                     |
| <b>Lehr-/Lernform / Teaching/Learning method</b> | Seminar and self-learning   |                     |
| <b>Vorkenntnisse / Previous knowledge</b>        |   |                     |
| <b>Examination</b>                               | Time of examination   | Type of examination |
| <b>Final exam of module</b>                      |   | G                   |
| <b>Course type</b>                               | Seminar   |                     |
| <b>SWS</b>                                       |   |                     |
| <b>Frequency</b>                                 |   |                     |
| <b>Workload attendance</b>                       | 0 h   |                     |

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