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**Modulhandbuch**

**Engineering Physics - Fach-Bachelor-Studiengang**

**im Wintersemester 2019/2020**

erstellt am 25.04.2024

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## Basismodule

### phy509 - Mechanics

|                             |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |                                                                                                                                                                                                                                                                                                             |
|-----------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Modulbezeichnung            |           | Mechanics                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |                                                                                                                                                                                                                                                                                                             |
| Modulkürzel                 |           | phy509                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |                                                                                                                                                                                                                                                                                                             |
| Kreditpunkte                |           | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |                                                                                                                                                                                                                                                                                                             |
| Workload                    |           | 180 h<br>(<br>Attendance: 84 hrs Self study: 96 hrs<br>)                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                                                                                                                                                                                                                                                                                                             |
| Verwendbarkeit des Moduls   |           | <ul style="list-style-type: none"><li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Basismodule</li></ul>                                                                                                                                                                                                                                                                                                                                                 |                  |                                                                                                                                                                                                                                                                                                             |
| Zuständige Personen         |           | <ul style="list-style-type: none"><li>Kittel, Achim (Prüfungsberechtigt)</li><li>Kühn, Martin (Prüfungsberechtigt)</li><li>Lienau, Christoph (Prüfungsberechtigt)</li><li>Nilius, Niklas (Prüfungsberechtigt)</li><li>Peinke, Joachim (Prüfungsberechtigt)</li><li>Schäfer, Sascha (Prüfungsberechtigt)</li><li>Uppenkamp, Stefan (Prüfungsberechtigt)</li><li>Wollenhaupt, Matthias (Prüfungsberechtigt)</li><li>Kühn, Martin (Modulverantwortung)</li></ul> |                  |                                                                                                                                                                                                                                                                                                             |
| Teilnahmevoraussetzungen    |           | Basic knowledge of mathematics acc. the pre-course of mathematics                                                                                                                                                                                                                                                                                                                                                                                             |                  |                                                                                                                                                                                                                                                                                                             |
| Kompetenzziele              |           | 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.                                                                                                                                                                                        |                  |                                                                                                                                                                                                                                                                                                             |
| Modulinhalte                |           | - Scientific reasoning - Space and Time - Kinematics - Dynamics - Motion in accelerated frames - Work and Energy - Laws of Conservation - Physics of rigid bodies - Deformable bodies and fluid media - Oscillations - Waves                                                                                                                                                                                                                                  |                  |                                                                                                                                                                                                                                                                                                             |
| Literaturempfehlungen       |           | Mechanics: D. Halliday, R. Resnick, J. Walker, S. W. Koch: Fundamentals of physics / Physik. Wiley-VCH, Weinheim, 2003 P. A. Tipler, G. Mosca, D. Pelté, M. Basler: Physics/Physik. Spektrum Akademischer Verlag, 2004 W. Demtröder: Experimentalphysik, Band 1: Mechanik und Wärme. Springer, Berlin, 2004 L. Bergmann, C. Schäfer, H. Gobrecht: Lehrbuch der Experimentalphysik, Band 1: Mechanik, Relativität, Wärme. De Gruyter, Berlin, 1998             |                  |                                                                                                                                                                                                                                                                                                             |
| Links                       |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |                                                                                                                                                                                                                                                                                                             |
| Unterrichtssprache          |           | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                                                                                                                                                                                                                                                                                                             |
| Dauer in Semestern          |           | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |                                                                                                                                                                                                                                                                                                             |
| Angebotsrhythmus Modul      |           | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                                                                                                                                                                                                                                                                                                             |
| Aufnahmekapazität Modul     |           | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |                                                                                                                                                                                                                                                                                                             |
| Modulart                    |           | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |                                                                                                                                                                                                                                                                                                             |
| Prüfung                     |           | Prüfungszeiten                                                                                                                                                                                                                                                                                                                                                                                                                                                |                  | Prüfungsform                                                                                                                                                                                                                                                                                                |
| Gesamtmodul                 |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  | weekly exercises, 2 hrs written exam or 45 min oral exam and assignment. [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. |
| Lehrveranstaltungsform      | Kommentar | SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Angebotsrhythmus | Workload Präsenz                                                                                                                                                                                                                                                                                            |
| Vorlesung                   |           | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                             | WiSe             | 28                                                                                                                                                                                                                                                                                                          |
| Übung                       |           | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                             | WiSe             | 28                                                                                                                                                                                                                                                                                                          |
| Präsenzzeit Modul insgesamt |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  | 56 h                                                                                                                                                                                                                                                                                                        |

## phy513 - Basic Laboratory

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>          | Basic Laboratory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Modulkürzel</b>               | phy513                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Kreditpunkte</b>              | 9.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Workload</b>                  | 270 h<br>(<br>270 h (Präsenzzeit 140h, Selbststudium: 130h)<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Verwendbarkeit des Moduls</b> | <ul style="list-style-type: none"><li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Basismodule</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Zuständige Personen</b>       | <ul style="list-style-type: none"><li>Krüger, Michael (Modulverantwortung)</li><li>Koch, Sandra (Modulverantwortung)</li><li>Huke, Philipp (Prüfungsberechtigt)</li><li>Hölling, Michael (Prüfungsberechtigt)</li><li>Koch, Sandra (Prüfungsberechtigt)</li><li>Krüger, Michael (Prüfungsberechtigt)</li><li>Neu, Walter (Prüfungsberechtigt)</li><li>Reck, Martin (Prüfungsberechtigt)</li><li>Schellenberg, Markus (Prüfungsberechtigt)</li><li>Schüning, Thomas (Prüfungsberechtigt)</li><li>Silies, Martin (Prüfungsberechtigt)</li><li>Teubner, Ulrich (Prüfungsberechtigt)</li></ul> |
| <b>Teilnahmevoraussetzungen</b>  | - Simultaneous hearing of Mechanics & Electrodynamics and Optics lectures - Course I is a prerequisite for course II                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Kompetenzziele</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>Modulinhalte</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>Literaturempfehlungen</b>     | <p>See <a href="https://uol.de/en/physics/laboratory-courses/basic-laboratory-course/experiments-in-winter-semester">https://uol.de/en/physics/laboratory-courses/basic-laboratory-course/experiments-in-winter-semester</a> for the first semester and will be provided via Stud-IP for the second semester</p> <p>Kirkup, L. (2019). Experimental Methods for Science and Engineering Students: An Introduction to the Analysis and Presentation of Data, Cambridge: Cambridge University Press. doi:10.1017/9781108290104</p>                                                           |
| <b>Links</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Unterrichtssprache</b>        | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Dauer in Semestern</b>        | 2 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Angebotsrhythmus Modul</b>    | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Aufnahmekapazität Modul</b>   | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Hinweise</b>                  | <p>The first part will take place in Oldenburg (Winter Semester)</p> <p>The second part will take place in Emden (Summer Semester)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Modulart</b>                  | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Modullevel</b>                | BM (Basismodul / Base)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Lehr-/Lernform</b>            | Laborpraktikum: 8 SWS<br>Seminar: 2 SWS<br><br>Praktikum: 4 WiSe 70 h<br>Seminar: 1 WiSe 14 h<br>Praktikum: HS EL 4 SoSe 56                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

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| Prüfung                       | Prüfungszeiten | Prüfungsform                                                                                           |
|-------------------------------|----------------|--------------------------------------------------------------------------------------------------------|
| <b>Gesamtmodul</b>            |                | 2 Fachpraktische Übungen (WiSe:1 Vortrag, 2 Übungen, 13 Protokolle; SoSe 11 Protokolle und Kolloquien) |
| <b>Lehrveranstaltungsform</b> | Praktikum      |                                                                                                        |
| <b>SWS</b>                    | 8              |                                                                                                        |
| <b>Angebotsrhythmus</b>       |                |                                                                                                        |
| <b>Workload Präsenzzeit</b>   | 112 h          |                                                                                                        |

## phy520 - Electrodynamics and Optics

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <b>Modulbezeichnung</b>          | Electrodynamics and Optics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |
| <b>Modulkürzel</b>               | phy520                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                     |
| <b>Kreditpunkte</b>              | 9.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                     |
| <b>Workload</b>                  | 270 h<br>(<br>Attendance 112 hrs Self study: 158 hrs<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                     |
| <b>Verwendbarkeit des Moduls</b> | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Basismodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |
| <b>Zuständige Personen</b>       | <ul style="list-style-type: none"> <li>Groß, Petra (Prüfungsberechtigt)</li> <li>Kittel, Achim (Prüfungsberechtigt)</li> <li>Lienau, Christoph (Prüfungsberechtigt)</li> <li>Nilius, Niklas (Prüfungsberechtigt)</li> <li>Peinke, Joachim (Prüfungsberechtigt)</li> <li>Schäfer, Sascha (Prüfungsberechtigt)</li> <li>Schellenberg, Markus (Prüfungsberechtigt)</li> <li>Uppenkamp, Stefan (Prüfungsberechtigt)</li> <li>van de Par, Steven (Prüfungsberechtigt)</li> <li>Wollenhaupt, Matthias (Prüfungsberechtigt)</li> <li>Silies, Martin (Prüfungsberechtigt)</li> <li>van de Par, Steven (Modulverantwortung)</li> </ul>                                                                                                                                                                                                          |                     |
| <b>Teilnahmevoraussetzungen</b>  | Mechanics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                     |
| <b>Kompetenzziele</b>            | <p>Electrodynamics and optics: 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. Optical systems: 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>Modulinhalte</b>              | <p>Electrodynamics and optics: 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 Optical systems: 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 low 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>Literaturempfehlungen</b>     | <p>Electrodynamics and optics: D. Meschede: Gerthsen, Physik. Springer, Berlin, 2005 (available in English) P. A. Tipler, G. Mosca, D. Pelte, M. Basler: Physik. Spektrum Akademischer Verlag, 2004 W. Demtröder: Experimentalphysik, Band 2: Elektrizität und Optik. Springer, Berlin, 2004 (available in English) H. Hänsel, W. Neumann: Physik. Elektrizität, Optik, Raum und Zeit. Spektrum Akademischer Verlag, Heidelberg, 2003 S. Brandt, H. D. Dahmen: Elektrodynamik. Eine Einführung in Experiment und Theorie. Springer, Berlin, 2005 W. Greiner: Klassische Elektrodynamik. Harri Deutsch, Frankfurt, 2002 E. Hecht: Optik. Oldenbourg, München, 2005 Optical systems: Waren J. Smith: Modern Optical Engineering, Mc Graw Hill, 4th edition, 2008 G. Schröder: Technische Optik, Vogel Verlag Würzburg, 2007 Scriptum</p> |                     |
| <b>Links</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                     |
| <b>Unterrichtssprache</b>        | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |
| <b>Dauer in Semestern</b>        | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |
| <b>Angebotsrhythmus Modul</b>    | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                     |
| <b>Aufnahmekapazität Modul</b>   | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |
| <b>Modulart</b>                  | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                     |
| <b>Lehr-/Lernform</b>            | Lecture: 6 hrs/week<br>Exercise: 2 hrs/week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                     |
| <b>Prüfung</b>                   | <b>Prüfungszeiten</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Prüfungsform</b> |
| <b>Gesamtmodul</b>               | 2 exams: 180 min written exam or 60 min 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |

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| Lehrveranstaltungsform             | Kommentar | SWS | Angebotsrhythmus | Workload Präsenz |
|------------------------------------|-----------|-----|------------------|------------------|
| Vorlesung                          |           | 6   | SoSe             | 84               |
| Übung                              |           | 2   | SoSe             | 28               |
| <b>Präsenzzeit Modul insgesamt</b> |           |     |                  | <b>112 h</b>     |

## phy540 - Mathematical Methods for Physics and Engineering I

|                             |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                |                  |
|-----------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|------------------|
| Modulbezeichnung            |                | Mathematical Methods for Physics and Engineering I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                |                  |
| Modulkürzel                 |                | phy540                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                |                  |
| Kreditpunkte                |                | 9.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                |                  |
| Workload                    |                | 270 h<br>(<br>Präsenzzeit: 84 Stunden Selbststudium: 186 Stunden<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                |                  |
| Verwendbarkeit des Moduls   |                | <ul style="list-style-type: none"><li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Basismodule</li><li>Fach-Bachelor Physik, Technik und Medizin (Bachelor) &gt; Basismodule</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                          |                                                |                  |
| Zuständige Personen         |                | <ul style="list-style-type: none"><li>Uppenkamp, Stefan (Modulverantwortung)</li><li>Doclo, Simon (Prüfungsberechtigt)</li><li>Hohmann, Volker (Prüfungsberechtigt)</li><li>Uppenkamp, Stefan (Prüfungsberechtigt)</li><li>van de Par, Steven (Prüfungsberechtigt)</li></ul>                                                                                                                                                                                                                                                                                                                         |                                                |                  |
| Teilnahmevoraussetzungen    |                | Abiturwissen Mathematik                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                |                  |
| Kompetenzziele              |                | <ul style="list-style-type: none"><li>To gain basic understanding of the principles of mathematical reasoning; to obtain knowledge in the application of calculus to solve problems in physics and engineering</li></ul>                                                                                                                                                                                                                                                                                                                                                                             |                                                |                  |
|                             |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                |                  |
| Modulinhalte                |                | <ul style="list-style-type: none"><li>Vector algebra (vectors in 2- and 3-space, vector multiplication, planes, lines, cylindrical and spherical coordinates)</li><li>Preliminary calculus (elementary functions, limits, series, differentiation, integration)</li><li>Complex numbers, preliminary complex analysis</li><li>Introduction to ordinary differential equations, especially for oscillatory systems</li><li>Partial differentiation</li><li>Vector calculus (scalar and vector fields, vector operators, line, surface and volume integrals, divergence and Stokes' theorem)</li></ul> |                                                |                  |
|                             |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                |                  |
| Literaturempfehlungen       |                | K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                |                  |
| Links                       |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                |                  |
| Unterrichtsprachen          |                | Englisch, Deutsch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                |                  |
| Dauer in Semestern          |                | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                |                  |
| Angebotsrhythmus Modul      |                | Wintersemester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                |                  |
| Aufnahmekapazität Modul     |                | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                |                  |
| Modulart                    |                | Pflicht / Mandatory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                |                  |
| Modullevel                  |                | BM (Basismodul / Base)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                |                  |
| Lehr-/Lernform              |                | Vorlesung/Lecture: 4 SWS, Übungen/Exercises: 2 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                |                  |
| Vorkenntnisse               |                | Abiturwissen Mathematik                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                |                  |
| Prüfung                     | Prüfungszeiten |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Prüfungsform                                   |                  |
| Gesamtmodul                 |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Max. 180 min written exam or 45 min oral exam. |                  |
| Lehrveranstaltungsform      | Kommentar      | SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Angebotsrhythmus                               | Workload Präsenz |
| Vorlesung                   |                | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                | 56               |
| Übung                       |                | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                | 28               |
| Präsenzzeit Modul insgesamt |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                | 84 h             |

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## Aufbaumodule

### phy031 - Atomic and Molecular Physics

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Modulbezeichnung          | Atomic and Molecular Physics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Modulkürzel               | phy031                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Kreditpunkte              | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Workload                  | 180 h<br>(<br>Präsenzzeit 84h, Selbststudium: 96h<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Verwendbarkeit des Moduls | <ul style="list-style-type: none"><li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Zuständige Personen       | <ul style="list-style-type: none"><li>Neu, Walter (Modulverantwortung)</li><li>Bayer, Tim-Daniel (Prüfungsberechtigt)</li><li>Englert, Lars (Prüfungsberechtigt)</li><li>Groß, Petra (Prüfungsberechtigt)</li><li>Kittel, Achim (Prüfungsberechtigt)</li><li>Schäfer, Sascha (Prüfungsberechtigt)</li><li>Lienau, Christoph (Prüfungsberechtigt)</li><li>Neu, Walter (Prüfungsberechtigt)</li><li>Nilius, Niklas (Prüfungsberechtigt)</li><li>Pengel, Dominik (Prüfungsberechtigt)</li><li>Wollenhaupt, Matthias (Prüfungsberechtigt)</li><li>Silies, Martin (Prüfungsberechtigt)</li></ul>                                                                                                                                                                                                        |
| Teilnahmevoraussetzungen  | Courses in Experimental Physics I and II and Mathematics I & II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Kompetenzziele            | Students gain knowledge of the basic principles of atomic and molecular physics. They gain the ability to distinguish between classical and quantum mechanical descriptions of microscopic matter by discussing key experiments. They acquire the competence to combine knowledge from experimental physics with mathematical and theoretical skills to interpret and qualitatively or quantitatively describe phenomena of atomic and molecular physics. The exercises and tutorials deepen the knowledge by assigning appropriate homework.                                                                                                                                                                                                                                                      |
| Modulinhalte              | <p>Concepts of atomic models; angular momentum, spin, and magnetic properties of the hydrogen atom; interaction with electric and magnetic fields; wave-particle dualism; introduction to quantum mechanics: photons, wave packets, Schrodinger equation, Heisenberg uncertainty principle relativity and Dirac equation; coupling schemes and atomic spectra; absorption and emission, transition probabilities; spectroscopic methods; bosons and fermions, periodic system of the elements; introduction to molecular physics; molecular spectra, rotational and vibrational excitation; selection rules.</p> <p>Applications: the electron in the box, the harmonic oscillator, the hydrogen atom, fine and hyperfine structure, line shapes, spectroscopy and modern experimental methods</p> |
| Literaturempfehlungen     | <p>1. Wolfgang Demtröder</p> <p>Atoms, Molecules and Photons: An Introduction to Atomic-, Molecular- and Quantum Physics</p> <p>Berlin, Heidelberg: Springer Berlin / Heidelberg, 2019</p> <p>2./3. Ingolf V Hertel und Claus-Peter Schulz</p> <p>Atoms, Molecules and Optical Physics 1 : Atoms and Spectroscopy, Springer, 2015</p> <p>Atoms, Molecules and Optical Physics 2: Molecules and Photons - Spectroscopy and Collisions</p> <p>Berlin, Heidelberg: Springer Berlin / Heidelberg, 2014</p> <p>4./5. Sune Svanberg</p> <p>Atomic and molecular spectroscopy : basic aspects and practical applications Springer, 1991</p>                                                                                                                                                               |

Laser spectroscopy for sensing : fundamentals, techniques and applications, Cambridge Woodhead Publishing, 2014

6./7. Wolfgang. Demtröder

Laser Spectroscopy 1 : Basic Principles Imprint: Springer, 2014

Laser Spectroscopy 2 : Experimental Techniques Imprint: Springer, 2015

8. Peter Van der Straten; Atoms and molecules interacting with light : atomic physics for the laser era. Cambridge University Press, 2016

9. Claude Cohen-Tannoudji und David Guery-Odelin; Advances in atomic physics : an overview. World Scientific, 2011

10. Rita Kakkar; Atomic and molecular spectroscopy : basic concepts and applications Cambridge University Press, 2015

Recent publications on specific topics

|                             |           |                                              |                  |                                                                                                                    |
|-----------------------------|-----------|----------------------------------------------|------------------|--------------------------------------------------------------------------------------------------------------------|
| Links                       |           |                                              |                  |                                                                                                                    |
| Unterrichtssprache          |           | Englisch                                     |                  |                                                                                                                    |
| Dauer in Semestern          |           | 1 Semester                                   |                  |                                                                                                                    |
| Angebotsrhythmus Modul      |           | jährlich                                     |                  |                                                                                                                    |
| Aufnahmekapazität Modul     |           | unbegrenzt                                   |                  |                                                                                                                    |
| Hinweise                    |           |                                              |                  |                                                                                                                    |
| Modulart                    |           | je nach Studiengang Pflicht oder Wahlpflicht |                  |                                                                                                                    |
| Modullevel                  |           | AC (Aufbaucurriculum / Composition)          |                  |                                                                                                                    |
| Lehr-/Lernform              |           | Vorlesung: 4 SWS, Übung: 2 SWS               |                  |                                                                                                                    |
| Prüfung                     |           | Prüfungszeiten                               |                  | Prüfungsform                                                                                                       |
| Gesamtmodul                 |           |                                              |                  | 1 Klausur (von 90 Min. bis 180 Min)(regulär) oder<br>1 mündliche Prüfung (von 30 Min. bis 45 Min) (auf<br>Anfrage) |
| Lehrveranstaltungsform      | Kommentar | SWS                                          | Angebotsrhythmus | Workload Präsenz                                                                                                   |
| Vorlesung                   |           | 4                                            |                  | 56                                                                                                                 |
| Übung                       |           | 2                                            |                  | 28                                                                                                                 |
| Präsenzzeit Modul insgesamt |           |                                              |                  | 84 h                                                                                                               |

## phy041 - Thermodynamics and Statistics

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |                                                                                                                                                                                                                                                                                                  |                         |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| <b>Modulbezeichnung</b>            | Thermodynamics and Statistics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Modulkürzel</b>                 | phy041                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Kreditpunkte</b>                | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Workload</b>                    | 180 h<br>(<br>attendance: 84 hrs self study: 96 hrs<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Verwendbarkeit des Moduls</b>   | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Zuständige Personen</b>         | <ul style="list-style-type: none"> <li>Kittel, Achim (Prüfungsberechtigt)</li> <li>Lienau, Christoph (Prüfungsberechtigt)</li> <li>Nilius, Niklas (Prüfungsberechtigt)</li> <li>Peinke, Joachim (Prüfungsberechtigt)</li> <li>Schäfer, Sascha (Prüfungsberechtigt)</li> <li>Wollenhaupt, Matthias (Prüfungsberechtigt)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Teilnahmevoraussetzungen</b>    | courses experimental physics 1, 2, 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Kompetenzziele</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>Modulinhalte</b>                | <p>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</p> |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Literaturempfehlungen</b>       | <p>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;</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Links</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Unterrichtssprache</b>          | Deutsch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Dauer in Semestern</b>          | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Angebotsrhythmus Modul</b>      | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Aufnahmekapazität Modul</b>     | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Modulart</b>                    | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Modullevel</b>                  | ---                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Lehr-/Lernform</b>              | Lecture: 4 hrs/week<br>Exercise: 2 hrs/week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |                                                                                                                                                                                                                                                                                                  |                         |
| <b>Prüfung</b>                     | <b>Prüfungszeiten</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            | <b>Prüfungsform</b>                                                                                                                                                                                                                                                                              |                         |
| <b>Gesamtmodul</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            | Weekly exercises, 120 min written exam or 45 min 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>Lehrveranstaltungsform</b>      | <b>Kommentar</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>SWS</b> | <b>Angebotsrhythmus</b>                                                                                                                                                                                                                                                                          | <b>Workload Präsenz</b> |
| Vorlesung                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 4          |                                                                                                                                                                                                                                                                                                  | 56                      |
| Übung                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 2          |                                                                                                                                                                                                                                                                                                  | 28                      |
| <b>Präsenzzeit Modul insgesamt</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |                                                                                                                                                                                                                                                                                                  | 84 h                    |

## phy505 - Lab Project I

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>          | Lab Project I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Modulkürzel</b>               | phy505                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Kreditpunkte</b>              | 9.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Workload</b>                  | 270 h<br>(<br>Attendance: 70 hrs Self-study: 200 hrs<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Verwendbarkeit des Moduls</b> | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Zuständige Personen</b>       | <ul style="list-style-type: none"> <li>Teubner, Ulrich (Modulverantwortung)</li> <li>Agert, Carsten (Prüfungsberechtigt)</li> <li>Anemüller, Jörn (Prüfungsberechtigt)</li> <li>Dietz, Mathias (Prüfungsberechtigt)</li> <li>Doclo, Simon (Prüfungsberechtigt)</li> <li>Ewert, Stephan (Prüfungsberechtigt)</li> <li>Groß, Petra (Prüfungsberechtigt)</li> <li>Gütay, Levent (Prüfungsberechtigt)</li> <li>Hartmann, Alexander (Prüfungsberechtigt)</li> <li>Hein, Andreas (Prüfungsberechtigt)</li> <li>Schäfer, Sascha (Prüfungsberechtigt)</li> <li>Held, Esther (Prüfungsberechtigt)</li> <li>Helms, Olaf (Prüfungsberechtigt)</li> <li>Hohmann, Volker (Prüfungsberechtigt)</li> <li>Hölling, Michael (Prüfungsberechtigt)</li> <li>Huke, Philipp (Prüfungsberechtigt)</li> <li>Kittel, Achim (Prüfungsberechtigt)</li> <li>Kühn, Martin (Prüfungsberechtigt)</li> <li>Koch, Sandra (Prüfungsberechtigt)</li> <li>Krüger, Michael (Prüfungsberechtigt)</li> <li>Kollmeier, Birger (Prüfungsberechtigt)</li> <li>Lienau, Christoph (Prüfungsberechtigt)</li> <li>Meyer, Bernd (Prüfungsberechtigt)</li> <li>Neu, Walter (Prüfungsberechtigt)</li> <li>Nilius, Niklas (Prüfungsberechtigt)</li> <li>Peinke, Joachim (Prüfungsberechtigt)</li> <li>Schellenberg, Markus (Prüfungsberechtigt)</li> <li>Poppe, Björn (Prüfungsberechtigt)</li> <li>Reck, Martin (Prüfungsberechtigt)</li> <li>Schmidt, Andreas Hermann (Prüfungsberechtigt)</li> <li>Schüning, Thomas (Prüfungsberechtigt)</li> <li>Silies, Martin (Prüfungsberechtigt)</li> <li>Teubner, Ulrich (Prüfungsberechtigt)</li> <li>Uppenkamp, Stefan (Prüfungsberechtigt)</li> <li>van de Par, Steven (Prüfungsberechtigt)</li> <li>Vogelgesang, Ralf (Prüfungsberechtigt)</li> <li>Wollenhaupt, Matthias (Prüfungsberechtigt)</li> <li>Lange, Sven Carsten (Prüfungsberechtigt)</li> </ul> |
| <b>Teilnahmevoraussetzungen</b>  | Basic laboratory course I & II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Kompetenzziele</b>            | Laboratory: Knowledge and experience about experimental work, managing experimental work and evaluating results. Design Fundamentals: 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>Modulinhalte</b>              | Laboratory: Experiments in the field of electronics and measurement technique<br>Design Fundamentals: Rules and Standards for Technical Drawings, Design Phases: • Functional requirements, performance specifications • Design methodology • Decision processes • Detailing • Manufacturing Drawings • Grouping of parts Basic Machine Elements: • Frames • Joints • Bearings • Sealing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Literaturempfehlungen</b>     | Laboratory: Specific project descriptions Design Fundamentals: ISO- and EN-Standards, Childs: Mechanical Design, Ulrich/Eppinger: Product Design and Development, Matousek: Engineering Design                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Links</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Unterrichtssprache</b>        | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Dauer in Semestern</b>        | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Angebotsrhythmus Modul</b>    | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Aufnahmekapazität Modul</b>   | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

|                                    |           |                                                                                                                                                           |                  |                  |
|------------------------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|
| <b>Modulart</b>                    |           | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                              |                  |                  |
| <b>Modullevel</b>                  |           | AC (Aufbaucurriculum / Composition)                                                                                                                       |                  |                  |
| <b>Lehr-/Lernform</b>              |           | Laboratory: 3 hrs/week<br>Lecture: 2 hrs/week                                                                                                             |                  |                  |
| Prüfung                            |           | Prüfungszeiten                                                                                                                                            |                  | Prüfungsform     |
| <b>Gesamtmodul</b>                 |           | 2 Prüfungsleistungen: 1 Hausarbeit (Gewichtung 1/3) und 1 Praktikumsbericht (max. 30 Seiten) mit Abschlusspräsentation (max. 30 Minuten) (Gewichtung 2/3) |                  |                  |
| Lehrveranstaltungsform             | Kommentar | SWS                                                                                                                                                       | Angebotsrhythmus | Workload Präsenz |
| Vorlesung                          |           | 2                                                                                                                                                         |                  | 28               |
| Praktikum                          |           | 3                                                                                                                                                         |                  | 42               |
| <b>Präsenzzeit Modul insgesamt</b> |           |                                                                                                                                                           |                  | 70 h             |

## phy541 - Mathematical Methods for Physics and Engineering II

|                                    |                                                                                                                                                                                                                                                                                                                                                                 |     |                                                      |                  |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------------------------------------|------------------|
| <b>Modulbezeichnung</b>            | Mathematical Methods for Physics and Engineering II                                                                                                                                                                                                                                                                                                             |     |                                                      |                  |
| <b>Modulkürzel</b>                 | phy541                                                                                                                                                                                                                                                                                                                                                          |     |                                                      |                  |
| <b>Kreditpunkte</b>                | 6.0 KP                                                                                                                                                                                                                                                                                                                                                          |     |                                                      |                  |
| <b>Workload</b>                    | 180 h<br>(<br>attendance: 56 hrs self study: 124 hrs<br>)                                                                                                                                                                                                                                                                                                       |     |                                                      |                  |
| <b>Verwendbarkeit des Moduls</b>   | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li> <li>Fach-Bachelor Physik, Technik und Medizin (Bachelor) &gt; Basismodule</li> </ul>                                                                                                                                                                 |     |                                                      |                  |
| <b>Zuständige Personen</b>         | <ul style="list-style-type: none"> <li>Doclo, Simon (Modulverantwortung)</li> <li>Doclo, Simon (Prüfungsberechtigt)</li> <li>Hohmann, Volker (Prüfungsberechtigt)</li> <li>Uppenkamp, Stefan (Prüfungsberechtigt)</li> </ul>                                                                                                                                    |     |                                                      |                  |
| <b>Teilnahmevoraussetzungen</b>    | Contents of the lecture "Mathematical Methods for Physics and Engineering I"                                                                                                                                                                                                                                                                                    |     |                                                      |                  |
| <b>Kompetenzziele</b>              | To obtain advanced knowledge in the application of mathematical methods to solve problems in physics and engineering                                                                                                                                                                                                                                            |     |                                                      |                  |
| <b>Modulinhalte</b>                | Matrices and vector spaces (linear vector spaces, basis, norm, matrices, matrix operations, determinant, inverse matrix, eigenvalue decomposition) - Quadratic forms - Linear equations (Gauss elimination, least-squares solution) - Functions of multiple variables (stationary points, constrained optimization using Lagrange multipliers) - Fourier series |     |                                                      |                  |
| <b>Literaturempfehlungen</b>       | K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006                                                                                                                                                                                                                                                   |     |                                                      |                  |
| <b>Links</b>                       |                                                                                                                                                                                                                                                                                                                                                                 |     |                                                      |                  |
| <b>Unterrichtssprache</b>          | Englisch                                                                                                                                                                                                                                                                                                                                                        |     |                                                      |                  |
| <b>Dauer in Semestern</b>          | 1 Semester                                                                                                                                                                                                                                                                                                                                                      |     |                                                      |                  |
| <b>Angebotsrhythmus Modul</b>      | Sommersemester                                                                                                                                                                                                                                                                                                                                                  |     |                                                      |                  |
| <b>Aufnahmekapazität Modul</b>     | unbegrenzt                                                                                                                                                                                                                                                                                                                                                      |     |                                                      |                  |
| <b>Modulart</b>                    | Pflicht / Mandatory                                                                                                                                                                                                                                                                                                                                             |     |                                                      |                  |
| <b>Modullevel</b>                  | BC (Basiscurriculum / Base curriculum)                                                                                                                                                                                                                                                                                                                          |     |                                                      |                  |
| <b>Lehr-/Lernform</b>              | Vorlesung/Lecture: 2 SWS,<br>Übungen/Exercises: 2 SWS                                                                                                                                                                                                                                                                                                           |     |                                                      |                  |
| Prüfung                            | Prüfungszeiten                                                                                                                                                                                                                                                                                                                                                  |     | Prüfungsform                                         |                  |
| <b>Gesamtmodul</b>                 |                                                                                                                                                                                                                                                                                                                                                                 |     | Max. 180 min. Klausur oder 45 min. mündliche Prüfung |                  |
| Lehrveranstaltungsform             | Kommentar                                                                                                                                                                                                                                                                                                                                                       | SWS | Angebotsrhythmus                                     | Workload Präsenz |
| Vorlesung                          |                                                                                                                                                                                                                                                                                                                                                                 | 2   |                                                      | 28               |
| Übung                              |                                                                                                                                                                                                                                                                                                                                                                 | 2   |                                                      | 28               |
| <b>Präsenzzeit Modul insgesamt</b> |                                                                                                                                                                                                                                                                                                                                                                 |     |                                                      | 56 h             |

## phy542 - Mathematical Methods for Physics and Engineering III

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |                                                       |                  |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------|------------------|
| <b>Modulbezeichnung</b>            | Mathematical Methods for Physics and Engineering III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |                                                       |                  |
| <b>Modulkürzel</b>                 | phy542                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |                                                       |                  |
| <b>Kreditpunkte</b>                | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |                                                       |                  |
| <b>Workload</b>                    | 180 h<br>(<br>180h (attendance: 56h; self-study: 124h)<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |                                                       |                  |
| <b>Verwendbarkeit des Moduls</b>   | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li> <li>Fach-Bachelor Physik, Technik und Medizin (Bachelor) &gt; Aufbaumodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                            |     |                                                       |                  |
| <b>Zuständige Personen</b>         | <ul style="list-style-type: none"> <li>Hohmann, Volker (Modulverantwortung)</li> <li>Doclo, Simon (Prüfungsberechtigt)</li> <li>Hohmann, Volker (Prüfungsberechtigt)</li> <li>Uppenkamp, Stefan (Prüfungsberechtigt)</li> <li>van de Par, Steven (Prüfungsberechtigt)</li> </ul>                                                                                                                                                                                                                                                                                            |     |                                                       |                  |
| <b>Teilnahmevoraussetzungen</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |                                                       |                  |
| <b>Kompetenzziele</b>              | <p>Students obtain advanced knowledge in analytical mathematical methods for physics and engineering and acquire the practical skills to apply these methods to solve practical problems in physics and engineering. In particular, students learn to formulate physical problems in a mathematically rigid way, which enables them to find solutions to difficult physical problems using analytic methods. This way, students acquire the mathematical foundations for mastering advanced courses in the various specializations of their respective degree programs.</p> |     |                                                       |                  |
| <b>Modulinhalte</b>                | <p>The course covers classical advanced analytic mathematics, in particular complex analysis, ordinary and partial differential equations, and integral transformations, such as Fourier and Laplace transforms. The theoretical background is covered in the lecture, which is used in the tutorials to prepare students for solving practical problems from physics and engineering, e.g., from Mechanics, Electrodynamics, Quantum Mechanics and Acoustics.</p>                                                                                                          |     |                                                       |                  |
| <b>Literaturempfehlungen</b>       | K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |                                                       |                  |
| <b>Links</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |                                                       |                  |
| <b>Unterrichtssprache</b>          | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |                                                       |                  |
| <b>Dauer in Semestern</b>          | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |                                                       |                  |
| <b>Angebotsrhythmus Modul</b>      | Wintersemester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |                                                       |                  |
| <b>Aufnahmekapazität Modul</b>     | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |                                                       |                  |
| <b>Modulart</b>                    | Pflicht / Mandatory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                                                       |                  |
| <b>Modullevel</b>                  | AC (Aufbaucurriculum / Composition)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                                                       |                  |
| <b>Lehr-/Lernform</b>              | Vorlesung/Lecture: 2 SWS,<br>Übungen/Exercises: 2 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |                                                       |                  |
| <b>Vorkenntnisse</b>               | Contents of the lectures "Mathematical Methods for Physics and Engineering I and II"                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |                                                       |                  |
| Prüfung                            | Prüfungszeiten                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     | Prüfungsform                                          |                  |
| <b>Gesamtmodul</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     | Max. 180 min. written exam, or max. 45 min. oral exam |                  |
| Lehrveranstaltungsform             | Kommentar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | SWS | Angebotsrhythmus                                      | Workload Präsenz |
| Vorlesung                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2   |                                                       | 28               |
| Übung                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2   |                                                       | 28               |
| <b>Präsenzzeit Modul insgesamt</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     | 56 h                                                  |                  |

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## phy551 - Quantum Structure of Matter

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>          | Quantum Structure of Matter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Modulkürzel</b>               | phy551                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Kreditpunkte</b>              | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Workload</b>                  | 180 h<br>(<br>Präsenzzeit 80h, Selbststudium: 100h<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Verwendbarkeit des Moduls</b> | <ul style="list-style-type: none"><li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Zuständige Personen</b>       | <ul style="list-style-type: none"><li>Cocchi, Caterina (Modulverantwortung)</li><li>Biehs, Svend-Age (Prüfungsberechtigt)</li><li>Cocchi, Caterina (Prüfungsberechtigt)</li><li>Lienau, Christoph (Prüfungsberechtigt)</li><li>Vogelgesang, Ralf (Prüfungsberechtigt)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Teilnahmevoraussetzungen</b>  | Mechanics, Electrodynamics and Optics, Atomic and Molecular Physics, Mathematical Methods for Physics and Engineering I-III. These courses are mandatory prerequisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Kompetenzziele</b>            | The students will learn the foundations of quantum structure of matter from a theoretical point of view. At the end of the course, they will be able to treat basic quantum mechanical problems related to matter in atomic, molecular, and crystalline form. They will learn the key theoretical methods that allow one to solve these problems exactly whenever possible, or approximately when the complexity of the many-body system impose it. The students will gain the ability to study physical phenomena with concrete technological implications such as, for example, light-matter interaction. Exercises, tutorials, and homework allow the students to consolidate the knowledge acquired during the lectures and to achieve the ability to independently treat the above-mentioned problems. |
| <b>Modulinhalte</b>              | <p>The foundations of quantum mechanics</p> <p>The Schrödinger equation</p> <p>The formalism of quantum mechanics: Operators, Dirac notation, Hilbert space</p> <p>Approximate methods: Perturbation theory and variational principle</p> <p>The many-body problem in solids</p> <p>Light-matter interaction and spectroscopy in solids</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Literatureempfehlungen</b>    | <p>D. Griffiths, Introduction to Quantum Mechanics, Pearson (2014)</p> <p>A. C. Philips, Introduction to Quantum mechanics, Wiley (2003)</p> <p>R. Eisberg &amp; R. Resnick, Quantum Physics, Wiley (1985)</p> <p>N. W. Ashcroft and D. Mermin, Solid state physics, Brooks Cole (1976)</p> <p>H. Kuzmany, Solid-state Spectroscopy, Springer (2009)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Links</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Unterrichtssprache</b>        | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Dauer in Semestern</b>        | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Angebotsrhythmus Modul</b>    | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Aufnahmekapazität Modul</b>   | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Modulart</b>                  | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Modullevel</b>                | AC (Aufbaucurriculum / Composition)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Lehr-/Lernform</b>            | Vorlesung: 4 SWS / lecture: 4 SWS<br>Tutorium: 2 SWS / tutorials 2 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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| Prüfung                       | Prüfungszeiten | Prüfungsform                                                   |
|-------------------------------|----------------|----------------------------------------------------------------|
| <b>Gesamtmodul</b>            |                | 1 Klausur (max. 180 Min.) oder 1 mündl. Prüfung (max. 45 min.) |
| <b>Lehrveranstaltungsform</b> | Vorlesung      |                                                                |
| <b>SWS</b>                    |                |                                                                |
| <b>Angebotsrhythmus</b>       | --             |                                                                |

## phy555 - Basic Engineering

|                             |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |                  |
|-----------------------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|
| Modulbezeichnung            |           | Basic Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                  |                  |
| Modulkürzel                 |           | phy555                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                  |
| Kreditpunkte                |           | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                  |
| Workload                    |           | 180 h<br>(<br>Attendance: 64 hrs Self study: 116 hrs<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |                  |
| Verwendbarkeit des Moduls   |           | <ul style="list-style-type: none"><li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>                                                                                                                                                                                                                                                                                                                                                                                   |                  |                  |
| Zuständige Personen         |           | <ul style="list-style-type: none"><li>Lange, Sven Carsten (Modulverantwortung)</li><li>Schmidt, Florian (Prüfungsberechtigt)</li><li>Lange, Sven Carsten (Prüfungsberechtigt)</li></ul>                                                                                                                                                                                                                                                                                                          |                  |                  |
| Teilnahmevoraussetzungen    |           | Basic Math (Algebra, Derivation, Integration) Basic knowledge in Physics (Mechanics, Thermodynamics, esp. Heat transfer)                                                                                                                                                                                                                                                                                                                                                                         |                  |                  |
| Kompetenzziele              |           | 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.                                                                                                                                                                                                                                                                          |                  |                  |
| Modulinhalte                |           | Applied Mechanics: - Static equilibrium (mainly 2D) - frame works - friction (Coulomb) - Hooke's law (3D including lateral contraction and thermal expansion) - bending and torsion with planar cross sections - Mohr's theory<br>Production Engineering: - Overview on manufacturing technologies, like - Casting and other primary shaping processes - Plastic deformation processes - Cutting and separating processes - Joining processes - Coating processes - Changing material properties |                  |                  |
| Literaturempfehlungen       |           | Applied Mechanics: Assmann: Technische Mechanik (in German); Meriam, Kraige: Engineering Mechanics, Beer, Russell, Johnston: Vector Mechanics for Engineers<br>Production Engineering: Groover: Fundamentals of Modern Manufacturing<br>DeGarmo: Materials and Processes in Manufacturing<br>König: Fertigungsverfahren (in German)                                                                                                                                                              |                  |                  |
| Links                       |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |                  |
| Unterrichtssprache          |           | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |                  |
| Dauer in Semestern          |           | 2 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                  |
| Angebotsrhythmus Modul      |           | halbjährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |                  |
| Aufnahmekapazität Modul     |           | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                  |
| Modulart                    |           | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |                  |
| Modullevel                  |           | BC (Basiscurriculum / Base curriculum)                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                  |
| Lehr-/Lernform              |           | Lecture with integrated sample problems and exercises                                                                                                                                                                                                                                                                                                                                                                                                                                            |                  |                  |
| Prüfung                     |           | Prüfungszeiten                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  | Prüfungsform     |
| Gesamtmodul                 |           | 2 exams: 180 min written exam or 60 min 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.                                                                                                                                                                                                          |                  |                  |
| Lehrveranstaltungsform      | Kommentar | SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Angebotsrhythmus | Workload Präsenz |
| Vorlesung                   |           | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | WiSe             | 56               |
| Übung                       |           | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | SoSe oder WiSe   | 28               |
| Präsenzzeit Modul insgesamt |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  | 84 h             |

## phy563 - Specialization

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |                                                                                                                          |                  |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------------------------------------------------------------------------------------------------------------------------|------------------|
| <b>Modulbezeichnung</b>            | Specialization                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |                                                                                                                          |                  |
| <b>Modulkürzel</b>                 | phy563                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |                                                                                                                          |                  |
| <b>Kreditpunkte</b>                | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |                                                                                                                          |                  |
| <b>Workload</b>                    | 180 h<br>(<br>Attendance: 56 hrs Self study: 124 hrs<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |                                                                                                                          |                  |
| <b>Verwendbarkeit des Moduls</b>   | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |                                                                                                                          |                  |
| <b>Zuständige Personen</b>         | <ul style="list-style-type: none"> <li>Doclo, Simon (Modulverantwortung)</li> <li>Kollmeier, Birger (Modulverantwortung)</li> <li>Kühn, Martin (Modulverantwortung)</li> <li>Neu, Walter (Modulverantwortung)</li> <li>Poppe, Björn (Modulverantwortung)</li> <li>Doclo, Simon (Prüfungsberechtigt)</li> <li>Huke, Philipp (Prüfungsberechtigt)</li> <li>Schüning, Thomas (Prüfungsberechtigt)</li> <li>Koch, Sandra (Prüfungsberechtigt)</li> <li>Kollmeier, Birger (Prüfungsberechtigt)</li> <li>Kühn, Martin (Prüfungsberechtigt)</li> <li>Steinfeld, Gerald (Prüfungsberechtigt)</li> <li>Neu, Walter (Prüfungsberechtigt)</li> <li>Poppe, Björn (Prüfungsberechtigt)</li> <li>Silies, Martin (Prüfungsberechtigt)</li> <li>Teubner, Ulrich (Prüfungsberechtigt)</li> <li>Looe, Hui Khee (Prüfungsberechtigt)</li> </ul>                                                                                                                                                       |     |                                                                                                                          |                  |
| <b>Teilnahmevoraussetzungen</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |                                                                                                                          |                  |
| <b>Kompetenzziele</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>Modulinhalte</b>                | <p>Specialization Laser and Optics: 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. The excursion to the fair "LASER World of PHOTONICS" in Munich is part of this course.</p> <p>Biomedical Physics &amp; Acoustics: 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: 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>Literaturempfehlungen</b>       | Acc. selected lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |                                                                                                                          |                  |
| <b>Links</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |                                                                                                                          |                  |
| <b>Unterrichtssprache</b>          | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |                                                                                                                          |                  |
| <b>Dauer in Semestern</b>          | 2 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                                                                                                                          |                  |
| <b>Angebotsrhythmus Modul</b>      | halbjährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |                                                                                                                          |                  |
| <b>Aufnahmekapazität Modul</b>     | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                                                                                                                          |                  |
| <b>Modulart</b>                    | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |                                                                                                                          |                  |
| <b>Lehr-/Lernform</b>              | Lecture: 4 hrs/week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |                                                                                                                          |                  |
| Prüfung                            | Prüfungszeiten                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     | Prüfungsform                                                                                                             |                  |
| <b>Gesamtmodul</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     | 1 Prüfungsleistung: 1 Klausur (max. 180 Min.) oder 1 mündliche Prüfung (max. 45 Min.) oder 1 Hausarbeit (max. 30 Seiten) |                  |
| Lehrveranstaltungsform             | Kommentar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | SWS | Angebotsrhythmus                                                                                                         | Workload Präsenz |
| Vorlesung                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 4   |                                                                                                                          | 56               |
| Seminar                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |                                                                                                                          |                  |
| <b>Präsenzzeit Modul insgesamt</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     | 56 h                                                                                                                     |                  |

## phy570 - Electronics

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |                                                      |                  |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------------------------------------------------|------------------|
| <b>Modulbezeichnung</b>            | Electronics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |                                                      |                  |
| <b>Modulkürzel</b>                 | phy570                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |                                                      |                  |
| <b>Kreditpunkte</b>                | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |                                                      |                  |
| <b>Workload</b>                    | 180 h<br>(<br>Attendance: 70 hrs Self study: 110 hrs<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |                                                      |                  |
| <b>Verwendbarkeit des Moduls</b>   | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbau module</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |                                                      |                  |
| <b>Zuständige Personen</b>         | <ul style="list-style-type: none"> <li>Haja, Andreas (Prüfungsberechtigt)</li> <li>Haja, Andreas (Modulverantwortung)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |                                                      |                  |
| <b>Teilnahmevoraussetzungen</b>    | Basic Lab. I, Math. Methods for Physics and Engineering I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |                                                      |                  |
| <b>Kompetenzziele</b>              | At the end of the course, students are able to plan, simulate and build simple electronic circuits. They are familiar with the fundamental laws of electricity, they know about major electronic components and how to use them properly. Also, they understand the concept of filters and are able to design and implement a filter circuit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |                                                      |                  |
| <b>Modulinhalte</b>                | The following topics will be covered during the course: - fundamentals of electricity - charges, current, voltage, Ohm's law, power - fundamental laws of direct current circuits - Kirchhoff's laws, voltage & current sources, simplification of circuits - major electronic components - resistors, capacitors, diodes, transistors - operational amplifiers & filters - op-amp basics, op-amp operating modes, passive filters, active filters During the course numerous projects will be developed by the students. The lecture implements a teaching concept similar to "inverted classroom", where students are provided with a range of learning materials (instructional videos, exercises, etc.), which they have to work through at home or in a team with other students. During the actual lecture, questions and exercises are discussed between lecturer and students. |     |                                                      |                  |
| <b>Literaturempfehlungen</b>       | - Lecture script and various recommendations of online sources - Practical Electronics for Inventors (Scherz, P. and Monk S.), McGraw Hill Education, Fourth Edition or newer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |                                                      |                  |
| <b>Links</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |                                                      |                  |
| <b>Unterrichtssprache</b>          | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |                                                      |                  |
| <b>Dauer in Semestern</b>          | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |                                                      |                  |
| <b>Angebotsrhythmus Modul</b>      | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |                                                      |                  |
| <b>Aufnahmekapazität Modul</b>     | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |                                                      |                  |
| <b>Modulart</b>                    | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |                                                      |                  |
| <b>Lehr-/Lernform</b>              | Lecture: 4 hrs/week<br>Exercise/Practical Work: 1 week, block course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |                                                      |                  |
| Prüfung                            | Prüfungszeiten                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     | Prüfungsform                                         |                  |
| <b>Gesamtmodul</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     | Max. 180 min. Klausur oder 30 min. mündliche Prüfung |                  |
| Lehrveranstaltungsform             | Kommentar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | SWS | Angebotsrhythmus                                     | Workload Präsenz |
| Vorlesung                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 4   |                                                      | 56               |
| Übung                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1   |                                                      | 14               |
| <b>Präsenzzeit Modul insgesamt</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |                                                      | 70 h             |

## phy581 - Material Sciences

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| <b>Modulbezeichnung</b>          | Material Sciences                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                      |
| <b>Modulkürzel</b>               | phy581                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                      |
| <b>Kreditpunkte</b>              | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                      |
| <b>Workload</b>                  | 180 h<br>(<br>Attendance: 56 hrs Self study: 124 hrs<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                      |
| <b>Verwendbarkeit des Moduls</b> | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                      |
| <b>Zuständige Personen</b>       | <ul style="list-style-type: none"> <li>Held, Esther (Modulverantwortung)</li> <li>Held, Esther (Prüfungsberechtigt)</li> <li>Helms, Olaf (Prüfungsberechtigt)</li> <li>Lünemann, Martin (Prüfungsberechtigt)</li> <li>Schüning, Thomas (Prüfungsberechtigt)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                      |
| <b>Teilnahmevoraussetzungen</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |
| <b>Kompetenzziele</b>            | Based on the microscopic structure of engineering materials the students understand their macroscopic properties and behaviour and are thus able to decide on the use of engineering materials taking the specific requirements into consideration.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                      |
| <b>Modulinhalte</b>              | <p>Classification of engineering materials, structure of engineering materials (structure of crystalline solids, imperfection in solids), single – and multiphase materials, phase diagrams of binary alloys, thermal analysis, lever rule, crystallization and microstructure development, phase transformation in metals, diffusion and thermally activated states, mechanical properties and testing methods, elastic and plastic deformation, hardness strengthening mechanisms, creep, fatigue, ferrous alloys and their annealing and heat treatments, nonferrous alloys, polymers (classification, structure and properties), ceramics and glasses (structure and properties), corrosion.</p> |                                                      |
| <b>Literaturempfehlungen</b>     | <p>William D. Callister, Jr.: Materials Sciences and Engineering An Introduction, Wiley</p> <p>Michael F. Ashby, David R.H. Jones: Engineering materials 1 an introduction to properties, applications and design, Oxford: Butterworth Heinemann</p> <p>Michael F. Ashby, David R.H. Jones: Engineering materials 2: an introduction to microstructures and processing</p>                                                                                                                                                                                                                                                                                                                           |                                                      |
| <b>Links</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |
| <b>Unterrichtssprache</b>        | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                      |
| <b>Dauer in Semestern</b>        | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                      |
| <b>Angebotsrhythmus Modul</b>    | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                      |
| <b>Aufnahmekapazität Modul</b>   | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                      |
| <b>Modulart</b>                  | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                      |
| <b>Lehr-/Lernform</b>            | Lecture with integrated exercises                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                      |
| Prüfung                          | Prüfungszeiten                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Prüfungsform                                         |
| <b>Gesamtmodul</b>               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Max. 180 min. Klausur oder 30 min. mündliche Prüfung |
| <b>Lehrveranstaltungsform</b>    | Vorlesung                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                      |
| <b>SWS</b>                       | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                      |
| <b>Angebotsrhythmus</b>          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                      |
| <b>Workload Präsenzzeit</b>      | 56 h                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                      |



## phy590 - Control Theory

|                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                    |                         |                         |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------|-------------------------|
| <b>Modulbezeichnung</b>            | Control Theory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                    |                         |                         |
| <b>Modulkürzel</b>                 | phy590                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                    |                         |                         |
| <b>Kreditpunkte</b>                | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                    |                         |                         |
| <b>Workload</b>                    | 180 h<br>(<br>120 h<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                         |                         |
| <b>Verwendbarkeit des Moduls</b>   | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                |                                    |                         |                         |
| <b>Zuständige Personen</b>         | <ul style="list-style-type: none"> <li>Huke, Philipp (Prüfungsberechtigt)</li> <li>Hein, Andreas (Prüfungsberechtigt)</li> <li>Huke, Philipp (Modulverantwortung)</li> <li>Huke, Philipp (Modulberatung)</li> </ul>                                                                                                                                                                                                                                                                             |                                    |                         |                         |
| <b>Teilnahmevoraussetzungen</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                    |                         |                         |
| <b>Kompetenzziele</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>Modulinhalte</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>Literaturempfehlungen</b>       | <p>Philipppen: Regelungstechnik mit Python<br/>Lutz, H. und Wendt, W.: Taschenbuch der Regelungstechnik Unbehauen;<br/>H.: Regelungstechnik I, Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme<br/>English books: K.J. Aström: Feedback Systems: An Introduction for Scientists and Engineers</p>                                                                                                                                                          |                                    |                         |                         |
| <b>Links</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                    |                         |                         |
| <b>Unterrichtssprache</b>          | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                         |                         |
| <b>Dauer in Semestern</b>          | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                    |                         |                         |
| <b>Angebotsrhythmus Modul</b>      | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                         |                         |
| <b>Aufnahmekapazität Modul</b>     | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                    |                         |                         |
| <b>Modulart</b>                    | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                    |                         |                         |
| <b>Modullevel</b>                  | AC (Aufbaucurriculum / Composition)                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                    |                         |                         |
| <b>Lehr-/Lernform</b>              | Online presentation / online methods                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                    |                         |                         |
| <b>Vorkenntnisse</b>               | <ul style="list-style-type: none"> <li>– Complex numbers</li> <li>– Ordinary differential equation</li> <li>– Laplace Transformation</li> </ul>                                                                                                                                                                                                                                                                                                                                                 |                                    |                         |                         |
| <b>Prüfung</b>                     | <b>Prüfungszeiten</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Prüfungsform</b>                |                         |                         |
| <b>Gesamtmodul</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 30 - 45 Minuten mündliche Prüfung. |                         |                         |
| <b>Lehrveranstaltungsform</b>      | <b>Kommentar</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>SWS</b>                         | <b>Angebotsrhythmus</b> | <b>Workload Präsenz</b> |
| Vorlesung                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 4                                  |                         | 56                      |
| Übung                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1                                  |                         | 14                      |
| <b>Präsenzzeit Modul insgesamt</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                    |                         | 70 h                    |

## phy501 - Numerical Methods

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>          | Numerical Methods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Modulkürzel</b>               | phy501                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Kreditpunkte</b>              | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Workload</b>                  | 180 h<br>(<br>180h (attendance: 56h; self-study: 124h)<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Verwendbarkeit des Moduls</b> | <ul style="list-style-type: none"><li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Zuständige Personen</b>       | <ul style="list-style-type: none"><li>Anemüller, Jörn (Prüfungsberechtigt)</li><li>Brand, Thomas (Prüfungsberechtigt)</li><li>Dietz, Mathias (Prüfungsberechtigt)</li><li>Hartmann, Alexander (Prüfungsberechtigt)</li><li>Hohmann, Volker (Prüfungsberechtigt)</li><li>Lücke, Jörg (Prüfungsberechtigt)</li><li>Meyer, Bernd (Prüfungsberechtigt)</li><li>Petrovic, Cornelia (Prüfungsberechtigt)</li><li>Hohmann, Volker (Modulverantwortung)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Teilnahmevoraussetzungen</b>  | Course Mathematical Methods II passed with a grade of at least 4.0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Kompetenzziele</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>Modulinhalte</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>Literatureempfehlungen</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>Unterrichtssprache</b>        | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Dauer in Semestern</b>        | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Angebotsrhythmus Modul</b>    | Annual, summer semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Aufnahmekapazität Modul</b>   | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Modulart</b>                  | Pflicht / Mandatory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Modullevel</b>                | AC (Aufbaucurriculum / Composition)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

|                             |                |                                                                                                                                                   |                  |                  |
|-----------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|
| Lehr-/Lernform              |                | Lecture: 2 hrs/week, Tutorial: 2 hrs/week                                                                                                         |                  |                  |
| Vorkenntnisse               |                | Basic computer knowledge; Basic programming skills, in particular Matlab; Knowledge in undergraduate Physics; Courses Mathematical Methods I-III. |                  |                  |
| Prüfung                     | Prüfungszeiten |                                                                                                                                                   | Prüfungsform     |                  |
| Gesamtmodul                 |                | Weekly graded programming exercises (equivalent to lab course), or (not preferred): max. 180 min. written exam or max. 45 min. oral exam          |                  |                  |
| Lehrveranstaltungsform      | Kommentar      | SWS                                                                                                                                               | Angebotsrhythmus | Workload Präsenz |
| Vorlesung                   |                | 2                                                                                                                                                 | SoSe und WiSe    | 28               |
| Übung                       |                | 2                                                                                                                                                 | SoSe und WiSe    | 28               |
| Präsenzzeit Modul insgesamt |                |                                                                                                                                                   |                  | 56 h             |

## phy502 - Solid State Physics

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |                       |                  |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----------------------|------------------|
| Modulbezeichnung          | Solid State Physics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |                       |                  |
| Modulkürzel               | phy502                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                       |                  |
| Kreditpunkte              | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                       |                  |
| Workload                  | 180 h<br>(<br>180 h (Präsenzzeit 84h, Selbststudium: 96h)<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |                       |                  |
| Verwendbarkeit des Moduls | <ul style="list-style-type: none"><li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |                       |                  |
| Zuständige Personen       | <ul style="list-style-type: none"><li>Nilius, Niklas (Modulverantwortung)</li><li>Kittel, Achim (Prüfungsberechtigt)</li><li>Lienau, Christoph (Prüfungsberechtigt)</li><li>Nilius, Niklas (Prüfungsberechtigt)</li><li>Schäfer, Sascha (Prüfungsberechtigt)</li><li>Wollenhaupt, Matthias (Prüfungsberechtigt)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |                       |                  |
| Teilnahmevoraussetzungen  | Experimental Physics I-IV, Quantum structure of Matter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                       |                  |
| Kompetenzziele            | 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. |     |                       |                  |
| Modulinhalte              | 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                                                                                                                                                                   |     |                       |                  |
| Literaturempfehlungen     | <div>1. N. W. Ashcroft, N. D. Mermin: Solid State Physics. Sounders College, Philadelphia,</div> <div>2. Introduction to Solid State Physics   Kittel, Charles   ISBN: 9780471415268</div> <div>3. S. Elliott: The Physics and Chemistry of Solids. John Wiley &amp; Sons, West Sussex (UK),</div> <div>4. H. Ibach, H. Lüth: Festkörperphysik. Springer, Berlin</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                       |                  |
| Links                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |                       |                  |
| Unterrichtssprache        | Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |                       |                  |
| Dauer in Semestern        | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |                       |                  |
| Angebotsrhythmus Modul    | jährlich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |                       |                  |
| Aufnahmekapazität Modul   | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |                       |                  |
| Modulart                  | je nach Studiengang Pflicht oder Wahlpflicht                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |                       |                  |
| Modullevel                | AC (Aufbaucurriculum / Composition)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |                       |                  |
| Lehr-/Lernform            | Vorlesung: 4 SWS, Übung: 2 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |                       |                  |
| Prüfung                   | Prüfungszeiten                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     | Prüfungsform          |                  |
| Gesamtmodul               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     | 120 min. written exam |                  |
| Lehrveranstaltungsform    | Kommentar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | SWS | Angebotsrhythmus      | Workload Präsenz |
| Vorlesung                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2   | SoSe und WiSe         | 28               |
| Übung                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2   | SoSe und WiSe         | 28               |

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| Lehrveranstaltungsform             | Kommentar | SWS | Angebotsrhythmus | Workload Präsenz |
|------------------------------------|-----------|-----|------------------|------------------|
| <b>Präsenzzeit Modul insgesamt</b> |           |     |                  | <b>56 h</b>      |

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## phy533 - Metrology

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|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Modulbezeichnung</b>          | Metrology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Modulkürzel</b>               | phy533                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Kreditpunkte</b>              | 6.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Workload</b>                  | 180 h<br>(<br>180 h (Präsenzzeit 56h, Selbststudium: 124h)<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Verwendbarkeit des Moduls</b> | <ul style="list-style-type: none"><li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Aufbaumodule</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Zuständige Personen</b>       | <ul style="list-style-type: none"><li>Meyer, Bernd (Modulverantwortung)</li><li>Meyer, Bernd (Modulberatung)</li><li>Doclo, Simon (Prüfungsberechtigt)</li><li>Hohmann, Volker (Prüfungsberechtigt)</li><li>Huke, Philipp (Prüfungsberechtigt)</li><li>Kittel, Achim (Prüfungsberechtigt)</li><li>Kollmeier, Birger (Prüfungsberechtigt)</li><li>Meyer, Bernd (Prüfungsberechtigt)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Teilnahmevoraussetzungen</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Kompetenzziele</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>Modulinhalte</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>Literaturempfehlungen</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 und Spektralanalyse mit MATLAB-Übungen. Teubner, Stuttgart;</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

J.-R. Ohm, H.D. Lüke: Signalübertragung. Springer, Berlin; B. Kollmeier;

Skript zur Signalverarbeitung und Messtechnik

|                             |           |                                                                      |                  |                                                                      |
|-----------------------------|-----------|----------------------------------------------------------------------|------------------|----------------------------------------------------------------------|
| Links                       |           |                                                                      |                  |                                                                      |
| Unterrichtssprache          |           | Englisch                                                             |                  |                                                                      |
| Dauer in Semestern          |           | 1 Semester                                                           |                  |                                                                      |
| Angebotsrhythmus Modul      |           | jährlich                                                             |                  |                                                                      |
| Aufnahmekapazität Modul     |           | unbegrenzt                                                           |                  |                                                                      |
| Modulart                    |           | Pflicht / Mandatory                                                  |                  |                                                                      |
| Modullevel                  |           | AC (Aufbaucurriculum / Composition)                                  |                  |                                                                      |
| Lehr-/Lernform              |           | Vorlesung: 3 SWS; SoSe 42h<br>Übung: 1SWS; SoSe 14h                  |                  |                                                                      |
|                             |           | Online presentation / online methods                                 |                  |                                                                      |
| Prüfung                     |           | Prüfungszeiten                                                       |                  | Prüfungsform                                                         |
| Gesamtmodul                 |           |                                                                      |                  |                                                                      |
|                             |           | Max. 90 min. Klausur oder 30 min. mündliche Prüfung (Gewichtung 1/2) |                  | Max. 90 min. Klausur oder 30 min. mündliche Prüfung (Gewichtung 1/2) |
|                             |           | und                                                                  |                  | und                                                                  |
|                             |           | 1 Referat oder 1 Hausarbeit (Gewichtung 1/2)                         |                  | 1 Referat oder 1 Hausarbeit (Gewichtung 1/2)                         |
| Lehrveranstaltungsform      | Kommentar | SWS                                                                  | Angebotsrhythmus | Workload Präsenz                                                     |
| Vorlesung und Übung         |           | 2                                                                    | SoSe und WiSe    | 28                                                                   |
| Seminar                     |           | 2                                                                    | SoSe und WiSe    | 28                                                                   |
| Präsenzzeit Modul insgesamt |           |                                                                      |                  |                                                                      |
| 56 h                        |           |                                                                      |                  |                                                                      |

# Abschlussmodul

## bam - Bachelorarbeitsmodul

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>Modulbezeichnung</b>          | Bachelorarbeitsmodul                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
| <b>Modulkürzel</b>               | bam                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |
| <b>Kreditpunkte</b>              | 15.0 KP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
| <b>Workload</b>                  | 450 h<br>(<br>Attendance: 28 hrs Self study: 422 hrs<br>)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |              |
| <b>Verwendbarkeit des Moduls</b> | <ul style="list-style-type: none"> <li>Fach-Bachelor Engineering Physics (Bachelor) &gt; Abschlussmodul</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |
| <b>Zuständige Personen</b>       | <ul style="list-style-type: none"> <li>Agert, Carsten (Prüfungsberechtigt)</li> <li>Brückner, Hans Josef (Prüfungsberechtigt)</li> <li>Hein, Andreas (Prüfungsberechtigt)</li> <li>Biehs, Svend-Age (Prüfungsberechtigt)</li> <li>Struve, Bert (Prüfungsberechtigt)</li> <li>Brand, Thomas (Prüfungsberechtigt)</li> <li>Doclo, Simon (Prüfungsberechtigt)</li> <li>Heinemann, Detlev (Prüfungsberechtigt)</li> <li>Ewert, Stephan (Prüfungsberechtigt)</li> <li>Gütay, Levent (Prüfungsberechtigt)</li> <li>Hartmann, Alexander (Prüfungsberechtigt)</li> <li>Schädler, Marc René (Prüfungsberechtigt)</li> <li>Schäfer, Sascha (Prüfungsberechtigt)</li> <li>Neu, Walter (Prüfungsberechtigt)</li> <li>Hohmann, Volker (Prüfungsberechtigt)</li> <li>Kittel, Achim (Prüfungsberechtigt)</li> <li>Kollmeier, Birger (Prüfungsberechtigt)</li> <li>Kühn, Martin (Prüfungsberechtigt)</li> <li>Schüning, Thomas (Prüfungsberechtigt)</li> <li>Peinke, Joachim (Prüfungsberechtigt)</li> <li>Lienau, Christoph (Prüfungsberechtigt)</li> <li>Meyer, Bernd (Prüfungsberechtigt)</li> <li>Poppe, Björn (Prüfungsberechtigt)</li> <li>van de Par, Steven (Prüfungsberechtigt)</li> <li>Nilius, Niklas (Prüfungsberechtigt)</li> <li>Petrovic, Cornelia (Prüfungsberechtigt)</li> <li>Teubner, Ulrich (Prüfungsberechtigt)</li> <li>Uppenkamp, Stefan (Prüfungsberechtigt)</li> <li>Vogelgesang, Ralf (Prüfungsberechtigt)</li> <li>Wollenhaupt, Matthias (Prüfungsberechtigt)</li> </ul> |              |
| <b>Teilnahmevoraussetzungen</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| <b>Kompetenzziele</b>            | Students will apply their diversified scientific and professional skills to plan, prepare, organize and produce single-handed a research study.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| <b>Modulinhalte</b>              | The thesis comprises empirical, theoretical or experimental research and development according to the field of specialization                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |
| <b>Literaturempfehlungen</b>     | as required                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |
| <b>Links</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| <b>Unterrichtsprachen</b>        | Deutsch, Englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |
| <b>Dauer in Semestern</b>        | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |              |
| <b>Angebotsrhythmus Modul</b>    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| <b>Aufnahmekapazität Modul</b>   | unbegrenzt                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |              |
| <b>Modulart</b>                  | Pflicht / Mandatory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |
| <b>Modullevel</b>                | ---                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |
| <b>Lehr-/Lernform</b>            | Seminar and self-learning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |              |
| Prüfung                          | Prüfungszeiten                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Prüfungsform |
| <b>Gesamtmodul</b>               | G                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |
| <b>Lehrveranstaltungsform</b>    | Seminar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
| <b>Angebotsrhythmus</b>          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |

