CARL VON OSSIETZKY universität OLDENBURG
FAKULTÄT V
INSTITUT FÜR PHYSIK

University of Applied Sciences
HOCHSCHULE EMDEN·LEER

Modulhandbuch

Bachelor Engineering Physics

As of: 28.04.2015

Semester -> / CP ->	3	6	9	12	15	18	21	24	27	30	
6	**Praxismodul Engineering Physics (PB)**					**Thesis**					
SWS	1 (2 Month)					2 (max. 4 month)					**3**
CP	15					15					**30**
5	**Regelungstechnik**		**Festkörperphysik**		**Werkstoffkunde**		**PB** *(e.g. Specialization)*		**PB** *(e.g. Laboratory Project II)*		
SWS	5		6		4		4		6		**25**
CP	6		6		6		6		6		**30**
4	**Numerische Methoden der Physik**		**Thermodynamik & Statistik**		**Physik. Messtechnik**		**Quantum Structure of Matter**		**PB** *(e.g. Specialization)*		
SWS	4		6		5		4		4		**23**
CP	6		6		6		6		6		**30**
3	**Mathematical Methods for Physics and Engineering III**		**Atomic and Molecular Physics**		**Laboratory Project I** *(Project / Design Fundamentals)*			**Specialization (6)[2]**	**PB** *(e.g. Computing)*		
SWS	4		6		6		2	2	5		**25**
CP	6		6		6		3	3	6		**30**
2	**Mathematical Methods for Physics and Engineering II**		**Electrodynamics and Optics** *(Electrodynamics and Optics/Optical Systems)*			**Basic Eng.** *(Applied Mechanics)*	**Electronics** *(Analog/Digital)*		**Special. (6)[1]** *Introduction*	**Basic Lab. (9)** *(Course II)*	
SWS	4		6		2	2	3	3	2	4	**26**
CP	6		6		3	3	3	3	3	4	**31**
1	**Mathematical Methods for Physics and Engineering I**			**Mechanics**		**Basic Engineering** *(Production Engineering)*	**Basic Laboratory (9)** *(Course I)*		**PB** *(Language)*		
SWS	6			6		2	4		4		**22**
CP	9			6		3	5		6		**29**

SWS: 101 **CP: 180**

[1,2] **Specialization (6 CP)** [1] *Introduction to Specializations in Engineering Physics,* [2] *"Biomedical Physics & Acoustics" or "Renewable Energies" or "Laser & Optics"*

CP: Credit Points

SWS: Semesterwochenstunden (Hours per week)

Fields	Mathe-matics	Engineering & Physics	Speziali-sation	Laboratory	Communi-cation & Manage-ment

PB Professionaliseriungs-bereich (45 CP)

Contents

1st Semester:

Module title:	**Mathematical Methods for Physics and Engineering I**
Module code:	phy540, BM 1
Course:	Mathematical Methods for Physics and Engineering I, lecture Mathematical Methods for Physics and Engineering I, exercise
Term:	Winter
Person in charge:	Dr. Uppenkamp
Lecturer:	Dr. Uppenkamp, Prof. Doclo
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week Exercise: 2 hrs/week
Workload:	attendance: 84 hrs self study: 186 hrs
Credit points:	9
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	To obtain basic knowledge in application of mathematical methods to solve problems in physics and engineering
Content:	Vector algebra (vectors in 2- and 3-space, vector products, planes, lines, cylindrical and spherical coordinates) Preliminary calculus (elementary functions, limits, series, differentiation, integration) Preliminary complex analysis Introduction to ordinary differential equations Partial differentiation Vector calculus (scalar and vector fields, vector operators, line, surface and volume integrals, divergence and Stokes' theorem)
Assessment/type of examination:	Max. 3 hrs written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, computer presentation
Literature:	K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006

Module title:	**Mechanics**
Module code:	phy510, BM 2
Course:	Mechanics, lecture Mechanics, exercise
Term:	Winter (Mechanics)
Person in charge:	Prof. Kühn
Lecturer:	Prof. Kühn
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week Exercise: 2 hrs/week
Workload:	Attendance: 84 hrs Self study: 96 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Basic knowledge of mathematics acc. the pre-course of mathematics
Aim/learning outcomes:	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. 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.
Content:	*Mechanics:* 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
Assessment/type of examination:	weekly exercises, 2 hrs written exam or 45 min oral exam and assignment (Design Fundamentals). Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, Beamer presentation, experiments.
Literature:	*Mechanics:* D. Halliday, R. Resnick, J. Walker, S. W. Koch: Fundamentals of physics / Physik. Wiley-VCH, Weinheim, 2003 P. A. Tipler, G. Mosca, D. Pelte, 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 *Design Fundamentals:* ISO- and EN- Standards, Childs: Mechanical Design, Ulrich/Eppinger: Product Design and Development, Matousek: Engineering Design

Module title:	**Basic Engineering**
Module code:	phyxxx, AM1
Course:	Applied Mechanics, lecture, winter semester Production Engineering, lecture, summer semester
Term:	Summer
Person in charge:	Prof. Dr. Lange
Lecturer:	Prof. Dr. Schmidt, Prof. Dr. Lange
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 1rd & 2th semester Bachelor Photonik
Teaching Methods/ semester periods per week:	Lecture with integrated sample problems and exercises / 4 hrs/week
Workload:	Attendance: 64 hrs Self study: 116 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Basic Math (Algebra, Derivation, Integration) Basic knowledge in Physics (Mechanics, Thermodynamics, esp. Heat transfer)
Aim/learning outcomes:	Applied Mechanics: Achieving basic knowledge in applied mechanics, especially in statics and elasticity theory Production Engineering: Achieving basic knowledge on how to produce objects with defined geometry and properties in an effective and economic way
Content:	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 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
Assessment/type of examination:	Written exam, 1hr.
Media:	Beamer, black board, electronic scripts
Literature:	Applied Mechanics: Assmann: Technische Mechanik (German); Meriam, Kraige: Engineering Mechanics, Beer, Russell, Johnston: Vector Mechanics for Engineers Production Engineering: Groover: Fundamentals of Modern Manufacturing DeGarmo: Materials and Processes in Manufacturing König: Fertigungsverfahren (in German)

Module title:	**Basic Laboratory**
Module code:	phy513, BM 3
Course:	Basic Laboratory Course I & II Communication & Presentation
Term:	Winter (course I, Oldenburg), summer (course II, Emden)
Person in charge:	Dr. Helmers
Lecturer:	Dr. Helmers and others
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 1st semester & 2nd semester
Teaching Methods/ semester periods per week:	Laboratory: 2*3 hrs/week Communication and presentation: 2*1 hr/week
Workload:	attendance: 112 hrs self study: 158 hrs
Credit points:	9
Prerequisites acc. syllabus	
Recommended prerequisites:	Simultaneous hearing of Mechanics & Electrodynamics and Optics lectures
Aim/learning outcomes:	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.
Content:	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.
Assessment/type of examination:	Successful execution and record keeping of the experiments, presentation of the results in lectures.
Media:	English and German Script (see http://www.physik.uni-oldenburg.de/Docs/praktika/45392.html for first semester experiments and will be provided via Stud-IP for second semester experiments, blackboard, Beamer presentation
Literature:	see http://www.physik.uni-oldenburg.de/Docs/praktika/45394.html for the first semester and will be provided via Stud-IP for the second semester

Module title:	**Language - PB**
Module code:	pb162
Course:	Language Course I and II (German, other language courses are possible)
Term:	Winter and Summer
Person in charge:	Dr. Engelhardt
Lecturer:	Sprachenzentrum
Language:	German (or as desired)
Curriculum allocation:	1^{st} and 2^{nd} semester B.Eng. Engineering Physics
Teaching Methods/ semester periods per week:	4 SWS per Semester (other languages may differ)
Workload:	attendance: 56 hrs per Semester self study: 42 hrs per Semester 2 intensive course (each 72 hrs)
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	The student can understand sentences and frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment). He/She can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. She/he can describe in simple terms aspects of his/her background, immediate environment and matters in areas of immediate need. Other language courses are in accordance with the guidelines given by the "Sprachenzentrum"
Content:	• Reading • Writing • Listening • Speaking • Lecturing • Grammar in scientific papers
Assessment/type of examination:	Written and oral examination acc. requirements ("Sprachprüfung" in accordance with: *Common European Framework of Reference for Languages* **CEFR** : level A2)
Media:	Black board, PC, language laboratory
Literature:	Dallapiazza, von Jan, Schönherr, Tangram. Deutsch als Fremdsprache, Lehrerbuch 1A u. 1B, 1999

2nd Semester:

Module title:	**Mathematical Methods for Physics and Engineering II**
Module code:	phy541, AM 3
Course:	Mathematical Methods for Physics and Engineering II, lecture Mathematical Methods for Physics and Engineering II, exercise
Term:	Summer
Person in charge:	Prof. Doclo
Lecturer:	Prof. Doclo
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Exercise: 2 hrs/week
Workload:	attendance: 56 hrs self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Contents of the lecture “Mathematical Methods for Physics and Engineering I”
Aim/learning outcomes:	To obtain advanced knowledge in application of mathematical methods to solve problems in physics and engineering
Content:	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 optimisation using Lagrange multipliers) Fourier series
Assessment/type of examination:	Max 3 hrs written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, computer presentation
Literature:	K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006

Module title:	**Electrodynamics and optics**
Module code:	phy520, BM 4
Course:	Electrodynamics and optics, lecture Electrodynamics and optics, exercise Optical systems, lecture (with embedded exercise)
Term:	Summer
Person in charge:	Prof. van der Par
Lecturer:	Lienau, van de Par, Schellenberg
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 6 hrs/week Exercise: 2 hrs/week
Workload:	Attendance 112 hrs Self study: 158 hrs
Credit points:	9
Prerequisites acc. syllabus	
Recommended prerequisites:	Mechanics
Aim/learning outcomes:	<u>Electrodynamics and optics:</u> 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. <u>Optical systems:</u> The students will learn the fundamentals of optics, with emphasis on applied optics. The students will be able to solve problems in optical metrology, illumination technology, Spectroscopy, Laser Technology and Microscopy in order to solve engineering questions. The students will be able to understand fundamentals of optical systems.
Content:	<u>Electrodynamics and optics:</u> Basics of Electrostatics Matter in an electric field The magnetic field Electrical circuits Motion of charges in electric and magnetic fields Magnetism in matter Induction Electromagnetic waves Light as electromagnetic wave <u>Optical systems:</u> Fundamentals of optics and theoretical models of light Ray optics, geometrical optics, validity range and applications Behaviour and properties of EM waves and applications Optical imaging Imaging construction elements Microscopy Colours Set-up and function of selected optical systems for illumination and metrology Optical Fibers

Assessment/type of examination:	3 hrs written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, Beamer presentation, experiments.
Literature:	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 Skriptum

Module title:	**Electronics**
Module code:	phy570, AM 4
Course:	Electronics, lecture Electronics, practical and theoretical exercises
Term:	Summer
Person in charge:	Prof. Dr. Brückner
Lecturer:	Prof. Dr. Brückner
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week Exercise/Practical Work: 1 week, block course
Workload:	Attendance: 70 hrs Self study: 110 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Basic Lab. I, Math. Methods for Physics and Engineering I
Aim/learning outcomes:	the students acquire basic competences to set-up and analyze digital and analog electronic circuits; furthermore basic knowledge for measurement methods as well as for handling measurement systems are imparted
Content:	logic functions and gates, digital circuit analysis and synthesis, flip-flops, digital counters and memories, A/D- and D/A converters, programmable logic devices , impedances, inductances and capacitances, complex alternating electric quantities, RCL-filter circuits, semiconductor circuits, rectifier circuits, operational amplifier circuits
Assessment/type of examination:	2 hrs written examination
Media:	Script, transparencies, blackboard, computer presentation
Literature:	Excerpts from lecture script Weddigen, Jüngst: Elektronik, Springer Verlag Böhmer: Elemente der angewandten Elektronik, Vieweg Verlag Hering, Bressler, Gutekunst: Elektronik für Ingenieure und Naturwissenschaftler, Springer Verlag, 2005 Hill: The Art of Electronics, Cambridge University Press, 1989

Module title:	**Specialization**
Module code:	phyxxx, AM2
Course:	Introduction to “Engineering Physics”, lecture, summer term Introduction to field of specialization, lecture, winter term
Term:	Winter and summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn, Prof. Kollmeier, Prof. Poppe
Lecturer:	Prof. Doclo, Prof. Neu, Prof. Kühn, Prof. Kollmeier, Prof. Poppe
Language:	English
Curriculum allocation:	Engineering Physics, 2nd semester & 3rd semester, compulsory
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	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.
Content:	***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. *Biomedical Physics & 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) *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.
Assessment/type of examination:	Max. 2 hrs written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Lecture script, transparencies, blackboard, electronic media, presentation
Literature:	Acc. selected lectures

3rd Semester:

Module title:	**Mathematical Methods for Physics and Engineering III**
Module code:	phy542, AM 5
Course:	Mathematical Methods for Physics and Engineering III, lecture Mathematical Methods for Physics and Engineering III, exercise
Term:	Winter
Person in charge:	Prof. Dr. Hohmann
Lecturer:	Prof. Dr. Hohmann, Prof. Dr. Doclo
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 3rd semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Exercise: 2 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Contents of the lecture "Mathematical Methods for Physics and Engineering I and II"
Aim/learning outcomes:	To obtain advanced knowledge in application of mathematical methods to solve problems in physics and engineering
Content:	Complex analysis (derivatives, integration, Taylor and Laurent series, residue theorem) Fourier and Laplace transforms Ordinary differential equations Partial differential equations
Assessment/type of examination:	2 hrs written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, computer presentation
Literature:	K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006

Module title:	**Atomic and molecular physics**
Module code:	phyxxx, AM 6
Course:	Atomic physics, lecture Atomic physics, exercise
Term:	Winter
Person in charge:	Prof. Dr. Walter Neu
Lecturer:	Prof. Dr. Walter Neu
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 3rd semester Fach-Bachelor in Physik, Pflicht, 3rd Semester Zwei-Fächer-Bachelor in Physik, 3rd Semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week Exercise: 2 hrs/week
Workload:	Attendance: 84 hrs Self study: 96 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Courses in Experimental Physics I and II
Aim/learning outcomes:	The students are competent on the fundamental principles of atomic and molecular physics. They are familiar to classical description and have established a quantum mechanical understanding. The exercises and tutorials deepen the knowledge by assigning appropriate homeworks.
Content:	Concepts of atomic models angular momentum, spin, and magnetic properties of the electrons interaction with electric and magnetic fields wave-particle dualism of electrons and photons introduction to quantum mechanics: wave packets, Schrodinger equation, Heisenberg uncertainty principle relativity and Dirac equation coupling schemes and atomic spectra Bosons and fermions periodic system of the elements Introduction to molecular physics Molecular spectra applications: the electron in the box, the harmonic oscillator, the hydrogen atom, fine and hyperfine structure, line shapes, spectroscopy and modern experimental methods
Assessment/type of examination:	45 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Lecture script, transparencies, blackboard, electronic media, presentation, lecture demonstrations
Literature:	W. Demtröder: Atoms, Molecules and Photons. Springer; 2nd ed., 2010 H. Haken, H. C. Wolf: The Physics of Atoms and Quanta: Introduction to Experiments and Theory. Springer, 7th ed., Berlin 2005 H. Haken, H. C. Wolf: Molecular Physics and Elements of Quantum Chemistry. Springer, Berlin, 2004. C. Cohen-Tannoudji, D. Guery-Odelin: Advances in Atomic

	Physics: An Overview. World Scientific Pub Co, 2011 I.V. Hertel, C.-P. Schulz: Atoms, Molecules and Optical Physics. Vol.1&2. Springer, Berlin, 2015 B. Thaller: Visual Quantum Mechanics – Selected topics with computer generated movies of quantum mechanical phenomena. Springer, Berlin, 2002.

Module title:	**Lab Project I**
Module code:	phyxxx, AM8
Course:	Laboratory Project I Design Fundamentals
Term:	Winter
Person in charge:	Prof. Dr. Brückner
Lecturer:	Prof. Dr. Brückner, Dr. Schüning
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 3rd semester
Teaching Methods/ semester periods per week:	Laboratory: 3 hrs/week Lecture: 2 hrs/week
Workload:	Attendance: 70 hrs Self-study: 200 hrs
Credit points:	9
Prerequisites acc. syllabus	Lecture "Electronics"
Recommended prerequisites:	Basic laboratory course I & II
Aim/learning outcomes:	*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.
Content:	*Laboratory:* Experiments in the field of electronics and measurement technique *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
Assessment/type of examination:	Report and project presentation; assignment (Design Fundamentals)
Media:	
Literature:	*Laboratory:* Specific project descriptions *Design Fundamentals:* ISO- and EN- Standards, Childs: Mechanical Design, Ulrich/Eppinger: Product Design and Development, Matousek: Engineering Design

Module title:	**Computing (C++)- PB**
Module code:	pb262
Course:	Programming Course C++
Term:	Winter
Person in charge:	Dr. Stefan Harfst
Lecturer:	Dr. Stefan Harfst
Language:	English
Curriculum allocation:	o Bachelor Engineering Physics, 3st semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Exercise: 2 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs (excersises)
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	basic knowledge in undergraduate physics and mathematics basic computer knowledge
Aim/learning outcomes:	• learning of the programming language C++ and understanding of basic concepts of programming • finding and correcting programming errors • development of computer programs and organization of complex projects • working with software libraries independent analysis of scientific problems and their implementation in C++
Content:	Linux basics, the C++ programming language (e.g. data types, loops, functions, classes, templates), compiler (function, process), OpenSource tools (e.g. make, gnuplot), implementation of numerical algorithms as application examples
Assessment/type of examination:	weekly practical exercises (programming exercise)
Media:	transparencies, blackboard, computer presentation
Literature:	• Stanley Lippman, JoséeLajoie, and Barbara E. Moo : C++ Primer (5th edition, updated for C++11) • Bjarne Stroustrup : Programming: Principles and Practice Using C++ (2nd edition, updated for C++11/C++14) • Scott Meyers : Effective C++ • Breymann, Ulrich: C++ : Einführung und professionelle Programmierung, Carl Hanser Verlag, 2007, ISBN 978- 3446410237 • Wolf, Jürgen: Grundkurs C++, Galileo Computing, 2013,ISBN 978-3836222945 Press, William H.: Numerical recipes : the art of scientific computing, Cambridge Univ. Press, 2007, ISBN 978-0521884075

Module title:	**Computing (Matlab) - PB**
Module code:	pbxxx
Course:	Computing (Matlab)
Term:	Winter
Person in charge:	Schellenberg
Lecturer:	Schellenberg
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 3nd semester, Professionalisation
Teaching Methods/ semester periods per week:	Lecture: 3 hrs/week Exercise: 2 hrs/week
Workload:	Attendance 70 hrs Self study: 110 hrs
Credit points:	6
Prerequisites acc. syllabus	Basic computer knowledge; knowledge in undergraduate physics
Recommended prerequisites:	Mechanics
Aim/learning outcomes:	Students acquire knowledge of the most important ideas and methods of computer science including one programming language.
Content:	General fundamentals of computer systems Input/output Numbers, characters, arrays, strings Algorithms Programming language (Matlab) Functions (procedural programming) Programme files (modular programming) Introduction to object orientated programming Introduction to GUI programming
Assessment/type of examination:	90 min written exam / homework / programming project / 30 mins oral exam weekly exercises
Media:	Transparencies, blackboard, data projector presentation, reference programs
Literature:	MATLAB und Simulink in der Ingenieurpraxis : Modellbildung, Berechnung und Simulation by Wolf Dieter Pietruszka; MATLAB: An Introduction with Applications by Amos Gilat Essential MATLAB for Engineers and Scientists by Brian Hahn and Daniel Valentine;

4th Semester:

Module title:	**Numerische Methoden der Physik**
Module code:	phy150, AM 9
Course:	Numerical methods, lecture Numerical methods, tutorial
Term:	Summer
Person in charge:	Prof. Hartmann, Prof. Dr. Hohmann
Lecturer:	Prof. Hartmann, Prof. Dr.Hohmann, Dr. Brand, PD Dr. Polley
Language:	Lecture: German; Tutorials: English and German; Materials and script: English)
Curriculum allocation:	Bachelor Engineering Physics, 4th semester Fach-Bachelor in Physik, Pflicht, 4th Semester Master Hörtechnik und Audiologie
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Tutorial: 2 hrs/week
Workload:	Attendance: 56 hrs Self study: 124hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Basic computer knowledge; knowledge in undergraduate physics
Aim/learning outcomes:	Students acquire theoretical knowledge of basic numerical methods and practical skills to apply these methods on physical problems within all areas of experimental, theoretical and applied physics.
Content:	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 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. An introduction to C or Matlab will be given at the beginning of the tutorial.
Assessment/type of examination:	Weekly graded programming exercises
Media:	Lecture script, transparencies, blackboard, data projector presentation, reference programs
Literature:	V. Hohmann: Computerphysik: Numerische Methoden

	(lecture script). Universität Oldenburg, http://medi.uni-oldenburg.de/16750.html W. H. Press et al.: Numerical Recipes in C - The Art of Scientific Computing. Cambridge University Press, Cambridge, 1992 A. L. Garcia: Numerical Methods for Physics. Prentice Hall, Englewood Cliffs (NJ), 1994 J. H. Mathews: Numerical Methods for Mathematics, Science and Engineering. Prentice Hall, Englewood Cliffs (NJ), 1992 B.W. Kernigham und D. Ritchie: The C Programming Language, Prentice Hall International, Englewood Cliffs (NJ), 1988

Module title:	**Thermodynamik und Statistik**
Module code:	phy041, AM 10
Course:	Thermodynamics and Statistics, lecture Thermodynamics and Statistics, exercise
Term:	Summer
Person in charge:	Prof. Peinke
Lecturer:	Prof. Peinke, (Neuberufung W2 Experimentalphysik)
Language:	German
Curriculum allocation:	Bachelor Engineering Physics, 4^{th} semester Fach-Bachelor in Physik, Pflicht, 4^{th} Semester Zwei-Fächer-Bachelor in Physik, LA Gymnasium, Pflicht, 4^{th} Semester Zwei-Fächer-Bachelor in Physik, LA GHR, Pflicht, 4^{th} Semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week Exercise: 2 hrs/week
Workload:	attendance: 84 hrs self study: 96 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	courses experimental physics 1, 2, 3
Aim/learning outcomes:	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.
Content:	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, Gibb's 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 (Planck's law) • Saha-Equation
Assessment/type of examination:	2 hrs written exam or 45 min oral exam, Here, you will find information about the consideration of bonus points for

	module marks.
Media:	Script, transparencies, blackboard, beamer presentation, experiments.
Literature:	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;

Module title:	**Physikalische Messtechnik**
Module code:	phy530, AM 11
Course:	Signalverarbeitung,lecture Physikalische Messtechnik, lecture Signalverarbeitung / Physikalische Messtechnik, excercise
Term:	Summer
Person in charge:	Prof. Dr. Dr. Kollmeier
Lecturer:	Prof. Dr. Dr. Kollmeier, Dr. Meyer, Prof. Dr. Jürgens
Language:	German
Curriculum allocation:	Bachelor Engineering Physics, 4th semester Fach-Bachelor in Physik, Pflicht, 4th Semester
Teaching Methods/ semester periods per week:	Lecture: 3 hrs/week Exercise: 1 hrs/week
Workload:	Attendance: 70 hrs Self study: 110 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	Procurement of fundamental principles of metrology to enable the student to analyze, understand and solve the principle problems of measurement techniques.
Content:	Sensors for measurements of the different physical quantities Data logging and processing Measuring systems
Assessment/type of examination:	1 1/2 hrs written exam or 45 min oral exam (Signalverarbeitung) and assignment (Phys. Messtechnik). Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, Beamer presentation, experiments.
Literature:	H.-R. Tränkler, E. Obermeier: Sensortechnik. Springer, Berlin, 1998 J. Niebuhr, G. Lindner: Physikalische Messtechnik mit Sensoren. Oldenbourg, München, 2001 J. F. Keithley [Ed.]: Low /Level Measurements Handbook. Keithley Instruments Inc., 1998 J.-R. Ohm, H. D. Lüke: Signalübertragung. Springer, Berlin, 2005 K.-D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung: Filterung und Spektralanalyse mit MATLAB-Übungen. Teubner, Stuttgart, 2002 Fourieranalyse

Module title:	**Quantum Structure of Matter**
Module code:	phyxxx, AM 7
Course:	Quantum Structure of Matter
Term:	Winter
Person in charge:	Prof. Lienau
Lecturer:	PD Dr. Vogelgesang, PD Dr. Gross, Prof. C. Lienau
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 4st semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week (including excercises)
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Mechanics, Electrodynamics and Optics, Atomic and Molecular Physics, Mathematical Methods for Physics and Engineering I-III. These courses are mandatory prerequisites.
Aim/learning outcomes:	The students will gain knowledge of the fundamental principles of quantum mechanics and their application to the modelling of the equilibrium structure of different atomic, molecular and solid state material systems. The course will enhance their competence to understand and apply basic theoretical concepts in quantum mechanics. The students will learn how to rationalize quantum effects and wave phenomena in a variety of material systems and will become acquainted with strategies how to explain the equilibrium steady-state structure of different types of matter. The students will also be introduced into the nonequilibrium dynamics of selected quantum systems.
Content:	The course aims at providing a modern introduction into quantum mechanical foundations of the structure of atomic, molecular and solid state systems. It will bridge the gap between „Atomic and Molecular Physics“ and „Solid State Physics.” The following content will be covered: 1. Introduction into quantum mechanics 2. Quantum theory: techniques and applications 3. Atomic and molecular structure 4. Light-matter interaction 5. Molecular spectroscopy 6. Introduction into quantum dynamics 7. Molecular reaction dynamics 8. Macromolecules and Aggregates 9. Solid State Materials The course will be held at the level of an advanced course in physical chemistry and requires basic knowledge of quantum mechanics as introduced in “Atomic and Molecular Physics”.
Assessment/type of examination:	Max. 3 hrs written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, computer presentation

Literature:	- P. W. Atkins, J. de Paulo, Physical Chemistry, 9th Edition, W. H. Freeman (2009) - W. Demtröder, Atoms, Molecules and Photons, 2nd Edition, Springer (2010) - W. Demtröder, Molecular Physics, Wiley-VCH (2005) - C. Cohen-Tannoudji, B. Diu, F. Laloe, Quantum Mechanics, Vol. I and II, 1st Edition, Wiley (1991) - N. W. Ashcroft, N. D. Mermin, Solid State Physics, 2nd Edition, Cengage Learning (1976). - S. H. Simon, The Oxford Solid State Basics, Oxford University Press (2013). - S. Haroche, J. M. Raimond, Exploring the Quantum: Atoms, Cavities and Photons, Oxford University Press (2006) - L. Susskind, Quantum Mechanics - The Theoretical Minimum, Basics Books (2014)

Module title:	**Specialization II - PB**
Module code:	pb159
Course:	Specialization
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Doclo, Prof. Neu, Prof. Kühn
Language:	German or english
Curriculum allocation:	Engineering Physics, 4th semester, Compulsory optional
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	Knowledge of the current state of research in the field of specialization and acquisition of specialist knowledge
Content:	Familiarization of the specific area of specialization in which the thesis will be written. Introduction into special problems of selected areas of physics and current publications **Please see lectures under Subjects of Specialization, page 39ff.**
Assessment/type of examination:	Max. 3 hrs written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Acc. selected lectures: Lecture script, transparencies, blackboard, electronic media, presentation
Literature:	Acc. selected lectures

5th Semester:

Module title:	**Regelungstechnik**
Module code:	phy590, AM 13
Course:	Regelungstechnik
Term:	Winter
Person in charge:	Prof. Dr. Andreas Hein
Lecturer:	Prof. Dr. Andreas Hein
Language:	Deutsch
Curriculum allocation:	BA Engineering Physics, 5th semester
Teaching Methods/ semester periods per week:	lecture: 4 hrs/week exercises: 1 hrs/week
Workload:	Attendance: 70 hrs Self study: 110 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Complex numbers, ordinary differential equations, Laplace transformation
Aim/learning outcomes:	The course provides an introduction to the principles of control engineering. Students should understand the basic elements, operations and characteristics of control systems. They should know how to analyse, model and design basic control systems. On completion of the course a student should be able to: Explain basic concepts of control systems Model simple electrical and mechanical systems Understand in depth first and second order systems Understand modelling using the state-space approach Determine transfer functions of simple control systems from differential equations Determine stability of feedback systems and evaluate error signals Design feedback control systems using PI, PID controllers Design feedback control systems in frequency domain and using the root locus method Die Studierenden • verfügen über Grundverständnis der Ansätze zur Steuerung und Regelung von technischen Systemen, • verstehen die Grundkonzepte der Modellierung von Systemen und deren Kopplung mit Reglern, • kennen die Methoden zur Bestimmung von Qualitätsmerkmalen von geregelten Systemen. Sie sind in der Lage • die Modellierung von technischen Systemen mit Hilfe von Differenzialgleichungen und deren Umsetzung in Übertragungsfunktionen durchzuführen, • Reglerstrukturen zu entwerfen, deren Stabilität zu prüfen und optimale Parameter der Regler zu

	bestimmen. Absolventen des Moduls haben die Kompetenz • sich in spezifische Fragen der Entwicklung von geregelten Systemen schnell einzuarbeiten, • Lösungsansätze zu präsentieren, • die technischen Herausforderung zu erkennen und durch Kommunikation mit anderen Disziplinen darauf zu reagieren.

Content:	Modelling of dynamical system, linear time-invariant systems, transfer functions, block diagrams, state space description, transfer functions and state-space description, relationship of pole/zero locations and dynamic response, stability of control systems, design of control systems, PID controller, design methods in the frequency domain, root-locus design method, state-space design
	
	Das Modul vermittelt die folgenden Inhalte:
	
	• Grundbegriffe
	• Analoge Übertragungsglieder:
	  ○ Lineare zeitinvariante (LZI-) Glieder
	  ○ Wirkungspläne
	  ○ Simulation und Modellbildung
	  ○ Testsignalantworten
	  ○ Frequenzgang
	  ○ Differentialgleichungen und Übertragungsfunktion
	  ○ Stabilität
	• Regelstreckenarten
	• Reglerarten
	• Lineare Regelkreise: Führungs- und Störverhalten
	• Stabilitätskriterien
	• Klassische Methoden der Analyse und Synthese:
	  ○ Realisierung
	  ○ Computergestützte Regelung MATLAB/Simulink

Assessment/type of examination:	1 h written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Blackboard, transparents and beamer projections, electronic hand-outs
Literature:	Lutz, H. und Wendt, W.: Taschenbuch der Regelungstechnik Unbehauen, H.: Regelungstechnik I, Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme

Module title:	**Festkörperphysik**
Module code:	phyxxx, AM14
Course:	Festkörperphysik
Term:	Winter
Person in charge:	apl. Prof. Dr. A. Kittel
Lecturer:	apl. Prof. Dr. A. Kittel, Prof. Dr. N. Nilius, Dr. H. Borchert
Language:	German
Curriculum allocation:	Fach-Bachelor in Physik, 5. Semester Master Engineering Physics, 1. Semester
Teaching Methods/ semester periods per week:	Lecture 4 hrs/week Exercises 2 hrs/week
Workload:	Attendance: 84 hrs Self-study: 96 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Experimentalphysik I-IV, Theoretische Physik I und II
Aim/learning outcomes:	Die Studierenden erwerben Kenntnisse über Phänomene der Festkörperphysik und ausgewählter Spezialgebiete (Halbleiterphysik, Photovoltaik, Tieftemperaturphysik, Supraleitung). Sie erlangen Fertigkeiten zur Anwendung grundlegender Methoden und Prinzipien der Beschreibung von Festkörperphänomenen (Symmetrien, reziproker Raum, Modenspektren, Bloch Gleichungen, Wechselwirkungen, Extrembetrachtungen wie starke und schwache Elektronenbindung,makroskopische Quantenphänomene, Beschreibung der Störung der periodischen Gitterstruktur). Sie erwerben Kompetenzen zur Erfassung der Funktion von technisch relevanten Bauteilen, zur vertiefenden Einarbeitung in weitergehende Bereiche und zur Entwicklung neuartiger Bauelemente aufgrund des erlernten Wissens. Außerdem erlangen sie Kompetenzen zur gesellschaftspolitischen Einordnung der Konsequenzen von physikalischer Forschung.
Content:	Kristallstrukturen und Symmetrien, Bravais-Gitter, Translationssymmetrie und reziprokes Gitter, Brillouin-Zone, Bindungstypen und -energien (kovalente, ionische, van der Waals, metallische und Wasserstoffbrücken-Bindung), Dynamik der Kristallgitter, Phononen, nichtlineare und anharmonische Effekte, spez. Wärme, Wärmeleitung und Umklapp-Prozesse, Elektronen in Festkörpern, quasifreies Elektronengas, Zustandsdichten und Ferminiveau, Transportgleichung, Elektronen im periodischen Potential, Blochtheorem, Bänderschema, effektive Masse, Zustandsdichten und Besetzung, Metalle/Isolatoren, Grundlagen der Halbleiter, dielektrische Eigenschaften, komplexe Brechungsindices für Metalle und Isolatoren, 1-Oszillatormodell, Kramers-Kronig-Relation, lokales Feld, Meta-Materialien, Grundlagen der Supraleitung, magnetische Eigenschaften, Dia-, Para-, Ferromagnetismus, Austauschwechselwirkung, Spinwellen, Spingläser
Assessment/type of examination:	2-stündige Klausur oder mündliche Prüfung von maximal 45 min. Dauer. Informationen zur Berücksichtigung von Bonuspunkten bei der Modulbenotung finden Sie hier.

Media:	Tafel, Folien, Beamerpräsentationen
Literature:	1. N. W. Ashcroft, N. D. Mermin: Solid State Physics. Sounders College, Philadelphia, BIS 2. N. W. Ashcroft, N. D. Mermin: Festkörperphysik. Oldenbourg, München, BIS 3. S. Elliott: The Physics and Chemistry of Solids. John Wiley & Sons, West Sussex (UK), BIS 4. H. Ibach, H. Lüth: Festkörperphysik. Springer, Berlin, BIS 5. Siegfried Hunklinger: Festkörperphysik, Oldenbourg, München, BIS 6. K. Kopitzki: Einführung in die Festkörperphysik. Teubner, Stuttgart, BIS

Module title:	**Werkstoffkunde**
Module code:	phyxxx, AM 12
Course:	Werkstoffkunde, Materials Science, lecture
Term:	Winter
Person in charge:	N.N.
Lecturer:	N.N.
Language:	English or German
Curriculum allocation:	Bachelor Engineering Physics, 5th semester
Teaching Methods/ semester periods per week:	Lecture 4 hrs/week with integrated exercises
Workload:	Attendance: 56 hrs Self study: 126 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Knowledge of the fundamental physical laws; poised use of the mathematical methods of physics Lecture "Atomic Physics"
Aim/learning outcomes:	The students are able - outgoing from the microscopic structure of engineering materials - to understand its macroscopic properties, so that they are able to involve the behaviour of engineering materials into engineering requirements independently
Content:	Introduction Classification of engineering materials in groups Constitution of engineering materials (microscopic structure, macroscopic properties) Physical basics of constitution: Constitution of single phase solids (crystals, amorphous materials, real materials) Constitution of multi-phase materials Basic diagrams of constitution of binary alloys Crystallisation Diffusion Properties of materials Physical properties Mechanical properties (plastic deformation, crack growth, friction, wear) Groups of materials (metals, ceramics, polymers) Selected materials (iron, aluminium, copper) Testing of materials (an overview of methods)
Assessment/type of examination:	1 hr written examination or 30 min oral exam
Media:	Blackboard, transparents and beamer projections, electronic hand-outs
Literature:	E. Hornbogen: Werkstoffe, Springer Verlag Berlin u. a. W. Bergmann: Werkstofftechnik Teil 1, Grundlagen; Carl Hanser Verlag München Wien Bargel, Schulze: Werkstoffkunde, VDI-Springer W. D. Callister, Jr.: Materials Science and Engineering, An Introduction; John Wiley-VCH Verlag Gmbh Weinheim

Module title:	**Specialization III – PB**
Module code:	pb077
Course:	Specialization
Term:	Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Doclo, Prof. Neu, Prof. Kühn
Language:	German or english
Curriculum allocation:	Engineering Physics, 5th semester, Compulsory optional
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	Knowledge of the current state of research in the field of specialization and acquisition of specialist knowledge
Content:	Familiarization of the specific area of specialization in which the thesis will be written. Introduction into special problems of selected areas of physics and current publications **Please see lectures under Subjects of Specialization, page 39ff.**
Assessment/type of examination:	Max. 3 hrs written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Acc. selected lectures: Lecture script, transparencies, blackboard, electronic media, presentation
Literature:	Acc. selected lectures
Module title:	Specialization III

(c) = compulsory subject / Pflichtfach, (cos) = compulsory optional subject / Wahlpflichtfach

Module title:	**Lab Project II – PB**
Module code:	pbxxx
Course:	Laboratory Project II
Term:	Winter
Person in charge:	Prof. Dr. Neu
Lecturer:	Profs. Photonik, Prof. Doclo, Prof. Kühn, Prof. Poppe
Language:	English/German
Curriculum allocation:	Bachelor Engineering Physics, 5th semester
Teaching Methods/ semester periods per week:	Laboratory: 5 hrs/week
Workload:	Attendance: 98 hrs Self study: 172 hrs
Credit points:	9
Prerequisites acc. syllabus	
Recommended prerequisites:	Basic laboratory course I & II; Lab project I
Aim/learning outcomes:	The students are enabled to systematically explore and structure a given project task. These projects are settled in the field of current research and are worked on in a team. This requires as well project scheduling, definition of milestones, specification and design, literature research, and presentation discussion of results. The students do not only gain technical and experimental experience but do also train soft-skills like team work, communication, presentation and management tasks
Content:	Projects close to current research projects
Assessment/type of examination:	Experimental work and laboratory reports or presentation or homework
Media:	Script, manuals, experiments.
Literature:	recent publications, as required

6th Semester:

Module title:	**Bachelor Thesis –**
Module code:	bam
Course:	Bachelor Thesis
Term:	Summer
Person in charge:	Teaching Staff Engineering Physics
Lecturer:	N.A.
Language:	German or English
Curriculum allocation:	Bachelor Engineering Physics, 6th semester
Teaching Methods/ semester periods per week:	Seminar and self-learning
Workload:	Attendance: 28 hrs Self study: 422 hrs
Credit points:	15
Prerequisites acc. syllabus	Bachelor curriculum Engineering Physics
Recommended prerequisites:	
Aim/learning outcomes:	Students will apply their diversified scientific and professional skills to plan, prepare, organize and produce single-handed a research study.
Content:	The thesis comprises empirical, theoretical or experimental research and development according to the field of specialization
Assessment/type of examination:	Bachelor thesis and colloquium
Media:	as required
Literature:	as required

Module title:	**Praxismodul Engineering Physics**
Module code:	prx110
Course:	Internship & Seminar
Term:	Winter
Person in charge:	Dr. Koch
Lecturer:	Teaching staff of Engineering Physics
Language:	English / German
Curriculum allocation:	Bachelor Engineering Physics, 6th semester
Teaching Methods/ semester periods per week:	self-learning
Workload:	Attendance: 350 hrs Self study: 100 hrs
Credit points:	15
Prerequisites acc. syllabus	
Recommended prerequisites:	Physics I – IV; metrology
Aim/learning outcomes:	The student will be able to conduct, conceive, analyze, and journalize ambitious physical experiments. He/she will gather operating experience with modern measuring processes.
Content:	Practical assessment in research institute, industrial company, clinic, or university. The students learn to apply their theoretical knowledge in an industrial environment.
Assessment/type of examination:	Report (13 CP), poster presentation (2 KP)
Media:	as required
Literature:	as required, Edward Zanders, Lindsay MacLeod, Presentation Skills for Scientists with DVD-ROM, Cambridge University Press, 2010, ISBN-13: 978-052174103

Subjects of Specialization:

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Biomedizinische Physik und Neurophysik**
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Kollmeier, Prof. Poppe, Prof. Verhey, Dr. Uppenkamp
Language:	German
Curriculum allocation:	Bachelor in Physik, 6. Semester; Bachelor Engineering Physics, 4th or 5th semester Master Engineering Physics, 1st – 3rd Semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Exercises: 2 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Inorganic and organic chemistry, biology (in each case Abitur level), physics (Bachelor level); additionally recommended: Practical course attempts from the progressing and/or block practical course from the areas acoustics and/or medical physics and/or signal processing
Aim/learning outcomes:	Students are expected to gain an overview of bio-medical physics. They shall understand the activities of physicists in medicine and be able to analyse current research topics of medical physics.
Content:	Medical bases: Anatomy and physiology of humans, sense and neuro physiology, Psychophysics, pathophysiology of select organ systems, pathology of select diseases, physics in the biomedicine: Methods of biophysics and neuro physics, Roentgen diagnostics, radiotherapy, nuclear medicine, tomography, the medical acoustics/ultrasonic, medical optics and laser applications, Audiology
Assessment/type of examination:	Successful attendance of the weekly exercises, 30 min. oral exam and presentation. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, Beamer presentation, experiments.
Literature:	Silbernagl, S., Lang, F.: Taschenatlas der Pathophysiologie, Thieme, 2007 Silbernagel, Despopulos: Taschenatlas der Physiologie, Thieme 2007 Klinke/Silbernagl: Lehrbuch der Physiologie, Thieme, 2005 J.Richter: Strahlenphysik für die Radioonkologie, Thieme. 1998

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Chemistry**
Term:	Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Dr. Koch
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 3rd or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Excursion
Workload:	Attendance: 28 hrs + 4 hrs Self study: 58 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	Students acquire knowledge of principles in chemistry
Content:	Atomic model Periodic system of the elements Chemical bond Quantitative relations, stoichiometry Chemical equilibria Acid / base equilibria Redox processes Fluorescent substances
Assessment/type of examination:	Presentation
Media:	Lecture script, transparencies, blackboard, data projector presentation
Literature:	G. Jander, E. Blasius, J.Strähle, E. Schweda: Lehrbuch der analytischen und präparativen anorganischen Chemie. Hirzel, Stuttgart, 2006 E. Riedel, C Janiak: Anorganische Chemie. Gruyter, 2007 R. Chang, J. Overby: General Chemistry, McGraw-Hill, 2011 N. Wiberg, A. F. Holleman, E. Wiberg: Holleman-Wiberg's Inorganic Chemistry. Academic Press, 2001

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Einführung in die Akustik** Angewandte und medizinische Akustik, VL Angewandte und medizinische Akustik, Übung
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Van de Par, Prof. Dr. Dr. Kollmeier Dr. Weber, Prof. Blau
Language:	German
Curriculum allocation:	Bachelor in Physik, 3.-6. Semester; Bachelor Engineering Physics, 4th or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Exercises: 2 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Physics (Bachelor level); additionally recommended: Practical course attempts from the progressing and/or block practical course from the areas acoustics and/or medical physics and/or signal processing
Aim/learning outcomes:	Students are expected to gain an overview of bio-medical physics. They shall understand the activities of physicists in medicine and be able to analyse current research topics of medical physics.
Content:	*Angewandte Akustik (3 KP):* Physikalische Grundlagen der Akustik, Schwingungen und Wellen, Erzeugung, Abstrahlung und Ausbreitung von Schall, akustische Messtechnik, Schalldämmung und -dämpfung, Raum- und Bauakustik, Elektroakustik/ Wandler *Medizinische Akustik (3 KP):* Signalanalyse, Bewertung von Schall, Akustik von Stimme und Sprache, Sprachpathologie, Stoßwellen, Photoakustischer Effekt; ausgesuchte Kapitel der medizinische Akustik, Vibrationen und des Ultraschalls
Assessment/type of examination:	Max. 45 min. oral exam or presentation, weekly exercises. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, Beamer presentation, experiments.
Literature:	B. Kollmeier: Skriptum Physikalische, technische und medizinische Akustik. Universität Oldenburg, http://medi.uni-oldenburg.de/16750.html. G. Müller, M. Möser (Eds.): Taschenbuch der technischen Akustik. Springer, Berlin, 2004 H. Kuttruff: Akustik: eine Einführung. Hirzel, Stuttgart, 2004. D. R. Raichel: The science and applications of acoustics. Springer, Berlin, 2000 A. D. Pierce: Acoustics: an introduction to its physical principles and applications. Acoustical Society of America, Melville (NY),1994

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Einführung in die Photonik**
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Christoph Lienau, PD Dr. Ralf Vogelgesang
Language:	German
Curriculum allocation:	Fach-Bachelor in Physik, Wahl, 3. - 6. Semester Bachelor Engineering Physics, 4. / 5. Semester Master Engineering Physics, 1. – 3. Semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Experimentalphysik I bis V
Aim/learning outcomes:	Vermittlung von vertieften Kenntnissen im Bereich der Photonik und Vorbereitung auf eine Bachelor-Arbeit in diesem Gebiet. Erwerb von Fertigkeiten zur selbständigen Vertiefung von Wissen im Bereich Photonik sowie zur Konzeption fortgeschrittener Experimente zur Klärung physikalischer Fragestellungen. Erwerb von Kompetenzen zur wissenschaftlichen Analyse komplexer Sachverhalte und zur selbstständigen Einordnung neuer Forschungsergebnisse sowie zur gesellschaftspolitischen Einordnung der Konsequenzen von physikalischer Forschung.
Content:	Licht und Materie (Grundlagen der Elektrodynamik, Maxwell Gleichungen, Materie Gleichungen) Fourier Representationen (Summen & Integrale, Lineare Systeme, Faltung) Optische Medien (Dispersion, Absorption, Pulspropagation, Dispersive Beiträge) Ebene Wellen an Grenzflächen (Fresnelgleichungen, Reflexion, Brechung, Evaneszente Wellen) Spiegel und Strahlteiler (Matrixformalismus, Strahlteiler, Resonatoren, Interferometer) Geometrische Optik (paraxiale Strahlenoptik, ABCD Matrizen, Resonatortypen, Abbildungssysteme) Wellenoptik (paraxiale Wellenoptik, Gauß'sche Strahlen, Skalare Beugungstheorie, Fresnel- und Fraunhofer Beugung) Kohärenz (Korrelationsfunktion, Kohärenzinterferometrie) Photonenoptik (Eigenschaften einzelner Photonen, Statistik von Photonenflüssen) Polarisationsoptik (Polarisationszustände, Jones und Stokes Formalismus, anisotrope Materialien) Fourier Optik (Holographie, Bildverarbeitung im reziproken Raum, Tomography) Photonische Kristalle (Schichtmedien, 2- und 3-dimensionale Kristalle, Blochmoden, Dispersion) Wellenleiteroptik (Moden, Dispersionsrelation, Feldverteilungen)

	Faseroptik (Stufen und Gradientenindexfasern, Dispersion und Dämpfung)
Assessment/type of examination:	90-minütige Klausur, mündliche Prüfung von max. 30 min. Dauer, Hausarbeit, oder mündlicher Vortrag.
Media:	Tafelaufschrieb, Overheadfolien zur Illustrativen Ergänzung
Literature:	B. E. A. Saleh, M. C. Teich: Grundlagen der Photonik. Wiley-VCH, Weinheim, BIS R. Menzel: Photonics. Springer, Berlin, BIS D. Meschede: Optics, Light and Lasers. Wiley-VCH, Weinheim, BIS G. A. Reider: Photonik. Springer, Berlin, BIS H. Fouckhardt: Photonik. Teubner, Stuttgart, BIS

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Einführung in die Sprachsignalverarbeitung** Speech processing / lecture with exercise
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr.-Ing. Gerkmann
Language:	English / German
Curriculum allocation:	- Bachelor Engineering Physics, 4th or 5th semester - Fach-Bachelor in Physik, 6th semester - MSc Hörtechnik und Audiologie, 1st or 2nd semester (module „Akustik und Signalverarbeitung")
Teaching Methods/ semester periods per week:	Lecture: 3 hrs/week Exercise: 1 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Contents of the lecture Physikalische Messtechnik
Aim/learning outcomes:	Students will be able to (a) explain the foundations of speech production, perception and analysis, (b) understand the mathematical and information-theoretical principles of speech signal processing, and (c) apply the studied methods to explain the working principle of practical speech processing systems.
Content:	Speech production and perception, speech analysis, speech signal processing (STFT, LPC, cepstrum, speech enhancement), speech coding, speech synthesis, automatic speech recognition, speech enhancement, selected topics on speech processing research and information theory
Assessment/type of examination:	2 hr written examination or 30 min. oral examination. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, data projection, experiments.
Literature:	- P. Vary, R. Martin: Digital Speech Transmission, Wiley 2006. - V. Pulkki, M. Karjalainen, Communication Acoustics, Wiley 2015. - J. Benesty, M. M. Sondhi, Y. Huang (Eds.): Handbook of Speech Processing, Springer, 2008.

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Energy Systems I**
Term:	Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Dr. Heinemann
Language:	
Curriculum allocation:	Bachelor in Engineering Physics, 4^{th} & 5^{th} Semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week each
Workload:	Attendance: 28 hrs each Self study: 62 hrs each
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	Naturwissenschaftliches Grundlagenwissen
Aim/learning outcomes:	Discussion of the following questions: How to supply energy to all people? How will energy production/consumption look like in the future? What are the available resources? Which technologies will be available? What are the conditions? How can energy be used in human-friendly manner?
Content:	Energy basics, energy resources, global energy overview, energy scenarios, techno-economic aspects of energy use (external costs, life cycle analysis, ..), environmental effects of energy use (greenhouse gas emissions, ozone, ..), conventional and advanced power plant technologies, power distribution, advanced storage technologies, solar thermal power plants, geothermal and ocean energies
Assessment/type of examination:	Klausur/en von max. 3 Stunden Dauer und /oder mündliche Prüfungen von max. 45 Minuten Dauer nach Maßgabe der Dozentin / des Dozenten sowie regelmäßige aktive und dokumentierte Teilnahme
Media:	
Literature:	Goldemberg, J. et al.: Energy for a Sustainable World, Wiley Eastern, 1988 Johansson, T.B. et al. (Eds.): Renewable Energy Sources for Fuels and Electricity, Island Press, Washington D.C., 1995 Khartchenko, N.V.: Advanced Energy Systems, Taylor & Francis, 1998 Nakicenovic, N., A. Grübler and A. McDonald (Eds.): Global Energy Perspectives, Cambridge University Press, 1998 Ramage, J.: Energy: A Guide Book, Oxford University Press, 1997 United Nations Development Programme (Ed.): World Energy Assessment: Energy and the Challenge of Sustainability, 2000

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Femtosecond Laser Technology**
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Teubner
Language:	English (German)
Curriculum allocation:	Photonik (BA) Bachelor Engineering Physics, 4th or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week
Workload:	Attendance: 28 hrs Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	Basics of optics, (basics of laser physics)
Aim/learning outcomes:	Starting from their basic knowledge of optics, the students do learn the special aspects of optics on ultrashort time scales which do not play a role in standard optics. The module yields a basic knowledge of the physics of femtosecond light pulses and their interaction with matter, as well as the technology of femtosecond lasers.
Content:	Linear and non-linear optics of ultrashort pulses such as: amplitude, phase and spectral phase of the electric field, chirp, phase and group velocity, dispersion, pulse compression, self focusing, self phase modulation, frequency conversion, multi photon effects; femtosecond laser pulse generation with various schemes, measurement of ultrashort pulses
Assessment/type of examination:	1 hr written final examination
Media:	black board, power point, practical work in the laboratory
Literature:	Rullière: Femtosecond Laser Pulses (Springer); Diels, & Rudolph: Ultrashort Laser Pulse Phenomena (Academic Press)

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Laser material processing**
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Dr.-Ing. Thomas Schüning
Language:	German
Curriculum allocation:	Bachelor Engineering Physics, 4th semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	Attendance: 56 hrs Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Knowledge in physics, optics, production engineering
Aim/learning outcomes:	Fundamental knowledge of the characteristics of the laser beam, Knowledge of laser sources for industrial applications, knowledge of procedures of the material processing with laser beams Knowledge of the physical-technical procedures of the individual manufacturing processes with laser beams; Ability for the estimation of favorable working parameters; The participants should be able to understand the procedures of the material processing with laser beams and evaluate the tasks of manufacturing
Content:	Overview of the procedures of the material processing with laser beams: Procedure, allocation of the procedures in relation to production engineering the laser beam as tool. Deepening treatment of the manufacturing processes with laser beams in relation of quality, speed and costs. The manufacturing processes are: Cutting procedure, joining process, surface processing, material property changing, generative process. • Examples from the industrial manufacturing.
Assessment/type of examination:	2 hr written final examination
Media:	Blackboard, transparencies, beamer presentation
Literature:	Script H. Hügel: Strahlwerkzeug Laser, Teubner Studienbücher Materialbearbeitung mit dem Laserstrahl im Geräte- und Maschinenbau, VDI-Verlag Hügel, Helmut: Laser in der Fertigung, Vieweg + Teubner Verlag

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Laser Physics**
Term:	Summer or Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Struve
Language:	German/English
Curriculum allocation:	Bachelor Engineering Physics, Specialization
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week
Workload:	Attendance: 28 hrs Self-study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	basic knowledge on electrodynamics, optics, atomic physics
Aim/learning outcomes:	students acquire basic knowledge on how lasers operate, on characteristics of laser radiation, and on different laser types
Content:	light-matter interaction, optical gain, optical resonators, laser operation, laser types, laser safety
Assessment/type of examination:	1 hr written examination or 30 min oral examination or homework or presentation
Media:	Script, blackboard, computer presentation
Literature:	B. Struve, Einführung in die Lasertechnik, 2009, VDE-Verlag C. Breck Hitz, J. J. Ewing, J. Hecht, Introduction to Laser Technology, 2012, Wiley Press

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Lasers in Medicine I (Lasers in Medicine)**
Term:	Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Neu
Language:	English
Curriculum allocation:	Pflicht: Photonik (BA) Bachelor Engineering Physics, 4th or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week
Workload:	Attendance: 28 hrs Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	Laser physics, Technical Optics
Aim/learning outcomes:	The students are enabled to understand basic laser biotissue interaction processes based on the knowledge of optical and thermal properties of biotissue. The students are able to describe the principle function of a laser, distinguish between the different laser types and designs regarding medical laser systems. The students have a basic knowledge on beam guiding techniques, medical applicators, and safety requirements. The students gain an overview on lasers in medicine and a first insight into clinical laser applications via an excursion to a clinic.
Content:	Optical and thermal properties of biotissue Basic interaction processes of light and biotissue Medical laser systems Beam guiding and applicators Introduction to lasers in medicine Laser safety and regulatory affairs in medicine Insight into clinical laser therapy (Excursion)
Assessment/type of examination:	Max. 2 hrs written exam or 30 min oral exam or presentation. Here, you will find information about the consideration of bonus points for module marks.
Media:	Lecture script, transparencies, blackboard, electronic media, presentation
Literature:	Berlien, Hans-Peter; Müller, Gerhard J., Breuer, H.; Krasner, N.; Okunata, T.; Sliney, D. (Eds.): Applied Laser Medicine. Springer-Verlag, 2003. ISBN: 978-3-540-67005-6 Niemz, Markolf H.: Laser-Tissue Interactions. Fundamentals and Applications.Series: Biological and Medical Physics, Biomedical Engineering. Springer-Verlag, 3rd enlarged ed. 2003. 2nd printing, 2007. ISBN: 978-3-540-72191 Sliney, D. Trokel, S.L.: Medical Lasers and Their Safe Use. Springer-Verlag 1993. Reprint 2011. ISBN: 978-3540978565.

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Lasers in Medicine II (Advanced Lasers in Medicine)**
Term:	Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Neu
Language:	English
Curriculum allocation:	Photonik (BA) , Bachelor Engineering Physics, 4th or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week
Workload:	Attendance: 28 hrs Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	Laser physics, Technical Optics, Lasers in medicine I
Aim/learning outcomes:	The students are able to analyze and model in depth optical properties of biotissue. They can explain laser-tissue interaction in depth. The students are able to design and evaluate medical laser systems and assign specific therapeutical areas. Special emphasis is put into dosimetry and minimal invasive techniques. An excursion to a university clinic enables the students to transfer the acquired course knowledge to practical experience.
Content:	Light propagation in biotissue Optical diagnostics and imaging, simulation, computer modelling Photochemical, photothermal, photomechanical interaction mechanisms Minimal invasive surgical therapies Medical laser applications Lasers in clinical diagnostics Dosimetry Excursion to a clinic; clinical laser applications
Assessment/type of examination:	Max. 2 hrs written exam or 30 min oral exam or presentation. Here, you will find information about the consideration of bonus points for module marks.
Media:	Lecture script, transparencies, blackboard, electronic media, presentation
Literature:	Berlien, Hans-Peter; Müller, Gerhard J., Breuer, H.; Krasner, N.; Okunata, T.; Sliney, D. (Eds.): Applied Laser Medicine. Springer-Verlag, 2003. ISBN: 978-3-540-67005-6 Niemz, Markolf H.: Laser-Tissue Interactions. Fundamentals and Applications.Series: Biological and Medical Physics, Biomedical Engineering. Springer-Verlag, 3rd enlarged ed. 2003. 2nd printing, 2007. ISBN: 978-3-540-72191 Sliney, D. Trokel, S.L.: Medical Lasers and Their Safe Use. Springer-Verlag 1993. Reprint 2011. ISBN: 978-3540978565. Puliafito, Carmen A: Laser Surgery and Medicine. Principles and Practice. J. Wiley&Sons, 1996. ISBN 0-471-12070-7 Recent publications (www.medline.de)

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Laser spectroscopy**
Term:	Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Neu
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 5th semester 1 Fach-Bachelor in Physik, 5th Semester 2 Zwei-Fächer-Bachelor in Physik, 3rd Semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week
Workload:	Attendance: 28 hrs Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	Optics, atomic and molecular physics, basics in quantum mechanics
Aim/learning outcomes:	Students learn the fundamental principles and techniques of laser spectroscopy on atoms and molecules. Special emphasis is put into applications of laser spectroscopy.
Content:	Optical spectroscopy and line shapes Atomic and molecular spectra Doppler limited spectroscopy High resolution single photon spectroscopy Time resolved laser spectroscopy Multi photon spectroscopy Doppler free spectroscopy Applications of laser spectroscopy
Assessment/type of examination:	Successful attendance of the weekly exercises, Max. 2 hrs written exam or 30 min oral exam
Media:	Lecture script, transparencies, blackboard, electronic media, presentation, lecture demonstrations
Literature:	W. Demtröder, Laserspektroskopie Bd.1&2, Springer, 6.Aufl., 2014&2013; engl. Laser Spectroscopy Vol. 1&2, Springer, 5nd ed. 2014 & 4th ed., 2008 W. Demtröder: Atoms, Molecules, and Photons. Springer, Berlin, 2010 H. Haken, H. C.Wolf: The Physics of Atoms and Quanta: Introduction to Experiments and Theory. Springer, 7th ed. Berlin 2005 S. Svanberg: Atomic and molecular spectroscopy. Basic aspects and practical applications. Springer, 2001. A. Corney: Atomic and laser spectroscopy. Clarendon Press, 1988. P. Hannaford: Femtosecond laser spectroscopy. Springer, New York , 2005.

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Micro Technology**
Term:	Winter or Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Ulrich Teubner, Prof. Dr. Hans-Josef Brückner
Language:	English (German)
Curriculum allocation:	Bachelor Engineering Physics, 5th semester
Teaching Methods/ semester periods per week:	Lecture: 3 hrs/week Laboratory: 1 hrs/week
Workload:	Attendance: 56 hrs Self study: 128 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	Today micro-electro-mechanical systems (MEMS) and micro-opto-electro-mechanical systems (MOEMS) are important in daily life and industry. The students get introduced to the field of micro technology and are prepared to work in industry. In the included laboratory part they obtain practical skills during application of their knowledge.
Content:	Materials for micro technology, thin layers, methods and processes for the generation and modification of thin films such as evaporation, sputtering, CVD, diffusion, doping etc., etching; special emphasis is put on lithographic methods and laser micro machining
Assessment/type of examination:	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework
Media:	blackboard, transparencies, practical work in laboratory
Literature:	F.Völklein, Th.Zetterer: Einführung in die Mikrosystemtechnik (Vieweg) Menz/Mohr/Paul: Micro System Technology (Wiley-VCH; also in German) Mack: Fundamental principles of Optical Lithography (Wiley) Suzuki/Smith; Microlithography (CRC) Further literature according indication during course

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Optik der Atmosphäre und des Ozeans**
Term:	Sommer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Dr. Reuter; NN PostDoc
Language:	German
Curriculum allocation:	Bachelor Engineering Physics, 4^{th} or 5^{th} semester Fach-Bachelor in Physik, 6^{th} Semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Exercise: 1hrs/week Excursion: 3 days (if available)
Workload:	Attendance: 42 hrs Self study: 48 hrs Excursion: 72 hrs (if available)
Credit points:	3
Prerequisites acc. syllabus	Experimental physics I – IV, metrology
Recommended prerequisites:	
Aim/learning outcomes:	Students will be able to understand the principles of optics in relation to the physics of the atmosphere and the ocean. This includes the fundamentals of optical interaction between light diffusion and experimental analysis of irradiance including the use of models to describe the radiative transfer.
Content:	Methods of radiometry, Theory of radiative transport, absorption and scattering, spectra of the sun, atmosphere, aerosol, light in the ocean, remote sensing
Assessment/type of examination:	Successful attendance of the weekly exercises, 1 hr written exam or 30 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, Beamer presentation, experiments.
Literature:	D. C. Mobley: Light and Water. Academic Press, San Diego (CA), 1994 I. S. Robinson: Measuring the Oceans from Space. Springer, Berlin, 2004 J. T. O. Kirk: Light and Photosynthesis in Aquatic Ecosystems. Cambridge University Press, Cambridge, 1994

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Optical communication technology**
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Brückner
Language:	English
Curriculum allocation:	Bachelor Engineering Physics, 4nd semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week, practical applications included in lecture
Workload:	Attendance: 28 hrs Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	Optics, electronics
Aim/learning outcomes:	Basic knowledge of fiber optical fiber systems, Competence to design and evaluate simple fiber systems
Content:	Optical fibers (structure, modal characteristics) Signal attenuation and dispersion in optical fibers Fundamentals of optical data transmission Optical fiber amplifiers, fiber lasers Optical fiber connections
Assessment/type of examination:	1 hr written examination or 30 min oral exam. or homework
Media:	Script, transparencies, blackboard, computer presentation
Literature:	Excerpts from lecture script H.-G. Unger: Optische Nachrichtentechnik 1, Hüthig Verlag, 1993 E. Voges, K. Petermann: Optische Kommunikationstechnik. Handbuch für Wissenschaft und Indutrie, Springer Verlag, 2002 J. M. Senior: Optical Fiber Communications. Principles and Practice, Prentice Hall, 1992

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Photovoltaics**
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Dr. Riedel, Dr. Hammer
Language:	German
Curriculum allocation:	Bachelor in Engineering Physics, 4^{th} or 5^{th} semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week
Workload:	Attendance: 28 hrs Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	Vorausgesetzt werden Grundkenntnisse der Festkörper-/ Halbleiterphysik und persönliches Interesse in den Bereichen der Solaren Strahlungswandlung und regenerative Energiequellen.
Aim/learning outcomes:	Die Studierenden entwickeln ein grundlegenden Verständnisses der Photovoltaik
Content:	Photonen-Solarstrahlung und maximaler Wirkungsgrad von Solarzellen; Prinzip des detaillierten Gleichgewichts; Struktur und Funktionkonventioneller Silizium-Solarzellen I+II; Strategien zur Erhöhung des Energiewandlungswirkungsgrades von Silizium-Solarzellen; Konzentrator- und Tandemsysteme; Dünnschichtsolarzellen; Thermophotovoltaik; Photovoltaik der dritten Generation;
Assessment/type of examination:	Vortrag ; Hausarbeit
Media:	Blackboard, transparencies, data projector presentation
Literature:	

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Power System and Grid**
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Ziethe
Language:	English
Curriculum allocation:	Bachelor in Engineering Physics, 4th or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week
Workload:	Attendance: 28 hrs Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	High-school knowledge of DC and AC current basics
Aim/learning outcomes:	• Understanding of electrical basic relations (voltage-current-power, reactive impedance, power factor, power factor compensation) • functional principles of electric machines (transformers, rotating e-machines)
Content:	• DC current • AC current basics • Basics of Magnetic circuits • Transformers • DC machines • Induction machines • Synchronous machines
Assessment/type of examination:	Written exam
Media:	Blackboard, transparencies, data projector presentation
Literature:	

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Science of Imaging, Scientific Sensors and Photography**
Term:	Winter or Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Ulrich Teubner, Prof. Dr. Hans-Josef Brückner
Language:	English (German)
Curriculum allocation:	Bachelor of Engineering Physics, 4^{th} or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Laboratory: 2 hrs/week
Workload:	Attendance: 56 hrs Self study: 128 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Basics of optics, electrodynamics, electronics
Aim/learning outcomes:	Imaging and detectors are of major importance everywhere in science and engineering. This course provides substantial background of the relevant physics and engineering methods. As a practical application, many aspects are explained within physics of photography. In the extended laboratory part, using modern imaging systems such as professional cameras, students get experience.
Content:	Optical imaging, aberrations, ray tracing, cameras and lenses, exposure, resolution, space bandwidth product, imaging issues and limits, fourier optics, optical transfer function, modern sensors (CCD, CMOS, scientific sensors such as backside illum. XUV-CCD, MCP etc.) in detail, dynamic range and noise, imaging systems, basics of image processing
Assessment/type of examination:	experimental work and laboratory reports or max. 2hr written examination or max 1h oral examination or presentation or homework
Media:	blackboard, transparencies, computer presentation, practical work in laboratory
Literature:	Nakamura: Image Sensors and Signal Processing for Digital Still Camera (Taylor & Francis); Eugene Hecht: Optics, Addison-Wesley; F.L. Pedrotti& S.L. Pedrotti: Introduction to Optics, Prentice-Hall; Further literature according indication during course

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Solar Energy Systems – Electric and Thermal**
Term:	Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Parisi, Holtorf
Language:	English
Curriculum allocation:	Bachelor in Engineering Physics, 4th or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week
Workload:	Attendance: 28 hrs Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	
Content:	
Assessment/type of examination:	
Media:	Blackboard, transparencies, data projector presentation
Literature:	

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**Wind Energy Utilization**
Term:	
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Kühn
Language:	English
Curriculum allocation:	• Bachelor in Engineering Physics, 4th or 5th semester • Master Sustainability Economics and Management • Bachelor Umweltwissenschaften • Zwei-Fächer-Bachelor Physik • etc.
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week Tutorial: 2 hrs/week
Workload:	Attendance: 52 hrs Self-study: 128 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Basic computer knowledge; mechanics; mathematical methods for physics and engineering
Aim/learning outcomes:	This lecture with exercises is intended as introduction into physics and engineering of wind energy utilisation. Nevertheless also social, historical and political aspects are regarded. The lecture gives a deeper understanding of physical effects, methods, calculations and parameters into the field of wind energy utilisation, wind physics and wind energy science. Experiments and exhibits are used to deliver deeper insights into the subjects of the lectures. The tutorial part consists of calculation exercises and an introduction into the common and professional software WindPro ® (subject to modifications). Students who have attended »Wind Energy Utilisation« in the Bachelor phase should be able to directly enrol for advanced wind energy lectures in the Master phase (without attending 5.04.4061 – Wind Energy).
Content:	• The wind: generation, occurence, measurement, profiles etc.; • Energy and power in the wind; • Drag driven converters; • Principle of lift driven converters; • Dimensionless parameters and characteristic diagrams of wind turbines; • Optimum twist and horizontal plan of the rotor blade; • Rotor power losses; • Power control; • Generator concepts and grid interaction; • Loads; • Mechanical design and components of a wind turbine; • Calculation of energy yield; • Economics; • Wind farms, wakes and wind farm efficiency;

	• Environmental effects; • Unconventional converters; • Prepared discussion about social and political aspects; • Use of wind farm calculation software WindPro.
Assessment/type of examination:	90 min written exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	data projector presentations, blackboard presentations and calculations, experiments, professional software for wind farm calculation for each 2-person-team
Literature:	• *English Language:* Robert Gasch, Wind Power Plants – Fundamentals, Design, Construction and Operation, 2nd Ed., 2012, Springer-Verlag; ISBN: 978-3-642-22937-4 • *German Language:* Robert Gasch, Windkraftanlagen - Grundlagen und Entwurf, 8. Aufl., 2013, Springer + Vieweg

Module title:	Specialization II / III - PB
Module code:	pb159 / pb077
Course:	**X-Ray Physics and Surface Analysis**
Term:	Winter or Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Ulrich Teubner
Language:	English or German
Curriculum allocation:	Bachelor Engineering Physics, 5th semester
Teaching Methods/ semester periods per week:	lecture + laboratory demonstrations
Workload:	Attendance: 28 hrs Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus	
Recommended prerequisites:	Atomic Physics, Basics knowledge on physics of solids
Aim/learning outcomes:	The students acquire broad theoretical and experimental knowledge on physics with X-rays and short wavelength radiation such as extreme ultra violet (EUV). The students learn how to investigate the structure of bulk solid materials and it's surface using X-rays and particles (such as electrons and ions). This includes the application of modern equipments such as scanning electron microscope (SEM; both, in theory and laboratory). Moreover, the course prepares to work in X-ray science and technology, e.g., with X-ray tubes, synchrotrons, free electron lasers and laser plasmas. Industrial applications of short wavelength plasma emission, e.g., as used for semiconductor chip production, is discussed as well.
Content:	interaction of short-wavelength electromagnetic radiation with matter; generation and (modern) sources of X-rays and EUV-radiation, X-ray diffraction (advanced theory and experimental methods), methods of structure analysis using X-rays; particle matter interaction; material analysis using electrons and ions (including SEM)
Assessment/type of examination:	max. 1hr written examination or max 45min oral examination or experimental work and laboratory reports or presentation or homework
Media:	blackboard, transparencies, laboratory demonstrations
Literature:	Spieß et al.: Moderne Röntgenbeugung (Teubner) Krieger: Strahlungsquellen für Technik und Medizin (Teubner) Kittel: Festkörperphysik (Oldenbourg) Attwood: Soft X-rays and extreme ultraviolett radiation (Cambridge Press) Further literature according indication during course