Modulhandbuch
Bachelor of Engineering
in Engineering Physics

Institute of Physics

January 27, 2021

Table 1: Curriculum - Bachelor Engineering Physics: Math , Physics , Engineering , Specialization , Laboratory , Thesis $\sum SWS = 101$, $\sum CP = 180$

CP →	3	6	9	12	15	18	21	24	27	30	sum
6. Semester	**Praxismodul Engineering Physics (PB)**					**Thesis**					
SWS	1(2 Month)					2 (max. 4 month)					3
CP	15					15					30
5. Semester	**Control Systems**		**Solid-State Physics**		**Material Science**		**PB** e.g. Spec.		**PB / Lab Project II**		
SWS	5		6		4		4		6		25
CP	6		6		6		6		6		30
4. Semester	**Numerical Methods**		**Thermodynamics & Statistics**		**Metrology**		**Quantum Structure of Matter**		**PB** e.g. Spec.		
SWS	4		6		5		4		4		23
CP	6		6		6		6		6		30
3. Semester	**Mathematical Methods for Physics and Engineering III**		**Atomic and Molecular Physics**		**Lab Project I** (Project)		**Specialization**		**PB** e.g. Computing		
SWS	4		6		6		2	2	5		25
CP	6		6		6		3	3	6		30
2. Semester	**Mathematical Methods for Physics and Engineering II**		**Electrodynamics and Optics**			**Basic Engineering** (Applied Mechanics)	**Electronics**		**Lab Project I** (Design Fundamentals)	**Basic Laboratory** (Course II)	
SWS	4		6		2	2	6		2	4	26
CP	6		6		3	3	6		3	4	31
1. Semester	**Mathematical Methods for Physics and Engineering I**			**Mechanics**		**Basic Engineering** (Production Engineering)	**Basic Laboratory** (Course I)		**PB** e.g. Language		
SWS	6			6		2	4		4		22
CP	9			6		3	5		6		29

Contents

1 1st Semester

1.1 Mathematical Methods for Physics and Engineering I

Module title:	Mathematical Methods for Physics and Engineering I (5.04.618)
Module code:	phy540
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
Location	Oldenburg
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:	Basic understanding of mathematics acc. pre-course
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 45 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

1.2 Mechanics

Module title:	Mechanics (5.04.612)
Module code:	phy509
Course:	Mechanics, lecture; Mechanics, exercise
Term:	Winter
Person in charge:	Prof. Kühn
Lecturer:	Prof. Kühn
Language:	English
Location	Oldenburg
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.
Content:	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. 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, Waerme. De Gruyter, Berlin, 1998

1.3 Basic Engineering

Module title:	Basic Engineering (5.04.641, 5.04.634)
Module code:	phy555
Course:	Production Engineering, lecture winter semester; Applied Mechanics, lecture, summer semester
Term:	Winter & Summer
Person in charge:	Prof. Dr. Lange
Lecturer:	Prof. Dr. Schmidt, Prof. Dr. Lange
Language:	English
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 1st and 2nd 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) and 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:	90-180 min. written exam each
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, Koenig: Fertigungsverfahren (in German)

1.4 Basic Laboratory

Module title:	Basic Laboratory (5.04.071 & 5.04.632)
Module code:	phy513
Course:	Basic Laboratory Course I & II, Communication & Presentation
Term:	Winter (course I, Oldenburg), summer (course II, Emden)
Person in charge:	PD Dr. Michael Krüger & Dr. rer. nat. Sandra Koch (Emden)
Lecturer:	Dr. Michael Krüger (Oldenburg) & Dr. rer. nat. Sandra Koch (Emden) & and more
Language:	English
Location	Oldenburg / Emden
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 - Course I is a prerequisite for course II
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 Link for the first semester and will be provided via Stud-IP for the second semester 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

1.5 Language - PB

Module title:	Language – PB (13.01.22 & 13.01.027)
Module code:	pb162
Course:	Language Course I and II (German)
Term:	Winter and Summer
Person in charge:	Dr. Engelhardt
Lecturer:	Sprachenzentrum
Language:	German
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 1st semester & 2nd semester
Teaching Methods/ semester periods per week:	Laboratory: 4 SWS per Semester
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

2 2nd Semester

2.1 Mathematical Methods for Physics and Engineering II

Module title:	Mathematical Methods for Physics and Engineering II (5.04.616)
Module code:	phy541
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
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week, Exercise: 2 hrs/week
Workload:	attendance: 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 45 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

2.2 Electrodynamics and Optics

Module title:	Electrodynamics and optics (5.04.612)
Module code:	phy520
Course:	Electrodynamics and optics - lecture, Electrodynamics and optics - exercise, Optical systems - lecture
Term:	Summer
Person in charge:	Prof. van der Par
Lecturer:	Lienau, van de Par, Schellenberg
Language:	English
Location	Oldenburg
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:	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 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:	Electrodynamics and optics: 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 Optical systems: 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:	2 max 3 hrs written exam or max 45 min oral exam (2/3 Electrodynamics and 1/3 Optical Systems). 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

2.3 Electronics

Module title:	Electronics (5.04.642)
Module code:	phy570
Course:	Electronics - lecture, Electronics - practical and theoretical exercises
Term:	Summer
Person in charge:	Prof. Dr. Haja
Lecturer:	Prof. Dr. Haja
Language:	English
Location	Oldenburg or Emden
Curriculum allocation:	Bachelor Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week Exercise: 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:	At the end of the course, students will be able to build simple circuits from basic elements of electrical engineering (analog and digital). They are familiar with the structure and function of microcontrollers, especially the Arduino. The students can plan and build simple electronic projects with the Arduino and program them with the C programming language.
Content:	The following topics will be covered during the course: (a) Basic laws of electrical engineering, (b) analog and digital components, (c) Fundamentals of computers and microcontrollers (especially Arduino), (d) Fundamentals of C programming for Arduino, (e) Design and layout of circuits, (f) Measurement and control with the Arduino. During the course numerous projects will be developed and presented in detail.
Assessment/type of examination:	max 3 hrs written or max 45 min oral exam
Media:	Script, transparencies, blackboard, computer presentation
Literature:	Lecture script and various recommendations of online sources

2.4 Lab Project

Module title:	Lab Project I (5.04.637)
Module code:	phy505
Course:	Laboratory Project I (Winter term), Design Fundamentals (Summer term)
Term:	Winter
Person in charge:	Prof. Dr. Brückner
Lecturer:	Prof. Dr. Brückner, Dr. Schüning
Language:	English
Location	Emden
Curriculum allocation:	Bachelor Engineering Physics, 2nd & 3rd semester
Teaching Methods/ semester periods per week:	Laboratory: 3 hrs/week, Lecture: 2hrs/week
Workload:	attendance: 70 hrs, self study: 200 hrs
Credit points:	9
Prerequisites acc. syllabus	
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: 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. 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.

3 3rd Semester

3.1 Mathematical Methods for Physics and Engineering III

Module title:	Mathematical Methods for Physics and Engineering III (5.04.638)
Module code:	phy542
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. Doclo
Language:	English
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 3rd semester
Teaching Methods/ semester periods per week:	Lecture: Lecture: 2 hrs/week, Exercise: 2 hrs/week
Workload: ⇐	attendance: 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:	3 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, computer presentation
Literature:	K. F. Riley, M. P. Hobson, S. J. Bence: Mathematical methods for physics and engineering. Third edition, 2006

3.2 Atomic and Molecular Physics

Module title:	Atomic and Molecular Physics (5.04.202)
Module code:	phy031
Course:	Atomic and Molecular Physics
Term:	Winter
Person in charge:	Prof. Dr. Walter Neu
Lecturer:	Prof. Dr. Walter Neu
Language:	Englisch
Location	Oldenburg
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 and Mathematics I & 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:	max. 3 hrs written or 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;

3.3 Specialization

Module title:	Specialization (5.04.620)
Module code:	phy563
Course:	two lectures out of "Introduction to field of specialization" - winter term lecture
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. Poppe
Language:	English
Location	Oldenburg
Curriculum allocation:	Engineering Physics, 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:	Mandatory courses of the semesters before
⇐ 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:	Laser and Optics: Introduction to relevant research fields in Laser and Optics. Knowledge of the characteristics of waves, optical radiation, design and function of optical elements and instruments, basic design of photonic systems and optical metrology. Biomedical Physics and Acoustics: Overview of the research fields in Oldenburg related to biomedical physics and acoustics (acoustical signal processing, audiology, biomedical signal processing, neurosensory 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:	2 examinations: Exam (30 - 60 minutes) or oral exam (15 - 30 minutes) or home work (5 - 15 pages) or presentation (15-30 minutes)
Media:	Lecture script, transparencies, blackboard, electronic media, presentation
Literature:	Acc. selected lectures

3.4 PB

3.4.1 c++

Module title:	Computing C/(C++) - PB (5.04.255)
Module code:	pb262
Course:	Programming Course C++
Term:	Winter
Person in charge:	Dr. Stefan Harfst
Lecturer:	Dr. Stefan Harfst
Language:	English
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 3rd semester
Teaching Methods/ semester periods per week:	Laboratory: Lecture: 2 hrs/week, Exercise: 2 hrs/week
Workload:	attendance: 56 hrs, self study: 124 hrs(exercises)
Credit points:	6
Prerequisites acc. syllabus	Lecture "Electronics"
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

3.4.2 matlab

Module title:	Computing (Matlab) - PB (5.04.256)
Module code:	pb351
Course:	Computing (Matlab)
Term:	Winter
Person in charge:	Schellenberg
Lecturer:	Schellenberg
Language:	English
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 3rd semester
Teaching Methods/ semester periods per week:	Laboratory: Lecture: 3 hrs/week, Exercise: 2 hrs/week
Workload:	attendance: 70 hrs, self study: 110 hrs(exercises)
⇐ 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:	Graded programming exercises (Fachpraktische Übung) / homework / 30 mins oral exam
Media:	Transparencies, blackboard, data projector presentation, reference programs
Literature:	

4 4th Semester

4.1 Numerical Methods of Physics

Module title:	Numerical Methods of Physics (5.04.241)
Module code:	phy501
Course:	Numerical methods - lecture, Numerical methods - tutorial
Term:	Summer
Person in charge:	Prof. Hartmann, Prof. Dr.Hohmann, Dr. Brand,
Lecturer:	Prof. Hartmann, Prof. Dr.Hohmann, Dr. Brand, PD Dr. Polley
Language:	Lecture: German; Tutorials: English and German; Materials and script: English)
Location	Oldenburg
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: Lecture: 2 hrs/week, Exercise: 2 hrs/week
Workload:	attendance: attendance: 56 hrs, self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Basic computer knowledge; knowledge in undergraduate physics Mathematics I & II
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; 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

4.2 Thermodynamics

Module title:	Thermodynamik und Einführung in die Statistische Physik (5.04.201)
Module code:	phy041
Course:	Thermodynamics and Statistics - lecture, Thermodynamics and Statistics - exercise
Term:	Summer
Person in charge:	Prof. Peinke
Lecturer:	Prof. Peinke
Language:	German, English with examination regulations 2019
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 4th semester; Fach-Bachelor in Physik, Pflicht, 4th Semester; Zwei-Fächer-Bachelor in Physik, LA Gymnasium, Pflicht, 4th Semester; Zwei-Fächer-Bachelor in Physik, LA GHR, Pflicht, 4th 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:	Die Studierenden erlernen die grundlegenden Prinzipien der phänomenologischen Thermodynamik einschließlich der Anwendungen auf dem Gebiet der Maschinen, sowie der mikroskopischen Thermodynamik und Statistik. Die Grundprinzipien werden auch anhand von Schlüsselexperimenten vermittelt. Die Veranstaltung bereitet auch den Besuch des Moduls Theoretische Physik III (Thermodynamik/Statistik) vor.
Content:	Thermodynamische Zustandsgroößen, Hauptsätze der Thermodynamik, ideale und reale Gase, Potentialfunktionen aus der Legendre-Transformation, irreversible Zustandsänderungen, Kreisprozesse, Aggregatzustände, offene Systeme und Phasenuübergaänge, Wärmeleitung und Diffusion, statistische Ansätze fuür Gleichverteilung im Volumen, Entropieänderungen, kinetische Gastheorie, Boltzmann-, Fermi-Dirac- und Bose-Einstein-Statistik, Maxwell Verteilung, Planckscher Strahler, Zustandsänderungen in Quantensystemen.
Assessment/type of examination:	max 3 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:	W. Demtröder: Experimentalphysik, Band 3: Atome, Moleküle, Festkörper. Springer, Berlin; St. J. Blundell, K. M. Blundell: Concepts in Thermal Physics, Oxford University Press, Oxford; M. W. Zemansky, R. H. Dittman: Heat and Thermodynamics. McGraw-Hill, New York; Van P. Carey: Statistical Thermodynamics and Microscale Thermophysics. Cambridge University Press, Cambridge (UK); H. B. Callen: Thermodynamics. John Wiley, New York; C. Kittel, H. Kroömer: Physik der Wärme. Oldenbourg, München; D. K. Kondepudi, I. Prigogine: Modern Thermodynamics. John Wiley, New York

4.3 Metrology

Module title:	Metrology (5.04.232a & 5.04.233a)
Module code:	phy530
Course:	Signal Processing - lecture, Measurement Technology - lecture,
Term:	Summer
Person in charge:	Prof. Dr. Meyer
Lecturer:	Prof. Dr. Meyer
Language:	English
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 4th semester
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
Aim/learning outcomes:	Den Studierenden werden grundlegende Prinzipien der Messtechnik und Signalverarbeitung sowie der Anwendung komplexer Messverfahren zur Extraktion der Messinformation vermittelt. Sie erlangen Fertigkeiten zur Durchführung fortgeschrittener Praktika und experimenteller Arbeiten in Forschungslabors. Sie entwickeln die Kompetenz zum analytischen Denken bei der Bewertung von Messsituationen, die sie zur Lösung von Messproblemen befähigen, wie sie in unterschiedlichen Branchen der Industrie anzutreffen sind (z.B. Automobil- und Halbleiterindustrie; analytische, pharmazeutische und medizinische Industrie).
⇐ Content:	SE Physikalische Messtechnik: Sensoren zur Messung unterschiedlicher physikalischer Größen (z.B. Kraft, Temperatur, Ladung, elektrische und magnetische Felder, Energien von Teilchen und Strahlung), hoch aufgelöste Messungen kleiner Signale, Einfluss von Störsignalen, Linearisierung und Reduktion von Störgroößen durch Kompensationsmethoden, Rauschreduktion, phasensensitiver Detektor (Lock-In), Komplexe Messsysteme wie z.B. Kernresonanz, Elektronenresonanz, Lasermesstechnik (u.a. Pump/Probe-Systeme), räumlich aufgelöste Messmethoden wie z.B. Kernspintomographie, Elektronen- und Rastersondenmikroskopie. VL Signalverarbeitung: Charakterisierung und Bearbeitung von Messsignalen (lineare Signalanalyse, Filterung), Charakterisierung und Beseitigung von Störeinfluüssen (empirische Statistik, Rauschen in physikalischen Systemen, Korrelationsanalyse, phasensensitiver Verstaärker, Methoden der Mittelung), Signaldigitalisierung, digitale Signalverarbeitung (u.a. zeitvariante Filterung, komplexe Verarbeitungsalgorithmen)
Assessment/type of examination:	max 3 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:	SE Physikalische Messtechnik: Elmar Schrüfer, Elektrische Meßtechnik: Messung elektrischer und nichtelektrischer Größen. Hanser Fachbuchverlag H.-R. Tränkler, E. Obermeier: Sensortechnik. Springer, Berlin; J. Niebuhr, G. Lindner: Physikalische Messtechnik mit Sensoren. Oldenbourg, München; J. F. Keithley [Ed.]: Low /Level Measurements Handbook. Keithley Instruments Inc; VL Signalverarbeitung: K.-D. Kammeyer, K. Kroschel: Digitale Signalverarbeitung: Filterung und Spektralanalyse mit MATLAB-Übungen. Teubner, Stuttgart; J.-R. Ohm, H. D. Luüke: Signaluübertragung. Springer, Berlin;B. Kollmeier: Skript zur Signalverarbeitung und Messtechnik

4.4 Quantum Structure of Matter

Module title:	Quantum Structure of Matter (5.04.471)
Module code:	phy551
Course:	Quantum Structure of Matter
Term:	Summer
Person in charge:	Prof. Dr. Caterina Cocchi
Lecturer:	Prof. Dr. Caterina Cocchi
Language:	English
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 4th 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 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 imposes 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 and allow the students to consolidate the knowledge acquired during the lectures and to achieve the ability to independently treat the above-mentioned problems.
Content:	The foundations of quantum mechanics: wave-particle duality and uncertainty principle The Schrödinger equation in one and three dimensions: Example of relevant potentials Key elements of the formalism of quantum mechanics: Operators, Dirac notation, Hilbert space Approximate methods: Perturbation theory and variational principle Relativistic quantum mechanics: The Dirac equation The many-body problem in atoms, molecules, and solids Light-matter interaction: transition probabilities, light absorption and emission.
Assessment/type of examination:	Max. 3 hrs written exam or max 45 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Script, transparencies, blackboard, computer presentation
Literature:	D. Griffiths, Introduction to Quantum Mechanics, Pearson (2014) B. Bransden and C. Joachin, Quantum Mechanics, Pearson (2000) N. W. Ashcroft and D. Mermin, Solid state physics, Brooks Cole (1976) Y. V. Nazarov and J. Danon, Advanced quantum mechanics, Cambridge University Press (2013)

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4.5 Specialization PB

Module title:	Specialization - PB
Module code:	acc module
Course:	Specialization
Term:	Winter or Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn, Prof. Poppe
Lecturer:	Prof. Doclo, Prof. Neu, Prof. Kühn, Prof. Poppe
Language:	German / English
Location	Oldenburg
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:	mandatory courses from the semesters before
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
Assessment/type of examination:	Max. 3 hrs written 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

5 5th Semester

5.1 Control Systems

Module title:	Control Systems
Module code:	phy590
Course:	Control Theory
Term:	Winter
Person in charge:	Prof. Philipp Huke
Lecturer:	Prof. Philipp Huke
Language:	English
Location	Oldenburg
Curriculum allocation:	Bachelor Engineering Physics, 5th semester
Teaching Methods/ semester periods per week:	Lecture: 4 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:	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. The students will achieve the competence to work into technical realization of controlled systems and to develop approaches for optimization.
Content:	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.
Assessment/type of examination:	max 45 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Media:	Blackboard, transparents and beamer projections, electronic handouts
Literature:	Philippsen: Regelungstechnik mit Python Lutz, H. und Wendt, W.: Taschenbuch der Regelungstechnik Unbehauen; H.: Regelungstechnik I, Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme English books: K.J. Aström: Feedback Systems: An Introduction for Scientists and Engineers

5.2 Solid-State Physics

Module title:	Festkörperphysik (5.04.301)
Module code:	phy502
Course:	Festkörperphysik
Term:	Winter
Person in charge:	apl. Prof. Dr. N. Nilius
Lecturer:	Prof. Dr. N. Nilius, Dr. H. Borchert
Language:	German, English with examination regulations 2019
Location	Oldenburg
Curriculum allocation:	Fach-Bachelor in Physik, 5. Semester Master Engineering Physics, 1. 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:	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:	max 3-stündige Klausur oder mündliche Prüfung von maximal 45 min. Informationen zur Berücksichtigung von Bonuspunkten bei der Modulbenotung finden Sie hier.
Media:	Tafel, Folien, Beamerpräsentationen
Literature:	N. W. Ashcroft, N. D. Mermin: Solid State Physics. Sounders College, Philadelphia, BIS; N. W. Ashcroft, N. D. Mermin: Festkörperphysik. Oldenbourg, München, BIS; S. Elliott: The Physics and Chemistry of Solids. John Wiley & Sons, West Sussex (UK), BIS; H. Ibach, H. Lüth: Festkörperphysik. Springer, Berlin, BIS; Siegfried Hunklinger: Festkörperphysik, Oldenbourg, München, BIS; 6. K. Kopitzki: Einführung in die Festkörperphysik. Teubner, Stuttgart, BIS

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5.3 Material Science

Module title:	Werkstoffkunde (5.04.609)
Module code:	phy581
Course:	Werkstoffkunde, Material Sciences, lecture
Term:	Winter
Person in charge:	Prof. Dr. T. Schüning
Lecturer:	Prof. Dr. T. Schüning
Language:	English
Location	Emden
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: 124 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:	max 90 min written examination or 30 min oral exam and presentation or home work
Media:	Blackboard, transparents and beamer projections, electronic handouts.
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

5.4 Specialization PB

Module title:	Specialization – PB
Module code:	acc module
Course:	Specialization
Term:	Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn, Prof. Poppe
Lecturer:	Prof. Doclo, Prof. Neu, Prof. Kühn, Prof. Poppe
Language:	German / English
Location	Oldenburg
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.
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

5.5 Laboratory Project II - PB

Module title:	Lab Project II - PB
Module code:	pb271
Course:	Laboratory Project II
Term:	Winter
Person in charge:	Prof. Dr. Neu
Lecturer:	Profs. Photonik, Prof. Doclo, Prof. Kühn, Prof. Poppe
Language:	English
Location	Emden
Curriculum allocation:	Bachelor Engineering Physics, 5th semester
Teaching Methods/ semester periods per week:	Laboratory: 5 hrs/week
Workload:	attendance: 70 hrs, self study: 110 hrs
Credit points:	6
⇐ 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

6 6th Semester

6.1 Bachelor Thesis

Module title:	Bachelor Thesis
Module code:	bam
Course:	Bachelor Thesis
Term:	Summer
Person in charge:	Teaching staff of Engineering Physics
Lecturer:	
Language:	Deutsch / English
Location	Oldenburg
Curriculum allocation:	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

6.2 Practice Module Engineering Physics

Module title:	Praxismodul Engineering Physics (5.04.709)
Module code:	prx108
Course:	Internship & Seminar
Term:	Summer
Person in charge:	Dr. Koch
Lecturer:	Teaching staff of Engineering Physics
Language:	Deutsch / English
Location	Oldenburg
Curriculum allocation:	Engineering Physics, 6th semester
Teaching Methods/ semester periods per week:	self-learning
Workload:	Attendance: 320 hrs, Self study: 130 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 CP)
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

Praxisphase/Internship Engineering Physcis

Module Number & Name: **prx108 Berufsfeldbezogenes Praktikum**

Lecture number: 5.04.709 (Berufsfeldbezogenes Praktikum Engineering Physics)

Plan of action:

1. Prior to the start of the internship and before signing any contracts, find a supervisor according to the list of examiners (please check the most current version with on the web page of the examination office:
https://uol.de/fileadmin/user_upload/f5/download/Studium_und_Lehre/Prueferlisten/2020/6_4_PL_FBa_EngineeringPhysics.pdf

2. Find an internship position
The combination with the Bachelor Thesis is possible but must be coordinated and approved by the supervisor. There are still two separate assessments required.

3. Duration 2 month

4. Recogniction:

   - ✓ Prepare the required documents according examination regulation (i.e. report / Poster …) and hand them over to your supervisor. The supervisor will grade your performance and will transmit the grade to the examination office (i.e. Ms. Osterkamp)

   - ✓ Registration for the poster presentation via Stud IP: 5.04.709. Berufsfeldbezogenes Praktikum, fill in the file: Engineering Physics, prx108_110 Berufsfeldbezogenes Praktikum_Praxismodul Engineering Physics and mail to sandra.koch@hs-emden-leer.de .

   - ✓ Upload the poster-file (if publication is allowed): Stud IP 5.04.709 (file name: Name_Supervisor_Semester_Titel)

   - ✓ Presentation of the poster; dates are normally April (summer semester) and October (winter semester)

   - ✓ Hand in the printed poster; minimum information needed: Headline “topic”, Name, email-address, study program and semester, supervisor university & company, logos of both universities & company, size: 70 cm x 100 cm (A0 or A1 possible)

Poster print free of charge possible

Poster print without CampusCard:
Apply for an account at the Hochschule Emden/Leer: engineering.physics@hs-emden-leer.de
Mal Poster (pdf-Format, name the size) to plotter@hs-emden-leer.de .
At least one week in advance.

Poster print with CampusCard
(Copy card, Access to PC Pool and printing, Library card, Electronic purse (Mensa), Locker Key (library), Poster printing)
Apply for a CampusCard by sending an email from your official email account (@uni-oldenburg.de) to engineering.physics@hs-emden-leer.de .

- Please add your family name and your first name
- Indicate if an account already exists
- Attach a passport photo named „family name_first name.jpg"

.
Upload poster: https://intranet.hs-emden-leer.de/?id=235&redirect_url=/rechenzentrum/service/plotterdienst-fuer-studierende/

The whole procedure is taking a week at minimum.

Arrange the poster transfer to the Uni Oldenburg: Sandra.Koch@hs-emden-leer.de.

7 Subjects of Specialization

7.1 Biomedical Physics and Neuroscience

Module title:	Specialization PB
Module code:	pb174
Course:	Biomedizinische Physik und Neurophysik (SS, 5.04.317)
Term:	Summer
Person in charge:	Prof. Dr. Poppe
Lecturer:	Prof. Kollmeier, Prof. Poppe, Dr. Uppenkamp
Language:	German
Location	Oldenburg
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:	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 analyze 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, max 45 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

7.2 Introduction to Acoustics

Module title:	Specialization PB
Module code:	pb171 / pb347
Course:	Einführung in die Akustik (5.04.253) & Einführung in die Hörforschung (5.04.254)
Term:	Summer
Person in charge:	Prof. Dr. ir. Doclo
Lecturer:	Prof. Dr. Van de Par, Prof. Dr. Dr. Kollmeier, Prof. Dr. Jürgens
Language:	German
Location	Oldenburg
Curriculum allocation:	Bachelor in Physik, 3.-6. Semester; Bachelor Engineering Physics, 4th or 5th semester
Teaching Methods/ semester periods per week:	Lecture + Exercises : 2 hrs/week (Akustik), Lecture: 2 hrs/week (Hörforschung)
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	3 & 3
Prerequisites acc. syllabus	
Recommended prerequisites:	Mandatory courses of the 1. and 2. semester
Aim/learning outcomes:	⇐ Nach Abschluss des Moduls haben die Studierenden die Kompetenz eine experimentelle Bachelorarbeit im Gebiet der Akustik oder der Medizinischen Physik / Hörforschung anzufertigen. Die Veranstaltung "Einführung in die Hörforschung" beinhaltet dabei die Aspekte der menschlichen Wahrnehmung und physiologischen Verarbeitung von Schall, während die Veranstaltung "Einführung in die Akustik" die technischen Aspekte der Schallerzeugung und Schallausbreitung behandelt.
Content:	Akustik: Physikalische Grundlagen der Akustik, Schwingungen und Wellen, Erzeugung, Abstrahlung und Ausbreitung von Schall, akustische Messtechnik, Schalldämmung und -dämpfung, Raum- und Bauakustik, Elektroakustik/ Wandler; Hörforschung: Funktion, Störungen und objektive Diagnostik des Hörens, Psychophysik, Hörgeräte- und Cochlea-Implantat-Verarbeitung, aktuelle Hörforschung in Oldenburg mit Streifzügen durch die Labors
Assessment/type of examination:	Oral exam
Media:	Script, transparencies, blackboard, Beamer presentation, experiments.
Literature:	B. Kollmeier: Skriptum Physikalische, technische und medizinische Akustik. Universität Oldenburg; 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; A. D. Pierce: Acoustics: an introduction to its physical principles and applications. Acoustical Society of America, Melville (NY),1994; B. Kollmeier: Skriptum Audiologie. Universität Oldenburg; J.O. Pickles „An introduction to the physiology of hearing“, Academic press, London; B. C. J. Moore „An introduction to the psychology of hearing“,Brill Academic Pub; 6. Auflage;

7.3 Introduction to Photonics

Module title:	Specialization PB
Module code:	pb259
Course:	Einführung in die Photonik (5.04.331)
Term:	Summer
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn
Lecturer:	Prof. Dr. Christoph Lienau, PD Dr. Ralf Vogelgesang
Language:	German
Location	Oldenburg
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:	max 120 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;

7.4 Nuclear and Atomic Physics

Module title:	Specialization PB
Module code:	pb260
Course:	Einführung in die Kern- und Teilchenphysik (5.04.341)
Term:	Summer
Person in charge:	Prof. Dr. Kühn, Prof. Dr. ir. Doclo
Lecturer:	Prof. Kollmeier, Prof. Poppe
Language:	German
Location	Oldenburg
Curriculum allocation:	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:	IMandatory courses of the 1. and 2. semester
Aim/learning outcomes:	Die Studierenden erwerben Kenntnisse über die grundlegenden Prinzipien und messtechnischen Methoden der Kern- und Elementarteilchenphysik sowie der dazugehörigen theoretischen Modelle (Feldtheorien). Sie erlangen Fertigkeiten zur Analyse kern- und teilchenphysikalischer Probleme, zur Einordnung neuer Experimente und Publikationen sowie zur selbständigen Beurteilung neuerer Entwicklungen. Sie erwerben Kompetenzen zur fundierten Einordnung der neuen Entwicklungen im Bereich der Kern- und Elementarteilchenphysik sowie zur Vernetzung mit den Kenntnissen aus den bisherigen Vorlesungen zur Experimental- und Theoretischen Physik. Außerdem erlangen sie Kompetenzen zur gesellschaftspolitischen Einordnung der Konsequenzen von physi-kalischer Forschung.
Content:	Phänomenologie der Kerne und Kernmodelle, Kernstrahlung, Teilchendetektoren, Beschleunigungsprinzipien, Teilchenzoo, Standardmodell der Elementarteilchenphysik, Einführung in die Physik jenseits des Standardmodells (GUT und Superstringtheorien). Studierende, die einen tiefergehenden Einblick in die Materie erwerben möchten, wird zusätzlich der Besuch der Vorlesung "Einführung in die Astrophysik" empfohlen. Aufgrund der hohen Dynamik der Forschungsergebnisse in beiden Bereichen wird in der Vorlesung mehrfach ein Überblick über neuere Publikationen gegeben.
Assessment/type of examination:	Klausur von max. 60 Minuten Dauer oder mündliche Prüfung von max. 45 Minuten Dauer.
Media:	Beamerpräsentation, historische Originalpublikationen, Audio-Files und kurze Filme.
Literature:	Jörn Bleck-Neuhaus, Elementare Teilchen, Springer Verlag, BIS; Wolfgang Demtröder, Experimentalphysik IV, Kern-, Teilchen und Astrophysik, Springer Verlag, BIS; Das & Ferbel, Introduction to Nuclear and Particle Physics World, Scientific, BIS; Historisch wichtige Original-Publikationen; Ggf. aktuelle Publikationen aus dem Physik Journal, Physics Today etc.

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7.5 Introduction to Material processing and its principles

Module title:	Specialization PB
Module code:	pb343
Course:	Einführung und Grundlagen zur Laser-Materialbearbeitung (5.04.706)
Term:	Winter
Person in charge:	Prof. Dr. Kühn, Prof. Dr. ir. Doclo
Lecturer:	Dr.-Ing. Thomas Schüning
Language:	German
Location	Emden
Curriculum allocation:	Bachelor Engineering Physics, 5th 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:	max 3 hr written final examination
Media:	Blackboard, transparencies, beamer presentation, Script
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

7.6 Science of Imaging, Scientific Sensors and Photography

Module title:	Specialization PB
Module code:	pb344
Course:	Science of Imaging, Scientific Sensors and Photography (5.04.672)
Term:	Summer
Person in charge:	Prof. Dr. Kühn, Prof. Dr. ir. Doclo
Lecturer:	Prof. Dr. Ulrich Teubner, Prof. Dr. Hans-Josef Brückner
Language:	Deutsch/English
Location	Emden
Curriculum allocation:	Bachelor of Engineering Physics, 4th or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week, Laboratory: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 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. 3 hr written examination or max 45 min oral examination or presentation or homework
Media:	blackboard, transparencies, computer presentation, practical work in laboratory
Literature:	U.Teubner, H.J. Brückner: Optical Imaging and Photography (De Gruyter, Berlin); Further literature: Nakamura: Image Sensors and Signal Processing for Digital Still Camera (CRC Taylor & Francis); E.Hecht: Optics (Addison-Wesley); F.L. Pedrotti & S.L. Pedrotti: Introduction to Optics (Prentice-Hall); Langford's Advanced Photography (CRC Taylor & Francis)Viele

7.7 Wind Energy Utilisation

Module title:	Specialization PB
Module code:	pb355
Course:	Wind Energy Utilisation (5.04.341)
Term:	Winter or Summer
Person in charge:	Prof. Dr. Kühn, Prof. Dr. ir. Doclo
Lecturer:	Prof. Dr. Kühn, Andreas Schmidt
Language:	English
Location	Oldenburg
Curriculum allocation:	Bachelor of Engineering Physics, 4th or 5th semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week, Software Training: 2hrs/week
Workload:	180 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	Basic computer knowledge; mechanics; mathematical methods for physics and engineering
Aim/learning outcomes:	Understanding basic principles of wind energy conversion. 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 Physics). ⇐
Content:	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). 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:	2 examinations: Exam (60 - 90 minutes) or oral exam (20 - 30 minutes) or report (15 - 30 pages)
Media:	blackboard, transparencies, computer presentation
Literature:	

7.8 Data Science with Python

Module title:	Specialization PB
Module code:	pb379
Course:	Data Science with Python
Term:	Winter
Person in charge:	Prof. Doclo, Prof. Neu, Prof. Kühn, Prof. Poppe
Lecturer:	
Language:	English
Location	Oldenburg
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:	
Content:	
Assessment/type of examination:	
Media:	Acc. selected lectures:
Literature:	