Modules for Engineering Physics

Date 18/10/19

Pflichtmodule

phy611 - Theoretical Methods

Module label	Theoretical Methods
Module code	phy611
Credit points	6.0 KP
Workload	180 h (attendance: 56 hrs, self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Alexander Hartmann
Entry requirements	
Skills to be acquired in this module	Computational Fluid Dynamics (CFD I & II) • Deeper understanding of the fundamental equations of fluid dynamics. • Overview of numerical methods for the solution of the fundamental equations of fluid dynamics. • Confrontation with complex problems in fluiddynamics. • To become acquainted with different, widely used CFD models that are used to study complex problems in fluid dynamics. • Ability to apply these CFD models to certain defined problems and to critically evaluate the results of numerical models. Computerorientierte Physik Extension and complement of qualification in theoretical physics through the acquisition of solid and deep knowledge of advanced concepts and methods in theoretical physics. Depending on the selected course the students acquire knowledge in the fields of basis numerical methods of theoretical physics, algorithms and data structures in scientific computing, code debugging. They obtain skills for a confident application of modern methods of theoretical physics such as diagram generation, Molecular Dynamics and Monte Carlo simulations and quantitative analysis of advanced problems of theoretical physics and in further development of the physical intuition. They enhance their competences to effectively deal with sophisticated problems of theoretical physics, to independently develop approaches to current issues of theoretical physics, and to comprehend common concepts and methods of theoretical physics and the natural sciences, in general. Modelling and Simulation The students attending successful the course acquire an advanced understanding of the conceptual design of models in the field of engineering sciences. Special emphasis is on identifying the significant physical processes and the choice of the most efficient modelling type. The interaction of numerical simulations with field measurements and laboratory measurements including the theory of similarity will be discussed. To meet the needs of renewable energy, laser technology, environmental sciences and marine sciences the practical focus is on the modelling and simulation of fluid dynamics in small scales and close to structures.
Module contents	Computational Fluid Dynamics (CFD I & II) • CFD I: The Navier-Stokes equations, filtering / averaging of Navier- Stokes equations, introduction to numerical methods, finite- differences, finite-volume methods, linear equation systems, NS-solvers, RANS, URANS, LES, DNS, turbulent flows, incompressible flows, compressible flows, efficiency and accuracy. • CFD II: Introduction to different CFD models, such as OpenFOAM and PALM. Application of these CFD models to defined problems from rotor aerodynamics and the atmospheric boundary layer. Computerorientierte Physik • Debugging • Data structures • Algorithms • Random number generation • Data analysis • Percolation • Monte Carlo simulation • Finite size scaling • Quantum Monte Carlo • Molecular dynamics simulations • Event-driven simulations • Graphs and algorithms

- Genetic algorithms
- optimization problems

Modelling and Simulation

- Understanding of advanced fluid dynamics including three-dimensional, transient and compressible processes
- Identifying the significant physical processes, defining the dimensionality and relevant scales in time and space
- Theory of similarity, range of dimensionless numbers
- Potential Theory
- Numerical Algorithms and possibilities of independent coding of simplest mathematical models
- Limitations of numerical models, risk of empirical approaches included in numerical models
- Introduction of a complete chain of Open-Source-CFD-Tools, considering preprocessing, processing and postprocessing tools
- Need and availability of appropriate measurement techniques for the steering, calibration and verification of models
- Contactless high-resolving measuring techniques in the fluid dynamics
- Limits of accuracy of different modelling and simulation concepts

Reader's advisory

- Computational Fluid Dynamics (CFD I & II)

J.H. Ferziger, M. Peric, Computational Methods for Fluid Dynamics, Springer, 2002.
C. Hirsch, Numerical Computation of Internal and External Flows: Introduction to the Fundamentals of CFD, Vol 1: Fundamentals of Computational Fluid Dynamics, 2nd edition, Butterworth-Heinemann, Amsterdam.
P. Sagaut, Large Eddy Simulation for Incompressible Flows, Springer, Berlin, 1998.
J. Fröhlich, Large Eddy Simulationen turbulenter Strömungen, Teubner, Wiesbaden, 2006. (in German)

- Computerorientierte Physik

T. H. Cormen, S. Clifford, C.E. Leiserson, und R.L. Rivest: Introduction to Algorithms. MIT Press, 2001.
K. Hartmann: Practical guide to computer simulation. World-Scientific, 2009.
J. M. Thijssen: Computational Physics. Cambridge University Press, 2007.
M. Newman, G. T. Barkema: Monte Carlo Methods in Statistical Physics. Oxford University Press, 1999.

- Modelling and Simulation

Versteeg, K.H. & Malalasekera, W.: An Introduction to Computational Fluid Dynamics. Prentice Hall, 2nd rev. Ed., 2007.

Links		
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency	halbjährlich	
Module capacity	unlimited	
Modullevel	---	
Modulart	je nach Studiengang Pflicht oder Wahlpflicht	
Lern-/Lehrform / Type of program	Lecture: 3hrs/week; Excercises: 1hrs/week	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		According selected course
Course type	Seminar	
SWS		
Frequency		
Workload attendance	0 h	

phy612 - Advanced Physics I

Module label	Advanced Physics I
Module code	phy612
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Bert Struve ◦ Björn Poppe
Entry requirements	
Skills to be acquired in this module	Fluiddynamik Fouriertechniken in der Physik The students know the definition of the Fourier-Transformation (FT) and learn about explicit examples. They know the properties and theorems of the FT, are able to apply these and describe physical processes both in time and frequency domain. They gain deep insights about physical processes analyzing the frequency domain and are able to utilize Fourier techniques solving physical problems, e.g. finding solutions of the time dependent Schrödinger equation. In addition, they learn about examples of the current english physical literature. Photonics Starting from basics, the module yields advanced knowledge of the physics of lasers, of optical radiation with matter, optoelectronic principles and components as, e.g. laser beams, different laser types, light emitters, detectors, modulators. The students acquire skills in working with lasers and optoelectronic components.
Module contents	Fluiddynamics I Base equations: Navier-Stokes equations, continuity equation, Bernoulli's law; Vortex and energy equations laminar flow and analysis of stability exact solutions and applications Fluiddynamics II Reynolds' turbulence Closure problems and approaches models of turbulence, principles of CFD, Cascade models – stochastic models Fouriertechniken in der Physik Motivation: Applications of the FT in physics. Examples for Fourier paires, properties of the FT: symmetries, important theorems, shifting, differentiation, convolution theorem, uncertainty relation. Examples concerning the convolution theorem: frequency comb, Hilbert transformation, autocorrelation function. Methods of the time/frequency analysis and Wigner distribution. FT in higher dimensions: tomography. Discrete FT, sampling theorem. Applications in quantum mechanics. Photonics Fundamentals of lasers (optical gain, optical resonator, laser beams), laser types, laser safety; electronic bandstructures in matter, semiconductor junctions, radiation laws, light emitting diodes, photodetectors, solar cells.
Reader's advisory	Fluiddynamics D. J. Tritton: Physical fluid dynamics. Clarendon Press, Oxford, 2003 G. K. Batchelor: An introduction to fluid dynamics. Cam- bridge University Press, Cambridge, 2002 U. Frisch: Turbulence: the legacy of A. N. Kolmogorov. Cambridge University Press, Cambridge, 2001 J. Mathieu, J. Scott: An introduction to turbulent flow. Cam- bridge University Press, Cambridge, 2000 P.A. Davidson: turbulence Oxford 2004 Fouriertechniken in der Physik (WS, 5.04.4651) R. Bracewell: „The Fourier Transform and its Applications“, McGraw-Hill, 3. Auflage (1999) T. Butz: „Fouriertransformation für Fußgänger“, Vieweg+Teubner, 7. Auflage (2011) D. W. Kammler: „A First Course in Fourier Analysis”, Cam- bridge University Press (2008) M. Wollenhaupt, A. Assion and T. Baumert: “Springer Handbook of Lasers and Optics”, Springer, Chapter 12, 2. Auflage (2012) L. Cohen: „Time Frequency Analysis“, Prentice Hall (1995) Weitere spezielle Literatur wird in der Vorlesung bekannt gegeben. Photonics C. Breck Hitz, J. J. Ewing, J. Hecht, Introduction to Laser Technology, 2012, Wiley Press F. Träger (ed.), Handbook of Laser and Optics, 2nd. ed. 2012, Springer Verlag, Berlin Saleh, Teich: Fundamentals of Photonics, John Wiley & Sons Ebeling: Integrierte Optoelektronik, Springer Verlag Original literature according indication during course

Links		
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency	jährlich	
Module capacity	unlimited	
Modullevel	MM (Mastermodul)	
Modulart	Wahlpflicht	
Lern-/Lehrform / Type of program	Lecture and exercise	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		1 exam or 1 presentation or 1 oral examination or 1 chore
Course type	Seminar	
SWS		
Frequency		
Workload attendance	0 h	

phy613 - Advanced Physics II

Module label	Advanced Physics II
Module code	phy613
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	
Skills to be acquired in this module	Theoretical Physics III: Quantum mechanics (M.Ed.): The students obtain competencies to identify application situations of quantum mechanics and to solve standard problems as well as to be able to impart knowledge properly (i.a. at schools). General Relativity: The students acquire basic knowledge in the field of general relativity as well as of aspects of astrophysics and cosmology. They obtain skills for a confident application of modern methods of theoretical physics. These include in particular differential geometric concepts and quantitative analysis of advanced problems of theoretical physics. They enhance their competences to effectively deal with sophisticated problems of theoretical physics, to independently develop approaches to current issues of theoretical physics, and to comprehend common concepts and methods of theoretical physics and the natural sciences, in general. Acoustics: Thorough understanding of acoustics and ability to make quantitative descriptions of phenomena in physical acoustics such as mechanical oscillations, acoustical wave propagation, reflections at boundaries, room acoustical properties, diffraction, and electro acoustical systems. Understanding of important concepts such as acoustical impedance, Q-factor, resonances, near and far field, standing waves, room modes, etc..
Module contents	Theoretical Physics III: Quantum mechanics (M.Ed.): Basic concepts and structures of non-relativistic quantum mechanics (superposition principle, wave function, operators, eigenvalue problem, probabilistic interpretation, Schrödinger equation, Hilbert space and current topics like quantal measurement without interaction, Bell's inequality, decoherence), interpretation problems and questions of impartation of quantum mechanics at schools or other places. General Relativity: • equivalence principle • motion in the gravitational field • metric • tensors • covariant differentiation • Riemann curvature tensor • Einstein's field equations • conserved quantities • Schwarzschild solution • black holes • gravitational radiation • experimental tests • cosmology • Friedmann equations Acousics: • Oscillations and waves • Physical fundamentals of acoustics • Generation and propagation of sound • Measurement and evaluation of sound • Processing and analysis of acoustic signals • Acoustics of voice and speech • Speech pathology • Acoustic insulation and attenuation • Room and building acoustics • Electro acoustics • Shock waves • Photoacoustic effect • Selected topics of acoustics, vibrations and ultrasonic
Reader's advisory	Theoretische Physik III: Quantenmechanik (M.Ed.) C. Cohen-Tannoudji, et al.: Quantenmechanik, de Gruyter; W. Nolting: Grundkurs Theoretische Physik, 5 Quantenmechanik, Springer Verlag; J. Pade: Quantenmechanik zu Fuß, Springer (auch englisch: Quantum Mechanics for Pedestrians 1 & 2, Springer); B.H. Bransden, C.J., Joachain: Quantum Mechanics, Prentice Hall; J. Audretsch: Verschränkte Welt, Wiley;

	F. Selleri: Die Debatte um die Quantentheorie, Vieweg Verlag. Allgemeine Relativitätstheorie C. W. Misner, K. S. Thorne, J. A. Wheeler: Gravitation. Freeman, New York, 2002 S. Weinberg: Gravitation and cosmology: principles and applications of the general theory of relativity. John Wiley, New York, 1972 R. d' Inverno: Introducing Einstein's relativity. Clarendon Press, Oxford, 1992 J. B. Hartle: Gravity: an introduction to Einstein's general relativity. Addison-Wesley, San Francisco (CA), 2003 Akustik Kollmeier, B.: Skriptum Physikalische, technische und medizinische Akustik, Universita?t Oldenburg Heckl, Müller: Taschenbuch der technischen Akustik, Springer Verlag F.G. Kollmann: Maschinenakustik, Springer Verlag
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel	MM (Mastermodul)
Modulart	Wahlpflicht
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		1 writen exam oder 1 präsentation oder 1 oral exam oder 1 seminar paper

Course type	Seminar
SWS	
Frequency	
Workload attendance	0 h

phy623 - Advanced Wind Energy Meteorology

Module label	Advanced Wind Energy Meteorology
Module code	phy623
Credit points	3.0 KP
Workload	90 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy625 - Deep Learning

Module label	Deep Learning		
Module code	phy625		
Credit points	5.0 KP		
Workload	150 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Language of instruction	English		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	MM (Mastermodul / Master module)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Lecture		
SWS	2.00		
Frequency	SuSe or WiSe		
Workload attendance	28 h		

phy626 - Dynamical Systems

Module label	Dynamical Systems		
Module code	phy626		
Credit points	5.0 KP		
Workload	150 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	MM (Mastermodul / Master module)		
Modulart	Pflicht / Mandatory		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Lecture		
SWS	2.00		
Frequency	SuSe or WiSe		
Workload attendance	28 h		

phy631 - Advanced Metrology

Module label	Advanced Metrology
Module code	phy631
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Walter Neu ◦ Björn Poppe ◦ Simon Doclo ◦ Martin Kühn
Entry requirements	
Skills to be acquired in this module	The course in Advanced Metrology sets up a high level route enabling the students to acquire skills to allow them to operate effectively in the majors of Engineering Physics. This is achieved by provision of state-of-the-art technical and physical approaches covering broad aspects of advanced metrology within the context of Laser&optics, Biomedical physics & acoustics, and renewable energies. Demonstrate systematic knowledge across appropriate advanced metrology technologies, management and environmental issues to provide solutions for international industries and/or research organisations
Module contents	The module combines theory and practical applications of the fundaments of metrology in all majors. • Fundamentals of Metrology • Dimensional Measurement Systems • Basic metrology operators including Association and Filtration. • Optical Metrology and Instrumentation • Surface and Nanometrology • Machine Tool and Large Volume Metrology • Process Measurement and Control • Individual Project
Reader's advisory	T. Yoshizawa (Ed.): Handbook of Optical Metrology: Principles and Applications, 2nd rev. ed., Crc Pr Inc., 2015 Recent publications on specific topics
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	je nach Studiengang Pflicht oder Wahlpflicht
Lern-/Lehrform / Type of program	Lecture: 3hrs/week; Computational Lab: 1hrs/week Lecture: 2 + 2 hrs/week Seminar: 4 hrs/week Practical Training: 4 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		1 written exam or 1 presentation or 1 oral exam or 1 seminar paper

Course type	Comment	SWS	Frequency	Workload attendance
VA-Auswahl (Specialization Biomedical Physics)		4.00	WiSe	56 h
VA-Auswahl (Specialization Acoustics)		2.00	WiSe	28 h
VA-Auswahl (Specialization Renewable Energies)		2.00	WiSe	28 h
VA-Auswahl (Specialization Laser & Optics)		2.00	WiSe	28 h
Total time of attendance for the module				140 h

phy640 - Seminar Advanced Topics in EP

Module label	Seminar Advanced Topics in EP
Module code	phy640
Credit points	3.0 KP
Workload	90 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master • Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Walter Neu ◦ Sandra Koch
Entry requirements	Participation: 1st -3rd semester. Presentation: Master thesis work in progress or finished; at least one successfully completed specialization module.
Skills to be acquired in this module	The students are enabled to demonstrate the ability to communicate clearly, both orally and in writing, to specialist and non-specialist audiences. Demonstrate knowledge, fundamental understanding and critical awareness of current research fields in the student`s master projects. Personal development through practice of communication, presentation, time management, teamwork, problem solving, project management, critical evaluation, numeracy, and IT skills.
Module contents	Current seminar topics
Reader's advisory	M. Alley: The Craft of Scientific Presentations, Springer, 2nd ed., 2013 Publications according to seminar topics
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel	MM (Mastermodul)
Modulart	Pflicht
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		max 1h oral presentation and written report or oral exam (1 hour and regular active and documented participation in the seminar spread over the first three semesters.

Course type	Seminar
SWS	2.00
Frequency	--
Workload attendance	28 h

phy653 - Engineering Sciences I

Module label	Engineering Sciences I
Module code	phy653
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Ulrich Teubner ◦ Martin Kühn ◦ Simon Doclo
Entry requirements	Acc. selected course
Skills to be acquired in this module	Acc. selected course
Module contents	Acc. selected course
Reader's advisory	Acc. selected course
Links	http://www.uni-oldenburg.de/ep/
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel	MM-PB (Professionalisierungsbereichsmodul im Master)
Modulart	Wahlpflicht
Lern-/Lehrform / Type of program	for courses please check the module description: http://www.uni-oldenburg.de/ep/
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Acc. selected course

Course type	Seminar
SWS	
Frequency	
Workload attendance	0 h

phy654 - Engineering Sciences II

Module label	Engineering Sciences II		
Module code	phy654		
Credit points	6.0 KP		
Workload	180 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule		
Contact person	Module responsibility ◦ Ulrich Teubner ◦ Martin Kühn ◦ Simon Doclo		
Entry requirements	acc. selected course		
Skills to be acquired in this module	acc. selected course		
Module contents	acc. selected course		
Reader's advisory	acc. selected course		
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency	halbjährlich		
Module capacity	unlimited		
Modullevel	MM-PB (Professionalisierungsbereichsmodul im Master)		
Modulart	Wahlpflicht		
Lern-/Lehrform / Type of program	acc. selected course		
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		acc. selected course	
Course type	Seminar		
SWS			
Frequency			
Workload attendance	0 h		

phy655 - Engineering Sciences III

Module label	Engineering Sciences III		
Module code	phy655		
Credit points	6.0 KP		
Workload	180 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule		
Contact person	Module responsibility ◦ Ulrich Teubner ◦ Martin Kühn ◦ Simon Doclo		
Entry requirements	acc. selected course		
Skills to be acquired in this module	acc. selected course		
Module contents	acc. selected course		
Reader's advisory	acc. selected course		
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency	halbjährlich		
Module capacity	unlimited		
Modullevel	MM-PB (Professionalisierungsbereichsmodul im Master)		
Modulart	Wahlpflicht		
Lern-/Lehrform / Type of program	acc. selected course		
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		acc. selected course	
Course type	Seminar		
SWS			
Frequency			
Workload attendance	0 h		

phy662 - Specialization III

Module label	Specialization III
Module code	phy662
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ BetreuerIn der Masterarbeit
Entry requirements	
Skills to be acquired in this module	Kennen lernen des aktuellen Forschungsstandes im Spezialgebiet und Erwerb fachlicher Spezialkenntnisse.
Module contents	Einarbeitung und wissenschaftliche Anleitung zum selbständigen Arbeiten im speziellen Fachgebiet, in dem die Masterarbeit geschrieben werden soll.
Reader's advisory	Wird entsprechend dem konkreten Thema spezifiziert.
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel	MM-PB (Professionalisierungsbereichsmodul im Master)
Modulart	Wahlpflicht
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		S

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		4.00		56 h
Exercises		2.00		28 h
Seminar				0 h
Total time of attendance for the module				84 h

phy663 - Specialization I

Module label	Specialization I
Module code	phy663
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Hans Josef Brückner ◦ Martin Kühn ◦ Simon Doclo
Entry requirements	Acc. selected course
Skills to be acquired in this module	The acquisition of knowledge and the strategy for understanding the subject topics is achieved through taught lectures, supervised laboratory sessions, tutorials, seminars, practical demonstrations and personal study presentations on coursework assignments. This module enables the students to emphasize on a field of specialisation in Engineering Physics at the cutting edge of research.
Module contents	The course is intended to be integrative, a culmination of knowledge, skills, competencies and experiences acquired in other modules, coupled with further development of these assets. Acc. selected course
Reader's advisory	Acc. selected course
Links	http://www.uni-oldenburg.de/ep/
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel	MM-PB (Professionalisierungsbereichsmodul im Master)
Modulart	Wahlpflicht
Lern-/Lehrform / Type of program	Acc. selected course
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Assignments may consist of case studies, practical reports, or reviews of recent research Material is introduced through lectures, laboratories, and directed reading and research. Students are given guidance on how to manage their learning, and at each stage in their development they are expected to take responsibility for their own learning. Acc. selected course

Course type	Comment	SWS	Frequency	Workload attendance
Seminar	Specialization Laser & Optics	4.00	SuSe and WiSe	56 h
Seminar	Specialization Renewable Energies	4.00	SuSe and WiSe	56 h
Seminar	Acoustics	4.00	SuSe and WiSe	56 h
Seminar	**Biomedical Physics** Choose one topic	4.00	SuSe and WiSe	56 h
Total time of attendance for the module				224 h

phy664 - Specialization II

Module label	Specialization II
Module code	phy664
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Martin Kühn ◦ Hans Josef Brückner ◦ Simon Doclo
Entry requirements	Acc. selected course
Skills to be acquired in this module	The acquisition of knowledge and the strategy for understanding the subject topics is achieved through taught lectures, supervised laboratory sessions, tutorials, seminars, practical demonstrations and personal study presentations on coursework assignments. This module enables the students to emphasize on a field of specialisation in Engineering Physics at the cutting edge of research.
Module contents	The course is intended to be integrative, a culmination of knowledge, skills, competencies and experiences acquired in other modules, coupled with further development of these assets. Acc. selected course
Reader's advisory	Acc. selected course
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel	MM-PB (Professionalisierungsbereichsmodul im Master)
Modulart	Wahlpflicht
Lern-/Lehrform / Type of program	Acc. selected course
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Assignments may consist of case studies, practical reports, or reviews of recent research Material is introduced through lectures, laboratories, and directed reading and research. Students are given guidance on how to manage their learning, and at each stage in their development they are expected to take responsibility for their own learning. Acc. selected course

Course type	Seminar
SWS	
Frequency	
Workload attendance	0 h

phy665 - Specialization IV

Module label	Specialization IV
Module code	phy665
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Hans Josef Brückner ◦ Martin Kühn ◦ Simon Doclo
Entry requirements	Acc. selected course
Skills to be acquired in this module	The acquisition of knowledge and the strategy for understanding the subject topics is achieved through taught lectures, supervised laboratory sessions, tutorials, seminars, practical demonstrations and personal study presentations on coursework assignments. This module enables the students to emphasize on a field of specialisation in Engineering Physics at the cutting edge of research.
Module contents	The course is intended to be integrative, a culmination of knowledge, skills, competencies and experiences acquired in other modules, coupled with further development of these assets. Acc. selected course
Reader's advisory	Acc. selected course
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel	MM-PB (Professionalisierungsbereichsmodul im Master)
Modulart	Wahlpflicht
Lern-/Lehrform / Type of program	Acc. selected cource
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Assignments may consist of case studies, practical reports, or reviews of recent research Material is introduced through lectures, laboratories, and directed reading and research. Students are given guidance on how to manage their learning, and at each stage in their development they are expected to take responsibility for their own learning. Acc. selected course

Course type	Seminar
SWS	
Frequency	
Workload attendance	0 h

phy681 - Tools and Skills for Scientific Engineering

Module label	Tools and Skills for Scientific Engineering	
Module code	phy681	
Credit points	6.0 KP	
Workload	180 h	
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule	
Contact person	Module responsibility ◦ Simon Doclo ◦ Walter Neu	
Entry requirements	Acc. selected course	
Skills to be acquired in this module	This module aims to raise the students understanding of the strategic, leadership, and technical aspects of project management and their role in adding competitive advantage to any enterprise. Concepts and techniques for programme and project management are introduced, developed and applied, with the aid of relevant case material. The students learn to consider specific key instrument types in current usage. This will be delivered in a project study format with each instrument being evaluated in terms of operating principle, design, and signal processing.	
Module contents	Acc. selected course	
Reader's advisory	Acc. selected course	
Links		
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency	halbjährlich	
Module capacity	unlimited	
Modullevel	MM-PB (Professionalisierungsbereichsmodul im Master)	
Modulart	Wahlpflicht	
Lern-/Lehrform / Type of program	Acc. selected course	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		Acc. selected course
Course type	Seminar	
SWS		
Frequency		
Workload attendance	0 h	

phy982 - Intelligent Systems

Module label	Intelligent Systems
Module code	phy982
Credit points	10.0 KP
Workload	300 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy988 - Introduction to Machine Learning and Data Mining

Module label	Introduction to Machine Learning and Data Mining	
Module code	phy988	
Credit points	5.0 KP	
Workload	150 h	
Used in course of study	• Master's Programme Engineering Physics (Master) > Pflichtmodule	
Contact person		
Entry requirements		
Skills to be acquired in this module		
Module contents		
Reader's advisory		
Links		
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency		
Module capacity	unlimited	
Modullevel	MM (Mastermodul / Master module)	
Modulart	Wahlpflicht / Elective	
Lern-/Lehrform / Type of program		
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		KL
Course type	Lecture	
SWS	2.00	
Frequency	SuSe or WiSe	
Workload attendance	28 h	

Advanced Physics

phy600 - Photonics

Module label	Photonics
Module code	phy600
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics
Contact person	Module responsibility ◦ Bert Struve
Entry requirements	Basic knowledge on optics, electrodynamics and atomic physics
Skills to be acquired in this module	Starting from basics, the module yields advanced knowledge of the physics of lasers, of interaction of optical radiation with matter, optoelectronic principles and components as, e.g. laser beams, diffrent laser types, light emitters, detectors, modulators. The students acquire skills in working with lasers and optoelectronic components.
Module contents	Fundamentals of lasers (optical gain, optical resonator, laser beams), laser types, laser safety; electronic bandstructures in matter, semiconductor junctions, radiation laws, light emitting diodes, photodetectors, solar cells
Reader's advisory	C. Breck Hitz, J. J. Ewing, J. Hecht, Introduction to Laser Technology, 2012, Wiley Press; G. Reider, Photonics, 2016, Springer Verlag; B. Struve, Einführung in die Lasertechnik, 2009, VDE Verlag; Saleh, Teich: Fundamentals of Photonics, John Wiley and Sons; Ebeling: Integrierte Optoelektronik, Springer Verlag; Original literature according indication during course
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 4 hrs/week , practical applications included in lecture
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		2 hr written examination or 30 min oral examination or experimental work or homework or presentation

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy601 - Allgemeine Relativitätstheorie

Module label	Allgemeine Relativitätstheorie
Module code	phy601
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics
Contact person	Module responsibility ◦ Andreas Engel
Entry requirements	
Skills to be acquired in this module	
Module contents	Aquivalenzprinzip, Bewegung im Gravitationsfeld, Metrik, Tensoren, Kovariante Ableitung, Riemannscher Krümmungstensor, Einsteinsche Feldgleichungen, Erhaltungsgrößen, Schwarzschild Lösung, Schwarze Löcher, Gravitationsstrahlung, Experimentelle Tests, Kosmologie, Friedmann-Gleichungen
Reader's advisory	C. W. Misner, K. S. Thorne, J. A. Wheeler: Gravitation. Freeman, New York, 2002; S. Weinberg: Gravitation and cosmology: principles and applications of the general theory of relativity. John Wiley, New York, 1972; R. d' Inverno: Introducing Einstein's relativity. Clarendon Press, Oxford, 1992; J. B. Hartle: Gravity: an introduction to Einstein's general relativity. Addison-Wesley, San Francisco (CA), 2003
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 3hrs/week; Exercise: 1hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy602 - Hochenergiestrahlenphysik & Space Environment

Module label	Hochenergiestrahlenphysik & Space Environment
Module code	phy602
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	Basic lectures in physics / engineering
Skills to be acquired in this module	Aim/learning outcomes: Hochenergiestrahlenphysik: Grundlegendes Verständnis der physikalischen Grundlagen der Hochenergie-Strahlenphysik (im Energiebereich ab ca. 106 eV). Die Studierenden sollen die universellen Ansätze der physikalischen Beschreibung der Erzeugung, Beschleunigung, Wechselwirkung und Detektion hochenergetischer Strahlung disziplinübergreifend kennen lernen. Space Environment: Basic understanding of the main components of the near-Earth space environment. The students shall become familiar with die different types of radiation and particles in space, their physical characteristics and their effects on hardware and humans in space. The interdisciplinary nature of these topics shall become clear.
Module contents	Hochenergiestrahlenphysik: Grundlagen der Hochenergie-Strahlenphysik, Strahlenarten in Umwelt, Kosmos und Medizin, Kosmische Strahlung, Grundlagen der Astroteilchenphysik, irdische und kosmische Beschleuniger, Wechselwirkung von Strahlung mit Materie, Detektionsmechanismen und Dosimetrie, Technische Realisierungen zur Beschleunigung und Detektion. Space Environment: Overview of radiation and particles in space and their energy ranges. The upper Earth atmosphere, the spectrum of the sun and its variability, plasma, solar- terrestrial interactions, the radiation belts of Earth, cosmic rays, meteoroids and meteors, near-Earth objects, space debris. Effects and potential protection measures.
Reader's advisory	H. Krieger: Strahlungsmessung und Dosimetrie, Springer Verlag, Wiesbaden, 2013; Grupen: Astroparticle Physics, Springer Verlag, Heidelberg, 2005; Falkenburg, Rhode (Eds.): From Ultra Rays to Astroparticles, Springer Verlag, Heidelberg, 2012
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	each lecture: 2hrs/week

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy603 - Fluiddynamik

Module label	Fluiddynamik
Module code	phy603
Credit points	6.0 KP
Workload	180 h (Attendance: 84 hrs, Self study: 96 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics
Contact person	Module responsibility ◦ Joachim Peinke
Entry requirements	
Skills to be acquired in this module	Fundamental knowledge and comprehension on the movement of fluids
Module contents	Fluid Dynamics I: Basic equations: Navier-Stokesequation, Continuity- equation, Bernoulli- equation; Vortex- equation { and Energy balance equations; laminar ows and stability analysis; exact solutions, application of basic equations Fluid Dynamics II: Reynolds-equation, " closing problem\of turbulence: Turbulence models: Cascade models, Stochastic models
Reader's advisory	J. Spurk, N. Aksel: Fluid Mechanics, Springer D. J. Tritton: Physical Fluid dynamics. Clarendon Press, Oxford, 2003 G. K. Batchelor: An introduction to fluid dynamics. Cambridge University Press, Cambridge, 2002 U. Frisch: Turbulence: the legacy of A. N. Kolmogorov. Cambridge University Press, Cambridge, 2001 J. Mathieu, J. Scott: An introduction to turbulent ow. Cambridge University Press, Cambridge, 2000 P.A. Davidson: turbulence Oxford 2004
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Reference text	Unterrichtssprache: English. German on demand, if no international students participate
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week; Excersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy604 - Kosmologie & Akkretionsscheiben

Module label	Kosmologie & Akkretionsscheiben
Module code	phy604
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	Kenntnisse aus den Vorlesungen Teilchen und Felder, Quantenmechanik (Astrophysik, Allgemeine Relativitätstheorie, Quantenfeldtheorie)
Skills to be acquired in this module	Die Studierenden erhalten einen Überblick über die aktuellen Fragestellungen der Kosmologie. Sie lernen die Konzepte und Methoden der Relativitätstheorie, der Feldtheorie, der Astrophysik und der Teilchenphysik zusammenzuführen, um sie auf die relevanten Fragestellungen der Kosmologie anzuwenden, und mit Hilfe der Beobachtungsdaten ein konsistentes Modell der Evolution des Universums zu formulieren.
Module contents	Kosmologie: Friedmann-Lemaitre Lösungen, Kosmische Hintergrundstrahlung, Nukleosynthese, Baryonenasymmetrie, Inflationäres Universum, Dunkle Materie, Dunkle Energie Akkretionsscheiben enstehen wenn Materie, z.B in Form von Gas oder Staub, auf ein massives kompaktes Objekt, wie ein schwarzes Loch oder ein Neutronenstern, zufallen. Dabei sammelt sich die Materie als rotierende Scheibe um das Zentralobjekt. Eine Akkretionsscheibe kann aus Plasma, Gas oder Staub bestehen. Da sich die einfallende Materie stark aufheizt, entsteht Wärmestrahlung die zum Aufspüren schwarzer Löcher oder Neutronensterne genutzt werden kann.
Reader's advisory	S. Weinberg: Cosmology, Oxford University Press 2008; V. Mukhanov: Physical Foundations of Cosmology, Cambridge University Press 2005; E. W. Kolb, M. S. Turner: The early universe. Addison- Wesley, Redwood City (CA), 1990; H. Goenner: Einführung in die Kosmologie. Spektrum Akademischer Verlag, Heidelberg, 1994
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	each lecture: 2 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy605 - Digital Signal Processing

Module label	Digital Signal Processing
Module code	phy605
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Simon Doclo
Entry requirements	Students should have acquired basic knowledge about continuous-time and discrete-time signal processing and system theory.
Skills to be acquired in this module	Vermittlung der theoretischen Methoden der digitalen Signal- und Systemdarstellung bis hin zu modernen Verfahren und Optimalsystemen zur Verarbeitung stochastischer Prozesse. Vertiefung des Vorlesungsstoffes in analytischen, numerischen und Programmierübungen. Nach Abschluss des Moduls beherrschen die Studierende moderne Signalverarbeitungsmethoden und können die gelernten Methoden zur Analyse akustischer Systeme und zur Erklärung der Funktionsweise signalverarbeitender Systeme einsetzen.
Module contents	Grundlagen der diskreten und integralen Signalrepräsentation (Eigenfunktionen), Abtastung, Signaltransformationen (Fourier-Transformation, Diskrete Fourier- Transformation, FFT, z-Transformation), Systemeigenschaften (Linearität, Zeitinvarianz, Stabilität, Kausalität), Methoden zur Beschreibung und Analyse von digitalen Systemen im Zeit- und Frequenzbereich (Impulsantwort, Übertragungsfunktion), stochastische Prozesse und lineare Systeme, digitale Filter, Optimalfilter, Adaptive Filter im Zeit- und Frequenzbereich
Reader's advisory	B. Girod, R. Rabenstein, A. Stenger, Signals and Systems, Wiley, 2001; J. G. Proakis, D. G. Manolakis, Digital Signal Processing - Principles, Algorithms and Applications, Prentice Hall, 2007; A. V. Oppenheim, R. W. Schafer, Discrete-Time Signal Processing, Prentice Hall, 2009; S. Haykin, Adaptive Filter Theory, Prentice Hall, 2001.
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week; Exersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy606 - Physics with Ultrashort Pulses and Fourier Methods

Module label	Physics with Ultrashort Pulses and Fourier Methods		
Module code	phy606		
Credit points	6.0 KP		
Workload	180 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Language of instruction	German		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	MM (Mastermodul / Master module)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Lecture		
SWS	4.00		
Frequency	SuSe or WiSe		
Workload attendance	56 h		

phy607 - Selected Topics in Advanced Physics

Module label	Selected Topics in Advanced Physics
Module code	phy607
Credit points	6.0 KP
Workload	180 h (Overall workload of 180 h)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics
Contact person	Module responsibility ◦ Walter Neu
Entry requirements	Related to selected course/s
Skills to be acquired in this module	The aim of this module is, to give students further access to also small courses (3 CP) which address the specific interest of the student and deliver unique in-depth knowledge or the opportunity to train specific physics skills.
Module contents	Photonics, Optics, Metrology,
Reader's advisory	Related to selected course/s
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Sommer- oder Wintersemester
Module capacity	unlimited
Reference text	This module offers special as well as advanced courses in Advanced Physics. The list of eligible courses will be updated each academic year. Please refer to the courses listed for this module in Stud.IP.
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Related to selected course/s
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Related to selected course/s

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy632 - Spectrophysics

Module label	Spectrophysics
Module code	phy632
Credit points	6.0 KP
Workload	180 h (Attendance: 28 hrs, Self study: 62 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	Module responsibility ◦ Walter Neu
Entry requirements	Atomic and Molecular Physics, Optical systems
Skills to be acquired in this module	Students gain in depth theoretical as experimental knowledge on advanced optical spectroscopy applied to atomic and molecular systems. They are qualified in setting up innovative methods and measurement devices based on their expert competence in up-to-date research and development areas. The module prepares the students to work in the field of optical science and engineering in general, and yields the base for all further specialisations within the field of optics and laser technology.
Module contents	Atomic structure and atomic spectra, molecular structure and molecular spectra, emission and absorption, width and shape of spectral lines, radiative transfer and transition probabilities, elementary plasma spectroscopy, experimental tools in spectroscopy, dispersive and interferometric spectrometers, light sources and detectors, laser spectroscopy, nonlinear spectroscopy, molecular spectroscopy, time resolved spectroscopy, coherent spectroscopy
Reader's advisory	A.Thorne, U. Litzen, S. Johansson: Spectrophysics. Principles and Applications. Springer, 1999. ISBN 978-3540651178; J.M. Hollas, M.J. Hollas: Modern Spectroscopy. Wiley, 2003. ISBN 978-0470844168; S. Svanberg: Atomic and molecular spectroscopy. Basic aspects and practical applications. Springer, 2001.; W. Demtröder, Laser Spectroscopy Vol. 1and2, Springer, 5nd ed. 2014 and 4th ed., 2008; Saleh and Teich, Fundamentals of Photonics (Wiley); Recent publications on specific topics
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy633 - Optics

Module label	Optics
Module code	phy633
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	Module responsibility ◦ Ulrich Teubner
Entry requirements	Electrodynamics
Skills to be acquired in this module	The students acquire broad theoretical and experimental knowledge of optics together with the necessary physical background. In the laboratory they acquire practical skills during application of their knowledge from lecture. The module prepares the students to work in the field of optical science and engineering in general, and yields the base for all further specialisations within the field of optics and laser technology.
Module contents	Fundamental and advanced concepts of optics. Topics include: reflection and refraction, optical properties of matter, polarisation, dielectric function and complex index of refraction, evanescent waves, dispersion and absorption of light, Seidel's abberations, Sellmeier's equations, optical systems, wave optics, Fourier analysis, wave packets, chirp, interference, interferometry, spatial and temporal coherence, diffraction (Huygens, Fraunhofer, Fresnel), focussing and optical resolution, brilliance, Fourier optics, optics at short wavelengths (extreme UV and X-rays)
Reader's advisory	Born and Wolf: Principles of Optics (Cambridg Press); E. Hecht: Optics (Addison-Wesley); Pedrotti and Pedrotti: Introduction to Optics (Prentice- Hall); Saleh and Teich, Fundamentals of Photonics (Wiley); all those books are also available in German
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: Lecture: 3 hrs/week, Laboratory: 1 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy679 - Acoustics

Module label	Acoustics
Module code	phy679
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics
Contact person	Module responsibility ◦ Steven van de Par ◦ Birger Kollmeier ◦ Björn Poppe
Entry requirements	
Skills to be acquired in this module	Die Studierenden erwerben fortgeschrittene der Akustik. Sie erlangen Fertigkeiten zum sicheren und selbstständigen Umgang mit modernen Konzepten und Methoden der Angewandten Physik. Sie erweitern ihre Kompetenzen hinsichtlich der Fähigkeiten zur erfolgreichen Bearbeitung anspruchsvoller Probleme der Angewandten Physik mit modernen experimentellen und numerischen Methoden, zur eigenständigen Erarbeitung von Zugängen zu aktuellen Entwicklungen der Angewandten Physik sowie zum Verständnis übergreifender Konzepte und Methoden der angewandten Physik.
Module contents	Schwingungen und Wellen, physikalische Grundlagen der Akustik, Erzeugung und Ausbreitung von Schall, Messung und Bewertung von Schall, Verarbeitung und Analyse akustischer Signale, Akustik von Stimme und Sprache, Sprachpathologie, Schalldämmung und -dämpfung, Raumund Bauakustik, Elektroakustik, Stoßwellen, Photoakustischer Effekt; ausgesuchte Kapitel der Akustik, der Vibrationen und des Ultraschalls
Reader's advisory	Kollmeier, B.: Skriptum Physikalische, technische und medizinische Akustik, Universität Oldenburg; Kuttfuff, H., Akustik Eine Einführung, Springer- Verlag; Heckl, Müller: Taschenbuch der technischen Akustik, Springer-Verlag; F.G. Kollmann: Maschinenakustik, Springer-Verlag
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 3hrs/week; Excersise: 1hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

Schwerpunkt: Biomedical Physics

bio279 - Basic Concepts in Animal Physiology

Module label	Basic Concepts in Animal Physiology
Module code	bio279
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master of Education Programme (Special Needs Education) Biology (Master of Education) > Mastermodule • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module responsibility ◦ Dominik Heyers Authorized examiners ◦ Dominik Heyers ◦ Christine Köppl ◦ Karin Dedek Module counceling ◦ Christine Köppl ◦ Karin Dedek
Entry requirements	
Skills to be acquired in this module	++ biological knowledge ++ knowledge of biological working methods + biologically relevant knowledge in the natural sciences and mathematics + statistics & scientific programming ++ abstract, logical, analytical thinking + deepened expertise in biological specialist field ++ independent learning and (research-based) working + teamwork Basic knowledge on physiological processes and their underlying mechanisms with a focus on human physiology. Performing, analysing and documenting physiological experiments.
Module contents	The lecture (Vorlesung: 5.02.271 - Physiologie der Tiere und des Menschen) covers topics such as cell physiology, sensory physiology, neurophysiology, functions of the vegetative system, blood physiology/immune response, blood cycle, respiration and digestion. Emphasis will be on human physiology. In the following lab exercises, students get the opportunity to perform physiological experiments linking to topics from the lecture. By performing experiments on themselves and computer simulations students will gain insight into the underlying physiological principles.
Reader's advisory	Klinke, Pape, Kurtz, Silbernagl: Physiologie, Aufl. 6, 2010 Schmidt, Lang, Heckmann: Physiologie des Menschen mit Pathophysiologie, Aufl. 31, 2011 (if available: Wehner, Gehring: Zoologie)
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Modullevel	---
Modulart	je nach Studiengang Pflicht oder Wahlpflicht
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	within a few weeks after the winter term lecture period	written exam (100%) To qualify for the exam, the following additional requirements need to be met: • regular participation in the laboratory experiments (no more than 1 day of

Examination	Time of examination	Type of examination
		absence) • lab protocols for each experiment which have been accepted by the respective supervisors A cumulative bonus can be obtained with good lab protocols. The decision whether a given protocol deserves the bonus lies with the respective supervisor of each experiment. The bonus improves the exam mark by maximally two steps (0.7). The bonus is optional, an exam mark of 1.0 is achievable without a bonus. A bonus cannot be applied to pass a failed exam. PLEASE NOTE: Additional conditions regarding attendance and ungraded activities as determined by the persons responsible for the module will apply.
Course type	Lecture	
SWS	4.00	
Frequency		
Workload attendance	56 h	

phy614 - Personalized Medicine

Module label	Personalized Medicine		
Module code	phy614		
Credit points	6.0 KP		
Workload	180 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	EB (Ergänzungsbereich / Complementary)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Lecture		
SWS	2.00		
Frequency	SuSe or WiSe		
Workload attendance	28 h		

phy635 - Bildgebende Verfahren/ Optische Messtechnik

Module label	Bildgebende Verfahren/ Optische Messtechnik
Module code	phy635
Credit points	6.0 KP
Workload	180 h (Attendance: 58 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	Einführung in die Photonik
Skills to be acquired in this module	Bildgebende Verfahren: Die Studierenden erlernen die physikalischen Grundlagen und die Funktionsweise der wichtigsten bildgebenden Verfahren in der Medizin zur Abbildung biologischer Strukturen und Prozesse, erwerben Fertigkeiten zur selbständigen Vertiefung diese Fachkenntnisse und Kompetenzen für eine Anwendung dieser Fachkenntnisse im Rahmen von Facharbeiten und Projekten in verschiedenen Bereichen der biomedizinischen Physik.; Optische Messtechnik: Den Studierenden wird ein grundlegender Einblick in die Fülle moderner optischer Messmethoden vermittelt, wobei der Fokus auf aktuelle Entwicklungen und auf Verfahren gesetzt wird, die in der universitären Forschung am Institut für Physik von besonderer Bedeutung sind. Sie erlernen unter Anleitung und anhand von z.T. vorgegebener Fachliteratur zu den jeweiligen Themen die selbstständige Erarbeitung neuartiger Messverfahren und die entsprechende medienunterstütze Präsentation. Es werden sowohl theoretische, als auch praxis- und anwendungsbezogene Kompetenzen vermittelt, die die Studierenden in die Lage versetzen sollen, eigenständige Lösungsansätze für zukünftige messtechnische Herausforderungen zu entwickeln.
Module contents	Bildgebende Verfahren: •Uberblick •uber Verfahren der medizinischen Bildgebung ("ionisierende / nicht-ionisierende" Verfahren, anatomische / funktionelle Bildgebung); Physikalischen Grundlagen (Abbil-dungsprinzipien, Prinzipien der Kontrastbildung, Mathematische Grundlagen der Tomographie); Einf•uhrung in Computertomographie (CT); Nuklearmedizin (Single Photon- und Positronen-Emissionstomographie (SPECT/PET)); Ultraschall; Magnetresonanztomographie (MRT); funktionelle MRT, Elektro- und Magnetoencephalographie (EEG/MEG); Medizinische Anwendungen, m•ogliche Nebenwirkungen, relative Vor- und Nachteile; Forschungsanwendungen.; Optische Messtechnik: Themen aus der modernen optischen Messtechnik, wie z.B. Oberflächen- und Entfernungs-messtechniken, Nahfeldmethoden, optische Werkzeuge zur Mikromanipulation, optische Fallen, Interferometrie und Holografie, Laser- und Kurzkohärenz-Messtechnik
Reader's advisory	Bildgebende Verfahren: O. Dössel: Bildgebende Verfahren in der Medizin. Springer, Berlin, 2000; Z. H. Cho, J. P. Jones, M. Singh: Foundations of Medical Imaging. John Wiley, New York, 1993; H. Morneburg: Bildgebende Systeme für die medizinische Diagnostik. Publicis MCD Verlag, Erlangen, 1995.; Optische Messtechnik: E. Hecht: Optik. Oldenbourg, München, 2001; W. Lauterborn, T. Kurz: Coherent Optics. Springer, Berlin, 2003; H. Fouckhardt: Photonik. Teubner, Stuttgart, 1994; Saleh, Bahaa E. A.; Teich, Malvin Carl: Grundlagen der Photonik, WILEY-VCH, Weinheim 2008.; G. A. Reider: Photonik. Springer, Berlin, 1997; M. Born, E. Wolf: Principles of Optics. Cambridge University Press, Cambridge, 1999; Zeitschriftenartikel, je nach Thema
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy678 - Processing and analysis of biomedical data

Module label	Processing and analysis of biomedical data
Module code	phy678
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	Basic signal processing, algebra knowledge
Skills to be acquired in this module	This course introduces basic concepts of statistics and signal processing and applies them to real-world examples of bio-medical data. In the second part of the course, recorded datasets are noise-reduced, analyzed, and discussed in views of which statistical tests and analysis methods are appropriate for the underlying data. The course forms a bridge between theory and application and offers the students the means and tools to set up and analyze their future datasets in a meaningful manner.
Module contents	Normal distributions and significance testing, Monte- Carlo bootstrap techniques, Linear regression, Correlation, Signal-to-noise estimation, Principal component analysis, Confidence intervals, Dipole source analysis, Analysis of variance Each technique is explained, tested and discussed in the exercises.
Reader's advisory	Kirkwood B.R. and Sterne A.C., Essential Medical Statistics: 2nd edition. Blackwell Science. Oxford, 2003; Cho, Z.H. and Singh J. P. J.M.: Foundations of Medical Imaging. John Wiley, New York, 1993; Kutz, J.N. Data-Driven Modeling and Scientific Computation: Methods for complex systems and Big Data. Oxford University Press, Oxford, 2013
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week; Exersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Exam or presentation or oral exam or homework or practical report

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy685 - Advanced Engineering Topics in Biomedical Physics & Acoustics

Module label	Advanced Engineering Topics in Biomedical Physics & Acoustics		
Module code	phy685		
Credit points	6.0 KP		
Workload	180 h (Overall workload of 180 h)		
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics		
Contact person	Module responsibility ◦ Björn Poppe ◦ Simon Doclo		
Entry requirements	Related to selected course/s		
Skills to be acquired in this module	The aim of this module is, to give students further access to also small courses (3 CP) which address the specific interest of the student and deliver unique in-depth knowledge or the opportunity to train specific engineering skills.		
Module contents	Photonics, Optics, Metrology,		
Reader's advisory	Related to selected course/s		
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency	Sommer- oder Wintersemester		
Module capacity	unlimited		
Modullevel	MM (Mastermodul / Master module)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program	Related to selected course/s		
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		Related to selected course/s	
Course type	Lecture		
SWS	4.00		
Frequency	SuSe or WiSe		
Workload attendance	56 h		

phy686 - Advanced Topics in Biomedical Physics & Acoustics

Module label	Advanced Topics in Biomedical Physics & Acoustics	
Module code	phy686	
Credit points	6.0 KP	
Workload	180 h (Overall workload of 180 h)	
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics	
Contact person	Module responsibility ◦ Björn Poppe ◦ Simon Doclo	
Entry requirements	Related to selected course/s	
Skills to be acquired in this module	The aim of this module is, to give students further access to also small courses (3 CP) which address the specific interest of the student and deliver unique in-depth knowledge or the opportunity to train specific engineering skills.	
Module contents	Photonics, Optics, Metrology,	
Reader's advisory	Related to selected course/s	
Links		
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency	Sommer- oder Wintersemester	
Module capacity	unlimited	
Modullevel	MM (Mastermodul / Master module)	
Modulart	Wahlpflicht / Elective	
Lern-/Lehrform / Type of program	Related to selected course/s	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		Related to selected course/s
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy695 - Spezialkurs Strahlenschutz

Module label	Spezialkurs Strahlenschutz
Module code	phy695
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	Experimentalphysik I-V, Kern- und Elementarteilchenphysik, Medizinsche Strahlentherapie, Grundkurs im Strahlenschutz
Skills to be acquired in this module	Der Kurs vertieft s•amtliche im Grundkurs im Strahlenschutz erlernten Kenntnisse, Fähigkeiten und Kompetenzen. Insbesondere wird Wert auf die Kompetenz gelegt Situationen und Fragen des Strahlenschutzes fundiert bewerten zu können.
Module contents	Inhalte entsprechend der Stoffzusammenstellung der Richtlinie Strahlenschutz in der Medizin und der Fachkunderichtlinie zur Röntgenverordnung: Strahlenschutzrelevante Aspekte in der Strahlentherapie, Nuklearmedizin und Radiologie. Dieser Kurs erfüllt zusammen mit dem Grundkurs die theoretischen Anforderungen zur Erlangung der Fachkunde im Strahlenschutz
Reader's advisory	Skript zum Kurs wird w•ahrend des Kurses zur Verfügung gestellt.
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy696 - Advanced Topics Speech and Audio Processing

Module label	Advanced Topics Speech and Audio Processing
Module code	phy696
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module counceling ◦ Simon Doclo
Entry requirements	Basic principles of signal processing (preferably successfully completed the course Signal- und Systemtheorie and/or Blockpraktikum Digitale Signalverarbeitung)
Skills to be acquired in this module	The students will gain in-depth knowledge on the subjects' speech and audio processing. The practical part of the course mediates insight about important properties of the methods treated in a self-study approach, while the application and transfer of theoretical concepts to practical applications is gained by implementing algorithms on a computer.
Module contents	After reviewing the basic principles of speech processing and statistical signal processing (adaptive filtering, estimation theory), this course covers techniques and underlying algorithms that are essential in many modern-day speech communication and audio processing systems (e.g. mobile phones, hearing aids, headphones): acoustic echo and feedback cancellation, noise reduction, dereverberation, microphone and loudspeaker array processing, active noise control. During the exercises a typical hands-free speech communication or audio processing system is implemented (in Matlab).
Reader's advisory	J. Benesty, M. M. Sondhi, Y. Huang: Handbook of Speech Processing, Springer, 2008.; P. Vary, R. Martin: Digital Speech Transmission, Wiley, 2006.; P. Loizou: Speech Enhancement: Theory and Practice, CRC Press, 2007.; S. Vaseghi: Advanced Digital Signal Processing and Noise Reduction, Wiley, 2006.; S. Haykin: Adaptive Filter Theory, Prentice Hall, 2013.
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	VL: 2 SWS, PR: 2 SWS
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Exam or presentation or oral exam or homework or practical report

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy697 - Informationsverarbeitung und Kommunikation

Module label	Informationsverarbeitung und Kommunikation
Module code	phy697
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hours, Self study: 124 hours)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	Kenntnisse der Inhalte aus den Veranstaltungen Lineare Algebra, Mathematische Methoden der Physik, Messtechnik und Block-Praktikum Digitale Signalverarbeitung (FPRB)
Skills to be acquired in this module	Die Studierenden erlernen, wie statistische Eigenschaften von Signalen zur Lösung von Problemen der Angewandten Physik, insbesondere der Klassifikation, parametrischen Modellierung und Übertragung von Signalen genutzt werden können. Theoretische Lernziele beinhalten damit eine Wiederholung und Festigung statistischer Grundlagen und eine Verständnis von deren Nutzung für Algorithmen unterschiedlicher Zielsetzung und Komplexität. Im praktischen Teil werden Eigenschaften der behandelten Methoden selbständig erarbeitet sowie Algorithmen auf dem Rechner implementiert und auf reale Daten angewendet, so daß der Umgang mit theoretischen Konzepten und ihre praktische Umsetzung erlernt werden.
Module contents	Grundfragen der Informationsverarbeitung (Klassifikation, Regression, Clustering), Lösungsmethoden basierend auf Dichteschätzung und diskriminativen Ansätzen (z.B. Bayes Schätzung, k-nearest neighbour, Hauptkomponentenanalyse, support-vector-machines, Hidden-Markov- Modelle), Grundlagen der Informationstheorie, Methoden der analogen und digitalen Nachrichtenübertragung, Prinzipien der Kanalcodierung und Kompression
Reader's advisory	T. M. Cover, J. A. Thomas: Elements of information theory. John Wiley, 1991; K. Sayood: Introduction to data compression. Kaufmann, 2003; Bishop: Pattern Recognition and Machine Learning, Springer, 2006; MacKay: Information Theory, Inference and Learning Algorithms, Cambridge University Press, 2003
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week; Excersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy698 - Selected Topics on Medical Radiation Physics & Medizinische Strahlenphysik

Module label	Selected Topics on Medical Radiation Physics & Medizinische Strahlenphysik
Module code	phy698
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	
Skills to be acquired in this module	5.04.4242: Neben den aktuellen Themen der Strahlenphysik erlernen die Studierenden den Umgang mit meist englischsprachigen Fachzeitschriften aus dem Bereich. Darüber hinaus werden Präsentationstechniken durch eigene Vorträge erlernt. Parallel zu der Veranstaltung wird die Verwendung eines Monte-Carlo Strahlungstransport-Codes (EGS) erlernt und somit die Fähigkeit vertieft, komplexe physikalische Modelle in eine Software umzusetzen.; 5.04.4642: Der Kurs vermittelt die Fähigkeit zum Verständnis grundlegender Anwendungen der Strahlenphysik in der Medizin. Die Studierenden erweitern somit ihre Kompetenzen im Hinblick auf die Bewertung fächerübergreifender Zusammenarbeit unterschiedlicher Disziplinen. Sie erlernen zudem den selbständigen Umgang mit fremdsprachlicher Literatur.
Module contents	5.04.4242: Aktuelle Themen aus der Medizinischen Strahlenphysik wie: IMRT, NMR, PET, SPECT usw.; 5.04.4642: Grundlagen der Strahlentherapie, Dosimetrie, Einführung in die Strahlentherapie, Wechselwirkung von Strahlung mit Materie, Elektronen, Photonen und Teilchenstrahlung, mathematische Beschreibung von Dosisverteilungen in Absorbern, Detektoren und dosimetrische Protokolle, Grundlagen der Bestrahlungsplanung sowie Brachytherapie.
Reader's advisory	Wird während des Kurses zur Verfügung gestellt. für 5.04.4642 zusätzlich: F. M. Khan: The Physics of Radiation Therapy. Lippincott Williams and Wilkins, Philadelphia, 2003; H. Krieger: Strahlungsmessung und Dosimetrie, Springer Verlag, Wiesbaden, 2013; H. Krieger, W. Petzhold: Strahlenphysik, Dosimetrie und Strahlenschutz, Band 1 und 2, Teubner, Stuttgart, 1997; AEA,SyllabusonMedicalPhysics
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week; Seminar: 2hrs/week Credit Points: 3 and 3
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy732 - Psychophysics and Audiology

Module label	Psychophysics and Audiology
Module code	phy732
Credit points	6.0 KP
Workload	180 h (Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics • Master's Programme Physics, Engineering and Medicine (Master) > Mastermodule
Contact person	Module responsibility ◦ Birger Kollmeier
Entry requirements	Bachelor in Physik, Technik und Medizin oder entsprechend
Skills to be acquired in this module	Kenntnisse in der biomedizinischen Physik mit Überblick über die (Neuro-)Physiologie sowie Schwerpunktsetzung in der Hörforschung und Neurosensorik. Fundierte Kenntnisse in der Interpretation und Modellierung von physiologischen und psychoakustischen Phänomenen beim Hören. Fundierte Kenntnisse der praktischen Anwendungen in der diagnostischen und rehabilitativen Audiologie sowie bei gehörbezogenen Mess- und Beurteilungsverfahren. Einblick in aktuelle Forschungsthemen der Medizinischen Physik und des Exzellenzclusters Hearing4All.
Module contents	Einführung in die Rezeptor-Biophysik, Sinnesphysiologie, psychophysikalische Mess- und Skalierungsverfahren, Methoden und Modelle der Psychophysik Anatomie, Physiologie und Diagnostik von Außen-, Mittel- und Innenohr sowie zentralem Hör- und Sprachsystem, Psychoakustik der absoluten und differentiellen Empfindungsgrößen, psychoakustische Funktionsmodelle, binaurales Hören, Wahrnehmung komplexer Signale, auditive Neurokognition, Sprachwahrnehmung, Modelle des Hörens. Psychoakustik und Sprachperzeption bei pathologischem Gehör, Hörgeräte und technische Hörhilfen, Grundlagen der Hör-Rehabilitation; Signalverarbeitung in technischen Hörhilfen, ausgesuchte Kapitel der Hörforschung und Audiologie.
Reader's advisory	? B. Kollmeier: Skriptum Audiologie. Universität Oldenburg, http://medi.uni-oldenburg.de/16750.html ? W. M. Hartmann: Signals, Sound, and Sensation. AIP Press, New York, 2005. ? J. Kießling, B. Kollmeier, G. Diller: Versorgung und Rehabilitation mit Hörgeräten, Thieme, Stuttgart, 1997 ? E. Zwicker, H. Fastl: Psychoacoustics: facts and models. Springer, Berlin, 1999
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		M

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	WiSe	28 h
Exercises		2.00	WiSe	28 h
Seminar		2.00	WiSe	28 h
Total time of attendance for the module				84 h

phy734 - Introduction to Neurophysics

Module label	Introduction to Neurophysics
Module code	phy734
Credit points	6.0 KP
Workload	180 h (Präsenzzeit:56 Stunden Selbststudium: 124 Stunden)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics • Master's Programme Physics, Engineering and Medicine (Master) > Mastermodule
Contact person	Module responsibility ◦ Jörn Anemüller
Entry requirements	Bachelor in Physik, Technik und Medizin oder entsprechend
Skills to be acquired in this module	Erkennen, wie die Dynamik in Nervennetzen durch ein Zusammenspiel physikalischer, chemischer und biologischer Prozesse ermöglicht wird. ? Überblick über die wichtigsten physikalischen Messverfahren zur Quantifizierung von Struktur und Funktion von Nervensystemen. ? Nutzung der Mathematik als grundlegende Sprache zur Beschreibung biophysikalischer Prozesse im Nervensystem mittels Stochastik, linearer Algebra, Differentialgleichungen. ? Informationsrepräsentation auf unterschiedlichen Längen- und Zeitskalen: Übergang von mikroskopischen Modellen Prozessen zu makroskopischen Funktionsmodellen. ? - Lernen und Adaptation als Anpassung eines biophysikalischen Systems an seine Umgebung
Module contents	? Biophysik synaptischer und neuronaler Übertragung ? Modellierung einzelner Nervenzellen: Hodgkin Huxley model, integrate and fire model, Ratenmodell, ? Biophysik neuronaler Sensorik in auditorischer, visueller und mechano-sensorischer Modalität ? Beschreibung neuronaler Dynamik: Theorie dynamischer Systeme, von mikroskopischer zu makroskopischer Aktivität. ? Prinzipien von Messverfahren neuronaler Aktivität: von Einzelzellableitungen zur EEG, MEG und fMRI ? Beschreibung der Funktion kleiner Nervennetze: Rezeptive Felder und ihre Beschreibung mit linearen und nicht-linearen Modellen ? Der neuronale Code: Spikes, spike trains, Populationscodierung, Zeit- vs. Ratencode ? Decodierung neuronaler Aktivität und ihre Anwendungen ? Simulation künstlicher neuronale Netze als ein Funktionsmodell, Hopfield Netzwerk, Boltzmann Maschine, Perzeptron und tiefe Netze ? Informationstheoretische Ansätze, Stimulusstatistik, Entropie, Transinformation ? - Lernen und Plastizität, Konditionierung und Verstärkungslernen, Hebb'sches Lernen, LTP, LTD
Reader's advisory	? Chow, Gutkin, Hansel, Meunier, Dalibard (Eds.): Methods and Models in Neurophysics (2003) ? Dayan, Abbott: Theoretical Neuroscience (2005) ? Galizia, Lledo (Eds.): Neurosciences, from molecule to behauvior (2013) ? Gerstner, Kistler, Naud, Paninski: Neuronal Dynamics - From single neurons to networks and models of Cognition (2014) ? Rieke, Warland, de Ruyter van Steveninck, Bialek: Spikes - Exploring the neural code (1999) ? Schnupp, Nelken, King: Auditory Neuroscience (2010)
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	Vorlesung: 2 SWS, Übung: 2 SWS
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		M

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	WiSe	28 h
Exercises		2.00	WiSe	28 h
Total time of attendance for the module				56 h

Schwerpunkt: Laser and Optics

inf308 - Microrobotics II

Module label	Microrobotics II
Module code	inf308
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Computing Science (Master) > Nicht Informatik • Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering • Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	Module responsibility ◦ Sergej Fatikow ◦ Die im Modul Lehrenden Authorized examiners ◦ Sergej Fatikow ◦ Die im Modul Lehrenden
Entry requirements	
Skills to be acquired in this module	After having given an established introduction in the module “Microrobotics and Microsystem Technology” this lecture offers a further specialisation in microrobotics. Within the course, all relevant areas (among others the research topics of the division “Microrobotics and Control Engineering (AMiR)”) will be presented and analysed. The student will be provided with an insight into current research projects of AMiR and of other research institutes of microrobotics worldwide; here mainly the requirements of industry to microrobots will be discussed. The lecture will be enhanced by practical courses in the research laboratories of AMiR. **Professional competence** The students: • name and recognise the basic concepts of nanotechnology, in particular, micro- and nanorobotics approaches • differentiate the development, control and application of micro- and nanorobotics systems • implement and design application-specific mirco- and nanorobotics systems **Methodological competence** The students: • transfer their control engineering and image processing abilities on interdisciplinary problems • transfer their hands-on experience to develop controls and apllications of microrobotic systems on new tasks **Social competence** The students: • work in a team **Self-competence** The students: • reflect their problem-solving behaviour and use hands-on experience to develop, control and application of microrobotics
Module contents	Smart and versatile microrobots; microactuators (piezo-, ferrofluid- and SMA-actuators) for microrobots; real-time image processing in the micro world (SEM, optical microscopy); micro force sensors and tactile sensors for microrobots; microrobot control systems, e.g. neural networks and fuzzy logic; haptic interface for the control of microrobots; neural speech interface for the control of microrobots; robot-based micro- and nanohandling (SEM, optical microscopy); applications: microassembly, nano-testing, cell handling; Micro Air Vehicles (MAVs); multi-robot systems: team behavior, communication, control issues

Reader's advisory

- Lecture notes (can be obtained in secretariate, A1-3-303)
- Fatikow, Sergej (Ed.): Automated Nanohandling by Microrobots, Springer, London, 2008

Links				
Languages of instruction	English , German			
Duration (semesters)	1 Semester			
Module frequency	once a year			
Module capacity	unlimited			
Modullevel	AS (Akzentsetzung / Accentuation)			
Modulart	Pflicht o. Wahlpflicht / compulsory or optioal			
Lern-/Lehrform / Type of program	V+Ü			
Vorkenntnisse / Previous knowledge	Mikrorobotik und Mikrosystemtechnik			
Examination	Time of examination		Type of examination	
Final exam of module	At the end of the lecture period		Oral Exam and exercises	
Course type	Comment	SWS	Frequency	Workload attendance
Lecture		3.00	SuSe	42 h
Exercises		1.00	SuSe	14 h
Total time of attendance for the module				56 h

phy608 - Biomedical Optics

Module label	Biomedical Optics
Module code	phy608
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy632 - Spectrophysics

Module label	Spectrophysics
Module code	phy632
Credit points	6.0 KP
Workload	180 h (Attendance: 28 hrs, Self study: 62 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	Module responsibility ◦ Walter Neu
Entry requirements	Atomic and Molecular Physics, Optical systems
Skills to be acquired in this module	Students gain in depth theoretical as experimental knowledge on advanced optical spectroscopy applied to atomic and molecular systems. They are qualified in setting up innovative methods and measurement devices based on their expert competence in up-to-date research and development areas. The module prepares the students to work in the field of optical science and engineering in general, and yields the base for all further specialisations within the field of optics and laser technology.
Module contents	Atomic structure and atomic spectra, molecular structure and molecular spectra, emission and absorption, width and shape of spectral lines, radiative transfer and transition probabilities, elementary plasma spectroscopy, experimental tools in spectroscopy, dispersive and interferometric spectrometers, light sources and detectors, laser spectroscopy, nonlinear spectroscopy, molecular spectroscopy, time resolved spectroscopy, coherent spectroscopy
Reader's advisory	A.Thorne, U. Litzen, S. Johansson: Spectrophysics. Principles and Applications. Springer, 1999. ISBN 978-3540651178; J.M. Hollas, M.J. Hollas: Modern Spectroscopy. Wiley, 2003. ISBN 978-0470844168; S. Svanberg: Atomic and molecular spectroscopy. Basic aspects and practical applications. Springer, 2001.; W. Demtröder, Laser Spectroscopy Vol. 1and2, Springer, 5nd ed. 2014 and 4th ed., 2008; Saleh and Teich, Fundamentals of Photonics (Wiley); Recent publications on specific topics
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy633 - Optics

Module label	Optics
Module code	phy633
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	Module responsibility ◦ Ulrich Teubner
Entry requirements	Electrodynamics
Skills to be acquired in this module	The students acquire broad theoretical and experimental knowledge of optics together with the necessary physical background. In the laboratory they acquire practical skills during application of their knowledge from lecture. The module prepares the students to work in the field of optical science and engineering in general, and yields the base for all further specialisations within the field of optics and laser technology.
Module contents	Fundamental and advanced concepts of optics. Topics include: reflection and refraction, optical properties of matter, polarisation, dielectric function and complex index of refraction, evanescent waves, dispersion and absorption of light, Seidel's abberations, Sellmeier's equations, optical systems, wave optics, Fourier analysis, wave packets, chirp, interference, interferometry, spatial and temporal coherence, diffraction (Huygens, Fraunhofer, Fresnel), focussing and optical resolution, brilliance, Fourier optics, optics at short wavelengths (extreme UV and X-rays)
Reader's advisory	Born and Wolf: Principles of Optics (Cambridg Press); E. Hecht: Optics (Addison-Wesley); Pedrotti and Pedrotti: Introduction to Optics (Prentice- Hall); Saleh and Teich, Fundamentals of Photonics (Wiley); all those books are also available in German
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: Lecture: 3 hrs/week, Laboratory: 1 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy634 - Biophotonics and Spectroscopy

Module label	Biophotonics and Spectroscopy
Module code	phy634
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	Module responsibility ◦ Walter Neu
Entry requirements	Basics in optics and laser physics, in particular, fundamentals of optics and photonics; atomic and molecular physics; spectrophysics
Skills to be acquired in this module	The students thoroughly deepen their knowledge on concepts of spectroscopy as well as on biophotonics, This module provides the theoretical background for analytical applications involving UV-Visible spectroscopy, atomic absorption, emission and laser based spectroscopies. The students develop a sound understanding of the principles and instrumentation of atomic and molecular spectroscopy with in depth applications to a wide range of environments e.g. analytical, biological, industrial, pharmaceutical, environmental. The students develop problem solving skills with reasoning based on theory underlying spectroscopy and photonics in biosciences and medicine thus providing a background to practical laboratory training.
Module contents	Application of atomic and molecular spectroscopy at a wide range of fields, e.g. industrial, biosciences, microscopy, pharmaceutical, environmental, trace analysis: 1. Explain the mechanisms of and fundamental distinctions between molecular and atomic spectroscopy 2. Recognise the issues regarding sensitivity and selectivity of molecular and atomic spectroscopy 3. Evaluate the limitations and analytical issues associated with each method 3. Demonstrate analytical application of these atomic and molecular absorption and emission techniques 4. Discriminate the analytical challenges that can be appropriately solved by these spectroscopic techniques
Reader's advisory	R. Noll: Laser-Induced Breakdown Spectroscopy. Fundamentals and Applications. Springer, Berlin, 2012. ISBN: 978-3-642-20667-2; S. Musazzi, U. Perini (Eds.): Laser-Induced Breakdown Spectroscopy. Theory and Applications. Springer Series in Optical Sciences, Berlin, 2014. ISBN: 978-3-642-45084-6; Braun, M., Gilch, P., Zinth, W.: Ultrashort Laser Pulses in Biology and Medicine. Springer Berlin; 2007. ISBN-13: 978-3540735656; S. Svanberg: Atomic and molecular spectroscopy. Basic aspects and practical applications. Springer, 2004.; W. Demtröder, Laser Spectroscopy Vol. 1 and 2, Springer, 5nd ed. 2014 and 4th ed., 2008; B. Di Bartolo, John Collins (Eds.): Biophotonics: Spectroscopy, Imaging, Sensing, and Manipulation. Springer Netherlands, 2011. ISBN: 978-90-481-9976-1; W. Fritzsche, J. Popp (Eds.): Optical Nano- and Microsystems for Bioanalytics. Springer Series on Chemical Sensors and Biosensors, Berlin, 2012. ISBN: 978-3-642-25497-0; Recent publications on specific topics
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Sommer- oder Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2 hrs/week, Seminar: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy636 - Fiber Technology and Integrated Optics

Module label	Fiber Technology and Integrated Optics
Module code	phy636
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	Module responsibility ◦ Martin Kühn ◦ Simon Doclo
Entry requirements	basic knowledge on laser physics, optoelectronics or optical communication
Skills to be acquired in this module	students acquire basic knowledge for applications and handling of optical bers and components and for assembling fiber systems
Module contents	properties and preparation of optical fibers, fiber connections, optical fiber components, active optical fibers, photonic crystal fibers, polarization management, fiber optical amplifiers and lasers, Raman fiber amplifier and laser, fiber optical sensors, optical metrology
Reader's advisory	Excerpts from lecture script.; Voges, Petermann: Optische Kommunikationstechnik, Springer Verlag, 2002; John M. Senior: Optical Fiber Communication, Prentice Hall 1992
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture (oder Praktikum)
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy637 - Laser Design and Beam Guiding

Module label	Laser Design and Beam Guiding
Module code	phy637
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	Module responsibility ◦ Walter Neu
Entry requirements	basic knowledge on optics and laser physics
Skills to be acquired in this module	Students acquire advanced knowledge for the design of lasers and laser systems, they also understand the propagation of laser beams and their forming.
Module contents	design of different laser types; physics of active and passive laser components; beams and resonators; lab work
Reader's advisory	G. Reider, Photonics, 2016, Springer Verlag, Berlin; W. Koechner, Solid-State Laser Engineering, 6th. rev. 2006, Springer Verlag, Berlin; B. Struve, Einführung in die Lasertechnik, 2009, VDEVerlag, Berlin; Additional literature given in the lecture
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 4 hrs/week , practical applications included in lecture
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy638 - Laser material processing

Module label	Laser material processing
Module code	phy638
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Contact person	Module responsibility ◦ Walter Neu
Entry requirements	Knowledge in physics, optics, production engineering
Skills to be acquired in this module	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
Module contents	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 favourable working parameters; The participants should be able to understand the procedures of the material processing with laser beams and evaluate the tasks of manufacturing
Reader's advisory	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
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy639 - Physics with ultrashort pulses and intense light

Module label	Physics with ultrashort pulses and intense light	
Module code	phy639	
Credit points	6.0 KP	
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)	
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics	
Contact person	Module responsibility ◦ Walter Neu	
Entry requirements	Basics in optics and laser physics, in particular, Fundamentals of Optics and Photonics; Atomic Physics, Electrodynamics	
Skills to be acquired in this module	The students acquire broad experimental knowledge of the application of intense light from femtosecond and high power laser systems. They should be acquainted with the interaction of intense light with matter in general and with respect to important scientific and technical applications (in industry) such as laser material processing, high field physics (i.e. laser matter interaction at high intensity), laser generated particle and radiation sources of ultrashort duration and/or ultrashort wavelength etc.	
Module contents	Femtosecond and high power laser systems and its application, absorption of intense laser light, basics of laser matter interaction at high intensity, diagnostics, applications in micro machining, laser generated ultrashort radiation such as high-order laser harmonics and femtosecond K-sources and keV and MeV electron and ion sources and their application to micro fabrication micro and nano analysis.; atto physics, strong field physics	
Reader's advisory	E.Gamaly; Femtosecond Laser-Matter Interactions (Pan Stanford); P.Gibbon: Short pulse laser interactions with matter (Imperial College Press); D.Bäuerle: Laser Processing and Chemistry (Springer); Further literature according indication during course	
Links		
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency		
Module capacity	unlimited	
Modullevel	MM (Mastermodul / Master module)	
Modulart	Wahlpflicht / Elective	
Lern-/Lehrform / Type of program	Lecture: 2 hrs/week; Laboratory: 2 hrs/week	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		KL
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy682 - Advanced Engineering Topics in Laser and Optics

Module label	Advanced Engineering Topics in Laser and Optics	
Module code	phy682	
Credit points	6.0 KP	
Workload	180 h (Overall workload of 180 h)	
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics	
Contact person	Module responsibility ◦ Walter Neu	
Entry requirements	Related to selected course/s	
Skills to be acquired in this module		
Module contents	Related to selected course/s	
Reader's advisory	Related to selected course/s	
Links		
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency	Sommer- oder Wintersemester	
Module capacity	unlimited	
Reference text	This module offers special as well as advanced engineering courses in Laser and Optics. The list of eligible courses will be updated each academic year. Please refer to the courses listed for this module in Stud.IP.	
Modullevel	MM (Mastermodul / Master module)	
Modulart	Wahlpflicht / Elective	
Lern-/Lehrform / Type of program	Related to selected course/s	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		KL
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy683 - Advanced Topics in Laser and Optics

Module label	Advanced Topics in Laser and Optics		
Module code	phy683		
Credit points	6.0 KP		
Workload	180 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics		
Contact person	Module responsibility ◦ Walter Neu		
Entry requirements	Related to selected course/s		
Skills to be acquired in this module	The aim of this module is, to give students further access to also small courses (3 CP) which address the specific interest of the student and deliver unique in-depth knowledge or the opportunity to train specific engineering skills.		
Module contents	Photonics, Optics, Metrology,		
Reader's advisory	Related to selected course/s		
Links			
Languages of instruction	English , German		
Duration (semesters)	1 Semester		
Module frequency	Sommer- oder Wintersemester		
Module capacity	unlimited		
Modullevel	MM (Mastermodul / Master module)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program	Related to selected course/s		
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Lecture		
SWS	4.00		
Frequency	SuSe or WiSe		
Workload attendance	56 h		

Schwerpunkt: Renewable Energies

inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

Module label	Fuzzy Control and Artificial Neural Networks in Robotics and Automation
Module code	inf303
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering • Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Sergej Fatikow ◦ Die im Modul Lehrenden Authorized examiners ◦ Sergej Fatikow ◦ Die im Modul Lehrenden
Entry requirements	
Skills to be acquired in this module	Experts in different branches try to approach their application-specific control and information processing problems by using fuzzy logic and artificial neural networks (ANN). The experiences gathered up to now prove robotics and automation technology to be predestined fields of application of both these approaches. The major topics of the course are control problems in robotics and automation technology, principles of fuzzy logic and ANN and their practical appplications, comparison of conventional and advanced control methods, combination of fuzzy logic and ANN in control systems. The course gives a comprehensive treatment of these advanced approaches for interested students. **Professional competence** The students: • recognise control problems in robotics and automation technology, • name principles of fuzzy logic and ANN and their practical appplications, • compare conventional and advanced control methods, • characterise the combination of fuzzy logic and ANN in control systems **Methodological competence** The students: • will acquire knowledge of the tools, methods and applications in fuzzy logic and ANN • deepen their knowledge for the practical use of the given methods • can use common software tools for design and application of fuzzy logic and ANN **Social competence** The students: • gain experience in interdisciplinary work • are integrated into the recent research work Objective of the module / skills: **Self-competence** The students: • are able to transfer the gained knowledge for later use in their theses or studies for AMiR • can Design (complex) fuzzy logic controller and ANN systems • reflect their (control) solutions by using methods learned in this course
Module contents	

- Control problems in robotics and automation technology
- Basic ideas of fuzzy logic and ANN
- Principles of fuzzy logic
- Fuzzy logic of rule-based systems
- ANN models
- ANN learning rules
- Multilayer perceptron networks and backpropagation
- Associative networks
- Self-organizing feature maps
- PID design principles
- Design of fuzzy control systems
- Fuzzy logic application examples
- Design of ANN control systems
- ANN application examples
- Fuzzy + Neuro: principles and applications

Reader's advisory	**Essential:**

- Lecture notes (available at the secretariat, A1-3-303) in book form

Recommended:

- Bothe, H.-H.: Neuro-Fuzzy-Methoden, Springer, 1998
- Braun, Feulner, Malaka: Praktikum Neuronale Netze, Springer, 1997
- Kahlert, J.: Fuzzy Control für Ingenieure, Vieweg, Braunschweig Wiesbaden, 1995
- Nauck, D., Klawonn, F. und Kruse, R.: Neuronale Netze und Fuzzy-Systeme, Vieweg, 1994
- Zell, A.: Simulation Neuronaler Netze, Addison-Wesley / Oldenbourg Verlag, Bonn, 1996

Secondary Literature:

- Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
- Bekey, A. and Goldberg, K.Y. (Eds.): Neural Networks in Robotics, Kluwer Academic, 1996
- Berns, K. und Kolb, T.: Neuronale Netze für technische Anwendungen, Springer, 1994
- Bothe, H.-H.: Fuzzy Logic, Springer, 1993
- Bunke, H., Kandel, A. (eds.): Neuro-Fuzzy Pattern Recognition, World Scientific Publ., 2000
- Kahlert, J. und Hubert, F.: Fuzzy-Logik und Fuzzy-Control, Vieweg, 1993
- Kim, Y.H. and Lewis, F.L.: High-Level Feedback Control with Neural Networks, World Scientific, 1998
- Kratzer, K.P.: Neuronale Netze, Carl Hanser, 1993
- Lämmel, U. und Cleve, J.: Künstliche Intelligenz (neuronale Netze), Fachbuchverlag Leipzig, 2001
- Lawrence, J.: Neuronale Netze, Systhema Verlag, München, 1992
- Omidvar, O. and van der Smagt, P. (eds.): Neural Networks for Robotics, Academic Press, 1997
- Patterson, D.W.: Künstliche neuronale Netze, Prentice Hall, 1996
- Pham, D.T. a200
- nd Liu, X.: Neural Networks for Identification, Prediction and Control, Springer, 1997
- Rigoll, G.: Neuronale Netze, Expert Verlag, Renningen-Malmsheim, 1994
- Ritter, H., Martinetz, Th. und Schulten, K.: Neuronale Netze, Addison-Wesley, 1991
- Schulte, U.: Einführung in Fuzzy-Logik, Franzis-Verlag, München, 1993
- Tizhoosh, H.R.: Fuzzy-Bildverarbeitung, Springer, 1998
- von Altrock, C.: Fuzzy Logic: Technologie, Oldenbourg, 1993
- White, D. and Sofge, D. (Eds.): Handbook of Intelligent Control, Van Nostrand Reinhold, New York, 1992
- Zakharian, S. Ladewig-Riebler, P. und Thoer, St.: Neuronale Netze für Ingenieure, Vieweg, Wiesbaden, 1998
- Zalzala, A. and Morris, A. (Eds.): Neural Networks for Robotic Control, Ellis Horwood, London, 1996
- Zimmermann H.-J. (Hrsg.): Datenanalyse, VDI-Verlag, 1995
- Zimmermann, H.-J. (Hrsg.): Neuro + Fuzzy: Technologien und Anwendungen, VDI-Verlag, 1995
- Zimmermann, H.-J. und von Altrock, C. (Hrsg.): Fuzzy Logic: Anwendungen, Oldenbourg, 1994

Links	
Languages of instruction	English , German
Duration (semesters)	1 Semester
Module frequency	once a year
Module capacity	unlimited
Modullevel	AS (Akzentsetzung / Accentuation)
Modulart	Pflicht o. Wahlpflicht / compulsory or optioal
Lern-/Lehrform / Type of program	V+Ü
Vorkenntnisse / Previous knowledge	Regelungstechnik

Examination	Time of examination	Type of examination

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period until the beginning of the next semester	Hands-on-exercises and oral Exam

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		3.00	SuSe	42 h
Exercises		1.00	SuSe	14 h
Total time of attendance for the module				56 h

inf510 - Energy Information Systems

Module label	Energy Information Systems
Module code	inf510
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik • Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies • Master's Programme Environmental Modelling (Master) > Mastermodule
Contact person	Module responsibility ◦ Sebastian Lehnhoff ◦ Die im Modul Lehrenden Authorized examiners ◦ Sebastian Lehnhoff ◦ Die im Modul Lehrenden
Entry requirements	
Skills to be acquired in this module	The students will learn different approaches to integrate distributed facilities, the regulatory framework, relevant standards and architecture concepts of energy management systems and will be able to apply this knowledge. **Professional competence** The students: • develop and evaluate IT-architectures for energy management systems • model objects of this domain appropriately • model energy information systems • realise and differentiate advanced tasks of decentralised energy management systems **Methodological competence** The students: • identify problems of energy management, analyse these problems systematically and provide solutions • apply different simulation approaches of decentralised plants and consumers **Social competence** The students: • discuss solutions for energy management systems in the group • develop use cases in teams • present self-developed solutions **Self-competence** The students: • reflect their actions with regard to structuring and decomposing systems • reflect their own use of power as a limited resource
Module contents	This module provides the computer science basics for energy management. It provides the requirements of energy supply information systems with the focus on technical components and the requirements of decentralised and renewable energy plants. These are: • Architectures for energy information systems, e.g. SOA, Seamless Integration Architecture (IEC TC 57), OPC-UA • Norms and standards of energy industry data models (CIM, 61850) • Systematisation of energy information system requirements based on ontologies • Development, analysis and adaption of energy industry reference models and processes • Methods and technologies to support energy industry processes • Methods and algorithms to support decision processes of the decentralised energy plants control • Smart Grid plant communication, particularly for load management • Methods for modelling and simulation of power supply system dynamics

Reader's advisory

- Crastan V.: "Elektrische Energieversorgung II", Springer 2004
- Heuck K., Dettman K. D., Schulz D.: "Elektische Energieversorgung I", 7. Aufl., Vieweg 2007
- Konstantin, P.: "Praxisbuch Energiewirtschaft", Springer 2006
- Schwab, A.: "Elektroenergiesysteme, Springer 2009

Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Modullevel	AS (Akzentsetzung / Accentuation)
Modulart	je nach Studiengang Pflicht oder Wahlpflicht
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the semester	Student research project or presentation

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	WiSe	28 h
Seminar		2.00	WiSe	28 h
Total time of attendance for the module				56 h

inf511 - Smart Grid Management

Module label	Smart Grid Management
Module code	inf511
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik • Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies • Master's Programme Environmental Modelling (Master) > Mastermodule • Master's Programme Postgraduate Programme Renewable Energy (Master) > Mastermodule
Contact person	Module responsibility ◦ Sebastian Lehnhoff ◦ Die im Modul Lehrenden Authorized examiners ◦ Sebastian Lehnhoff ◦ Die im Modul Lehrenden
Entry requirements	
Skills to be acquired in this module	After successful completion of the course the students should be able to understand the existing structures and technical basis of energy systems to produce, transfer and distribute electricity and their interaction and dependency on each other. They should have developed an understanding for necessary IT- and process control technology components, methods and processes to control and operate electrical energy systems. The students are able to estimate and evaluate the requirements and challenges of ICT and computer science which are caused by the development and integration of unforeseable fluctuations of decentralised plants. The students will be able to estimate the influence of distributed control concepts and algorithms for decentralised plants and consumers in the so called Smart Grid energy systems. Regarding the requirements the students will be able to analyse the safety, reliability, realtime capability and flexibility of Smart Grid energy systems. **Professional competence** The students: • understand the existing structures and the technical basis of energy systems producing, transferring and distributing electricity and their interaction and dependency on each other. • develop an understanding for necessary IT- and process control technology components, methods and processes to control and operate electrical energy systems. • estimate and evaluate the requirements and challenges of ICT and computer science which are caused by the development and integration of unforeseeable fluctuations of decentralised plants. • estimate the influence of distributed control concepts and algorithms for decentralised plants and consumers in the so called Smart Grid energy systems. **Methodological competence** The students: • analyse the safety, reliability, realtime capability and flexibility of Smart Grid energy systems • use advanced mathemtical methods to calculate networks **Social competence** The students: • create solutions in small teams • discuss their solutions **Self-competence** The students: • reflect their own use of electricity as a limited resource
Module contents	Content of the Module: In this course information technology, economical energy industry and technical basic knowledge and methods are analysed by using concrete Smart Grid approaches. The basic calculation methods for an intelligent grid management are introduced. This module deals with the technical and economical framework for a permissable electrical network as well as

mathematical modelling and calculation methods to analyse conditions of electrical energy networks (in stationary conditions).
These are:

- The organisation of the EU energy market (regulatory framework, responsibility in liberalisation of electrical energy systems)
- Establishment and operation of electrical energy supply networks (network topology, statutory duties of supply, supply quality/system services, malfunctions and protection systems)
- Network calculation (complex vector representation, effective/idle power, mathematical performance models/net model, transformation: node performance to node voltage and electricity, calculation of conductive current, current flow, fix-point-iteration, Newton-Raphson-Method, voltage drop, transformer model)

- Intelligent network management (Smart Grids), aggregation forms, machine learning approaches)

Reader's advisory	**Suggested reading:**

- Crastan V.: "Elektrische Energieversorgung II", Springer 2004
- Heuck K., Dettman K. D., Schulz D.: "Elektische Energieversorgung I", 7. Aufl., Vieweg 2007
- Konstantin, P.: "Praxisbuch Energiewirtschaft", Springer 2006
- Schwab, A.: "Elektroenergiesysteme, Springer 2009

Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Modullevel	AS (Akzentsetzung / Accentuation)
Modulart	je nach Studiengang Pflicht oder Wahlpflicht
Lern-/Lehrform / Type of program	V+Ü
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the semester	Oral exam

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		3.00	SuSe	42 h
Exercises		1.00	SuSe	14 h
Total time of attendance for the module				56 h

phy605 - Digital Signal Processing

Module label	Digital Signal Processing
Module code	phy605
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Simon Doclo
Entry requirements	Students should have acquired basic knowledge about continuous-time and discrete-time signal processing and system theory.
Skills to be acquired in this module	Vermittlung der theoretischen Methoden der digitalen Signal- und Systemdarstellung bis hin zu modernen Verfahren und Optimalsystemen zur Verarbeitung stochastischer Prozesse. Vertiefung des Vorlesungsstoffes in analytischen, numerischen und Programmierübungen. Nach Abschluss des Moduls beherrschen die Studierende moderne Signalverarbeitungsmethoden und können die gelernten Methoden zur Analyse akustischer Systeme und zur Erklärung der Funktionsweise signalverarbeitender Systeme einsetzen.
Module contents	Grundlagen der diskreten und integralen Signalrepräsentation (Eigenfunktionen), Abtastung, Signaltransformationen (Fourier-Transformation, Diskrete Fourier- Transformation, FFT, z-Transformation), Systemeigenschaften (Linearität, Zeitinvarianz, Stabilität, Kausalität), Methoden zur Beschreibung und Analyse von digitalen Systemen im Zeit- und Frequenzbereich (Impulsantwort, Übertragungsfunktion), stochastische Prozesse und lineare Systeme, digitale Filter, Optimalfilter, Adaptive Filter im Zeit- und Frequenzbereich
Reader's advisory	B. Girod, R. Rabenstein, A. Stenger, Signals and Systems, Wiley, 2001; J. G. Proakis, D. G. Manolakis, Digital Signal Processing - Principles, Algorithms and Applications, Prentice Hall, 2007; A. V. Oppenheim, R. W. Schafer, Discrete-Time Signal Processing, Prentice Hall, 2009; S. Haykin, Adaptive Filter Theory, Prentice Hall, 2001.
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week; Exersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy609 - Photovoltaic Physics

Module label	Photovoltaic Physics
Module code	phy609
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Martin Kühn
Entry requirements	Solid-state-Pysics, semi-conductor Physics, Module Renewable Energy Technologies I
Skills to be acquired in this module	describe schematically the events around the pn-junction under bias in the dark and under illumination, calculate the width of the space charge region, use solar cell data sheets in their professional career, discuss the concepts of solar cell materials, design and optimization, choose a PV technology for a given project
Module contents	This specialization module covers the physics of photovoltaics. The behaviour of solar cells is discussed from a fundamental physical point of view to explain the differences in performance and limits of various photovoltaic materials. Students learn how solar cells function, are designed and optimized, Optical and electronical properties of semiconductors, light absorption, Charge carrier generation/recombination/life time, Charge carrier transport across the pn-junction in equilibrium and under light and voltage bias, Transport equations, Current-voltage characteristics, efficiency, Quantum efficiency, Design concepts to optimize the efficiency, Overview of the most important PV technologies
Reader's advisory	S. Hegedus, A. Luque, Handbook of Photovoltaic Science and Engineering, published John Wiley and Sons (2nd Edition 2011); Christiana Honsberg and Stuart Bowden, PVCDROM, http://www.pveducation.org/pvcdrom/instructions, Access date 2.10.2014; lecture notes for the respective courses
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 4 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		1 Exam

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy616 - Computational Fluid Dynamics 1 / 2

Module label	Computational Fluid Dynamics 1 / 2
Module code	phy616
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master • Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Martin Kühn
Entry requirements	
Skills to be acquired in this module	Deeper understanding of the fundamental equations of fluid dynamics. Overview of numerical methods for the solution of the fundamental equations of fluid dynamics. Confrontation with complex problems in fluiddynamics. To become acquainted with different, widely used CFD models that are used to study complex problems in fluid dynamics. Ability to apply these CFD models to certain defined problems and to critically evaluate the results of numerical models.
Module contents	CFD I: The Navier-Stokes equations, filtering / averaging of Navier- Stokes equations, introduction to numerical methods, finite- differences, finite-volume methods, linear equation systems, NS-solvers, RANS, URANS, LES, DNS, turbulent flows, incompressible flows, compressible flows, efficiency and accuracy. CFD II: Introduction to different CFD models, such as OpenFOAM and PALM. Application of these CFD models to defined problems from rotor aerodynamics and the atmospheric boundary layer.
Reader's advisory	J.H. Ferziger, M. Peric, Computational Methods for Fluid Dynamics, Springer, 2002; C. Hirsch, Numerical Computation of Internal and External Flows: Introduction to the Fundamentals of CFD, Vol 1: Fundamentals of Computational Fluid Dynamics, 2nd edition, Butterworth-Heinemann, Amsterdam; P. Sagaut, Large Eddy Simulation for Incompressible Flows, Springer, Berlin, 1998; J. Fröhlich, Large Eddy Simulationen turbulenter Strömungen, Teubner, Wiesbaden, 2006 (in German)
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	Lecture: 2hrs/week, Excersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		• 1 Klausur oder • 1 Referat oder • 1 mündliche Prüfung oder • 1 fachpraktische Übung

Course type	VA-Auswahl (Vorlesungen oder Praktikum oder Seminar)
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy641 - Energy Ressources & Systems

Module label	Energy Ressources & Systems
Module code	phy641
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self-study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Detlev Heinemann
Entry requirements	
Skills to be acquired in this module	After successful completion of the module students should be able to: • characterize the global energy system and analyze the structure and constraints of today's energy system, • explain the availability and connection between solar and wind energy, • identify the problems and challenges of energy supply due to uctuating energy resources with varying and seasonal load profiles, • relate the solar irradiance conversion process as well as the atmospheric radiation balance of the earth to Wind Energy Meteorology.
Module contents	This module will give an overview on the global energy system and the challenges of energy supply due to uctuating energy resources with varying and seasonal load profiles. Energy Meteorology (Lecture - 90 h workload) Section I: Solar Irradiance • Radiation laws, • Solar geometry, • Interaction of solar irradiance with the atmosphere, • Radiation climatology, • Solar radiation model, • Statistical properties of solar irradiance, • Measuring devices to ascertain solar radiation balance, • Satellite-supported data acquisition to assess solar irradiance, Section II: Wind Flow • Origin and potential of atmospheric energy movements, Heat balance of the atmosphere, • Physical laws of atmospheric flow, • Wind circulation in the atmosphere, local winds, • Wind flow in atmospheric layers (vertical structure, Ekman Layer), • Assessment of wind potential (European Wind Atlas: model, concept, • Wind Measurements, Energy Systems (Lecture - 90 h workload) • Definitions, separation electrical - thermal energy use, • Resources and reserves, • Energy system analysis: Efficiencies at various levels of the energy chain; Exergy analysis, • Energy scenarios, • Climate change, • Advanced (power plant) technologies for conventional fuels, • Electric power systems with large shares of renewables
Reader's advisory	Energy Meteorology: • IEA Word Energy Outlook (http://wordenergyoutlook.org/) • Iqbal, M. 1984: An Introduction to Solar Radiation, Academic Press, Toronto • Liou, K.-N. 2002: An Introduction to Atmospheric Radiation, Academic Press: 2nd edition, Page 2 of 39 • Peixoto, J.P. and Oort A.H. 2007: Physics of Climate Book, Surge Publishing • Rasmussen, B. 1988: Wind Energy, 2, Routledge: 1st edition • Sathyajith, M. 2006: Wind energy: fundamentals, resource analysis and economics, Springer • Stull, R.B. 1988: An Introduction to Boundary Layer Meteorology, Springer 1st edition Energy Systems:

- Ramage, J.: Energy: A Guide Book (Oxford University Press, 1997)
- Boyle, G. et al. (Eds.): Energy Systems and Sustainability (Oxford University Press, 2003)
- Blok, K.: Introduction to Energy Analysis (Techne Press, Amsterdam, 2007)
- Houghton, J.: Global Warming: The Complete Briefing, 5th Ed. (Cambridge University Press, 2015)
- UNDP (Ed.): World Energy Assessment: Energy and the Challenge of Sustainability (2000/2004), http://www.undp.org/energy/weapub2000.htm
- GEA: Global Energy Assessment { Toward a Sustainable Future (Cambridge University Press and International Institute for Applied System Analysis, Laxenburg, 2012), www.iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/Chapters_Home.en.html
- Goldemberg, J. et al.: Energy for a Sustainable World (Wiley Eastern, 1988)
- Nakicenovic, N., A. Grübler and A. McDonald (Eds.): Global Energy Perspectives (Cambridge University Press, Cambridge, 1998)
- Khartchenko, N.V.: Advanced Energy Systems (Taylor and Francis, 1998)
- IEA (International Energy Agency): World Energy Statistics and Balances 2015
- BP: Statistical Review of World Energy 2016 (http://www.bp.com/en/global/corporate/

energy-economics.html)

- EIA: International Energy Outlook 2016 (www.eia.doe.gov/forecasts/ieo/)
- United Nations: 2013 Energy Statistics Yearbook (2016) (unstats.un.org/unsd/energy/yearbook/)

Links		
Language of instruction	English	
Duration (semesters)	1 Semester	
Module frequency	Wintersemester	
Module capacity	unlimited	
Modullevel	MM (Mastermodul / Master module)	
Modulart	Wahlpflicht / Elective	
Lern-/Lehrform / Type of program	each Lecture: 2hrs/week	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		KL
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy642 - Renewable Energy Technologies I for Engineering Physics

Module label	Renewable Energy Technologies I for Engineering Physics
Module code	phy642
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Hans-Gerhard Holtorf
Entry requirements	
Skills to be acquired in this module	After successful completion of the module students should be able to: critically evaluate and compare relevant Renewable Energy conversion processes and technologies: photovoltaics, fuel cells and storage critically appraise various electrochemical storage processes and the respective storage techniques analyse various system components and their interconnections within a complex Renewable Energy supply system.
Module contents	This module will give an overview over a selection of the major renewable energy technologies and some possibilities of their storage. The focus is on the scientific principles of components and the technical description of the components. Further detailed system analysis will be presented in other modules. Physics of PV: • Basic and most important properties of solar radiation related to photovoltaics • PV cells basics: Fundamental physical processes in photovoltaic materials • Characterisation and basic modelling of solar cells Component Description: • PV generator • Charge controller • Inverter • Balance of system components System Description • Grid Connected System • Stand Alone System Fuel Cells and Energy Storage (Lecture - 90 h workload) • Fundamentals of electrochemistry and thermodynamics, energy and environmental balances • Basics of hydrogen production - starting materials, processes, efficiencies, environmental impacts • Basics of fuel cells function, materials, construction, systems, applications • Fundamental setup of most common battery types • Fundamental chemical reactions in these batteries • Operational characteristics, weir processes and service lives of these batteries
Reader's advisory	Photovoltaics • Green, Martin A., 1981: Solar cells : operating principles, technology and system applications, Prentice Hall, • Green, M.A., 2007: Third Generation Photovoltaics, Advanced Solar Energy Conversion, Springer Series in Photonics, • Markvart, Tom and Castaner, Luis, 2003: Practical Handbook of Photovoltaics, Fundamentals and Applications, Elsevier Science, • Nelson, Jenny, 2003: The Physics of Solar Cells (Properties of Semiconductor Materials), Imperial College Press, • Stuart R. Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish (Edit.), 2007: Applied Photovoltaics, Earthscan Publications Ltd., • Twidell, John and Weir, Toni, 2005: Renewable Energy Resources Taylor and Francis. Fuel Cells and Energy Storage • Larminie/Dicks: Fuel Cells Systems Explained, 2000, (Wiley, 2000, ISBN 0-471-49026-1), • EG and G Services, Parsons Inc.: Fuel Cell Handbook, (DE-AM26-99FT40575, 7th Edition, 2005; www. fuelcells.org/fchandbook.pdf),

- G. Hoogers (Ed.): Fuel Cell Technology Handbook, (CRC Press, Boca Raton/London, 2003, ISBN 0-8493-0877-1),
- C.-J. Winter/J. Nitsch: Hydrogen as an Energy Carrier (Springer-Verlag, Heidelberg/N.Y., 1985, ISBN 0-387- 18896-7/3-540-18896-7),
- O'Hayre/Cha/Colella/Prinz: Fuel Cell Fundamentals, (Wiley, 2009, 2nd ed., IBSN 978-0-470-25843-9),
- C.H. Hamann, A. Hammett, W. Vielstich, Electrochemistry, 2nd Ed. Wiley, Weinheim 2007,
- D. Pletcher, A First Course in Electrode Processes. The Electrochemical Consultancy, 1991,
- A.J. Bard, L.R. Faulkner, Electrochemical Methods, Fundamentals and Applications. 2. Ed., Wiley, 2001,
- M. Winter, R.J. Brodd; What are Batteries, Fuel Cells and Supercapacitors? in Chem. Rev. 2004, Vol. 104, pp. 4245-4269,
- A.J. Bard, G. Inzelt, F. Scholz (Eds.) Electrochemical Dictionary. 2. Au . Springer, Berlin 2012 (Available as an eBook, very good explanation in English), Page 7 of 39,
- Fischer, W. (1996). Stationary lead-acid batteries - an introductory handbook. Brilon, Germany: Hoppecke.

Links		
Language of instruction	English	
Duration (semesters)	1 Semester	
Module frequency	Wintersemester	
Module capacity	unlimited	
Modullevel	MM (Mastermodul / Master module)	
Modulart	Wahlpflicht / Elective	
Lern-/Lehrform / Type of program	each lecture: 2 hrs/week	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		written exam
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy643 - Renewable Energy Technologies II for Engineering Physics

Module label	Renewable Energy Technologies II for Engineering Physics
Module code	phy643
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Herena Torio
Entry requirements	
Skills to be acquired in this module	After successful completion of the module students should be able to: • critically evaluate and compare major Renewable Energy conversion processes and technologies in solar thermal energy and biomass energy, • analyze various system components and their interconnections within a complex Renewable Energy supply system, • evaluate the Renewable Energy supply systems' operational size and efficiency, • critically evaluate non-technical impact and side effects when implementing renewable energy supply systems.
Module contents	Solar Thermal Energy (Seminar and Exercises - 90 h workload) • Assessment of solar thermal ambient parameters: regional global, diffuse, reflected solar radiation on horizontal and on tilted plane, ambient temperature, • Solar thermal collectors, • Solar thermal heat exchangers, • Solar thermal storages, • Solar thermal systems and their operation, • Characterization of solar thermal systems. Biomass Energy (Lecture - 90 h workload) • Energy mix overview; gas, heat, electricity, Pros and Cons of biomass, • Chemical composition of biomass: sugar, cellulose, starch, fats. Oils, proteins, lignin, • Natural photosynthesis in plants: chemical storage of solar energy; general mechanisms, • Chemistry and Biology (microorganism) of Biogas Technology, • Conversion processes of biomass: classification, main pathways, • Introduction to catalysis used in biomass conversion, • Chemical fuels (chemical energy storage) from biomass, routes to platform chemicals and separation processes, • Technology concepts for bioenergy usage, • Introduction into economical and legal constraints.
Reader's advisory	Biomass Energy • R. Schlögl (Ed.), Chemical Energy Storage, De Gruyter, 2013, ISBN: 978-3-11-026407-4, Chapter 2, Pages 59-133, • D.L. Klass. Biomass for renewable energy, fuels, and chemicals, Chapter 4 Virgin Biomass Production, p. 91ff, • Food and Agriculture Organization of the UN (FAO) http://www.fao.org, • IEA Energy Technology Essentials - Biomass for Power Generation and CHP. http://www.iea.org/techno/essentials3.pdf, • R.A. Houghton, Forest Hall, and Scott J. Goetz. Importance of biomass in the global carbon cycle J. Geophys.Res., 114, 2009, • Schlögl, Robert (2013). Chemical energy storage (Elektronische Ressource] ed.). Berlin [u.a.]: De Gruyter., • Twidell and Weir. Renewable Energy Resources, Chapter 10, http://www.4shared.com/document/HpYwRDPy/Renewable_Energy_Resources_2nd.html,- Wheildon`s 2013, http://www.wheildons.co.uk/ wp-content/uploads/2013/07/carbon-neutral.jpg,

- Waste-to-Energy Research and Technology Council(WtERT), 2009, http://www.wtert.eu/default.asp?

Menue=13&ShowDok=12#Hydrolysis,Solar Thermal

- DGS, (2010) Planning and installing solar thermal systems, a guide for installers, architects and engineers, 2nd ed.,
- Duffie JA, Beckman WA (2013) Solar engineering of thermal processes: Wiley,
- Kasper, B., and Antony, F. (2004). Solarthermische Anlagen

Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2 hrs/week and Seminar: 2 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Referat

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Practical		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				112 h

phy644 - Wind Energy Physics, Data & Analysis

Module label	Wind Energy Physics, Data & Analysis
Module code	phy644
Credit points	6.0 KP
Workload	180 h (attendance: 2*28 hrs, self-study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Martin Kühn
Entry requirements	
Skills to be acquired in this module	After successful completion of the module students should be able to: - Evaluate wind energy related measurements, • Interprete such measurements gained in the field of wind energy applications, - Critically evaluate measured data
Module contents	The winter term lecture teaches the basic knowledge in wind energy physics. Physical properties of fluids, wind characterization and anemometers, aerodynamic aspects of wind energy conver sion, dimensional analysis, (pitheorem), and wind turbine performance, design of wind turbines, electrical systems. The sequentially following WPhyMPr adresses problems based on real wind data, which will be solved on at least four important aspects in wind physics. The course will comprise lectures and assignments as well as self-contained work in groups of 3 persons. The content consist of the following four main topics, following the chronological order of the work process: Data handling (measurements, measurement technology, handling of wind data, assessment of measurement artefacts in wind data, preparation of wind data for further processing); Energy Meteorology (geographical distribution of winds, wind regimes on different time and length scales, vertical wind profile, distribution of wind speed, differences between onshore and offshore conditions); Measure - Correlate - Predict (MCP) (averaging of wind data, bin-wise averaging of wind data, long term correlation and long term correction of wind data, sources of long term wind data); LIDAR (analyses and conversion of data from LIDAR measurements
Reader's advisory	
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Sommer- und Wintersemester
Module capacity	unlimited
Reference text	The module starts in the winter term: Wind Energy Phyics has to be taken before participating in Wind Physics Measurement Project
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		1 Exam

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy646 - Wind Physics Student's Lab

Module label	Wind Physics Student's Lab
Module code	phy646
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Martin Kühn
Entry requirements	Basic computer knowledge; mechanics; mathematical methods for physics and engineering; basic knowledge of wind energy utilization; previous knowledge of metrology, basic knowledge of aerodynamics
Skills to be acquired in this module	The "Wind Physics Student's Lab" aims to foster the learning process by own research activities of the students in wind physics and additionally to build up skills for scientific and experimental work and scientific writing. Therefore, this course is also intended as preparation for the master thesis. The course is organized as seminar with integrated work in the laboratory. The students will investigate an individual, self-formulated research question and will be guided by the supervisors through the research-based learning process. The work in groups and discussion of solutions aims to improve skills in team working. In order to introduce the students to current wind energy research, the course is offered in three versions. These versions represent the work of the three research groups at ForWind - University Oldenburg.
Module contents	Content of Wind2Grid-Seminar The seminar consists of three main phases with different learning steps: 1st phase: Class-room seminar building up basic competences identification of the technical tasks introduction to current research introduction to the learning platform investigating standard situations and functional interaction by means of the experimental system defining an own research question defining an experimental strategy planning the experiment 2nd phase: Laboratory work (1 week) set-up, execution, data acquisition and decommissioning of the experiment 3rd phase: Evaluation and documentation evaluating the experiment documentation with a short report (paper) presentation The seminar "Wind turbine rotor in turbulent inflow" is connected to the scientific work of the research group Turbulence, Wind Energy and Stochastics (TWIST). In this seminar, turbulent wind fields and their effects on wind turbines will be investigated. Students learn how turbulence can be described, investigated and evaluated for different purposes. The students gain a deep understanding of the phenomenon of turbulence. They learn to work with measured data from the open field and perform own experiments with an active turbulence grid and a model of a wind turbine in a turbulent wind tunnel. They learn to establish their own research questions and are encouraged to develop own methods. The seminar consists of three main phases with different learning steps: 1st phase: Class-room seminar - building up basic competences - identification of the technical and/or scientific tasks - introduction to current research - introduction to the experiment related to the seminar • investigating standard situations and functional interaction by means of the experimental system • defining own research questions • defining an experimental strategy • planning the experiment 2nd phase: Laboratory work • set-up, execution, data acquisition and decommissioning of the experiment 3rd phase: Evaluation and documentation • evaluating the experiment • documentation with a short report (paper) • presentation

Reader's advisory	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, 9th Ed., 2016, Springer + Vieweg; ISBN: 978-3-658-12360-4 German Language: CEwind eG / Alois Schaffarczyk, Einführung in die Windenergietechnik; 1st Ed. 2012, Carl Hanser Verlag, Munich English Language: Erich Hau, Wind Turbines: Fundamentals, Technologies, Application, Economics, 3rd Ed., 2013, Springer-Verlag; ISBN 978-3-642-27151-9 German Language: Erich Hau, Windkraftanlagen. Grundlagen, Technik, Einsatz, Wirtschaftlichkeit. 5th Ed., 2014, Springer-Verlag; ISBN: 978-3-642-28877-7
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Sommer- und Wintersemester
Module capacity	unlimited
Reference text	Each seminar offered within the module holds for 6 credit points. Thus, students have to register for only one of the offered seminars within the module.
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Seminar with laboratory experiments for research oriented learning / Seminar mit Blockpraktikum zum forschungsbasierten Lernen: 4 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Portfolio

Course type	Seminar
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy647 - Future Power Supply Systems

Module label	Future Power Supply Systems
Module code	phy647
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Carsten Agert
Entry requirements	Knowledge from module RE technology I, Mathematics
Skills to be acquired in this module	After successful completion of the module students should be able to • explain the management, power balancing and the provision of ancillary services within future electricity grid configurations with high shares of fluctuating and distributed generation • perform power system simulation with related software tools • describe different grid-designs, including mini- and microgrids • compare different markets for electricity (Futures' Market, Day-Ahead-Market, Intraday-Market, Balancing Power Market, Self-Consumption) and assess the suitability of these concepts for promoting the implementation of higher shares of fluctuating distributed power generation within the electricity grid. • explain the technical principles and resulting limiting factors of concepts and components required for power control within \Smart City", \Smart Grid", and \Smart Home" concepts
Module contents	Future Power Supply Systems: • Technology and characteristics of conventional power plants based e. g. on coal, gas, and nuclear, • Fundamentals, structure, technologies and operation of (AC-) electricity grids (incl. balancing power, voltage management, etc.), • Fluctuating distributed generation: Characteristics and solutions on the transmission and distribution grid levels, incl. storage, vehicle-to-grid-concepts, smart inverters, heat pumps / CHP, etc, • Interactions between technology and economics: The different electricity markets (Futures Market, Day-Ahead-Market, Intraday-Market, Balancing Power Market, Self-Consumption) and their links to the physical world, - \Smart City", \Smart Grid", \Smart Home", - Mini- and Micro-Grids, • Energy scenarios and modelling, • Chemical energy carriers in the energy system: power-togas (e.g. methane) and power-to-liquids (e.g.methanol)
Reader's advisory	Future Power Supply Systems: Buchholz, B.M., Styczynski Z. (2014). Smart Grids - Fundamentals and Technologies in Electricity Networks. Springer Ed., Khartchenko, N. et al. (2013). Advanced Energy Systems, Second Edition (Energy Technology). CRC Press Inc. Hemami, A. (2015). Electricity and Electronics for Renewable Energy Technology: An Introduction (Power Electronics and Applications) CRC Press, Schlögl, R. (2013) Ed., Chemical Energy Storage, De Gruyter
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture and Seminar: 4 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Report (presentation: 50 min, Term-paper: 5 pp.) or Exercises (8 Exercises). In addition, active participation is required. The criteria to fulfil the requirement of the active participation are announced at the beginning of the term.

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy648 - Wind Resources and its Applications

Module label	Wind Resources and its Applications
Module code	phy648
Credit points	6.0 KP
Workload	180 h (Attendance: 72 hrs, Self study: 108 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Martin Kühn
Entry requirements	Knowledge in Basics Wind Energy, Fluid Dynamics I, Matlab
Skills to be acquired in this module	assess different aspects of wind energy farms by modelling, comparison, explanation of wind energy potential, wind energy farm's output, power curves, wind energy project development, assess in detail in uences of meteorological/ climatological aspects on the performance of wind power systems, summarize physical processes governing atmospheric wind flows, value atmospheric boundary layer flow relevant for wind power conversion, argue methods for wind resource assessment and forecasting
Module contents	Advanced Wind Energy Meteorology (Lecture -90 h workload) Atmospheric Boundary Layer (turbulence, vertical structure, special BL effects) Atmospheric Flow Modelling: Linear models, RANS and LES models Wind farm modelling Offshore-Specific Conditions Resource Assessment and Wind Power Forecasting Wind Measurements and Statistics Wind Energy Applications - from Wind Resource to Wind Farm Operations (Lecture - 90 h workload) Evaluation of Wind Resources Weibull Distribution Wind velocity measurements to determine energy yield Basics of Wind Atlas Analysis and Application Program (WAsP) Method, Partial models using WAsP Measure-Correlate-Predict (MCP) Method of long term corrections of wind measurement data in correlation to long term reference data Conditions for stable, neutral and instable atmospheric conditions Wind yield from wind distribution and the power curve Basics in appraising the yearly wind yield from a wind turbine. Wake Effect and Wind Farm Recovery of original wind fields in the downstream of wind turbines Basics of Riso Models Spacing and effciency in wind farms Positive and Negative Effects of Wind Farms Wind Farm Business Income from the energy yield from wind farms Profit optimization by increase of energy production Wind farm project development Wind farm operation and Surveillance of power production vs. wind climate, power curves, and turbine availability
Reader's advisory	Advanced Wind Energy Meteorology Holton, J.R. and G. J. Hakim, 2013: An Introduction to Dynamic Meteorology, 5th Edition, Academic Press, New York Stull, R.B., 1988: An Introduction to Boundary Layer Meteorology. Kluwer Academic Pub. Wind Energy Applications - from Wind Resource to Wind Farm Operations Burton, T., N. Jenkins, D. Sharpe and E. Bossanyi, 2011: Wind Energy Handbook, Second Edition, John Wiley. Gasch, R. and J. Twele, 2012: Wind Power Plants: Fundamentals, Design, Construction and Operation; Second Edition, Springer http://www.av8n.com/how/htm/airfoils.html, Last access: 4/2016 http://www.windpower.org/en/, Last access: 4/2016
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 4 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		1 Exam
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy649 - Design of Wind Energy Systems

Module label	Design of Wind Energy Systems
Module code	phy649
Credit points	6.0 KP
Workload	180 h (Attendance: 72 hrs, Self study: 108 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Martin Kühn
Entry requirements	Basics in Wind Energy Utilisation
Skills to be acquired in this module	Design of Wind Energy Systems: The students attending the course will have the possibility to expand and sharpen of their knowledge about wind turbine design from the basic courses. The lectures include topics covering the whole spectrum from early design phase to the operation of a wind turbine. Students will learn in exercises how to calculate and evaluate design aspects of wind energy converters. At the end of the lecture, they should be able to: estimate the site specific energy yield, calculate the aerodynamics of wind turbines using the blade element momentum theory, model wind fields to obtain specfic design situations for wind turbines, estimate the influence of dynamics of a wind turbine, especially in the context of fatigue loads, transfer their knowledge to more complex topics such as simulation and measurements of dynamic loads, calculate the economic aspects of wind turbine Aeroelastic Simulation of Wind turbines: student who has met the objectives of the course will be able to: understand the basic concept of an aero-servo-elastic computer code to determine the unsteady aerodynamic loads, derive and validate the required parameters to model the aero-hydro-elastic response of a wind turbine, identify and interpret the required empirical parameters to correct the blade element momentum (BEM) method with respect to dynamic in flow, unsteady airfoil aerodynamics (dynamic stall), yawed flow, dynamic wake modeling, explain the effects of the different models on the resulting time series and validate the code, interpret design standards for on- and offshore wind turbines, select the required load cases according to sitespecific environmental data, identify the dimensioning load cases and calculate design loads for different main components of a wind turbine.
Module contents	Design of Wind Energy Systems Introduction to industrial wind turbine design, rotor aerodynamics and Blade Element Momentum (BEM) theory, dynamic loading and system dynamics, wind field modelling for fatigue and extreme event loading, design loads and design aspects of onshore wind turbines, simulation and measurements of dynamic loads, design of offshore wind turbines, power quality and grid integration on wind turbines. Aeroelastic Simulation of Wind turbines: The course focuses on the practical implications and handson experience of the aero-hydro-servo-elastic modelling and simulation of wind turbines. The subjects are similar but the treatment is complementary to the parallel course `Design of Wind Energy Systems', which deals with the underlying theoretical background: advanced wind field modelling for fatigue and extreme event loading, modelling of wind farm flow and wake effects, rotor aerodynamics (e.g. stationary or dynamic effects, comparison of Blade Element Momentum theory and more advanced methods like free vortex methods or CFD), structural dynamics and dynamic modelling of wind turbine structures (modelling by ordinary or partial differential equations, stochastics, multi body system modelling), advanced control of wind turbines, design standards, design loads and design aspects of off-shore and onshore wind turbines. The students analyse in pairs a model of an entire wind turbine with the aid of a typical wind turbine design tool like GH Bladed, Flex5 or Aerodyn/FAST.
Reader's advisory	T. Burton et. al.: Wind Energy Handbook. John Wiley, New York, 2nd ed., 2011; R. Gasch, J. Twele: Wind Power Plants. Springer, Berlin, 2nd ed., 2011.; Garrad Hassan, Bladed, Wind Turbine Design Software, Theory Manual; Selected papers from e.g. Wind Energy Journal, Wiley Interscience
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture and seminar: 2 and 2 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Exam or presentation or oral exam or homework or practical report

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy687 - Advanced Engineering Topics in Renewable Energies

Module label	Advanced Engineering Topics in Renewable Energies
Module code	phy687
Credit points	6.0 KP
Workload	180 h (Overall workload of 180 h)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Martin Kühn
Entry requirements	Related to selected course/s
Skills to be acquired in this module	The aim of this module is, to give students further access to also small courses (3 CP) which address the specific interest of the student and deliver unique in-depth knowledge or the opportunity to train specific engineering skills in the field renewable energy technologies.
Module contents	E.g. metrology, data logging, measurement methodology, construction, monitoring, control engineering, remote sensing.
Reader's advisory	Related to selected course/s
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Sommer- oder Wintersemester
Module capacity	unlimited
Reference text	This module offers special as well as advanced courses in engineering science. The list of eligible courses will be updated each academic year. Please refer to the courses listed for this module in Stud.IP.
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Related to selected course/s
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Related to selected course/s

Course type	Lecture (oder Seminar mit Praktikum) *(Hier ist ein Kommentar)*
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy689 - Advanced Topics in Renewable Energies

Module label	Advanced Topics in Renewable Energies	
Module code	phy689	
Credit points	6.0 KP	
Workload	180 h (Overall workload of 180 h)	
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies	
Contact person	Module responsibility ◦ Walter Neu	
Entry requirements	Related to selected course/s	
Skills to be acquired in this module	The aim of this module is, to give students further access to also small courses (3 CP) which address the specific interest of the student and deliver unique in-depth knowledge or the opportunity to train specific engineering skills.	
Module contents	Photonics, Optics, Metrology	
Reader's advisory	Related to selected course/s	
Links		
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency	Sommer- oder Wintersemester	
Module capacity	unlimited	
Modullevel	MM (Mastermodul / Master module)	
Modulart	Wahlpflicht / Elective	
Lern-/Lehrform / Type of program	Related to selected course/s	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		Related to selected course/s
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy699 - Photovoltaics Systems & Energy Meteorology

Module label	Photovoltaics Systems & Energy Meteorology
Module code	phy699
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Hans-Gerhard Holtorf
Entry requirements	Basic knowledge of solar radiation and solar resources phy642 Renewable Energy Technologies I
Skills to be acquired in this module	After successful completion of the module students should be able to: • explain the concepts of physical processes governing the surface solar irradiance available for solar energy applications • model the solar radiation and show their expertise in application, adaptation and development of models • discuss state-of-the-art-methods in satellite-based irradiance estimation and solar power forecasting • categorize and feature different PV systems (PV on-grid, PV off-grid, PV pumping, PV-hybrid) • explain concepts behind PV system design • explain the operation principles of PV systems
Module contents	This specialization module covers more in-depth topics concerning photovoltaic systems and solar energy meteorology. Based on their knowledge about the solar resource and photovoltaic technology, students learn to design a photovoltaic system for various environmental conditions and predict its performance. I. Adv. Solar Energy Meteorology (Lecture - 90 h workload) • Physics of radiative processes in the atmosphere • Physical modelling of atmospheric radiative transfer (incl. computing tools) • Solar irradiance modelling for solar energy applications • Solar spectral irradiance: Theory and relevance for solar energy systems • Satellite-based estimation of solar irradiance • Solar irradiance (and solar power) forecasting • Solar radiation measurements: Basics and setup of highquality measurement system II. Photovoltaic Systems (Lecture - 90 h workload) • Detailed description of involved balance of system components (e.g. inverter, charge controllers) • System Operation • Detailed System Design -from meteorological input across component rating to energy service output
Reader's advisory	S. Hegedus, A. Luque, Handbook of Photovoltaic Science and Engineering, published John Wiley and Sons (2nd Edition 2011) Christiana Honsberg and Stuart Bowden, PVCDROM,http://www.pveducation.org/pvcdrom/instructions, Access date 2.10.2014 Deutsche Gesellschaft fuer Solarenergie, Planning and installing photovoltaic systems: a guide for installers, architects and engineers. Earthscan, London, Third Edition, 2013 (ISBN-13: 978-1849713436)
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 4 hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Passing of the written exam in Solar Energy Meteorology (120 min). Active participation in

Examination	Time of examination	Type of examination
		Photovoltaic Systems. The specific conditions of the active participation will be communicated in the beginning of the semester.

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy984 - Semiconducting Materials for Solar Energy

Module label	Semiconducting Materials for Solar Energy		
Module code	phy984		
Credit points	6.0 KP		
Workload	180 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	EB (Ergänzungsbereich / Complementary)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Seminar		
SWS	2.00		
Frequency	SuSe or WiSe		
Workload attendance	28 h		

phy987 - Control of Wind Turbines and Wind Farms

Module label	Control of Wind Turbines and Wind Farms
Module code	phy987
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	EB (Ergänzungsbereich / Complementary)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

European Wind Energy Master

phy616 - Computational Fluid Dynamics 1 / 2

Module label	Computational Fluid Dynamics 1 / 2
Module code	phy616
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master • Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Martin Kühn
Entry requirements	
Skills to be acquired in this module	Deeper understanding of the fundamental equations of fluid dynamics. Overview of numerical methods for the solution of the fundamental equations of fluid dynamics. Confrontation with complex problems in fluiddynamics. To become acquainted with different, widely used CFD models that are used to study complex problems in fluid dynamics. Ability to apply these CFD models to certain defined problems and to critically evaluate the results of numerical models.
Module contents	CFD I: The Navier-Stokes equations, filtering / averaging of Navier- Stokes equations, introduction to numerical methods, finite- differences, finite-volume methods, linear equation systems, NS-solvers, RANS, URANS, LES, DNS, turbulent flows, incompressible flows, compressible flows, efficiency and accuracy. CFD II: Introduction to different CFD models, such as OpenFOAM and PALM. Application of these CFD models to defined problems from rotor aerodynamics and the atmospheric boundary layer.
Reader's advisory	J.H. Ferziger, M. Peric, Computational Methods for Fluid Dynamics, Springer, 2002; C. Hirsch, Numerical Computation of Internal and External Flows: Introduction to the Fundamentals of CFD, Vol 1: Fundamentals of Computational Fluid Dynamics, 2nd edition, Butterworth-Heinemann, Amsterdam; P. Sagaut, Large Eddy Simulation for Incompressible Flows, Springer, Berlin, 1998; J. Fröhlich, Large Eddy Simulationen turbulenter Strömungen, Teubner, Wiesbaden, 2006 (in German)
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	Lecture: 2hrs/week, Excersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		• 1 Klausur oder • 1 Referat oder • 1 mündliche Prüfung oder • 1 fachpraktische Übung

Course type	VA-Auswahl (Vorlesungen oder Praktikum oder Seminar)
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy640 - Seminar Advanced Topics in EP

Module label	Seminar Advanced Topics in EP
Module code	phy640
Credit points	3.0 KP
Workload	90 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master • Master's Programme Engineering Physics (Master) > Pflichtmodule
Contact person	Module responsibility ◦ Walter Neu ◦ Sandra Koch
Entry requirements	Participation: 1st -3rd semester. Presentation: Master thesis work in progress or finished; at least one successfully completed specialization module.
Skills to be acquired in this module	The students are enabled to demonstrate the ability to communicate clearly, both orally and in writing, to specialist and non-specialist audiences. Demonstrate knowledge, fundamental understanding and critical awareness of current research fields in the student`s master projects. Personal development through practice of communication, presentation, time management, teamwork, problem solving, project management, critical evaluation, numeracy, and IT skills.
Module contents	Current seminar topics
Reader's advisory	M. Alley: The Craft of Scientific Presentations, Springer, 2nd ed., 2013 Publications according to seminar topics
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel	MM (Mastermodul)
Modulart	Pflicht
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		max 1h oral presentation and written report or oral exam (1 hour and regular active and documented participation in the seminar spread over the first three semesters.

Course type	Seminar
SWS	2.00
Frequency	--
Workload attendance	28 h

phy659 - Introduction to Micro Meteorology

Module label	Introduction to Micro Meteorology
Module code	phy659
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	VA-Auswahl (Das Modul wird an der Patnerhochschule angeboten.)
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy669 - Aeroelastic Simulation of Wind Turbines / Wind Physics Measurement Project

Module label	Aeroelastic Simulation of Wind Turbines / Wind Physics Measurement Project
Module code	phy669
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	Module counceling ◦ Martin Kühn
Entry requirements	Wind Energy Utilization (Bachelor) or Wind Energy (Master), Design of Wind Energy Systems (parallel
Skills to be acquired in this module	A student who has met the objectives of the course will be able to: o understand the basic concept of an aero-servo-elastic computer code to determine the unsteady aerodynamic loads, o derive and validate the required parameters to model the aero-hydro-elastic response of a wind turbine, o identify and interpret the required empirical parameters to correct the blade element momentum (BEM) method with respect to dynamic inflow, unsteady airfoil aerodynamics (dynamic stall), yawed flow, dynamic wake modeling, o explain the effects of the different models on the resulting time series and validate the code, o interpret design standards for on- and offshore wind tur- bines, select the required load cases according to site-specific environmental data, o identify the dimensioning load cases and calculate design loads for different main components of a wind turbine.
Module contents	The course focuses on the practical implications and hands-on experience of the aero-hydro-servo-elastic modelling and simulation of wind turbines. The subjects are similar but the treatment is complementary to the parallel course ‘Design of Wind Energy Systems’, which deals with the underlying theoretical background: o advanced wind field modelling for fatigue and extreme event loading, o modelling of wind farm flow and wake effects, o rotor aerodynamics (e.g. stationary or dynamic effects, comparison of Blade Element Momentum theory and more advanced methods like free vortex methods or CFD), o structural dynamics and dynamic modelling of wind tur- bine structures (modelling by ordinary or partial differential equations, stochastics, multi body system modelling), o advanced control of wind turbines, o design standards, design loads and design aspects of offshore and onshore wind turbines. The students analyse in pairs a model of an entire wind tur- bine with the aid of a typical wind turbine design tool like GH Bladed, Flex5 or Aerodyn/FAST.
Reader's advisory	o T. Burton et. al.: Wind Energy Handbook. John Wiley, New York, 2nd ed., 2011 o R. Gasch, J. Twele: Wind Power Plants. Springer, Berlin, 2nd ed., 2011. o Garrad Hassan, Bladed, Wind Turbine Design Software, Theory Manual o Selected papers from e.g. Wind Energy Journal, Wiley Interscience
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	SE / Ü: 2 SWS
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy670 - Fluiddynamics II/Wind Energy Meterology

Module label	Fluiddynamics II/Wind Energy Meterology
Module code	phy670
Credit points	6.0 KP
Workload	180 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy673 - Diffusions and Stochastic Differential Equations

Module label	Diffusions and Stochastic Differential Equations		
Module code	phy673		
Credit points	5.0 KP		
Workload	150 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Language of instruction	German		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	MM (Mastermodul / Master module)		
Modulart	Pflicht / Mandatory		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Vorlesung und Übung (Das Modul wird an der Patnerhochschule angeboten.)		
SWS	4.00		
Frequency	SuSe or WiSe		
Workload attendance	56 h		

phy674 - Turbulence Theory

Module label	Turbulence Theory
Module code	phy674
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Vorlesung und Übung (Das Modul wird an der Patnerhochschule angeboten.)
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy684 - Wind Turbine Technology and Aerodynamics

Module label	Wind Turbine Technology and Aerodynamics
Module code	phy684
Credit points	10.0 KP
Workload	300 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture (Das Modul wird an der Patnerhochschule angeboten.)		2.00	SuSe or WiSe	28 h
Seminar (Das Modul wird an der Patnerhochschule angeboten.)		2.00	SuSe or WiSe	28 h
Exercises (Das Modul wird an der Patnerhochschule angeboten.)		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				84 h

phy688 - Planning and Development of Wind Farms

Module label	Planning and Development of Wind Farms		
Module code	phy688		
Credit points	5.0 KP		
Workload	150 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Language of instruction	German		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	MM (Mastermodul / Master module)		
Modulart	Pflicht / Mandatory		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	VA-Auswahl (Das Modul wird an der Patnerhochschule angeboten.)		
SWS	4.00		
Frequency	SuSe or WiSe		
Workload attendance	56 h		

phy692 - Research Project EWEM

Module label	Research Project EWEM		
Module code	phy692		
Credit points	9.0 KP		
Workload	270 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Languages of instruction			
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	---		
Modulart	je nach Studiengang Pflicht oder Wahlpflicht		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		BE	
Course type	Seminar		
SWS			
Frequency			
Workload attendance	0 h		

phy991 - Stochastic Processes

Module label	Stochastic Processes
Module code	phy991
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				84 h

phy992 - Time Series Analysis

Module label	Time Series Analysis
Module code	phy992
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy993 - Advanced Time Series Analysis

Module label	Advanced Time Series Analysis
Module code	phy993
Credit points	10.0 KP
Workload	300 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		4.00	SuSe or WiSe	56 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				84 h

phy994 - Optimization and Data Fitting

Module label	Optimization and Data Fitting
Module code	phy994
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Practical		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy995 - Physics of Sustainable Energy

Module label	Physics of Sustainable Energy		
Module code	phy995		
Credit points	5.0 KP		
Workload	150 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Language of instruction	German		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	MM (Mastermodul / Master module)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Lecture		
SWS	4.00		
Frequency	SuSe or WiSe		
Workload attendance	56 h		

phy996 - Offshore Wind Energy

Module label	Offshore Wind Energy
Module code	phy996
Credit points	10.0 KP
Workload	300 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	6.00
Frequency	SuSe or WiSe
Workload attendance	84 h

phy997 - Wind Turbine Measurement Techniques

Module label	Wind Turbine Measurement Techniques		
Module code	phy997		
Credit points	10.0 KP		
Workload	300 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Language of instruction	German		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	MM (Mastermodul / Master module)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Lecture		
SWS	6.00		
Frequency	SuSe or WiSe		
Workload attendance	84 h		

phy998 - Probabilistic Methods in Wind Energy

Module label	Probabilistic Methods in Wind Energy
Module code	phy998
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy621 - Advanced Engineering Topics in Wind Energy

Module label	Advanced Engineering Topics in Wind Energy		
Module code	phy621		
Credit points	5.0 KP		
Workload	150 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	EB (Ergänzungsbereich / Complementary)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	VA-Auswahl		
SWS	2.00		
Frequency	SuSe or WiSe		
Workload attendance	28 h		

phy622 - Advanced Topics in Wind Energy

Module label	Advanced Topics in Wind Energy		
Module code	phy622		
Credit points	5.0 KP		
Workload	150 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Language of instruction	German		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	EB (Ergänzungsbereich / Complementary)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	VA-Auswahl		
SWS	2.00		
Frequency	SuSe or WiSe		
Workload attendance	28 h		

phy645 - Wind Physics Measurement Project

Module label	Wind Physics Measurement Project		
Module code	phy645		
Credit points	3.0 KP		
Workload	90 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	EB (Ergänzungsbereich / Complementary)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Lecture		
SWS	2.00		
Frequency	SuSe or WiSe		
Workload attendance	28 h		

phy985 - Stochastic Processes in Experiments

Module label	Stochastic Processes in Experiments		
Module code	phy985		
Credit points	3.0 KP		
Workload	90 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master		
Contact person			
Entry requirements			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel	EB (Ergänzungsbereich / Complementary)		
Modulart	Wahlpflicht / Elective		
Lern-/Lehrform / Type of program			
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		KL	
Course type	Seminar		
SWS	2.00		
Frequency	SuSe or WiSe		
Workload attendance	28 h		

phy624 - Composite Materials and Fibres

Module label	Composite Materials and Fibres
Module code	phy624
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy627 - Optimization in modern Power Systems

Module label	Optimization in modern Power Systems
Module code	phy627
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy628 - Modelling and Analysis of Sustainable Energy Systems using Operations Research

Module label	Modelling and Analysis of Sustainable Energy Systems using Operations Research
Module code	phy628
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy629 - Optimization in modern Power Systems

Module label	Optimization in modern Power Systems
Module code	phy629
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy657 - Experimental Structural Mechanics

Module label	Experimental Structural Mechanics
Module code	phy657
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy675 - Integration of Wind Power in the Power System

Module label	Integration of Wind Power in the Power System
Module code	phy675
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy981 - HardTech Entrepreneurship

Module label	HardTech Entrepreneurship
Module code	phy981
Credit points	10.0 KP
Workload	300 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy983 - Life Cycle Assessment of Products and Systems

Module label	Life Cycle Assessment of Products and Systems
Module code	phy983
Credit points	10.0 KP
Workload	300 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

phy986 - System Safety and Reliability Engineering

Module label	System Safety and Reliability Engineering
Module code	phy986
Credit points	5.0 KP
Workload	150 h
Used in course of study	• Master's Programme Engineering Physics (Master) > European Wind Energy Master
Contact person	
Entry requirements	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Total time of attendance for the module				56 h

Schwerpunkt: Acoustics

phy605 - Digital Signal Processing

Module label	Digital Signal Processing
Module code	phy605
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Contact person	Module responsibility ◦ Simon Doclo
Entry requirements	Students should have acquired basic knowledge about continuous-time and discrete-time signal processing and system theory.
Skills to be acquired in this module	Vermittlung der theoretischen Methoden der digitalen Signal- und Systemdarstellung bis hin zu modernen Verfahren und Optimalsystemen zur Verarbeitung stochastischer Prozesse. Vertiefung des Vorlesungsstoffes in analytischen, numerischen und Programmierübungen. Nach Abschluss des Moduls beherrschen die Studierende moderne Signalverarbeitungsmethoden und können die gelernten Methoden zur Analyse akustischer Systeme und zur Erklärung der Funktionsweise signalverarbeitender Systeme einsetzen.
Module contents	Grundlagen der diskreten und integralen Signalrepräsentation (Eigenfunktionen), Abtastung, Signaltransformationen (Fourier-Transformation, Diskrete Fourier- Transformation, FFT, z-Transformation), Systemeigenschaften (Linearität, Zeitinvarianz, Stabilität, Kausalität), Methoden zur Beschreibung und Analyse von digitalen Systemen im Zeit- und Frequenzbereich (Impulsantwort, Übertragungsfunktion), stochastische Prozesse und lineare Systeme, digitale Filter, Optimalfilter, Adaptive Filter im Zeit- und Frequenzbereich
Reader's advisory	B. Girod, R. Rabenstein, A. Stenger, Signals and Systems, Wiley, 2001; J. G. Proakis, D. G. Manolakis, Digital Signal Processing - Principles, Algorithms and Applications, Prentice Hall, 2007; A. V. Oppenheim, R. W. Schafer, Discrete-Time Signal Processing, Prentice Hall, 2009; S. Haykin, Adaptive Filter Theory, Prentice Hall, 2001.
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week; Exersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy676 - Acoustical Metrology

Module label	Acoustical Metrology
Module code	phy676
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics
Contact person	Module responsibility ◦ Simon Doclo
Entry requirements	
Skills to be acquired in this module	Fähigkeit, Messunsicherheiten entsprechend GUM berücksichtigen zu können Verständnis fortgeschrittener Verfahren der akustischen Messtechnik mit dem Ziel, diese Verfahren bewerten, implementieren und anwenden zu können.
Module contents	Messunsicherheiten - GUM, Schlecht gestellte Probleme - Regularisierung, Zoom-FFT / hochauflösende Verfahren, Messung von Nichtlinearitäten, spezielle Anwendungen (Messung der Schallintensität, in-situ-Messung von Reflektanz und Absorptionsgrad, akustische Kamera, ...)
Reader's advisory	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week, Exercise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy677 - Speech processing

Module label	Speech processing	
Module code	phy677	
Credit points	6.0 KP	
Workload	180 h	
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics	
Contact person		
Entry requirements		
Skills to be acquired in this module		
Module contents		
Reader's advisory		
Links		
Language of instruction	German	
Duration (semesters)	1 Semester	
Module frequency		
Module capacity	unlimited	
Modullevel	MM (Mastermodul / Master module)	
Modulart	Wahlpflicht / Elective	
Lern-/Lehrform / Type of program		
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		KL
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy678 - Processing and analysis of biomedical data

Module label	Processing and analysis of biomedical data
Module code	phy678
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	Basic signal processing, algebra knowledge
Skills to be acquired in this module	This course introduces basic concepts of statistics and signal processing and applies them to real-world examples of bio-medical data. In the second part of the course, recorded datasets are noise-reduced, analyzed, and discussed in views of which statistical tests and analysis methods are appropriate for the underlying data. The course forms a bridge between theory and application and offers the students the means and tools to set up and analyze their future datasets in a meaningful manner.
Module contents	Normal distributions and significance testing, Monte- Carlo bootstrap techniques, Linear regression, Correlation, Signal-to-noise estimation, Principal component analysis, Confidence intervals, Dipole source analysis, Analysis of variance Each technique is explained, tested and discussed in the exercises.
Reader's advisory	Kirkwood B.R. and Sterne A.C., Essential Medical Statistics: 2nd edition. Blackwell Science. Oxford, 2003; Cho, Z.H. and Singh J. P. J.M.: Foundations of Medical Imaging. John Wiley, New York, 1993; Kutz, J.N. Data-Driven Modeling and Scientific Computation: Methods for complex systems and Big Data. Oxford University Press, Oxford, 2013
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week; Exersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Exam or presentation or oral exam or homework or practical report

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy679 - Acoustics

Module label	Acoustics
Module code	phy679
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Advanced Physics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics
Contact person	Module responsibility ◦ Steven van de Par ◦ Birger Kollmeier ◦ Björn Poppe
Entry requirements	
Skills to be acquired in this module	Die Studierenden erwerben fortgeschrittene der Akustik. Sie erlangen Fertigkeiten zum sicheren und selbstständigen Umgang mit modernen Konzepten und Methoden der Angewandten Physik. Sie erweitern ihre Kompetenzen hinsichtlich der Fähigkeiten zur erfolgreichen Bearbeitung anspruchsvoller Probleme der Angewandten Physik mit modernen experimentellen und numerischen Methoden, zur eigenständigen Erarbeitung von Zugängen zu aktuellen Entwicklungen der Angewandten Physik sowie zum Verständnis übergreifender Konzepte und Methoden der angewandten Physik.
Module contents	Schwingungen und Wellen, physikalische Grundlagen der Akustik, Erzeugung und Ausbreitung von Schall, Messung und Bewertung von Schall, Verarbeitung und Analyse akustischer Signale, Akustik von Stimme und Sprache, Sprachpathologie, Schalldämmung und -dämpfung, Raumund Bauakustik, Elektroakustik, Stoßwellen, Photoakustischer Effekt; ausgesuchte Kapitel der Akustik, der Vibrationen und des Ultraschalls
Reader's advisory	Kollmeier, B.: Skriptum Physikalische, technische und medizinische Akustik, Universität Oldenburg; Kuttfuff, H., Akustik Eine Einführung, Springer- Verlag; Heckl, Müller: Taschenbuch der technischen Akustik, Springer-Verlag; F.G. Kollmann: Maschinenakustik, Springer-Verlag
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 3hrs/week; Excersise: 1hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy685 - Advanced Engineering Topics in Biomedical Physics & Acoustics

Module label	Advanced Engineering Topics in Biomedical Physics & Acoustics	
Module code	phy685	
Credit points	6.0 KP	
Workload	180 h (Overall workload of 180 h)	
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics	
Contact person	Module responsibility ◦ Björn Poppe ◦ Simon Doclo	
Entry requirements	Related to selected course/s	
Skills to be acquired in this module	The aim of this module is, to give students further access to also small courses (3 CP) which address the specific interest of the student and deliver unique in-depth knowledge or the opportunity to train specific engineering skills.	
Module contents	Photonics, Optics, Metrology,	
Reader's advisory	Related to selected course/s	
Links		
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency	Sommer- oder Wintersemester	
Module capacity	unlimited	
Modullevel	MM (Mastermodul / Master module)	
Modulart	Wahlpflicht / Elective	
Lern-/Lehrform / Type of program	Related to selected course/s	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		Related to selected course/s
Course type	Lecture	
SWS	4.00	
Frequency	SuSe or WiSe	
Workload attendance	56 h	

phy686 - Advanced Topics in Biomedical Physics & Acoustics

Module label	Advanced Topics in Biomedical Physics & Acoustics
Module code	phy686
Credit points	6.0 KP
Workload	180 h (Overall workload of 180 h)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module responsibility ◦ Björn Poppe ◦ Simon Doclo
Entry requirements	Related to selected course/s
Skills to be acquired in this module	The aim of this module is, to give students further access to also small courses (3 CP) which address the specific interest of the student and deliver unique in-depth knowledge or the opportunity to train specific engineering skills.
Module contents	Photonics, Optics, Metrology,
Reader's advisory	Related to selected course/s
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	Sommer- oder Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Related to selected course/s
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Related to selected course/s

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy694 - Machine Learning II

Module label	Machine Learning II
Module code	phy694
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics
Contact person	Module responsibility ◦ Simon Doclo
Entry requirements	The course requires the introductory course "Machine Learning - Probabilistic Unsupervised Learning" or equivalent courses. Furthermore, basic knowledge in higher Mathematics as taught as part of first degrees in Physics, Mathematics, Statistics, Engineering or Computer Science (basic linear algebra and analysis) is required. Additionally, programming skills are required (the course supports matlab and python). Many relations to statistical physics, statistics, probability theory, stochastic exist but the course's content will be developed independently of detailed prior knowledge in these fields.
Skills to be acquired in this module	The students will deepen their knowledge on mathematical models of data and sensory signals. Building up on the previously acquired Machine Learning models and methods, the students will be lead closer to current research topics and will learn about models that currently represent the state-of-the-art. Based on these models, the students will be exposed to the typical theoretical and practical challenges in the development of current Machine Learning algorithms. Typical such challenges are analytical and computational intractabilities, or local optima problems. Based on concrete examples, the students will learn how to address such problems. Applications to different data will teach skills to use the appropriate model for a desired task and the ability to interpret an algorithm's result as well as ways for further improvements. Furthermore, the students will learn interpretations of biological and artificial intelligence based on state-of-the-art Machine Learning models.
Module contents	This course builds up on the basic models and methods introduced in introductory Machine Learning lectures. Advanced Machine Learning models will be introduced alongside methods for efficient parameter optimization. Analytical approximations for computationally intractable models will be defined and discussed as well as stochastic (Monte Carlo) approximations. Advantages of different approximations will be contrasted with their potential disadvantages. Advanced models in the lecture will include models for clustering, classification, recognition, denoising, compression, dimensionality reduction, deep learning, tracking etc. Typical application domains will be general pattern recognition, computational neuroscience and sensory data models including computer hearing and computer vision.
Reader's advisory	Pattern Recognition and Machine Learning, C. M. Bishop, Springer 2006. (best suited for lecture).; Information Theory, Inference, and Learning Algorithms, D. MacKay, Cambridge University Press, 2003. (free online)
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week, Exercise: 2hrs/week (incl. prog. laboratory)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy696 - Advanced Topics Speech and Audio Processing

Module label	Advanced Topics Speech and Audio Processing
Module code	phy696
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hrs, Self study: 124 hrs)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module counceling ◦ Simon Doclo
Entry requirements	Basic principles of signal processing (preferably successfully completed the course Signal- und Systemtheorie and/or Blockpraktikum Digitale Signalverarbeitung)
Skills to be acquired in this module	The students will gain in-depth knowledge on the subjects' speech and audio processing. The practical part of the course mediates insight about important properties of the methods treated in a self-study approach, while the application and transfer of theoretical concepts to practical applications is gained by implementing algorithms on a computer.
Module contents	After reviewing the basic principles of speech processing and statistical signal processing (adaptive filtering, estimation theory), this course covers techniques and underlying algorithms that are essential in many modern-day speech communication and audio processing systems (e.g. mobile phones, hearing aids, headphones): acoustic echo and feedback cancellation, noise reduction, dereverberation, microphone and loudspeaker array processing, active noise control. During the exercises a typical hands-free speech communication or audio processing system is implemented (in Matlab).
Reader's advisory	J. Benesty, M. M. Sondhi, Y. Huang: Handbook of Speech Processing, Springer, 2008.; P. Vary, R. Martin: Digital Speech Transmission, Wiley, 2006.; P. Loizou: Speech Enhancement: Theory and Practice, CRC Press, 2007.; S. Vaseghi: Advanced Digital Signal Processing and Noise Reduction, Wiley, 2006.; S. Haykin: Adaptive Filter Theory, Prentice Hall, 2013.
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	VL: 2 SWS, PR: 2 SWS
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Exam or presentation or oral exam or homework or practical report

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy697 - Informationsverarbeitung und Kommunikation

Module label	Informationsverarbeitung und Kommunikation
Module code	phy697
Credit points	6.0 KP
Workload	180 h (Attendance: 56 hours, Self study: 124 hours)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics
Contact person	Module responsibility ◦ Björn Poppe
Entry requirements	Kenntnisse der Inhalte aus den Veranstaltungen Lineare Algebra, Mathematische Methoden der Physik, Messtechnik und Block-Praktikum Digitale Signalverarbeitung (FPRB)
Skills to be acquired in this module	Die Studierenden erlernen, wie statistische Eigenschaften von Signalen zur Lösung von Problemen der Angewandten Physik, insbesondere der Klassifikation, parametrischen Modellierung und Übertragung von Signalen genutzt werden können. Theoretische Lernziele beinhalten damit eine Wiederholung und Festigung statistischer Grundlagen und eine Verständnis von deren Nutzung für Algorithmen unterschiedlicher Zielsetzung und Komplexität. Im praktischen Teil werden Eigenschaften der behandelten Methoden selbständig erarbeitet sowie Algorithmen auf dem Rechner implementiert und auf reale Daten angewendet, so daß der Umgang mit theoretischen Konzepten und ihre praktische Umsetzung erlernt werden.
Module contents	Grundfragen der Informationsverarbeitung (Klassifikation, Regression, Clustering), Lösungsmethoden basierend auf Dichteschätzung und diskriminativen Ansätzen (z.B. Bayes Schätzung, k-nearest neighbour, Hauptkomponentenanalyse, support-vector-machines, Hidden-Markov- Modelle), Grundlagen der Informationstheorie, Methoden der analogen und digitalen Nachrichtenübertragung, Prinzipien der Kanalcodierung und Kompression
Reader's advisory	T. M. Cover, J. A. Thomas: Elements of information theory. John Wiley, 1991; K. Sayood: Introduction to data compression. Kaufmann, 2003; Bishop: Pattern Recognition and Machine Learning, Springer, 2006; MacKay: Information Theory, Inference and Learning Algorithms, Cambridge University Press, 2003
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Sommersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Wahlpflicht / Elective
Lern-/Lehrform / Type of program	Lecture: 2hrs/week; Excersise: 2hrs/week
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		KL

Course type	Lecture
SWS	4.00
Frequency	SuSe or WiSe
Workload attendance	56 h

phy730 - Machine Learning

Module label	Machine Learning
Module code	phy730
Credit points	6.0 KP
Workload	180 h (Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Physics, Engineering and Medicine (Master) > Mastermodule
Contact person	Module responsibility ◦ Jörg Lücke
Entry requirements	Basic knowledge in higher Mathematics as taught as part of first degrees in Physics, Mathematics, Statistics, Engineering or Computer Science (basic linear algebra and analysis). Basic programming skills (course supports matlab & python). Many relations to statistical physics, statistics, probability theory, stochastic but the course's content will be developed independently of detailed prior knowledge in these fields.
Skills to be acquired in this module	The students will acquire advanced knowledge about mathematical models of data and ensory signals, and they will learn how such models can be used to derive algorithms for data and signal processing. They will learn the typical scientific challenges associated with algorithms for unsupervised knowledge extraction including, clustering, dimensionality reduction, compression and signal enhancements. Typical examples will include applications to computer vision and computer hearing. Furthermore, the students will learn modern interpretations of neural learning and neural perception based on probabilistic data models.
Module contents	Introduction to unsupervised learning methods, i.e., methods that extract knowledge from data without the requirement of explicit knowledge about individual data points. We will introduce a common probabilistic framework for learning and a methodology to derive learning algorithms for different types of tasks. Examples that are derived are algorithms for clustering, classification, component extraction, feature learning, blind source separation and dimensionality reduction. Relations to neural network models and learning in biological systems will be discussed were appropriate.
Reader's advisory	? C. M. Bishop, Pattern Recognition and Machine Learning, Springer 2006 (best suited for lecture). ? K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012. ? D. MacKay, Information Theory, Inference, and Learning Algorithms, Cambridge University Press, 2003 (free online) ? K. Petersen, M. Pederson, The Matrix Cookbook, (free online)
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	Vorlesung: 2 SWS, Übungen: 2 SWS
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Klausur (max 180 Min.) oder mündliche Prüfung (30 Min.)

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	WiSe	28 h
Exercises		2.00	WiSe	28 h
Total time of attendance for the module				56 h

phy732 - Psychophysics and Audiology

Module label	Psychophysics and Audiology
Module code	phy732
Credit points	6.0 KP
Workload	180 h (Präsenzzeit: 56 Stunden Selbststudium: 124 Stunden)
Used in course of study	• Master's Programme Engineering Physics (Master) > Schwerpunkt: Acoustics • Master's Programme Engineering Physics (Master) > Schwerpunkt: Biomedical Physics • Master's Programme Physics, Engineering and Medicine (Master) > Mastermodule
Contact person	Module responsibility ◦ Birger Kollmeier
Entry requirements	Bachelor in Physik, Technik und Medizin oder entsprechend
Skills to be acquired in this module	Kenntnisse in der biomedizinischen Physik mit Überblick über die (Neuro-)Physiologie sowie Schwerpunktsetzung in der Hörforschung und Neurosensorik. Fundierte Kenntnisse in der Interpretation und Modellierung von physiologischen und psychoakustischen Phänomenen beim Hören. Fundierte Kenntnisse der praktischen Anwendungen in der diagnostischen und rehabilitativen Audiologie sowie bei gehörbezogenen Mess- und Beurteilungsverfahren. Einblick in aktuelle Forschungsthemen der Medizinischen Physik und des Exzellenzclusters Hearing4All.
Module contents	Einführung in die Rezeptor-Biophysik, Sinnesphysiologie, psychophysikalische Mess- und Skalierungsverfahren, Methoden und Modelle der Psychophysik Anatomie, Physiologie und Diagnostik von Außen-, Mittel- und Innenohr sowie zentralem Hör- und Sprachsystem, Psychoakustik der absoluten und differentiellen Empfindungsgrößen, psychoakustische Funktionsmodelle, binaurales Hören, Wahrnehmung komplexer Signale, auditive Neurokognition, Sprachwahrnehmung, Modelle des Hörens. Psychoakustik und Sprachperzeption bei pathologischem Gehör, Hörgeräte und technische Hörhilfen, Grundlagen der Hör-Rehabilitation; Signalverarbeitung in technischen Hörhilfen, ausgesuchte Kapitel der Hörforschung und Audiologie.
Reader's advisory	? B. Kollmeier: Skriptum Audiologie. Universität Oldenburg, http://medi.uni-oldenburg.de/16750.html ? W. M. Hartmann: Signals, Sound, and Sensation. AIP Press, New York, 2005. ? J. Kießling, B. Kollmeier, G. Diller: Versorgung und Rehabilitation mit Hörgeräten, Thieme, Stuttgart, 1997 ? E. Zwicker, H. Fastl: Psychoacoustics: facts and models. Springer, Berlin, 1999
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	Wintersemester
Module capacity	unlimited
Modullevel	MM (Mastermodul / Master module)
Modulart	Pflicht / Mandatory
Lern-/Lehrform / Type of program	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		M

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	WiSe	28 h
Exercises		2.00	WiSe	28 h
Seminar		2.00	WiSe	28 h
Total time of attendance for the module				84 h

Abschlussmodul

mam - Master´s Thesis Module

Module label	Master´s Thesis Module		
Module code	mam		
Credit points	30.0 KP		
Workload	900 h		
Used in course of study	• Master's Programme Engineering Physics (Master) > Abschlussmodul		
Contact person	Module responsibility ◦ BetreuerIn der Masterarbeit		
Entry requirements	Master Curriculum Engineering Physics		
Skills to be acquired in this module	The learned aquirements and methods are applied on a specific scientific problem nand combined with aquired key skills such as team work, project management and presentations skills.		
Module contents	The master thesis constitutes the final examination of the master study program. Within this context the students are dealing indepentendly with a current topic of research from the fields of the working groups. The work is accompanied by a seminar for presentation and validation of the interim results and the progress of the work. The results will be defended in a final colloquium and generally shall be contributed to a scientific paper.		
Reader's advisory	as required		
Links			
Languages of instruction	German, English		
Duration (semesters)	1 Semester		
Module frequency	jährlich		
Module capacity	unlimited		
Modullevel	Abschlussmodul (Abschlussmodul)		
Modulart	Pflicht		
Lern-/Lehrform / Type of program	Seminar, Labor und Selbststudium		
Vorkenntnisse / Previous knowledge			
Examination	Time of examination	Type of examination	
Final exam of module		Master thesis and colloquium	
Course type	Seminar		
SWS			
Frequency			
Workload attendance	0 h		