Modulhandbuch
Master of Science
in Engineering Physics

Institute of Physics

March 3, 2021

CP →	3	6	9	12	15	18	21	24	27	30	sum
4.→ Semester	**Thesis**										
CP	30										30
3.→ Semester	**Theoretical Methods**		**Advanced Topics in EP**	**Specialization**		**Advanced Research Project**					
CP	6		3	6		15					30
2.→ Semester	**Advanced Physics**		**Engineering Sciences**		**Specialization**		**Specialization**		**Tools and Skills in Engineering Sciences**		
CP	6		6		6		6		6		30
1.→ Semester	**Advanced Physics**		**Advanced Metrology**		**Engineering Sciences**		**Engineering Sciences**		**Specialization**		
CP	6		6		6		6		6		30

Fields of study: Physics , Engineering Specialization Laboratory Management Thesis $\sum CP = 120$

The field of specialization consists of *Biomedical Physics*, *Acoustics*, *Laser & Optics*, *Renewable Energies*.

Contents

1 Specialization

DGMP

Deutsche Gesellschaft für Medizinische Physik e.V.

Studiengangszertifikat

Die Deutsche Gesellschaft für Medizinische Physik e.V.

zertifiziert den konsekutiven Bachelor-/Masterstudiengang

„Engineering Physics“

der

Carl von Ossietzky Universität Oldenburg

für die

Fachanerkennung für Medizinische Physik

mit Berechtigung zum Führen der Bezeichnung

"Medizinphysiker (DGMP)"

gemäß der gültigen Weiterbildungsordnung der DGMP vom 09.05.2015
unter den in der Anlage zu diesem Zertifikat genannten Voraussetzungen.

Die Zertifizierung gilt vom 18.1.2018 bis zum 30.9.2022.

Berlin, den 18.1.2018

Prof. Dr. Katia Parodi
Präsidentin der DGMP

SGZ 0021/18

Deutsche Gesellschaft für Medizinische Physik e.V.

Anlage zum Studiengangszertifikat

für den konsekutiven Bachelor-/Masterstudiengang

„Engineering Physics“

der

Carl von Ossietzky Universität Oldenburg

Diese Zertifizierung ist eine Verlängerung der Zertifizierung vom 01.06.2015 und gilt unter den folgenden Voraussetzungen:

1. Die Absolvent/innen haben die Bachelorstudiengänge „Physik“ oder „Engineering Physics“ erfolgreich abgeschlossen und die Veranstaltungen
    - 5.04.341 „Kern- und Teilchenphysik“
    - 5.04.462 „Hochenergiestrahlenphysik “
    - 5.02.271 „Physiologie der Tiere und Menschen”
    - 5.04.317 „Biomedizinische Physik und Neurophysik“
    - 5.04.4666 „Personalized Medicine“
    - 5.04.4207 „Processing and analysis of Biomedical Data“
    - 05.04.4021 „Bildgebende Verfahren“

   belegt.

2. Diese Zertifizierung gilt für das Spezialgebiet (gemäß WBO der DGMP):
    a) N6. Strahlentherapie, falls folgende Veranstaltungen belegt wurden:
    - 05.04.4642 „Medizinische Strahlenphysik“
    - 05.04.4222 „Spezialkurs Strahlenschutzseminar“
    - 05.04.4242 „Selected Topics on Medical Radiation Physics”
    - 05.04.4221 „Grundkurs im Strahlenschutz”

    b) N9. Klinische Audiologie, falls folgende Module belegt wurden:
    - 05.04.4021 „PPAA“
    - 05.04.4203 „Angewandte Psychophysik“
    - 05.04.4586 „Advanced Topics Speech and Audio Processing”

3. Diese Zertifizierung gilt für die Wahlgebiete (gemäß WBO der DGMP):
    a) N6 bzw. N9 mit den unter Pkt. 2 genannten Veranstaltungen sofern sie nicht schon als Spezialgebiet gewählt wurden.
    b) N14. Physikalische Messtechniken in der Medizin, falls mindestens zwei der folgenden Veranstaltungen belegt wurden:

- 05.04.4586 Digital Signal Processing
- 05.04.4012 Informationsverarbeitung und Kommunikation
- 05.04.4052 „Optische Messtechnik“

Es müssen mindestens zwei Gebiete belegt werden mit insgesamt 15 ECTS-Punkten und mindestens 5 ECTS-Punkten pro Gebiet.

4. Die Zertifizierung gilt vom 18.1.2018 bis zum 30.09.2022 bzw. bis zu einer Änderung des Curriculums. Für eine Rezertifizierung ist rechtzeitig ein erneuter Zertifizierungsantrag zu stellen.

Die Absolventen des Studienganges müssen sich bei Beginn der klinischen Tätigkeit zur Weiterbildung anmelden (Anträge unter www.dgmp.de, WBB-Antrag).

Die Kandidaten haben während der i.d.R. dreijährigen berufspraktischen, klinischen Weiterbildungsphase nach Abschluss des Studiums insgesamt mindestens 150 Weiterbildungspunkte (gleich Stunden) im Sinne der kontinuierlichen Fortbildung (CPD) durch den Besuch anerkannter Weiterbildungsveranstaltungen im Spezialgebiet - das auch das Arbeitsgebiet sein muss - nachzuweisen.

Für das Spezialgebiet „Strahlentherapie“ ist die Fachkunde im Strahlenschutz bei Antragstellung nachzuweisen.

Diese Anerkennung gilt auch für Absolventen des konsekutiven Bachelor-/Masterstudiengans „Physik“ der Carl von Ossietzky Universität Oldenburg, wenn die entsprechenden Veranstaltungen erfolgreich bestanden wurden.

2 Mandatory Courses

2.1 Advanced Metrology

⇐

Module title:	Advanced Metrology
Module code:	phy631
Course:	5.04.4660 Advanced Metrology
Term:	Winter
Person in charge:	P. Huke
Lecturer:	P. Huke
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week first, 2 hrs/week second half of semester Experimental /Seminar work: 0 hrs/week first 2 hrs/week second
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Metrology
Aim/learning outcomes:	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. Experimental setups, simulations and signal analysis from experiments are explained within the context of Laser and optics, Biomedical physics and 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.
Content:	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.
Assessment/type of examination:	Exam, presentation, homework
Literature:	Recent publications on specifc topics D.L. Allen, D.W. Mills: Signal Analysis (Time, Frequency, Scale and Structure) T. Yoshizawa (Ed.): Handbook of Optical Metrology: Principles and Applications, 2nd rev. ed., Crc Pr Inc., 2015

2.2 Advanced Topics in Engineering Physics

⇐

Module title:	Seminar Advanced Topics in Engineering Physics
Module code:	phy640
Course:	Seminar Advanced Topics in Engineering Physics (WS and SS, 5.04.656)
Term:	Winter and Summer
Person in charge:	Prof. Dr. Neu
Lecturer:	Prof. Dr. Neu, Dr. S. Koch
Language:	German or English on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st - 4th semester
Teaching Methods/ semester periods per week:	Seminar: 2 hrs/week
Workload:	Attendance: 28 hrs, Self study: 62 hrs
Credit points:	3
Prerequisites acc. syllabus:	
Recommended prerequisites:	Participation: 1st - 3rd semester. Presentation: Master thesis work in progress or finished; at least one successfully completed specialization module.
Aim/learning outcomes:	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.
Content:	Current seminar topics
Assessment/type of examination:	1 Exam and regular active and documented participation in the seminar spread over the first three semesters.
Literature:	M. Alley: The Craft of Scientific Presentations, Springer, 2nd ed., 2013 Publications according to seminar topics

2.3 Theoretical Methods

2.3.1 Computer Physics

⇐

Module title:	Theoretical Methods
Module code:	phy611
Course:	Computerorientierte Physik, (WS, 5.04.4521)
Term:	Winter
Person in charge:	Prof. Dr. Hartmann
Lecturer:	Prof. Dr. Hartmann
Language:	German
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 3nd semester
Teaching Methods/ semester periods per week:	Lecture: 3hrs/week; Excercises: 1hrs/week
Workload:	attendance: 56 hrs, self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Theoriemodule des Bachelor-Studiums, Kenntnisse einer höheren Programmiersprache (vorzugsweise C)
Aim/learning outcomes:	Erweiterung und Abrundung der Ausbildung in theoretischer Physik durch den Erwerb solider und vertiefter Kenntnisse fortgeschrittener Konzepte und Methoden der theoretischen Physik. Die Studieren- den erwerben je nach gewählter Veranstaltung Kenntnisse auf den Gebieten Vertiefung des Verständnisses der nichtrelativistischen Quantenmechanik, Grundlagen der relativistischen Quantenmechanik, grundlegende numerische Methoden der theoretischen Physik, Algorithmen und Datenstrukturen im wissenschaftlichen Rechnen, Debugging, Grundlagen der allgemeinen Relativitätstheorie, Aspekte der Astrophysik und Kosmologie. Sie erlangen Fertigkeiten im sicheren Umgang mit modernen Methoden der theoretischen Physik wie Diagrammentwicklungen, Molekulardynamik- und Monte-Carlo-Simulationen und differentialgeometrischen Konzepten, in der quantitative Analyse von fortgeschrittenen Problemen der theoretischen Physik und in der Weiterentwicklung der physikalischen Intuition. Sie erweitern ihre Kompetenzen zur erfolgreichen Bearbeitung anspruchsvoller Probleme der theoretischen Physik mit modernen analytischen und numerischen Methoden, zur eigen- ständigen Erarbeitung von Zugängen zu aktuellen Entwicklungen der theoretischen Physik und zum Verständnis übergreifender Konzepte und Methoden der theoretischen Physik und der Naturwissenschaften allgemein.

Content:	Debugging, Datenstrukturen, Algorithmen, Zufallszahlen, Daten- analyse, Perkolation, Monte-Carlo-Simulationen, Finite-Size Scaling, Quanten-Monte-Carlo, Molekulardynamik-Simulationen, ereignisgetriebene Simulationen, Graphen und Algorithmen, genetische Algorithmen, Optimierungsprobleme
Assessment/type of examination:	1 Klausur
Literature:	T. H. Cormen, S. Clifford, C.E. Leiserson, und R.L. Rivest: Intro- duction 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

2.3.2 Modelling and Simulation

⇐

Module title:	Theoretical Methods
Module code:	phy611
Course:	Modelling and Simulation (WS, 5.04.4665)
Term:	Winter
Person in charge:	Prof. Dr.-Ing. Strybny
Lecturer:	Prof. Dr.-Ing. Strybny
Language:	German or English depending on demand
Location	Emden
Curriculum allocation:	Master Engineering Physics, 3st semester; Bachelor Maritime Technology and Shipping Management, 6th semester
Teaching Methods / semester periods per week:	Lecture: 3hrs/week; Computational Lab: 1hrs/week
Workload:	attendance: 52 hrs, self study: 128 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	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.
Content:	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
Assessment / type of examination:	2hrs written exam
Literature:	Versteeg, K.H. , Malalasekera, W.: An Introduction to Computational Fluid Dynamics. Prentice Hall, 2nd rev. Ed., 2007

2.3.3 Personalized Medicine

⇐

Module title:	Theoretical Methods
Module code:	phy611
Course:	Personalized Medicine (SS, 5.04.4666)
Term:	Summer
Person in charge:	T. Schmidt.
Lecturer:	Prof. Dr. T. Schmidt
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 3st semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	attendance: 72 hrs, self study: 108 hrs
Credit points:	6
Prerequisites acc. syllabus;	
Recommended prerequisites:	Statistics, Computing
Aim/learning outcomes:	Students should understand current high-throughput methods used in research and clinics. They should be aware of the advantages and challenges and should be able to judge and interpret the results. In addition, the students should accomplish a sound understanding of basic algorithms which are used to analyze big and complex data sets. They should be able to choose, use and interpret appropriate tools and methods. Finally, students should be able to address the limitations and prospects of big-data analyses in complex systems.
Content:	The lecture aims to provide an overview about current experimental high-throughput methods and bioinformatic algorithms to address the challenges of exponentially growing amounts of data. In addition to basic algorithms and methods like alignments, hidden markov models, Viterbi, graphs or protein-protein interaction networks, the lecture aims to gives an introduction to a data-driven view of disease biology.
Assessment/type of examination:	Max. 3 hrs written exam or 45 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Literature:	Genomic and Personalized Medicine: V1-2 Huntington F. Willard, Geoffrey S. Ginsburg; Academic Press; 2. Edition. (30. Oktober 2012); Cancer Genomics: From Bench to Personalized Medicine; Graham Dellaire, Jason Berman; Academic Press; 1. Edition (17. January 2014); Systems Biology: A Textbook; Eda Klipp et al (2009); Wiley-VCH Verlag GmbH, Co. KGaA; Auflage: 1. Edition;

2.4 Tools and Skills in Engineering Sciences(TSES)

2.4.1 TSES-Photonics

⇐

Module title:	Tools and Skills in Engineering Sciences
Module code:	phy681
Course:	Tools in advanced photonics (SS, 5.04.4671)
Term:	Summer
Person in charge:	Prof. Dr. Neu
Lecturer:	Brückner, Neu, Struve, Teubner, Schellenberg, Koch
Language:	German or English
Location	Emden
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lab course: 4hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basics in optics and laser physics, in particular, fundamentals of optics and photonics; atomic and molecular physics; spectrophysics
Aim/learning outcomes:	Teaching and learning in this component will be through "hands on" demonstration. This form of teaching and learning is important in acquiring competence and skills and advancing understanding by practical experience. The students learn to consider specific key instrument types in current usage in the field of photonics, laser and optics. This will be delivered in a lab course study format with each instrument being evaluated in terms of operating principle, design, and signal processing.
Content:	Laser design and concepts in photonics, solid state lasers, tunable laser systems, gas lasers, industrial laser systems, ultrashort laser systems, diode lasers, optical fiber technology, photonics instrumentation.
Assessment/type of examination:	max 1h oral examination or experimental work and laboratory reports or presentation or homework
Literature:	T. Yoshizawa (Ed.): Handbook of Optical Metrology: Principles and Applications, 2nd rev. ed., Crc Pr Inc., 2015 Saleh and Teich, Fundamentals of Photonics (Wiley) W. Demtröder, Laser Spectroscopy Vol. 1 and 2, Springer, 5nd ed. 2014 and 4th ed., 2008 Frank Träger (Ed.): Springer Handbook of Lasers and Optics. Springer, 2nd ed., 2012 Recent publications on specific topics

2.4.2 TSES-Workshop Management

⇐

Module title:	Tools and Skills in Engineering Sciences
Module code:	phy681
Course:	Workshop Management (SS, 5.04.4666)
Term:	Summer
Person in charge:	Prof. Philipp Huke
Lecturer:	Prof. Philipp Huke
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Seminar: 2hrs/week; Excersise: 2hrs/week
Workload:	Attendance: 28 hrs, Self study: 152 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	Students are able to organize summer schools, workshops, (sport) events, etc.
Content:	Students should develop ideas for summer schools or workshops within the field of physics or public-spirited to enhance the community of the study course Engineering Physics. Events will be planned, arranged and carried out by the participants. The seminar includes: (1) developing ideas for summer schools, workshops, sport events, conferences, etc. (2) planning financial aspects (3) funding (4) time tables (e.g. Gantt charts) (5) human resources
Assessment/type of examination:	1 homework
Literature:	Projektportfolio-Management : Strategisches und operatives Multi-Projektmanagement in der Praxis Matthias Hirzel [Hrsg.] ; Wolfgang Alter [Hrsg.] ; Cornelia Niklas [Hrsg.] 4., Überarbeitete und erweiterte Auflage., Wiesbaden : Springer Gabler, 2019 Agiles Projektmanagement im Berufsalltag : Für mittlere und kleine Projekte Ursula. Kusay-Merkle 1st ed. 2018., Berlin, Heidelberg: Springer Berlin Heidelberg : Imprint: Springer Gabler, 2018 Project management 2.0 : leveraging tools, distributed collaboration, and metrics for project success Harold Kerzner Hoboken, New Jersey: John Wiley and Sons, Inc, 2015

2.4.3 TSES-International Sustainability Management

⇐

Module title:	Tools and Skills in Engineering Sciences
Module code:	phy681
Course:	International Sustainability Management (WS, 2.12.021 and 2.12.022)
Term:	Winter
Person in charge:	Prof. Dr. Neu
Lecturer:	Prof. Dr. Bernd Siebenhüner
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week; Seminar: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Aim/learning outcomes:	Knowledge on the basic concepts and strategies of sustainability management related to corporate practice: - Sustainability: Basic concepts, strategies, - Domestic and international challenges for business, - Business case for sustainable development, - Integrative concepts of sustainable corporations, - Sustainable strategies, - Management instruments Discussing topics of international sustainability management with students from different scientific disciplines. Ability to present and evaluate different concepts and instruments of international sustainability management
Content:	This module consists of a one lecture and one seminar (2 weekly contact hours per lecture/seminar) dealing with basic concepts and strategies of sustainability management within corporations. Both, lecture and seminar give an overview of current sustainability strategies for companies and present a variety of instruments to integrate and initiate sustainable development within corporations. While the lecture focuses more on theoretical approaches and introduces basic concepts of corporate sustainability management, the seminar provides a variety of case studies and business cases to demonstrate different concepts and instruments of sustainability management. The seminar provides the possibilities for inter- and transdisciplinary exchange and discussions.
Assessment/type of examination:	Presentation and written summary

Literature:

BMU/BDI (Eds.) 2002: Sustainability Management in Business Enterprises. CSM, University of Lueneburg (Schaltegger, Herzig, Kleiber, Müller),
Charter, Martin/Tischner, Ursula (Eds.) (2001): Sustainable Solutions, Developing Products and Services for the Future, Sheffield: Greenleaf;
Board on Sustainable Development of the National Research Council, 1999 Our Common Journey: A Transition Toward Sustainability. Washington D.C.: National Academy Press;
Dyllick, Thomas, and Kay Hockerts, 2002 "Beyond the Business Case for Corporate Sustainability." Business Strategy and the Environment, 2002: 130-141;
Gladwin, T., et al., 1995 "Shifting paradigms for sustainable development: Implications for management theory and research." Academy of Management Review, 20: 874 - 907;
Hart, Stuart, 1997 "Strategies for a sustainable world." Harvard Business Review, January-February 1997: 67-76;
Holliday, Charles O., et al., 2002 Walking the Talk. The Business Case for Sustainable Development. Sheffield: Greenleaf;
Hutchinson, Andrew, and Frances Hutchinson, 1997 Environmental Business Management: Sustainable Development in the New Millennium. London u.a.: McGraw-Hill.
Shrivastava, Paul, and Stuart L. Hart, 1995 "Creating sustainable corporations." Business Strategyandthe Environment 1995: 154 165

2.4.4 TSES-Sustainability of Renewable Energy

⇐ sustainability

Module title:	Tools and Skills in Engineering Sciences
Module code:	phy681
Course:	Sustainability of Renewable Energy (SS, 5.06.511)
Term:	Summer
Person in charge:	Prof. Dr. Agert
Lecturer:	Prof. Dr. Agert, Dr. Torio
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week; Seminar: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Aim/learning outcomes:	After successful completion of the module students should be able to: -analyse, and critically compare and evaluate selected sustainability concepts and strategies addressing renewable energy systems -critically appraise and analyse the principles and implications of selected scientific methods and theories for a sustainable energy supply -critically evaluate the suitability and meaningfulness of different sustainability indicators, theories, methods and practices regarding their role and impact for developed countries, on the one hand, and developing countries, on the other -perform an integral assessment, involving several relevant aspects related to the sustainability of a particular real -life renewable energy project as well as identify the main barriers, potentials and driving factors for improving it -perform a literature review on selected sustainability approaches to a professional standard and extract the main related conclusions, and arguing critically on them-present data and information both verbally and in the written form, including quotation to a professional standard

Content:	The module “Sustainability of RE” provides the theoretical background for understanding main concepts and interdisciplinary scientific methods from the context as well as their role in the sustainability debate. Sustainability Seminar (Lecture and Seminar -180 h workload) -Strategies and dimensions in sustainability research and discussion: efficiency, consistency and sufficiency, as well as related concepts (e.g. rebound) -Growth/De-growth and decoupling of growth and emission -Life-cycle analysis -Thermodynamic methods: exergy, EROI and related approaches -Social indicators and their relation to energy use -Economic indicators and related paradigms in the context of energy consumption -Resilience and its operationalisation for energy systems-Methods for developing and assess socio-technical scenarios
Assessment/type of examination:	Report (20 pages) or presentation (45 minutes) and report (10 pages)
Literature:	An additional list of relevant up to date scientific papers and literature will be given in the seminar. Some basic reading hints are: -Klöpffer, Walter (Ed.), Background and Future Prospects in Life Cycle Assessment, Springer Dordrecht 2014 -United Nations, Our Common Future, Report of the World Commission on Environment and Development, 1987 -Daly, Herman / Farley, Joshua, Ecological Economics - Principles and Applications, Island Press Washington 2004 -Kallis, Giorgos / Kerschner, Christian / Martinez, Joan, The Economics of Degrowth; in: Ecological Economics XXX 2012, p. 1-9 -Krysiak, Frank C., Entropy, Limits to Growth, and the prospects for weak sustainability; Ecological Economics 58, 2006, p. 182-191

2.4.5 TSES-Spezialkurs Strahlenschutzseminar

⇐

Module title:	Spezialkurs Strahlenschutzseminar
Module code:	phy695 oder phy681
Course:	Spezialkurs Strahlenschutzseminar (WS, 5.04.4222)
Term:	Winter
Person in charge:	Prof. Dr. B.Poppe
Lecturer:	Prof. Dr. B. Poppe, Dr. A. Rühmann, H. von Boetticher, K. Dörner
Language:	Deutsch
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st-3rd semester
Teaching Methods/ semester periods per week:	Lecture: 4hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Experimentalphysik I-V, Kern- und Elementarteilchenphysik, Medizinsche Strahlentherapie, Grundkurs im Strahlenschutz
Aim/learning outcomes:	Der Kurs vertieft sämtliche 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.
Content:	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.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report
Literature:	Skript zum Kurs wird während des Kurses zur Verfügung gestellt

2.5 Project

⇐

Module title:	Advanced Research Project
Module code:	phy691
Course:	Advanced Research Project
Term:	Winter or Summer
Person in charge:	Prof. Dr. Kühn, Prof. Dr. ir. Doclo, Prof. Dr. Neu
Lecturer:	Acc
Language:	English
Location	Acc. selected course
Curriculum allocation:	Master Engineering Physics, 3th Semester
Teaching Methods/ semester periods per week:	Project work / 40 hours/week
Workload:	Attendance: 320 hrs, Self study: 130 hrs
Credit points:	15
Prerequisites acc. syllabus:	
Recommended prerequisites:	Sound knowledge in the specialisation field of Master thesis
Aim/learning outcomes:	Students are able to search for and to state an adequate research problem in the field of the working group or industry (problem should be related to the topics covered in the masters programme). They are capable to derive research questions based on the statement of the problem and prepare an elaborated research proposal yielding lab work that serves as the preliminary study for the Master's Thesis. Students are in a position to develop the specialised bases (detailed theoretical background of the topic, ample and critically annotated literature review, research objectives and research question(s), fully developed methods section, sketched workplan) of the Master's Thesis Project in terms of content and style in such a way that they form a sound basis for a successful Master's Thesis. Students gain expertise in workflow optimization, data collection and data analysis. Independent management and transformation of a complex and unpredictable problem from the general field of study contexts of the Master degree program "Engineering Physics" (including related subject areas) utilizing scientific state-of-the-art research methods.

Content:	Independent research for the definition of a physics and engineering solution to a problem in the choosen field. Specialized knowledge of a subject area as foundation for the student's research. The assignment of specific tasks will be given after consulting the responsible lecturers and is depending upon the current research profile. The Advanced research project (preliminary study to the Master's thesis) forms the basis of the Master's Thesis Project and must contain the following aspects: - Detailed theoretical background of the topic - Ample and critically annotated literature review - Research objectives and research question(s) - Fully developed methods section - Draft of a fully formed table of contents
Assessment/type of examination:	Reports or presentation
Literature:	Acc. Research field, Recent publications on specific topics

2.6 Thesis

⇐

Module title:	Master Thesis
Module code:	MAM
Course:	Master Thesis
Term:	Summer or Winter
Person in charge:	Supervising tutor
Lecturer:	Supervising tutor
Language:	German or English
Location	
Curriculum allocation:	Master Engineering Physics, 4. Semester
Teaching Methods/ semester periods per week:	Seminar, Laboratory and self studies
Workload:	900
Credit points:	30 including 3 CP (Seminar) and 2 CP (Colloquium)
Prerequisites acc. syllabus:	Master Curriculum Engineering Physics
Recommended prerequisites:	
Aim/learning outcomes:	Die erlernten Kenntnisse und Methoden sind auf ein konkretes wissenschaftliches Problem anzuwenden und mit den erworbenen Schlüsselqualifikationen wie Teamarbeit, Projektmanagement und Präsentationstechniken zu kombinieren.
Content:	Die Masterarbeit bildet den Abschluss des Masterstudiums. In ihrem Rahmen bearbeiten die Studierenden selbständig ein aktuelles Thema aus den Forschungsgebieten der Arbeitsgruppen. Begleitet wird die Arbeit durch ein Seminar zur Darstellung und Überprüfung der Zwischenergebnisse und des Fortgangs der Arbeit. Die Ergebnisse werden in einem Abschlusskolloquium verteidigt und sollen in der Regel zu einer wissenschaftlichen Publikation beitragen.
Assessment/type of examination:	Master Thesis and colloquium
Literature:	As required

3 Advanced Physics

3.1 Photonics

⇐

Module title:	Photonics
Module code:	phy600
Course:	Photonics (WS, 5.04.4668)
Term:	Winter
Person in charge:	Prof. Dr. B. Struve
Lecturer:	Prof. Dr. H. Brückner, Prof. Dr. B. Struve
Language:	German or English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week , practical applications included in lecture
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basic knowledge on optics, electrodynamics and atomic physics
Aim/learning outcomes:	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, different laser types, light emitters, detectors, modulators. The students acquire skills in working with lasers and optoelectronic components.
Content:	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
Assessment/type of examination:	2 hr written examination or 30 min oral examination or experimental work or homework or presentation
Literature:	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

3.2 General Relativity

⇐

Module title:	Allgemeine Relativitätstheorie
Module code:	phy601
Course:	Allgemeine Relativitätstheorie (WS, 5.04.4261)
Term:	Winter
Person in charge:	Prof. Dr. A. Engel
Lecturer:	Prof. D. A. Engel
Language:	German
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 3hrs/week; Exercise: 1hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	
Content:	Äquivalenzprinzip, Bewegung im Gravitationsfeld, Metrik, Tensoren, Kovariante Ableitung, Riemannscher Krümmungstensor, Einsteinsche Feldgleichungen, Erhaltungsgrößen, Schwarzschild Lösung, Schwarze Löcher, Gravitationsstrahlung, Experimentelle Tests, Kosmologie, Friedmann-Gleichungen
Assessment/type of examination:	1 Klausur oder 1 Referat oder 1 mündliche Prüfung oder 1 Hausarbeit
Literature:	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

3.3 Hochenergiestrahlenphysik and Space Environment

⇐

Module title:	Hochenergiestrahlenphysik und Space Environment
Module code:	phy602
Course:	Hochenergiestrahlenphysik (WS, 5.04.4642) und Space Enviroment (WS, 5.04.776)
Term:	Winter
Person in charge:	Prof. Dr. B. Poppe
Lecturer:	Prof. Dr. B. Poppe, Dr. Hui Khee Looe, Dr. G. Drolshagen, Dr. D. Koschny
Language:	German (5.04.4642) and Englisch (5.04.776)
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	each lecture: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basic lectures in physics / engineering
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.
Content:	**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.
Assessment/type of examination:	1 Klausur oder 1 Referat oder 1 mündliche Prüfung oder 1 Hausarbeit

Literature:	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

3.4 Fluiddynamik

⇐

Module title:	Fluiddynamik
Module code:	phy603
Course:	Fluiddynamik I (WS, 5.04.4070) und Fluiddynamik II (SS, 4071)
Term:	Term: Winter and Summer
Person in charge:	Prof. Dr. Peinke
Lecturer:	Jun. Prof- Laura Lukassen (winter) Prof. Dr. Peinke (summer)
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st and 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week; Excersise: 2hrs/week
Workload:	Attendance: 84 hrs, Self study: 96 hrs
Credit points:	6
Prerequisites acc. syllabus:	Fluid Dynamics I has to be taken before Fluid Dynamics II
Recommended prerequisites:	
Aim/learning outcomes:	Fundamental knowledge and comprehension on the movement of fluids
Content:	**Fluid Dynamics I:** Basic equations: Navier-Stokes-equation, Continuity- equation, Bernoulli- equation; Vortex- equation – and Energy balance equations; laminar flows and stability analysis; exact solutions, application of basic equations **Fluid Dynamics II:** Reynolds-equation, „closing problem“ of turbulence: Turbulence models: Cascade models, Stochastic models
Assessment/type of examination:	1 Prüfung im Sommersemester
Literature:	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 flow. Cam- bridge University Press, Cambridge, 2000 P.A. Davidson: turbulence Oxford 2004

3.5 Kosmologie und Akkretionsscheiben

⇐

Module title:	Kosmologie und Akkretionsscheiben
Module code:	phy604
Course:	Kosmologie (SS, 5.04.4539) und Akkretionsscheiben (SS, 5.04.1003)
Term:	Summer
Person in charge:	Prof. Dr. B. Poppe
Lecturer:	Prof. D. J. Kunz-Drolshagen und Dr. Saskia Grunau
Language:	German, English on request
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	each lecture: 2 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	3 and 3
Prerequisites acc. syllabus:	
Recommended prerequisites:	Kenntnisse aus den Vorlesungen Teilchen und Felder, Quantenmechanik (Astrophysik, Allgemeine Relativitätstheorie, Quantenfeldtheorie)
Aim/learning outcomes:	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.
Content:	**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.
Assessment/type of examination:	1 Klausur oder 1 Referat oder 1 mündliche Prüfung oder 1 Hausarbeit
Literature:	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

3.6 Digital Signal Processing

⇐

Module title:	Digital Signal Processing
Module code:	phy605
Course:	Digital Signal Processing (SS, 5.04.4586)
Term:	Term: Summer
Person in charge:	Prof. Dr. Doclo
Lecturer:	Prof. Dr. Doclo
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st – 3rd Semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week; Exersise: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Students should have acquired basic knowledge about continuous-time and discrete-time signal processing and system theory.
Aim/learning outcomes:	Theoretical methods of signal processing and system theory for discrete-time signals and systems. Application of the theoretical methods in analytical, numerical and programming exercises.
Content:	System properties (stability, linearity, time-invariance, causality); Discrete-time signal processing: sampling theorem, time-domain analysis (impulse response, convolution), z-transform, frequency-domain analysis (transfer function, discrete-time Fourier transform, discrete Fourier transform, FFT, STFT), digital filter design (FIR, IIR, linear phase filter, signal flow graph), multi-rate signal processing (down/up-sampling, filter banks); Statistical signal processing: stationarity, ergodicity, correlation, Wiener-Khinchin theorem, spectral estimation; Adaptive filters: optimal filters, Wiener filter, time-domain algorithms (RLS, NLMS), frequency-domain algorithms (FDAF);Matlab exercises about discrete-time signal processing and adaptive filters.
Assessment/type of examination:	written exam (2 hours)
Literature:	A. V. Oppenheim, R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, 2013. J. G. Proakis, D. G. Manolakis, "Digital Signal Processing – Principles, Algorithms and Applications", Prentice Hall, 2013. S. Haykin, „Adaptive Filter Theory", Pearson, 2013. P. P. Vaidyanathan, „Multirate systems and filter banks", Prentice Hall, 1993. K.-D. Kammeyer, K. Kroschel, „Digitale Signalverarbeitung: Filterung und Spektralanalyse mit MATLAB-Übungen", Broschiert, 2018.

3.7 Physics with Ultrashort Pulses and Fourier Methods

⇐

Module title:	Physics with Ultrashort Pulses and Fourier Methods
Module code:	phy606
Course:	Physics with Ultrashort Pulses (SS, 5.04.4662) und Fouriertechniken in der Physik (WS, 5.04.4651
Term:	
Person in charge:	Prof. Dr. Ulrich Teubner
Lecturer:	Prof. Dr. Ulrich Teubner and Prof. Dr. Wollenhaupt
Language:	Englisch and German
Location	
Curriculum allocation:	Master Engineering Physics, 1st - 3rd Semester
Teaching Methods/ semester periods per week: Lecture 2hrs/week; Exersise: 2hrs/week	
Workload: Attendance: 56hrs,Self Study: 124 hrs	
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basics of Optics and Laser Physics
Aim/learning outcomes:	**Physics with ultrashort pulses:** Die Studierenden erwerben experimentelle und theoretische Kenntnisse über ultrakurze Laserpulse. und erweitern auf diese Weise auch ihre Kenntnisse der Laserphysik. Sie erwerben ein grundlegendes Verständnis für deren besondere Eigenschaften, sowie deren Erzeugung und Charakterisierung, welches sie dann in der Praxis anwenden können. Darüber hinaus lernen sie die speziellen und vielfältigen Anwendungsfelder ultrakurzer Laserpulse kennen. Insgesamt erhalten sie auf dieser Grundlage auch die Kompetenz, die den Zugang zu weiterführenden Gebieten, wie z.B. der Ultrakurzzeitspektroskopie und -chemie, der Lasermikrotechnik, der Hochleistungslaserphysik inklusive der Laserplasmaphysik, der Attosekundenphysik und den Laseranwendungen in der Biologie und Medizin ermöglich **Fouriertechniken in der Physik:** Die Studierenden kennen die Definition der Fouriertransformation und haben Beispiele dazu kennen gelernt. Sie kennen die Eigenschaften und Theoreme der Fouriertransformation, können diese anwenden und physikalische Vorgänge in der Zeit- und Frequenzdomäne beschreiben. Sie gewinnen vertiefte Einsichten über physikalische Vorgänge mit Hilfe der Analyse in der Frequenzdomäne und sind in der Lage, Fouriermethoden auf physikalische Probleme anzuwenden, z.B. Techniken zur Lösung der zeitabhängigen Schrödingergleichung. Sie haben darüber hinaus Beispiele aus der aktuellen englischsprachigen physikalischen Fachliteratur kennen gelernt.

Content:	**Physics with ultrashort pulses:** Lineare und nichtlineare Optik ultrakurzer Lichtpulse, u.a. Amplitude, Phase, spektrale Phase des elektrischen Feldes, chirp, Phasen- und Gruppengeschwindigkeit, Gruppengeschwindigkeitsdispersion, Pulskompression, Selbstfokussierung, Selbstphasenmodulation, Multiphotoneneffekte, Erzeugung, Verstärkung und Vermessung ultrakurzer Laserpulse, u.a.m. **Fouriertechniken in der Physik:** Motivation: Anwendungen der Fouriertransformation in der Physik. Beispiele für Fourierpaare, Eigenschaften der FT: Symmetrien. Wichtige Theoreme, Verschiebung, Differentiation, Faltungssatz, Unschärferelation. Beispiele zum Faltungssatz: Frequenzkamm, Hilberttransformation, Autokorrelationsfunktion. Methoden der Zeit/Frequenzanalyse / Wignerverteilung. FT in höheren Dimensionen: Tomographie. Diskrete FT, Samplingtheorem. Anwendungen in der Quantenmechanik
Assessment/type of examination:	2 written or 2 oral exams
Literature:	Physics with ultrashort pulses: 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",Cambridge 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. Fouriertechniken in der Physik: C. Rullière: Femtosecond Laser Pulses. Springer, Berlin, 2004 J.-C. Diels, W. Rudolph: Ultrashort Laser Pulse Phenomena. Academic Press, Amsterdam, 2006 K. Jesse: Femtosekundenlaser. Springer, Berlin, 2005

3.8 Acoustics

⇐

Module title:	Acoustics
Module code:	phy679
Course:	Akustik (SS,5.04.711)
Term:	Sommer
Person in charge:	Prof. Dr. Steven van de Par, Prof. Dr. Dr. Birger Kollmeier
Lecturer:	Prof. Dr. Steven van de Par, Prof. Dr. Dr. Birger Kollmeier
Language:	Deutsch
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd Semester
Teaching Methods/ semester periods per week:	Lecture: 3hrs/week; Excersise: 1hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	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.
Content:	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, Raum- und Bauakustik, Elektroakustik, Stoßwellen, Photoakustischer Effekt; ausgesuchte Kapitel der Akustik, der Vibrationen und des Ultraschalls.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report
Literature:	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

3.9 Spectrophysics

⇐

Module title:	Spectrophysics
Module code:	Phy632
Course:	Applied Photonics I / Spectrophysics (WS, 5.04.4661)
Term:	Winter
Person in charge:	Prof. Dr. W. Neu
Lecturer:	Prof. Dr. W. Neu
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 3 hrs/week, Laboratory: 1 hrs/week
Workload:	Attendance: 28 hrs, Self study: 62 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Atomic and Molecular Physics, Optical systems
Aim/learning outcomes:	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.
Content:	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
Assessment/type of examination:	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework
Literature:	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

3.10 Optics

⇐

Module title:	Optics
Module code:	Phy633
Course:	Applied Photonics II - Fundamentals of Optics (WS, 5.04.657)
Term:	Winter
Person in charge:	Prof. Dr. Teubner
Lecturer:	Prof. Dr. Ulrich Teubner
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: Lecture: 3 hrs/week, Laboratory: 1 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Electrodynamics
Aim/learning outcomes:	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.
Content:	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)
Assessment/type of examination:	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework
Literature:	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

3.11 Selected Topics in Advanced Physics

⇐

Module title:	Selected Topics in Advanced Physics
Module code:	phy607
Course:	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.
Term:	winter or summer
Person in charge:	Prof. Dr. Walter Neu
Lecturer:	Related to selected course/s
Language:	Related to selected course/s
Location	Oldenburg
Curriculum allocation:	1st to 3rd semester
Teaching Methods/ semester periods per week:	Related to selected course/s
Workload:	Overall workload of 180 h
Credit points:	3 + 3 or 6
Prerequisites acc. syllabus	
Recommended prerequisites:	Related to selected course/s
Aim/learning outcomes:	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.
Content:	Photonics, Optics, Metrology,
Assessment/type of examination:	Related to selected course/s
Literature:	Related to selected course/s

4 Biomedical Physics

4.1 Engineering Sciences

4.1.1 Grundlagen der Physiologie

⇐

Module title:	Grundlagen der Physiologie
Module code:	bio279
Course:	Physiologie der Tiere und des Menschen (WS, 5.02.271)
Term:	Winter
Person in charge:	Dominik Heyers
Lecturer:	
Language:	Dominik Heyers, Christine Köppl, Karin Dedek
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1. Semester
Teaching Methods/ semester periods per week:	lecture 4 hrs/week
Workload:	Attendance: 56 hrs, Self Study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	biologische Fachkenntnisse Kenntnisse biologischer Arbeitstechniken biologierelevante naturwissenschaftliche/mathematische Grundkenntnisse Statistik und wissenschaftliches Programmieren Abstraktes, logisches, analytisches Denken vertiefte Fachkompetenz in biologischem Spezialgebiet Selbstständiges Lernen und (forschendes) Arbeiten Teamfähigkeit Vermittlung grundlegender Kenntnisse und Zusammenhänge der Physiologie mit Schwerpunkt Humanphysiologie. Vermittlung des Zusammenhanges von Struktur und Funktion als wesentliches Basikonzept der Biologie; Vermittlung naturwissenschaftlicher Arbeitsweisen: Hypothesenbildung, Versuchsplanung, Versuchsdurchführung, Datensammlung, Interpretation, Fehleranalyse; Anleitung zum eigenen, forschend-entdeckenden Experimentieren; Schaffen von Experimentiergelegenheiten. Reflektion des Experimentierens als Weg der Erkenntnisgewinnung

Content:	Der Vorlesungsstoff (Vorlesung: 5.02.271 - Physiologie der Tiere und des Menschen) umfasst die Gebiete Allgemeine Zellphysiologie, Sinnesphysiologie, Neuro- und Muskelphysiologie, vegetative Funktionen, Blut und Immunabwehr, Herz und Kreislauf, Regulation des inneren Milieus, sowie Atmung und Ernährung und Verdauung. In der Vorlesung steht die Physiologie des Menschen im Vordergrund. In der sich anschließenden Übung werden eine Reihe von physiologischen Experimenten mit direktem Bezug zur Vorlesung durchgeführt. Anhand von Eigenversuchen sowie Simulationen am Computer erlernen die Teilnehmer Erkenntnisse zum Verständnis der physiologischen Vorgänge des eigenen Körpers.
Assessment/type of examination:	1 written exam
Literature:	Klinke, Pape, Kurtz, Silbernagl: Physiologie, Aufl. 6, 2010 Schmidt, Lang, Heckmann: Physiologie des Menschen mit Pathophysiologie, Aufl. 31, 2011 (sinnvolle Zusatzliteratur, falls verfügbar: Wehner, Gehring: Zoologie)

4.1.2 Personalized Medicine

⇐

Module title:	Personalized Medicine
Module code:	phy614
Course:	Personalized Medicine (SS, 5.04.4666)
Term:	Summer
Person in charge:	T. Schmidt.
Lecturer:	Prof. Dr. T. Schmidt
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 3st semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	attendance: 72 hrs, self study: 108 hrs
Credit points:	6
Prerequisites acc. syllabus;	
Recommended prerequisites:	Statistics, Computing
Aim/learning outcomes:	Students should understand current high-throughput methods used in research and clinics. They should be aware of the advantages and challenges and should be able to judge and interpret the results. In addition, the students should accomplish a sound understanding of basic algorithms which are used to analyze big and complex data sets. They should be able to choose, use and interpret appropriate tools and methods. Finally, students should be able to address the limitations and prospects of big-data analyses in complex systems.
Content:	The lecture aims to provide an overview about current experimental high-throughput methods and bioinformatic algorithms to address the challenges of exponentially growing amounts of data. In addition to basic algorithms and methods like alignments, hidden markov models, Viterbi, graphs or protein-protein interaction networks, the lecture aims to gives an introduction to a data-driven view of disease biology.
Assessment/type of examination:	Max. 3 hrs written exam or 45 min oral exam. Here, you will find information about the consideration of bonus points for module marks.
Literature:	Genomic and Personalized Medicine: V1-2 Huntington F. Willard, Geoffrey S. Ginsburg; Academic Press; 2. Edition. (30. Oktober 2012); Cancer Genomics: From Bench to Personalized Medicine; Graham Dellaire, Jason Berman; Academic Press; 1. Edition (17. January 2014); Systems Biology: A Textbook; Eda Klipp et al (2009); Wiley-VCH Verlag GmbH, Co. KGaA; Auflage: 1. Edition;

4.1.3 Spezialkurs Strahlenschutz

⇐

Module title:	Spezialkurs Strahlenschutzseminar
Module code:	phy695 oder phy681
Course:	Spezialkurs Strahlenschutzseminar (WS, 5.04.4222)
Term:	Winter
Person in charge:	Prof. Dr. B.Poppe
Lecturer:	Prof. Dr. B. Poppe, Dr. A. Rühmann, H. von Boetticher, K. Dörner
Language:	Deutsch
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st-3rd semester
Teaching Methods/ semester periods per week:	Lecture: 4hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Experimentalphysik I-V, Kern- und Elementarteilchenphysik, Medizinsche Strahlentherapie, Grundkurs im Strahlenschutz
Aim/learning outcomes:	Der Kurs vertieft sämtliche 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.
Content:	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.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report
Literature:	Skript zum Kurs wird während des Kurses zur Verfügung gestellt

4.1.4 Einführung in die Neurophysik

⇐

Module title:	Einführung in die Neurophysik
Module code:	phy734
Course:	Einführung in die Neurophysik
Term:	Winter
Person in charge:	Dr. J. Anemüller
Lecturer:	J. Anemüller, M. Dietz
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st – 3rd Semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week; Excersise: 2hrs/week
Workload:	Attendance: 56 hours, Self study: 124 hours
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	
Content:	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
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report
Literature:	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)

4.1.5 Advanced Engineering Topics in Biomedical Physics and Acoustics

⇐

Module title:	Advanced Engineering Topics in Biomedical Physics and Acoustics
Module code:	phy685
Course:	This module offers special as well as advanced engineering courses in Biomedical Physics and Acoustics. The list of eligible courses will be updated each academic year. Please refer to the courses listed for this module in Stud.IP.
Term:	winter or summer
Person in charge:	Prof. Dr. B. Poppe and Prof. Dr. ir. Doclo
Lecturer:	Related to selected course/s
Language:	Related to selected course/s
Location	Oldenburg
Curriculum allocation:	1st to 3rd semester
Teaching Methods/ semester periods per week:	Related to selected course/s
Workload:	Overall workload of 180 h
Credit points:	3 + 3 or 6
Prerequisites acc. syllabus	
Recommended prerequisites:	Related to selected course/s
Aim/learning outcomes:	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.
Content:	Photonics, Optics, Metrology,
Assessment/type of examination:	Related to selected course/s
Literature:	Related to selected course/s

4.2 Specialization

4.2.1 Psychophysik und Audiologie

⇐

Module title:	Psychophysik und Audiologie
Module code:	phy732
Course:	Psychophysik und Audiologie (WS, 5.04.4021)
Term:	Winter
Person in charge:	Prof. Dr. B.Poppe and Prof. Dr. ir. Doclo
Lecturer:	Prof. Dr. Dr. B. Kollmeier, Prof. Dr. S. van de Par, Dr. T. Brand, Dr. S. Uppenkamp, Dr. R. Weber
Language:	Deutsch
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st - 3rd semester
Teaching Methods/ semester periods per week:	Lecture: 3hrs/week; Excersise: 1hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Einführende Module sowie möglichst ein vertiefendes Modul in Akustik und Signalverarbeitung
Aim/learning outcomes:	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.
Content:	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.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report

Literature:	Skript: Kollmeier, B.: Psychologische, physiologische und audiologische Akustik (Audiologie); WA Yost, Fundamentals of Hearing, Academic Press, 2000.; Blauert, Jens, Räumliches Hören, S. Hirzel Verlag, 1997.; A Bregman, Auditory Scene Analysis, MIT Press, 1990.; M Cooke, Modelling Auditory Processing and Organisation, Cambridge University Press, 1993.; P Dallos and AN Popper and RR Fay, The Cochlea, Springer Handbook in Auditory Research, 1996.; Kießling, J., Kollmeier, B., Diller, G., Versorgung und Rehabilitation mit Hörgeräten, Thieme, Stuttgar; Moore, Brian C. J., Hearing, Academic Press, 1995.; Moore, Brian C. J., An introduction to the psychology of hearing, Academic Press, 1997.; JO Pickles, An Intoduction to the Physiology of Hearing, Academic Press, 1988.; W Yost and A Popper and R Fay, Human Psychophysics, Springer Handbook in Auditory Research 3, Springer Verlag, 1993.; Zwicker, E. and Fastl, H., Psychoacoustics : Facts and Models, Springer, 1999.

4.2.2 Selected Topics on Medical Radiation Physics and Medical Radiation Physics

⇐

Module title:	Selected Topics on Medical Radiation Physics and Medizinische Strahlenphysik
Module code:	phy698
Course:	Selected Topics on Medical Radiation Physics (SS, 5.04.4242) and Medizinische Strahlenphysik (SS, 5.04.4642)
Term:	Sommer
Person in charge:	Prof. Dr. B.Poppe
Lecturer:	Dr. A. Rühmann, Prof. Dr. B. Poppe (5.04.4242) Prof. Dr. B. Poppe, Dr. K. Dörner, Dr. H. K. Looe, Dr. N. Chofor (5.04.4242)
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st-3rd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week; Seminar: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	3 and 3
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	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.
Content:	5.04.4242: Aktuelle Themen aus der Medizinischen Strahlenphysik wie: IMRT, NMR, PET, SPECT usw.; 5.04.4642: Grundlagen der Strahlentherapie, Dosimetrie, Einfuührung 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.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report

Literature:	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; IAEA,SyllabusonMedicalPhysics

4.2.3 Processing and Analysis of Biomedical Data

⇐

Module title:	Processing and analysis of biomedical data
Module code:	phy678
Course:	Processing and analysis of biomedical data (WS, 5.04.4207)
Term:	Winter
Person in charge:	Prof. Dr. B. Poppe
Lecturer:	S. Uppenkamp, S. Ewert, V. Hohmann
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st-3rd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week; Exersise: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basic signal processing, algebra knowledge
Aim/learning outcomes:	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.
Content:	Normal distributions and significance testing, Monte-Carlo bootstrap techniques, Linear regression, Correlation, Signal-to-noise estimation, Principal component analysis, Confi-dence intervals, Dipole source analysis, Analysis of variance Each technique is explained, tested and discussed in the exercises.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report
Literature:	Kirkwood B.R. and Sterne A.C., Essential Medical Statistics: 2nd editition. 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

4.2.4 Bildgebende Verfahren und Optische Messtechnik

⇐

Module title:	Bildgebende Verfahren/ Optische Messtechnik
Module code:	phy635
Course:	Bildgebende Verfahren (SS, 5.04.4021) / Optische Messtechnik (SS, 5.04.4052)
Term:	Summer
Person in charge:	Prof. Dr. B. Poppe
Lecturer:	Prof. Dr. V. Hohmann, Dr. S. Uppenkamp, Dr. G. Gülker
Language:	Deutsch
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week
Workload:	Attendance: 58 hrs, Self study: 124 hrs
Credit points:	3 und 3
Prerequisites acc. syllabus:	
Recommended prerequisites:	Einführung in die Photonik
Aim/learning outcomes:	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.

Content:	Bildgebende Verfahren: Überblick über Verfahren der medizinischen Bildgebung ("ionisierende / nicht-ionisierende" Verfahren, anatomische / funktionelle Bildgebung); Physikalischen Grundlagen (Abbil-dungsprinzipien, Prinzipien der Kontrastbildung, Mathematische Grundlagen der Tomographie); Einführung in Computertomographie (CT); Nuklearmedizin (Single Photon- und Positronen-Emissionstomographie (SPECT/PET)); Ultraschall; Magnetresonanztomographie (MRT); funktionelle MRT, Elektro- und Magnetoencephalographie (EEG/MEG); Medizinische Anwendungen, mögliche Nebenwirkungen, relative Vor- und Nachteile; Forschungsanwendungen.; Optische Messtechnik: Themen aus der modernen optischen Messtechnik, wie z.B. Oberflächen- und Entfernungsmesstechniken, Nahfeldmethoden, optische Werkzeuge zur Mikromanipulation, optische Fallen, Interferometrie und Holografie, Laser- und Kurzkohärenz-Messtechnik
Assessment/type of examination:	2 written or oral exams
Literature:	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

4.2.5 Advanced Topics in Biomedical Physics and Acoustics

⇐

Module title:	Advanced Topics in Biomedical Physics and Acoustics
Module code:	phy686
Course:	This module offers special as well as advanced courses in Biomedical Physics and Acoustics. The list of eligible courses will be updated each academic year. Please refer to the courses listed for this module in Stud.IP.
Term:	winter or summer
Person in charge:	Prof. Dr. B. Poppe and Prof. Dr. ir. Doclo
Lecturer:	Related to selected course/s
Language:	Related to selected course/s
Location	Oldenburg
Curriculum allocation:	1st to 3rd semester
Teaching Methods/ semester periods per week:	Related to selected course/s
Workload:	Overall workload of 180 h
Credit points:	3 + 3 or 6
Prerequisites acc. syllabus	
Recommended prerequisites:	Related to selected course/s
Aim/learning outcomes:	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.
Content:	Photonics, Optics, Metrology,
Assessment/type of examination:	Related to selected course/s
Literature:	Related to selected course/s

5 Acoustics

5.1 Engineering Sciences

5.1.1 Machine Learning I

⇐

Module title:	Machine Learning I
Module code:	phy730
Course:	Machine Learning I – Probabilistic Unsupervised Learning (WS, 5.04.4213)
Term:	Winter
Person in charge:	Prof. Dr. ir. Doclo
Lecturer:	Prof. Dr. Jörg Lücke
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st-3rd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week, Exercise: 2hrs/week (incl. prog. laboratory)
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	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 and 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.
Aim/learning outcomes:	The students will acquire advanced knowledge about mathe-matical models of data and sensory signals, and they will learn how such models can be used to derive algorithms for data and signal processing. They will learn the typical scien-tific 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 percep-tion based on probabilistic data models.

Content:	The field of Machine Learning develops and provides methods for the analysis of data and signals. Typical application domains are computer hearing, computer vision, general pattern recognition and large-scale data analysis (recently often termed "Big Data"). Furthermore, Machine Learning methods serve as models for information processing and learning in humans and animals, and are often considered as part of artificial intelligence approaches. This course gives an 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 frame-work for learning and a methodology to derive learning algo-rithms 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.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report
Literature:	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)

5.1.2 Machine Learning II

⇐

Module title:	Machine Learning II
Module code:	phy694
Course:	Machine Learning II – Learning and inference methods (SS, 5.04.4215)
Term:	Summer
Person in charge:	Prof. Dr. ir. Doclo
Lecturer:	Prof. Dr. Jörg Lücke
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st-3rd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week, Exercise: 2hrs/week (incl. prog. laboratory)
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	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.
Aim/learning outcomes:	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.

Content:	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.
Assessment/type of examination:	written or oral exam
Literature:	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)

5.1.3 Advanced Engineering Topics in Biomedical Physics and Acoustics

⇐

Module title:	Advanced Engineering Topics in Biomedical Physics and Acoustics
Module code:	phy685
Course:	This module offers special as well as advanced engineering courses in Biomedical Physics and Acoustics. The list of eligible courses will be updated each academic year. Please refer to the courses listed for this module in Stud.IP.
Term:	winter or summer
Person in charge:	Prof. Dr. B. Poppe and Prof. Dr. ir. Doclo
Lecturer:	Related to selected course/s
Language:	Related to selected course/s
Location	Oldenburg
Curriculum allocation:	1st to 3rd semester
Teaching Methods/ semester periods per week:	Related to selected course/s
Workload:	Overall workload of 180 h
Credit points:	3 + 3 or 6
Prerequisites acc. syllabus	
Recommended prerequisites:	Related to selected course/s
Aim/learning outcomes:	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.
Content:	Photonics, Optics, Metrology,
Assessment/type of examination:	Related to selected course/s
Literature:	Related to selected course/s

5.2 Specialization

5.2.1 Psychophysik und Audiologie

⇐

Module title:	Psychophysik und Audiologie
Module code:	phy732
Course:	Psychophysik und Audiologie (WS, 5.04.4021)
Term:	Winter
Person in charge:	Prof. Dr. B.Poppe and Prof. Dr. ir. Doclo
Lecturer:	Prof. Dr. Dr. B. Kollmeier, Prof. Dr. S. van de Par, Dr. T. Brand, Dr. S. Uppenkamp, Dr. R. Weber
Language:	Deutsch
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st - 3rd semester
Teaching Methods/ semester periods per week:	Lecture: 3hrs/week; Excersise: 1hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Einführende Module sowie möglichst ein vertiefendes Modul in Akustik und Signalverarbeitung
Aim/learning outcomes:	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.
Content:	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.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report

Literature: Skript: Kollmeier, B.: Psychologische, physiologische und audiologische Akustik (Audiologie);
WA Yost, Fundamentals of Hearing, Academic Press, 2000.;
Blauert, Jens, Räumliches Hören, S. Hirzel Verlag, 1997.;
A Bregman, Auditory Scene Analysis, MIT Press, 1990.;
M Cooke, Modelling Auditory Processing and Organisation, Cambridge University Press, 1993.;
P Dallos and AN Popper and RR Fay, The Cochlea, Springer Handbook in Auditory Research, 1996.;
Kießling, J., Kollmeier, B., Diller, G., Versorgung und Rehabilitation mit Hörgeräten, Thieme, Stuttgar;
Moore, Brian C. J., Hearing, Academic Press, 1995.;
Moore, Brian C. J., An introduction to the psychology of hearing, Academic Press, 1997.;
JO Pickles, An Intoduction to the Physiology of Hearing, Academic Press, 1988.;
W Yost and A Popper and R Fay, Human Psychophysics, Springer Handbook in Auditory Research 3, Springer Verlag, 1993.;
Zwicker, E. and Fastl, H., Psychoacoustics : Facts and Models, Springer, 1999.

5.2.2 Processing and analysis of biomedical data

⇐

Module title:	Processing and Analysis of Biomedical Data
Module code:	phy678
Course:	Processing and analysis of biomedical data (WS, 5.04.4207)
Term:	Winter
Person in charge:	Prof. Dr. ir. Doclo
Lecturer:	S. Uppenkamp, S. Ewert, V. Hohmann
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st-3rd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week, Exercise: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basic signal processing, algebra knowledge
Aim/learning outcomes:	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.
Content:	Normal distributions and significance testing, Monte-Carlo bootstrap techniques, Linear regression, Correlation, Signal-to-noise estimation, Principal component analysis, Confi-dence intervals, Dipole source analysis, Analysis of variance Each technique is explained, tested and discussed in the exercises.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report
Media:	Slides, Computer Exercises
Literature:	Kirkwood B.R. and Sterne A.C., Essential Medical Statistics: 2nd editition. 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

5.2.3 Advanced Topics Speech and Audio Processing

⇐

Module title:	Advanced Topics Speech and Audio Processing
Module code:	Phy696
Course:	Advanced Topics Speech and Audio Processing (WS, 5.04.4586)
Term:	Winter
Person in charge:	Prof. Dr. ir. Doclo
Lecturer:	Prof. Dr. S. Doclo, Prof. Dr.-Ing. T. Gerkmann
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week, Exercise: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basic principles of signal processing (preferably successfully completed the course Signal- und Systemtheorie and/or Blockpraktikum Digitale Signalverarbeitung)
Aim/learning outcomes:	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.
Content:	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).
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report
Literature:	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.

5.2.4 Advanced Topics in Biomedical Physics and Acoustics

⇐

Module title:	Advanced Topics in Biomedical Physics and Acoustics
Module code:	phy686
Course:	This module offers special as well as advanced courses in Biomedical Physics and Acoustics. The list of eligible courses will be updated each academic year. Please refer to the courses listed for this module in Stud.IP.
Term:	winter or summer
Person in charge:	Prof. Dr. B. Poppe and Prof. Dr. ir. Doclo
Lecturer:	Related to selected course/s
Language:	Related to selected course/s
Location	Oldenburg
Curriculum allocation:	1st to 3rd semester
Teaching Methods/ semester periods per week:	Related to selected course/s
Workload:	Overall workload of 180 h
Credit points:	3 + 3 or 6
Prerequisites acc. syllabus	
Recommended prerequisites:	Related to selected course/s
Aim/learning outcomes:	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.
Content:	Photonics, Optics, Metrology,
Assessment/type of examination:	Related to selected course/s
Literature:	Related to selected course/s

6 Laser and Optics

6.1 Engineering Sciences

6.1.1 Spectrophysics

⇐

Module title:	Spectrophysics
Module code:	Phy632
Course:	Applied Photonics I / Spectrophysics (WS, 5.04.4661)
Term:	Winter
Person in charge:	Prof. Dr. Neu
Lecturer:	Prof. Dr. Walter Neu
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 3 hrs/week,Laboratory: 1 hrs/week
Workload:	Attendance: 28 hrs, Self study: 62 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Atomic and Molecular Physics, Optical systems
Aim/learning outcomes:	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.
Content:	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
Assessment/type of examination:	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework

Literature:	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

6.1.2 Optics

⇐

Module title:	Optics
Module code:	Phy633
Course:	Applied Photonics II - Fundamentals of Optics (WS, 5.04.657)
Term:	Winter
Person in charge:	Prof. Dr. Neu
Lecturer:	Prof. Dr. Ulrich Teubner
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 3 hrs/week, Laboratory: 1 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Electrodynamics
Aim/learning outcomes:	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.
Content:	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)
Assessment/type of examination:	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework
Literature:	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

6.1.3 Mikrorobotik II

⇐

Module title:	Mikrorobotik II
Module code:	Inf308
Course:	Mikrorobotik II (2.01.308)
Term:	Summer
Person in charge:	Prof. Dr. Sergej Fatikow
Lecturer:	Prof. Dr. Sergej Fatikow
Language:	German, English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st – 3rd Semester
Teaching Methods/ semester periods per week:	Lecture: 3 hrs/week, exercise: 1 hr/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	Nachdem im Modul "Mikrorobotik und Mikrosystemtechnik" eine fundierte Einführung in die Mikrosystemtechnik und Mikrorobotik gegeben wurde, bietet diese Veranstaltung eine Vertiefung in das komplexe Gebiet der Mikro- und Nanorobotik. Dabei werden alle relevanten Teilbereiche der Mikrorobotik, u.a. auch sämtliche Forschungsthemen der Abteilung für Mikrorobotik und Regelungstechnik (AMiR) präsentiert und analysiert. Dem Student wird u.a. ein tiefer Einblick in die aktuellen Forschungsprojekte der AMiR und anderer Mikrorobotik-Institute weltweit ermöglicht, wobei in erster Linie die Anforderungen der Industrie an die Mikrorobotik diskutiert werden. Die Veranstaltung wird durch praxisnahe Übungen in den Forschungslaboren der AMiR abgerundet.

	Fachkompetenzen Die Studierenden benennen und erkennen die Grundkonzepte der Nanotechnologie, insbesondere die Ansätze der Mikro- und Nanorobotik differenzieren die Konzepte der Mikro- und Nanorobotik, speziell auf den Gebieten der Entwicklung, Steuerung/Regelung und Anwendung von mikro- und nanorobotischen System wenden ihr Wissen für den Entwurf von anwendungsspezifischen Mikro- und Nanorobotersystemen an. **Methodenkompetenzen** Die Studierenden übertragen die erlangten Fähigkeiten in den Bereichen der Regelungstechnik und Bildverarbeitung auf fachübergreifende Problemstellungen übertragen die Kompetenz praktische Erfahrungen in der Entwicklung, Steuerung/Regelung und Anwendung von mikrorobotischen Systemen auf neue Aufgaben. **Sozialkompetenzen** Die Studierenden arbeiten im Team **Selbstkompetenzen** Die Studierenden reflektieren ihr Vorgehen beziehen ihre praktischen Erfahrungen in der Entwicklung, Steuerung/Regelung und Anwendung von mikrorobotischen Systemen in ihre Handlungen ein
Content:	- Rasterelektronenmikroskopie und Rasterkraftmikroskopie - Intelligente multifunktionale Mikrorobotik - Mikroaktoren (Piezo-, Ferrofluid-, SMA-Aktoren) für Mikroroboter - Echtzeit-Bildverarbeitung in der Mikro- und Nanowelt (REM, AFM, optische Mikroskopie) - Mikrokraftsensoren und taktile Sensoren für Mikroroboter - Roboterregelung, u.a. mit Hilfe neuronaler Netze und Fuzzy-Logik - Haptische Benutzerschnittstelle zur Steuerung von Mikrorobotern - Roboterbasierte Mikro- und Nanohandhabung (REM, TEM, AFM, optische Mikroskopie) - Anwendungen: Mikro- und Nanomontage, Test von Nanoschichten, Handhabung und Charakterisierung von Kohlenstoffnanoröhren, Handhabung biologischer Zellen - Mehrrobotersysteme in der Mikrowelt: Kommunikation, Steuerung, Kooperation
Assessment/type of examination:	Fachpraktische Übungen und mündliche Prüfung

Literature:	Vorlesungsskript in Buchform (kann nach Fertigstellung zum Selbstkostenpreis im Sekretariat A1 3-303 erworben werden) Fatikow, Sergej (Ed.): Automated Nanohandling by Microrobotics, Springer, London, 2008

6.1.4 Medizinische Optik

⇐

Module title:	Medizinische Optik
Module code:	phy608
Course:	Medizinische Optik (WS, 5.04.663)
Term:	Winter
Person in charge:	Prof. Dr. Neu
Lecturer:	Prof. Dr. Neu
Language:	German (English)
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st – 3rd Semester
Teaching Methods/ semester periods per week:	Lecture / 4 hrs/week
Workload:	Attendance:56 hours, Self study: 124 hours
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Medizin für Naturwissenschaftler, Optik, Laserphysik
Aim/learning outcomes:	Vermittlung fortgeschrittener Kenntnisse im Bereich der medizinischen Optik und optischer Technologien in der Medizin sowie deren theoretischem Hintergrund und der experimentellen Methoden. Die Studierenden werden wissenschaftlich kompetent positioniert, um aktuelle Entwicklungen kritisch zu verfolgen und die Gestaltung (Entwicklung und Design) innovativer optischer Applikationen in der Medizin zu initiieren.
Content:	Physiologie und Psychophysik des Sehens, Theorie von Abbildungssystemen, Ophthalmologische Optik, Lichttechnik, Photometrie, Sehen am Arbeitsplatz und im Verkehr, optische Messungen am Patienten, diagnostische und therapeutische Laseranwendungen, Strahlenschutz (Infrarot, UV, Laser), Mikroskopie, Beugungs- und subbeugungsbegrenzte Verfahren, optische Spektroskopie, Fluoreszenzverfahren
Assessment/type of examination:	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework
Media:	Lecture script, transparencies, blackboard, electronic media, presentation, lecture practical demonstrations
Literature:	Bille, J., Schlegel, W.: Medizinische Physik 3. Medizinische Laserphysik. Springer, Berlin, 2005. ISBN: 3540266305 Faller, A., Schünke, M.: Der Körper des Menschen. Thieme Verlag, 2004. Glaser, R.: Biophysics. Springer-Verlag, 2001 Dössel, O.: Bildgebende Verfahren in der Medizin. Springer-Verlag, 2000. Hoppe,W., Lohmann, W., Markl, H., Ziegler, H. (Hrsg.): Biophysik. Springer-Verlag 1982 J. Kiefer: Biological Radiation Effects, Springer Verlag 1990

6.1.5 Advanced Engineering Topics in Laser and Optics

⇐

Module title:	Advanced Engineering Topics in Laser and Optics
Module code:	phy682
Course:	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.
Term:	winter or summer
Person in charge:	Prof. Dr. W. Neu
Lecturer:	Related to selected course/s
Language:	Related to selected course/s
Location	Oldenburg
Curriculum allocation:	1st to 3rd semester
Teaching Methods/ semester periods per week:	Related to selected course/s
Workload:	Overall workload of 180 h
Credit points:	3 + 3 or 6
Prerequisites acc. syllabus	
Recommended prerequisites:	Related to selected course/s
Aim/learning outcomes:	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.
Content:	Photonics, Optics, Metrology,
Assessment/type of examination:	Related to selected course/s
Literature:	Related to selected course/s

6.2 Specialization

6.2.1 Laser Design and Beam Guiding

⇐

Module title:	Laser Design and Beam Guiding
Module code:	Phy637
Course:	Laser Design and Beam Guiding (SS, 5.04.4664)
Term:	Summer
Person in charge:	Prof. Dr. W. Neu
Lecturer:	Prof. Dr. B. Struve
Language:	English / German
Location	Oldenburg / Emden
Curriculum allocation:	Master Engineering Physics 2nd semester, specialization Laser and Optics
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week , practical applications included in lecture
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	basic knowledge on optics and laser physics
Aim/learning outcomes:	students acquire advanced knowledge for the design of lasers and laser systems, they also understand the propagation of laser beams and their forming.
Content:	design of different laser types; physics of active and passive laser components; beams and resonators; lab work
Assessment/type of examination:	2 hr written examination or 30 min oral examination or experimental work or homework presentation
Literature:	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, VDE-Verlag, Berlin; Additional literature given in the lecture

6.2.2 Lasermaterialbearbeitung

⇐

Module title:	Lasermaterialbearbeitung
Module code:	Phy638
Course:	Lasermaterialbearbeitung unter besonderen werkstoffwissenschaftlichen Aspekten (WS, 5.04.4669)
Term:	Winter
Person in charge:	Prof. Dr. W. Neu
Lecturer:	Dr.-Ing. Thomas Schüning
Language:	German
Location	Emden
Curriculum allocation:	Photonik (BA); Master Engineering Physics, 1st – 3rd Semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Knowledge in physics, optics, production engineering
Aim/learning outcomes:	Fundamental knowledge of the characteristics of the laser beam, Knowledge of laser sources for industrial applications, knowledge of procedures of the material processing with laser beams Knowledge of the physical-technical procedures of the individual manufacturing processes with laser beams; Ability for the estimation of favorable working parameters; The participants should be able to understand the procedures of the material processing with laser beams and evaluate the tasks of manufacturing
Content:	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
Assessment/type of examination:	Fachpraktische Übung oder Referat oder mündliche Prüfung
Literature:	Script;H. Hügel: Strahlwerkzeug Laser, Teubner Studienbücher; Materialbearbeitung mit dem Laserstrahl im Geräte- und Maschinenbau, VDI-Verlag; Hügel, Helmut: Laser in der Fertigung, Vieweg + Teubner Verlag

6.2.3 Biophotonics and Spectroscopy

⇐

Module title:	Biophotonics and Spectroscopy
Module code:	phy634
Course:	Biophotonics and Spectroscopy (SS, 5.04.4667)
Term:	Winter or Summer
Person in charge:	Prof. Dr. W. Neu
Lecturer:	W. Neu, M. Schellenberg, S. Koch
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st – 3rd Semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week, Seminar: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basics in optics and laser physics, in particular, fundamentals of optics and photonics; atomic and molecular physics; spectrophysics
Aim/learning outcomes:	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.
Content:	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
Assessment/type of examination:	max. 2hr written examination or max 1h oral examination or experimental work and laboratory reports or presentation or homework

Literature: 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

6.2.4 Physics with Ultrashort Pulses and Intense Light

⇐

Module title:	Physics with Ultrashort Pulses and Intense Light
Module code:	phy639
Course:	Physics with Ultrashort Pulses and Intense Light (SS, 5.04.4663)
Term:	Summer
Person in charge:	Prof. Dr. W. Neu
Lecturer:	Prof. Dr. Ulrich Teubner
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week; Laboratory: 2 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basics in optics and laser physics, in particular, Fundamentals of Optics and Photonics; Atomic Physics, Electrodynamics
Aim/learning outcomes:	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.
Content:	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
Assessment/type of examination:	experimental work and laboratory reports or max. 2hr written examination or max 1h oral examination or presentation or homework
Literature:	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

6.2.5 Fiber Technology and Integrated Optics

⇐

Module title:	Fiber Technology and Integrated Optics
Module code:	phy636
Course:	Fiber Technology and Integrated Optics (WS, 5.04.664) (lecture and experimental work in laboratory)
Term:	Winter
Person in charge:	Prof. Dr. Brückner, Prof. Dr. Kühn, Prof. Dr. ir. Doclo
Lecturer:	Prof. Dr. Brückner
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, specialization Laser and Optics
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	basic knowledge on laser physics, optoelectronics or optical communication
Aim/learning outcomes:	students acquire basic knowledge for applications and handling of optical fibers and components and for assembling fiber systems
Content:	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
Assessment/type of examination:	Experimental work or 1 hr written examination or 30 min oral examination
Literature:	Excerpts from lecture script.; Voges, Petermann: Optische Kommunikationstechnik, Springer Verlag, 2002; John M. Senior: Optical Fiber Communication, Prentice Hall 1992

6.2.6 Advanced Topics in Laser and Optics

⇐

Module title:	Advanced Topics in Laser and Optics
Module code:	phy683
Course:	This module offers special as well as advanced 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.
Term:	winter or summer
Person in charge:	Prof. Dr. W. Neu
Lecturer:	Related to selected course/s
Language:	Related to selected course/s
Location	Oldenburg
Curriculum allocation:	1st to 3rd semester
Teaching Methods/ semester periods per week:	Related to selected course/s
Workload:	Overall workload of 180 h
Credit points:	3 + 3 or 6
Prerequisites acc. syllabus	
Recommended prerequisites:	Related to selected course/s
Aim/learning outcomes:	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.
Content:	Photonics, Optics, Metrology,
Assessment/type of examination:	Related to selected course/s
Literature:	Related to selected course/s

7 Renewable Energies

7.1 Engineering Sciences

7.1.1 Energy Ressource and Systems

⇐

Module title:	Energy Ressource and Systems
Module code:	phy641
Course:	Energy Meteorology (WS, 5.06.021) and Energy Systems (WS, 5.06.022)
Term:	Winter
Person in charge:	Dr. D. Heinemann
Lecturer:	Dr. D. Heinemann
Language:	English
Location	Oldenburg
Curriculum allocation:	1st Semester
Teaching Methods/ semester periods per week:	each Lecture: 2hrs/week
Workload:	Attendance: 56 hrs, Self-study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus	
Recommended prerequisites:	
Aim/learning outcomes:	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 fluctuating 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.

Content:	This module will give an overview on the global energy system and the challenges of energy supply due to fluctuating 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
Assessment/type of examination:	written exam

Literature:

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/)

7.1.2 Renewable Energy Technologies I for Engineering Physics

⇐

Module title:	Renewable Energy Technologies I for Engineering Physics
Module code:	Phy642
Course:	Photovoltaics (WS 5.06.035) and Fuel Cells and Energy Storage (WS, 5.06.036)
Term:	Winter
Person in charge:	H. Holtorf
Lecturer:	Dr. R. Knecht, Prof. Dr. R. Steinberger-Wilckens, Dr. H. Holtorf
Language:	English
Location	Oldenburg
Curriculum allocation:	1st semester
Teaching Methods/ semester periods per week:	each lecture: 2 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	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.

Content:	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
Assessment/type of examination:	Written exam, 2 times 1 hour related to the specific fields of renewable energy within the module

Literature:	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. Aufl. 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.

7.1.3 Renewable Energy Technologies II for Engineering Physics

⇐

Module title:	Renewable Energy Technologies II for Engineering Physics
Module code:	phy643
Course:	Biomass Energy (WS, 5.06.031) and Solar Thermal (WS, 5.06.032)
Term:	Winter
Person in charge:	H. Torio
Lecturer:	Prof. Dr. Michael Wark, Dr. Herena Torio
Language:	English
Location	Oldenburg
Curriculum allocation:	1st Semester or 3rd semester
Teaching Methods/ semester periods per week:	Lecture: 2 hrs/week and Seminar: 2 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	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.

Content:	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.
Assessment/type of examination:	1 Referat (limited page number) and one written exam of 1 hour. Assessments related to the specific fields of renewable energy within the module

Literature:

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.

7.1.4 Wind Energy Physics, Data and Analysis

⇐

Module title:	Wind Energy Physics, Data and Analysis
Module code:	phy644
Course:	Wind Energy Physics (WS,5.04.4061) and Wind Physics Measurements Project (SS, 5.04.4234)
Term:	Winter Winter and Summer
Person in charge:	Prof. Dr. M. Kühn
Lecturer:	Prof. Dr. Martin Kühn, Dr. Detlev Heinemann, Dr. Matthias Wächter, Dipl.-Phys., Prof. Dr. Joachim Peinke
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	attendance: 2*28 hrs, self-study: 124 hrs
Workload:	6
Credit points:	
Prerequisites acc. syllabus:	The module starts in the winter term: Wind Energy Physics has to be taken before participating in Wind Physics Measurement Project
Recommended prerequisites:	
Aim/learning outcomes:	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
Content:	The winter term lecture 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, (pi-theorem), 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)

Assessment/type of examination:	Portfolio
Literature:	R. Gasch , J. Twele : Wind Power Plants Fundamentals, Design, Construction and Operation, 2nd Ed., Springer Verlag, 2012, ISBN: 978 3 642 22937 4 S. Emeis : Wind Energy Meteorology: Atmospheric Physics for Wind Power Generation, Springer, 2012 Evaluation of site specific wind conditions; MEASNET Guideline; Version 1; November 2009; free available in the internet: http://www.measnet.com/wpcontent/uploads/2012/04/Measnet_SiteAssessment_V10.pdf IEC 61400 12 1:2005 Power performance measurements of electricity producing wind turbines; guideline

7.1.5 Computational Fluid Dynamics

⇐

Module title:	Computational Fluid Dynamics
Module code:	phy616
Course:	Computational Fluid Dynamics I and II, (SS, 5.04.4072 and 5.04.4075)
Term:	Summer
Person in charge:	Prof. Dr. L. Lukassen,
Lecturer:	Prof. Dr. L. Lukassen, Prof. Dr. J. Peinke , Dr. B. Stoevesandt
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 3nd semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week, Excersise: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	Fluid Dynamics I
Recommended prerequisites:	
Aim/learning outcomes:	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.
Content:	**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.
Assessment/type of examination:	1 written or oral exam or 1 report

Literature:	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)

7.1.6 Fuzzy-Regelung und künstliche neuronale Netzte in Robotik und Automation

⇐

Module title:	Fuzzy-Regelung und künstliche neuronale Netze in Robotik und Automation
Module code:	inf303
Course:	Fuzzy-Regelung uns künstliche neuronale Netze in Robotik und Automation (SS, 2.01.303)
Term:	Summer
Person in charge:	B. Poppe, N.N.
Lecturer:	Prof. Dr. Sergej Fatikow
Language:	German
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st – 3rd Semester
Teaching Methods/ semester periods per week:	VL: 3 SWS, Ü: 1 SWS
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	Studierende sollen als Spezialisten verschiedener Disziplinen ihre anwendungsspezifischen Steuerungs- und Informationsverarbeitungsprobleme durch den Einsatz von Fuzzy-Logik und neuronaler Netze lösen können.
Content:	Steuerungsprobleme in Robotik und Automation, Einführung in Fuzzy- und Neuro-Systeme, Grundlagen der Fuzzy-Logik, Fuzzy-Logik regelbasierter Systeme, Modelle neuronaler Netze, Lernalgorithmen für neuronale Netze, Mehrschichtige Netze und Backpropagation, Assoziativspeicher und stochastische Netze, Selbstorganisierende Netze, Entwurf klassischer Regler, Entwurf von Fuzzy-Regelungssystemen, Praktische Anwendungen der Fuzzy-Logik, Entwurf von Neuro-Regelungssystemen, Praktische Anwendungen neuronaler Netze, Fuzzy + Neuro: Grundlagen und Anwendungen
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report

Literature:

Essentiell:
Vorlesungsskript in Buchform (erhältlich zum Selbstkostenpreis von Euro 10,- im Sekretariat, A1-3-303);

Empfohlen:
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;

Gute Sekundärliteratur:
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. and 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

7.1.7 Digital Signal Processing

⇐

Module title:	Digital Signal Processing
Module code:	phy605
Course:	Digital Signal Processing (SS, 5.04.4586)
Term:	Term: Summer
Person in charge:	Prof. Dr. Doclo
Lecturer:	Prof. Dr. Doclo
Language:	German or English depending on demand
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st – 3rd Semester
Teaching Methods/ semester periods per week:	Lecture: 2hrs/week; Exersise: 2hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Students should have acquired basic knowledge about continuous-time and discrete-time signal processing and system theory.
Aim/learning outcomes:	Theoretical methods of signal processing and system theory for discrete-time signals and systems. Application of the theoretical methods in analytical, numerical and programming exercises.
Content:	System properties (stability, linearity, time-invariance, causality); Discrete-time signal processing: sampling theorem, time-domain analysis (impulse response, convolution), z-transform, frequency-domain analysis (transfer function, discrete-time Fourier transform, discrete Fourier transform, FFT, STFT), digital filter design (FIR, IIR, linear phase filter, signal flow graph), multi-rate signal processing (down/up-sampling, filter banks); Statistical signal processing: stationarity, ergodicity, correlation, Wiener-Khinchin theorem, spectral estimation; Adaptive filters: optimal filters, Wiener filter, time-domain algorithms (RLS, NLMS), frequency-domain algorithms (FDAF);Matlab exercises about discrete-time signal processing and adaptive filters.
Assessment/type of examination:	written exam (2 hours)
Literature:	A. V. Oppenheim, R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, 2013. J. G. Proakis, D. G. Manolakis, "Digital Signal Processing – Principles, Algorithms and Applications", Prentice Hall, 2013. S. Haykin, „Adaptive Filter Theory", Pearson, 2013. P. P. Vaidyanathan, „Multirate systems and filter banks", Prentice Hall, 1993. K.-D. Kammeyer, K. Kroschel, „Digitale Signalverarbeitung: Filterung und Spektralanalyse mit MATLAB-Übungen", Broschiert, 2018.

7.1.8 Advanced Engineering Topics in Renewable Energies

⇐

Module title:	Advanced Engineering Topics in Renewable Energies
Module code:	phy687
Course:	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.
Term:	winter or summer
Person in charge:	Prof. Dr. Martin Kühn
Lecturer:	Related to selected course/s
Language:	Related to selected course/s
Location	Oldenburg
Curriculum allocation:	1st to 3rd semester
Teaching Methods/ semester periods per week:	Related to selected course/s
Workload:	Overall workload of 180 h
Credit points:	3 + 3 or 6
Prerequisites acc. syllabus	
Recommended prerequisites:	Related to selected course/s
Aim/learning outcomes:	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.
Content:	E.g. metrology, data logging, measurement methodology, construction, monitoring, control engineering, remote sensing.
Assessment/type of examination:	Related to selected course/s
Literature:	Related to selected course/s

7.2 Specialization

7.2.1 Photovoltaic Physics

⇐

Module title:	Photovoltaic Physics
Module code:	phy609
Course:	Photovoltaic Physics (SS, 5.04.4063)
Term:	Summer
Person in charge:	Prof. Dr. M. Kühn
Lecturer:	Dr. Michael Richter, Dr. Levent Güntay
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Solid-state-Pysics, semi-conductor Physics, Module Renewable Energy Technologies I
Aim/learning outcomes:	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
Content:	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
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report
Literature:	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

7.2.2 Wind Physics Student's Lab

⇐

Module title:	Wind Physics Student's Lab
Module code:	phy646
Course:	Wind Physics Student's Lab; Currently two different seminars: • Dynamics and control of grid-connected wind turbines (WS, 5.04.4238) • Wind turbine rotor in turbulent inflow (WS, 5.04.4239)
Term:	Winter and Summer
Person in charge:	Prof. Dr. Kühn
Lecturer:	Andreas Schmidt
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 3rd semester
Teaching Methods/ semester periods per week:	Seminar with laboratory experiments for research-based learning / Seminar mit Blockpraktikum zum forschungsbasierten Lernen: 4 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	Wind Energy Utilization (BA) or equivalent course, Design of Wind Energy Systems: in SAME SEMESTER or before
Recommended prerequisites:	Basic computer knowledge; mechanics; mathematical methods for physics and engineering; basic knowledge of wind energy utilization; previous knowledge of metrology, basic knowledge of aerodynamics. Prerequisites for "Dynamics and control of grid-connected wind turbines": Function of lift-driven wind energy converters; description of rotor behavior by means of dimensionless parameters, basics of electrotechnics. Prerequisites for "Wind turbine rotor in turbulent inflow": Basics of stochastics.
Aim/learning outcomes:	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 different versions. These versions represent the work of different research groups at ForWind – University Oldenburg. The seminars will be offered in subsequent semesters or in parallel.

Content:

The seminar "Dynamics and control of grid-connected wind turbines" is related to the work of the research group Wind Energy Systems (WESys). It intends to give a deeper insight into two fields of wind engineering: One is the grid connection and interaction of wind turbines and the other is their operational control as special case in the field of control engineering. The seminar uses an experimental system which allows to investigate control tasks and interaction mechanisms of the functional chain of wind field, rotor, drive train, generator, transformer and electric grid. The seminar consists of three main phases:

1st phase: Preparational learning

- building up basic competences
- identification of the technical tasks
- introduction to current research
- introduction to the experiment
- investigating standard situations, physical effects and functional principles by means of the experimental system

2nd phase: Research-based learning

- defining own research questions
- defining an experimental strategy
- planning the experiment
- 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 to measure wind flows in high resolutions and how turbulence can be described, investigated and evaluated for different purposes. The students gain a deep understanding of the phenomenon of turbulence. They perform own experiments in a wind tunnel with an active turbulence grid. They learn to establish their own research questions and are encouraged to develop own methods.

The seminar consists of three main phases:

1st phase: Preparational learning

- building up basic competences
- introduction to current research
- practical measurements of flows with different sensors in the wind tunnel
- evaluation methods of data of turbulent wind flows

2nd phase: Research-based learning

- defining own research questions
- defining an experimental strategy
- planning the experiment
- set-up, execution, data acquisition and decommissioning of experiments

3rd phase: Evaluation and documentation

- evaluating the experiment

Assessment/type of examination:	Portfolio
Literature:	English Language: Robert Gasch, Wind Power Plants – Fundamentals, Design, Construction and Operation, 2nd Ed., 2012, Springer-Verlag; ISBN: 978-3-642-22937-4 German Language: Robert Gasch, Windkraftanlagen - Grundlagen und Entwurf, 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. 6th Ed., 2016, Springer-Verlag; ISBN: 978-3-662-53154-9

7.2.3 Future Power Supply Systems

⇐

Module title:	Future Power Supply Systems
Module code:	phy647
Course:	Future Power Supply Systems (SS, 5.06.306)
Term:	Summer
Person in charge:	Prof. Dr. Carsten Aggert
Lecturer:	Prof. Dr. Carsten Aggert
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture and Seminar: 4 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	Renewable Energy Technologies I
Recommended prerequisites:	Knowledge from module RE technology I, Mathematics
Aim/learning outcomes:	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 micro-grids - 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

Content:	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-to-gas (e.g. methane) and power-to-liquids (e.g.methanol)
Assessment/type of examination:	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.
Literature:	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

7.2.4 Wind Resources and its Applications

⇐

Module title:	Wind Resources and its Applications
Module code:	phy648
Course:	Wind Resources and its Applications (SS, Advanced Wind Energy Meteorology, 5.04.4063 and SS, Wind Energy Application, 5.06.205)
Term:	Summer
Person in charge:	Prof. Dr. M. Kühn
Lecturer:	Dr. Igor Waldl, Dr. Detlev Heinemann
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	Attendance: 72 hrs, Self study: 108 hrs
Credit points:	6
Prerequisites acc. syllabus:	Energy Meteorology
Recommended prerequisites:	Knowledge in Basics Wind Energy, Fluid Dynamics I, Matlab,
Aim/learning outcomes:	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 influences 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.

Content:	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 Risø Models Spacing and efficiency 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
Assessment/type of examination:	

Literature:	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

7.2.5 Design of Wind Energy Systems

⇐

Module title:	Design of Wind Energy Systems
Module code:	phy649
Course:	Design of Wind Energy Systems (SS, 5.04.4235)
Term:	Winter
Person in charge:	Prof. Dr. M. Kühn
Lecturer:	Prof. Dr. Martin Kühn, Dr. Vlaho Petrovic
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture and seminar: 2 and 2 hrs/week
Workload:	Attendance: 72 hrs, Self study: 108 hrs
Credit points:	6
Prerequisites acc. syllabus:	Wind Energy Utilization (Bachelor) or Wind Energy (Master)
Recommended prerequisites:	Basics in Wind Energy Utilisation
Aim/learning outcomes:	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 specific 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
Content:	- 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.
Assessment/type of examination:	Exam or presentation or oral exam or homework or practical report

Literature:	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

7.2.6 Photovoltaic Systems and Energy Meteorology

⇐

Module title:	Photovoltaic Systems and Energy Meteorology
Module code:	phy699
Course:	Photovoltaic Systems (SS, 5.06.302) and Advanced Solar Energy Meteorology (SS 5.04.4064)
Term:	Summer
Person in charge:	Hans Holtorf
Lecturer:	Hans Holtorf, Phd , Dr. Detelv Heinemann
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture: 4 hrs/week
Workload:	Attendance: 56 hrs, Self study: 124 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basic knowledge of solar radiation and solar resources phy642 Renewable Energy Technologies I
Aim/learning outcomes:	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

Content:	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 high-quality 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
Assessment/type of examination:	Passing of the written exam in Solar Energy Meteorology (120 min). Active participation in Photovoltaic Systems. The specific conditions of the active participation will be communicated in the beginning of the semester.
Literature:	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) Heinrich Haeberlin, Photovoltaics: System Design and Practice, John Wiley and Sons, First Edition, Chichester, 2012.(ISBN-13: 978-1119992851) lecture notes for the respective courses

7.2.7 Smart Grid Management

⇐

Module title:	Smart Grid Management
Module code:	Inf511
Course:	Smart Grid Management (SS, 2.01.511)
Term:	Summer
Person in charge:	Prof. Dr. M. Kühn
Lecturer:	Prof. Dr. Sebastian Lehnhoff
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 2nd semester
Teaching Methods/ semester periods per week:	Lecture / excercise: 3 and 1 hrs/week
Workload:	Attendance: 72 hrs,Self study: 108 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	physics, digital information processing

Aim/learning outcomes:	After successful completion of the course, students should understand the existing structures and technical basics of energy systems for the generation, transmission and distribution of electrical energy and their interactions and interdependencies. They should be able to develop an understanding of the necessary information and control technology components, procedures and processes for the management and operation of electrical energy systems and be able to assess and evaluate the challenges and demands, in particular for information and communication technology (ICT) and for energy informatics, which arise from the expansion and integration of unpredictably fluctuating decentralised generators into the existing system. The students should be enabled to assess the influence of distributed control concepts and algorithms for distributed generators and consumers in so-called Smart Grids on the operation of electrical energy systems and to analyse it with regard to the requirements for operational safety, reliability, real-time capability and flexibility. **Expertise** The students • name and recognise the existing structures and technical bases of energy systems for the generation, transmission and distribution of electrical energy as well as interactions and interdependencies between them • identify necessary information and control components, procedures and processes for the control and operation of electrical energy systems • assess the challenges posed by the development and integration of decentralised producers into the existing system who fluctuate unpredictably • assess the influence of distributed control concepts and algorithms for distributed generators and consumers in so-called smart grids on the operation of electrical energy systems **Methodological skills** The students: • analyse requirements in terms of operational safety, reliability, real-time capability and flexibility in so-called Smart Grids for the operation of electrical energy systems • use advanced mathematical methods of network calculation **Social competencies** The students: • develop solutions to given problems in small groups • discuss their own solutions with one another **Personal competences** The students: • reflect on their own behaviour with the limited resource of energy

Content:	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 pointer, effective/idle power, mathematical performance models/net model, transformation: node performance to node voltage and electricity, calculation of conductive current, power-flow calculation, fix-point-iteration, Newton-Raphson-Method, voltage drop, transformer model) • Intelligent network management (Smart Grids), Aggregation forms, machine learning approaches) • 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
Assessment/type of examination:	oral exam or written exam
Literature:	• N Singh, E Kliokys, H Feldmann, R Kussel, R Chrustowski und C Joborowicz: "Power system modelling and analysis in a mixed energy management and distribution management system" • Prabha Kundur: "Power system stability and control" • Federico Milano: "Power system modelling and scripting" • Daniel Kirschen und Goran Strbac: "Fundamentals of Power System Economics"

7.2.8 Energieinformationssysteme

⇐

Module title:	Energieinformationssysteme
Module code:	inf510
Course:	Energieinformationssysteme (WS, 2.01.510)
Term:	Winter
Person in charge:	Prof. Dr. M. Kühn
Lecturer:	Dr. Jörg Bremer, Prof. Dr. Sebastian Lehnhoff, Astrid Niesse
Language:	Deutsch
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics, 1st semester
Teaching Methods/ semester periods per week:	Lecture / seminar: 2 and 2 hrs/week
Workload:	Attendance: 72 hrs, Self study: 108 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	
Aim/learning outcomes:	Die Studierenden besitzen Kenntnisse über verschiedene Ansätze zur Integration dezentraler Anlagen, den regulatorischen Rahmen, die dazu relevanten Normen und Architekturkonzepte und können dieses Wissen in konkreten Anwendungsfällen zielgerichtet anwenden. Fachkompetenzen Die Studierenden: entwerfen und bewerten IT-Architekturen für das Energiemanagement modellieren die Objekte der Domäne modellieren Energieinformationssysteme erkennen und differenzieren weitergehende Fragestellungen im Rahmen des dezentralen Energiemanagements Methodenkompetenzen Die Studierenden: benennen Probleme aus dem Bereich der Energiemanagement und analysieren diese methodisch und schlagen Lösungen vor wenden verschiedene Ansätze zur Simulation dezentraler Erzeuger und Verbraucher an Sozialkompetenzen Die Studierenden: diskutieren gemeinsam Lösungen aus dem Bereich des Energiemanagements erstellen Use-Cases in Kleingruppen präsentieren ihre Lösungen. Selbstkompetenzen Die Studierenden: reflektieren ihr Handeln durch geeignete Strukturierung und Zerlegung von Systemen reflektieren den eigenen Umgang mit der begrenzten Ressource Energie

Content:	Die Veranstaltung behandelt die Informatikgrundlagen zum Energiemanagement: Vermittlung von Kenntnissen zu den Anforderungen an Informationssysteme der Energieversorgung mit besonderer Berücksichtigung der technischen Komponenten und Anforderungen dezentraler und regenerativer Energieerzeugung. Im Einzelnen sind dies: Architekturtypen für Energieinformationssysteme, wie bspw. SOA, Seamless Integration Architecture (IEC TC 57), OPC-UA Datenmodelle der Energiebranche unter Berücksichtigung vorhandener Standards und Normen (CIM, 61850) Systematisierung von domänenspezifischen Anforderungen an Energieinformationssysteme durch eine einheitliche "Begriffswelt" (Ontologie) Entwicklung, Analyse und Adaption von Referenzmodellen und -prozessen für die Energiewirtschaft Verfahren und Techniken zur Unterstützung von Prozessen in der Energiewirtschaft Verfahren und Algorithmen zur Entscheidungsunterstützung beim Einsatz dezentraler Energieerzeugungsanlagen Kommunikation mit Anlagen in Smart Grids, insbesondere bzgl. Lastmanagement Methoden zur abstrakten Modellierung und Simulation der Dynamik in Stromversorgungssystemen
Assessment/type of examination:	Referat oder Hausarbeit
Media:	
Literature:	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

7.2.9 Control of Wind Turbines and Wind Farms

⇐

Module title:	Specialization
Module code:	phy987
Course:	Control of Wind Turbines and Wind Farms
Term:	Summer
Person in charge:	Prof. Dr. M. Kühn
Lecturer:	Dr. Vlaho Petrović
Language:	English
Location	Oldenburg
Curriculum allocation:	Master Engineering Physics 2nd semester
Teaching Methods/ semester periods per week:	Lectures and exercises: 4 hours per week and home assignments
Workload:	Attendance: 72 hrs, Self study: 108 hrs
Credit points:	6
Prerequisites acc. syllabus:	
Recommended prerequisites:	Basic knowledge in linear algebra and mathematical analysis is required. Furthermore, a basic understanding of wind turbines and wind farms is required (e.g. Design of Wind Energy Systems). A good grasp of the Matlab/Simulink environment is required for exercises.
Aim/learning outcomes:	After successful completion of the course, students • will have understood the structure and the main components of the control system in a wind farm • will have understood the main objectives for a wind farm control system and will be able to develop appropriate control algorithms for the said objectives • will have understood relevant physical phenomena in a wind farm • will be able to develop a control-oriented model of a wind turbine, and will have understood how to use it for the design and analysis of control algorithms • will be able to independently apply different techniques from control engineering • will have trained how to use methods from linear algebra and mathematical analysis for the design and analysis of control algorithms

Content:	The course covers the main techniques used in wind turbine and wind farm control. The course is structured in five sections: Section I: Introduction to control in wind energy • Introduction to the governing physics • Control objectives in wind energy • Overview of the control system Section II: Control oriented modelling • Modelling in time domain • Modelling in frequency domain • Time and frequency response Section III: Standard wind turbine control • Torque and pitch control • Tuning of a PI controller • Stability analysis • Control of coupled systems Section IV: Advanced wind turbine control • Advanced control design approaches • State space control • Estimation techniques Section V: Wind farm control • Wake control strategies • Active power control • Power maximization
Assessment/type of examination:	Oral exam or written exam
Media:	Beamer, PCs with Matlab/Simulink for exercises
Literature:	Burton et al: Wind Energy Handbook, John Wiley, New York, Second Edition, 2011. Ogata: Modern Control Engineering, Prentice Hall, Upper Saddle River, New Jersey, Third Edition, 1997.

7.2.10 Advanced Topics in Renewable Energies

⇐

Module title:	Advanced Topics in Renewable Energies
Module code:	phy689
Course:	This module offers special as well as advanced courses in Renweable Energies. The list of eligible courses will be updated each academic year. Please refer to the courses listed for this module in Stud.IP.
Term:	winter or summer
Person in charge:	Prof. Dr.M. Kühn
Lecturer:	Related to selected course/s
Language:	Related to selected course/s
Location	Oldenburg
Curriculum allocation:	1st to 3rd semester
Teaching Methods/ semester periods per week:	Related to selected course/s
Workload:	Overall workload of 180 h
Credit points:	3 + 3 or 6
Prerequisites acc. syllabus	
Recommended prerequisites:	Related to selected course/s
Aim/learning outcomes:	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.
Content:	E.g. Fluid dynamics, metrology, data logging, measurement methodology, construction, monitoring, control engineering, remote sensing.
Assessment/type of examination:	Related to selected course/s
Literature:	Related to selected course/s