Module Handbook
Master “Wind Energy Engineering”

Table of content

Table of content 2
Module overview 4
Compulsory elective modules 5
Module number [1]: Scientific and technical writing 6
Module number [2]: Global wind industry and turbine technology 7
Module number [3]: Wind Energy Planning 9
Module number [4]: Advanced engineering mathematics 10
Module number [5]: Mechanical engineering basics 11
Module number [6]: Electrical engineering basics 13
Module number [7]: German for foreign students 14
Module number [8]: English for engineers 15
Module number [9]: Energy economics 16
Module number [10]: Wind turbine aerodynamics 18
Module number [11]: Certification, load assumptions and simulations 19
Module number [12]: Control and automation of wind power plants 21
Module number [13]: Tower and rotor structures 22
Module number [14]: Mechanical drive train 24
Module number [15]: Electrical engineering for wind turbines 25
Module number [16]: Finite elements (FE) & fatigue analysis 26
Module number [17]: Machinery components 27
Module number [18]: Electrical machines, power electronics, control 29
Module number [19]: Grid integration 30
Module number [20]: Structures – rotor blades and civil engineering 32
Module number [21]: Project: development of a wind turbine 33
Module number [22]: Advanced wind farm planning 35
Module number [23]: Offshore wind energy: operation and maintenance 37
Module number [24]: Experimental and computational fluid dynamics 39
Module number [25]: Modelling & simulation of wind turbines 40
Module number [26]: Turbine measurements 42
Module number [27]: Controller design for wind turbines and wind farms 43
Module number [28]: Wind energy challenge project 44
Module number [29]: Green entrepreneurship 46
Module number [30]: Wind Farm Project Development 48
Module number [31]: Master thesis 50

Module overview – Current offer

1. Semester (WiSe)	2. Semester (SuSe)	3. Semester (WiSe)			
		Mechanical engineering	Electrical engineering	Structural engineering	Project development
1 Scientific and technical writing (Jebsen)	10 Wind turbine aerodynamics (Risius, Schlipf)	17 Machinery components (Quell, Ingwersen, Kraemer)	18 Electrical machines and power electronics (Saiju)	20 Structures, rotor blades and civil engineering (Faber, Risius, Previtali)	22 Advanced wind farm planning (Nikolai, Winterfeldt)
2 Global wind industry & turbine technology (Faber, Schlipf, Funk, Schubert, Funk Rave, Schneider)	11 Certification, load assumptions & simulations (Faber, Manjock)	16 Finite elements (FE) & fatigue analysis (N.N., Stankovic)	19 Grid integration (Jauch, Nottrott)	16 Finite elements (FE) & fatigue analysis (N.N., Stankovic)	30 Wind farm project development (Blohm)
9 Energy economics (Hartmann)	12 Control and automation of wind power plants (Schütt)	21 Project: Development of a wind turbine (Quell, Faber et al.)	21 Project: Development of a wind turbine (Quell, Faber et al.)	21 Project: Development of a wind turbine (Quell, Faber et al.)	21 Project: Development of a wind turbine (Quell, Faber et al.)
4 Advanced engineering mathematics (Schlipf)	13 Tower and rotor structures (Faber, Risius, Keindorf)	2 Electives	2 Electives	2 Electives	2 Electives
Elective A	14 Mechanical drive train (Quell)				
Elective B	15 Electrical engineering for wind turbines (Leiße)				

4. Semester (SuSe)

Thesis (module no. 31)

Last updated July 2024

Compulsory elective modules – Current offer

1. Semester (WiSe)

- 5 Mechanical engineering basics (Weychardt)
- 6 Electrical engineering basics (Saiju)
- 7 German for foreign students (Kähler)
- 8 English for engineers (Reimer)

3. Semester (WiSe)

- 3 Wind energy planning and applied geoinformatics (Möller)
- 23 Offshore wind energy: operation and maintenance (Birk)
- 24 Experimental and computational fluid dynamics (Risius)
- 25 Modelling & simulation of wind turbines (Jauch)
- 26 Turbine measurements (Sachse)
- 27 Controller design for wind turbines and wind farms (Schlipf)

Module number [1]: Scientific and technical writing

Course	Master of Science – Wind Energy Engineering
Module name	Scientific and technical writing
Abbreviation (if applicable)	
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Dr. Simon Jebsen, University of Southern Denmark
Lecturer/s	Dr. Simon Jebsen, University of Southern Denmark
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	2 SH lectures, 2 SH writing laboratory
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	English language skills according to admission requirements
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	By the end of the module, the students will be able to: • write academic texts using technical vocabulary • structure academic texts writing concise sentences • define research questions • employ paraphrase and summary • employ quotation and a correct citation style • gain the knowledge of drafting, revising and editing academic texts • evaluate sources for relevance and reliability • identify effective writing techniques in his or her own work and in peer writing • avoid plagiarism • present scientific results in an appropriate way
Subjects covered	• Formats for scientific and technical writing • Structuring scientific papers and texts, especially paragraph structure (topic sentence, supporting example, transition sentence) • Effective introductions, summaries and paraphrase • Effective use of quotation and various citation styles • Writing process (pre-writing, writing, re-writing) • Reading and responding to assigned readings • Giving peer-feedback to fellow writers • Presentation of scientific results
Form of examination	Written report
Media used	Powerpoint presentation, StudIP
Recommended literature	• Bailey, S. (2011). Academic Writing: A Handbook for International Students. Third Edition. London/New York: Routledge. • Rienecker, L., Jørgensen, P., Stray, P. & Skov, S. (2013). The Good Paper: A Handbook for Writing Papers in Higher Education. Frederiksberg: Samfundslitteratur.

Module number [2]: Global wind industry and turbine technology

Course	Master of Science – Wind Energy Engineering
Module name	Global wind industry and turbine technology
Abbreviation (if applicable)	
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences
Lecturer/s	Matthias Schubert, wyncon Martin Schneider, anemos Gesellschaft für Umweltmeteorologie mbH Robin Funk, EMD Deutschland Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences Prof. h.c. Dr. Klaus Rave, Flensburg University of Applied Sciences Prof. Dr.-Ing. David Schlipf, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	4 SH lectures with exercises
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	None
Use of the module in other degree programmes	Master degree programme Energy and Environmental Management, Europa-Universität Flensburg. The module is relevant for those of the students from the sub-programme Energy and Environmental Management in Developing/Industrial Countries who want to expand existing knowledge in the field of wind energy. It is also of interest to a smaller number of students who, in the course of their studies in Energy Management, become involved with the certification, planning and operation of wind turbines, or who seek employment in the field of wind energy following their studies. The Energy and Environmental Management degree programme at the European University of Flensburg has no comparable courses of its own, so that there is good supplementary potential if there is interest and demand.
Learning outcomes: aims of the module, acquired skills	• This course gives an overview on the global wind business and its major players from industry, developers, investors, operators, government and regulatory organisations, research communities as well as networks and associations. • Students will be introduced to the value chain of the wind business end-to-end from assessing a project site to operating and servicing a wind farm. • They shall develop an initial understanding of the major drivers for success in the wind business. • They will learn about the history of wind turbines and the development of their designs and concepts in that historic context. • This introductory overview shall help students in identifying their specific field(s) of interest in the broad area of wind business. • It shall further support them in understanding the broader context of the detailed knowledge that will be covered by specific lectures of the program.

Subjects covered	• Students will learn about the relation between different environmental conditions, legislation / regulatory regimes, financing aspects, technology concepts and their effects on the wind industry. • They will get an overview on the development of the global wind energy markets and their major players in a historical and political context. • The lecture covers major aspects of developing wind projects such as site assessment, economic forecasting, financing, planning and building. • It will cover the fundamentals of energy meteorology (wind systems, boundary layers, turbulence, mesoscale models) and methods for generating the required data for wind projects with wind atlas, software (WAsP) or short and long-term measurements. • Students will understand the physical, technical and legal aspects of wind energy parks and will be able to calculate their energy production and emissions within the frame of site assessment. • They shall be able to assess emissions and influences on the environment and get acquainted with methods of measuring and calculating noise, shadows, wake effects, optical impact according to IEC standards. • Students will learn about major milestones in the history of wind energy utilization with a focus on modern grid-electricity generation since the 1980s. • They shall have an overview about wind turbine main characteristics and are able to differentiate turbine types by their technical architectures and concepts. • The lecture shall generate an understanding about major pro and cons of principal design solutions, thereby capturing why some principals have survived the design evolution (and more interestingly: why others failed).
Form of examination	Written examination (120 min) or oral examination
Media used	black board, power point presentation,
Recommended literature	• Manwell, J. F., McGowan, J. G., Rogers, A. L.: Wind Energy Explained. Wiley, Chichester, 2009 • Troen, I. and E. L. Petersen: European Wind Atlas. Risø National Laboratory, Roskilde, 1989 • CEwind, Hrsg.: Einführung in die Windenergietechnik. Carl Hanser Verlag, München, 2012 • CEwind, ed.: Understanding Wind Energy Technology. Wiley, 2014 i.p. • IEC 61400 International Electrotechnical Commission • Technische Richtlinien (FGW-Richtlinien) • Manuals programs WindPRO and Windfarmer • Gasch R. und Twele, J. (Hrsg.): Windkraftanlagen (9. Aufl.). Springer Vieweg, 2016 • Hau, E.: Windkraftanlagen (7. Aufl.). Springer Vieweg, 2017

Module number [3]: Wind energy planning and applied geoinformatics

Course	Master of Science – Wind Energy Engineering
Module name	Wind energy planning and applied geoinformatics
Abbreviation (if applicable)	WEPAG
Subtitle (if applicable)	
Seminar (if applicable)	Wind farm planning and geospatial methods
Semester	Winter semester
Person in charge of module	Prof. Dr. Bernd Möller, Europa-Universität Flensburg
Lecturer/s	Prof. Dr. Bernd Möller, Europa-Universität Flensburg
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	Elective course in the Master Sustainable Energy at the Europa-Universität Flensburg
Learning outcomes: aims of the module, acquired skills	• Acquisition of knowledge about levels of onshore and offshore wind energy planning • Gaining knowledge on location-specific aspects of wind energy suitability, infrastructural planning, approval planning and site management. • The students gain practical skills of using geographical information systems for wind energy planning and project management. • The students learn about how location relates to political, social, technical and legal aspects of wind energy planning and management. • Students can assess suitability of regions and locations for wind energy projects.
Subjects covered	• Wind energy planning procedures and policy review • Introduction to the use of GIS software for engineers and planners • Geographical assessment of wind energy potentials • Acquisition and application of geospatial data and information • Identification of suitable areas and preliminary location analysis • Spatial modelling of environmental aspects of wind energy • Regional mapping of preferential sites • National suitability mapping • Marine spatial planning for offshore wind energy
Form of examination	Lab exercise portfolio (~15 pages)
Media used	White board, power point presentation, beamer, Lab with QGIS and relevant geodata.
Recommended literature	• De Smith, Longley and Goodchild: Geospatial Analysis – A Comprehensive Guide. Available online: http://spatialanalysisonline.com/ • GIS for Renewable Energy. GIS Best Practices series, ESRI 2010. • Sunak, Höfer, Siddique, Madlener, De Doncker: A GIS-based Decision Support System for the Optimal Siting of Wind Farm Projects. E.ON Energy Research Center Series, Volume 7, Issue 2 • Selected scientific papers made available by the lecturer.

Module number [4]: Advanced engineering mathematics

Course	Master of Science – Wind Energy Engineering
Module name	Advanced engineering mathematics
Abbreviation (if applicable)	AdvMath
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dr.-Ing. David Schlipf, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr.-Ing. David Schlipf, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Sound Knowledge of undergraduate Mathematic
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• The students will be introduced into the classical methods of advanced engineering calculus. • Besides learning classical methods of advanced engineering calculus the students will also be able to apply the methods to wind energy applications
Subjects covered	• Ordinary Differential Equations (ODEs) • Linear Algebra. Vector Calculus • Fourier Analysis. Partial Differential Equations (PDEs) • Complex Analysis • Numeric Analysis • Optimization, Graphs • Probability, Statistics
Form of examination	Written examination (120 min) or oral examination
Media used	black board
Recommended literature	• E. Kreyszig, Advanced Engineering Mathematics, 10th Ed, J. Wiley and Sons, 2011, ISBN 978-0-470-64613-7

Module number [5]: Mechanical engineering basics

Course	Master of Science – Wind Energy Engineering
Module name	Mechanical engineering basics
Abbreviation (if applicable)	
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dr.-Ing. J.H. Weychardt, University of applied Sciences Kiel
Lecturer/s	Prof. Dr.-Ing. J.H. Weychardt, University of applied Sciences Kiel
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	4 SH lectures with practical exercises
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Bachelor degree in an engineering discipline or in physics; NOT for students with bachelor degree in mechanical or civil engineering
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• This course provides a bridging opportunity for students who have completed a Bachelor of Science (Electrical/Electro technical Engineering). • Goal: To prepare students to utilize FEM-based computational tools. • First, the students are introduced to basic mechanics concepts: applied loads (forces, bending moments and torques), the resulting internal loads and the generation of stresses. Point loads, uniformly distributed loads and parabolic load distributions will be analyzed. • This forms the foundation for the development of simple models, which can be analyzed using FEA techniques e.g. beams in bending must have at least 3 layers of elements: the neutral layer, one in tension, one in compression. • In this manner, students are prepared for laboratory experiments with FEM software in the computer lab.
Subjects covered	• Introduction: The finite element method, types of finite elements and what they can calculate, a motivation of what the students have to learn. • Axioms, principles and sign conventions in mechanics. • Statics: Resolution of forces, static equilibrium systems, calculation of support reactions. • Mechanics of Materials: Mechanical stress, Hooke’s law, normal and shear stresses, axial loads and torsion. • Strength calculation: The voltage analogue; comparison of voltage manipulation with the determination of stresses due to tension/compression, bending and torsion of prismatic straight bars. • Kinematics and Kinetics of (a) point masses and (b) rigid bodies in pure rotation. • Beam model, concentrated and distributed loads, shear force, bending moment and torque curves. • Application to the modelling of FEM systems.
Form of examination	Written examination (120 min) or oral examination
Media used	Whiteboard, PC and video projector, e-learning platform, in-class experiments, numerical simulations, lecture notes, drilled exercises

Recommended literature	• Beer, F., Johnston, E.R., deWolf, J., Mazurek, D: Mechanics of Materials. McGraw Hill, 6th edition, 2011 • Gere, J.M., Goodno, B.J.: Mechanics of Materials, CEngage Learning, 8th edition, 2012 • Popov, E.: Engineering Mechanics of Solids.”, Prentice Hall, 2nd edition, 1998 • Buchanan, G.: Mechanics of Materials. HRW.

Module number [6]: Electrical engineering basics

Course	Master of Science – Wind Energy Engineering
Module name	Electrical engineering basics
Abbreviation (if applicable)	
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dr.-Ing. Rajesh Saiju, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr.-Ing. Rajesh Saiju, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Bachelor degree in an engineering discipline or in physics; NOT for students with bachelor degree in electrical engineering.
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• The course allows the students to understand the basics of electrical engineering • They are able to apply the learned basics to observed electrical phenomena
Subjects covered	• Basic quantities and basic laws • DC circuit: current in resistor, current in inductor, voltage at capacitor • AC circuits: calculation of steady states in AC circuits using complex number calculation • 3-phase AC • Electric and magnetic field
Form of examination	Written examination (120 min) or oral examination
Media used	black board, power point presentation,
Recommended literature	• Ose, R., Elektrotechnik für Ingenieure, Fachbuchverlag Leipzig • Zastrow, D.; Elektrotechnik, Vieweg, Braunschweig • Weisgerber, W.; Elektrotechnik für Ingenieure Bd. 1 + 2,Vieweg, Braunschweig • Gussow, M.; Basic Electricity, McGrawHill

Module number [7]: German for foreign students

Course	Master of Science – Wind Energy Engineering
Module name	German for foreign students
Abbreviation (if applicable)	
Subtitle (if applicable)	Basic knowledge of German language
Seminar (if applicable)	German for foreign students
Semester	Winter semester
Person in charge of module	Sybille Kähler, Flensburg University of Applied Sciences
Lecturer/s	Sybille Kähler, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	German
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• basic language skills corresponding to A1 (breakthrough or beginner) or A2 (waystage or elementary) of the Common European Framework of Reference for Languages (CEF) depending on the students' preknowledge
Subjects covered	• A1: after completion of this course students can - understand and use familiar everyday expressions and very basic phrases related to particular concrete situations - introduce themselves and others - ask and answer questions about personal details - interact in a simple way • A2: after completion of this course students can: - understand and use sentences and frequently used expressions related to areas of most immediate relevance - communicate in simple and routine tasks - exchange information on familiar and routine matters - describe in simple terms aspects of their background, immediate environment and matters in areas of immediate need
Form of examination	Oral or written examination (90 min.)
Media used	white board, beamer, hand-outs
Recommended literature	• Jin, F., Voß, U.: Deutsch als Fremdsprache. Grammatik aktiv A1-B1. Üben. Hören. Sprechen. Cornelsen Verlag, Hamburg •

Module number [8]: English for engineers

Course	Master of Science – Wind Energy Engineering
Module name	English for engineers
Abbreviation (if applicable)	ENGL
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Dr. Margret Reimer, Flensburg University of Applied Sciences
Lecturer/s	Dr. Margret Reimer, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• Students will become conversant with the general and specialized language foundations for the formulation of scientific and technical discourse. • Students will become aware in particular of collocations and linguistic conventions that can be problematic for German speakers and will familiarise themselves with verb-noun and adjective-noun combinations used in technical communication
Subjects covered	• Controlled formulating • Exercises for easy and accurate conversion of facts into language. • Basic technical terms and their linguistic description in definitions: circuit, conductance, conductivity, efficiency, machine, magnitude, resistance, resistor, power, quantity, speed, switch, velocity, ...) • Technical communication: complaints, damage reports, technical reports, invitation to seminars, ... • Treatment of selected topics: disturbance and errors; velocity; modernization; naming and defining, building, design and construction; the environment; quality
Form of examination	Written Examination (120 min) or oral examination
Media used	black board, power point presentation, internet
Recommended literature	Bonamy, D.: Technical English 3. Pearson Longman, 2011 ISBN: 978-1-4082-2947-7 Ibbotson M.: Professional English in Use. Engineering. Technical English for Professionals. Cambridge University Press, 2009. ISBN: 978-0-521-73488-2 Murphy, R.: English Grammar in Use. 3rd Edition. Cambridge University Press, 2010 ISBN: 978-0-521-53289-1 University of Oxford Style Guide www.ox.ac.uk How to give good presentation Hbr.org/2013/06 how-to-give-a Killer-presentation

Module number [9]: Energy economics

Course	Master of Science – Wind Energy Engineering
Module name	Energy economics
Abbreviation (if applicable)	EE
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dr. Claus Hartmann, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr. Claus Hartmann, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Admission to the M. Sc. Wind Energy Engineering
Use of the module in other degree programmes	Mandatory course in the Bachelor Energiewissenschaften (Schwerpunkt Energie- und Umweltmanagement) at the Flensburg University of Applied Sciences
Learning outcomes: aims of the module, acquired skills	• Students are introduced to the fundamental problems and the overall contexts of the economics of energy. • Students will learn about the different parts of energy demand and the different ways of energy supply. • An understanding of the limitations of non-renewable energy sources and the difficulties of their substitution by renewable and often intermittent energy sources is taught. • The differences in the markets for grid-bound fuels are taught. • At the end of the seminar, each student is able to understand the basic relationships of the various energy markets and classify the contribution of different energy sources, fuels and technologies in the context of the total energy system and sustainable development.
Subjects covered	• Why is energy a subject of economics? • Energy as a resource; • Energy consumption and sustainable development; • Energy and the environment; Social costs of energy; • General aspects of energy markets; Prices in energy markets; • The coal market; The crude oil market; The natural gas market; The electricity market; The market for district heating; • Energy demand by sector; Industry, Households, Commercial sector, Transport, • Potentials, costs and limits of renewable energy sources, • Solar energy for electricity, Solar energy for low temperature heat, Wind energy, Energy from biomass, Hydropower, Geothermal energy, Wave and tidal energy, • Potentials, costs and limits of the rational use of energy by sector, Industry, Households, Commercial Sector, Transport, • Scenarios of sustainable long term energy systems
Form of examination	Presentation of the different teams and a final written report by each team
Media used	Group work and lectures with projector based presentations
Recommended literature	• Energy Institute (see most recent year): **Statistical Review of World Energy**. Internet

	• IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change • Christian von Hirschhausen, Clemens Gerbaulet, Claudia Kemfert, Casimir Lorenz, Pao-Yu Oei: Energiewende "Made in Germany", Springer Verlag.

Module number [10]: Wind turbine aerodynamics

Course	Master of Science – Wind Energy Engineering
Module name	Wind turbine aerodynamics
Abbreviation (if applicable)	Intro WT Aero
Subtitle (if applicable)	Basic knowledge of wind turbine aerodynamics
Seminar (if applicable)	
Semester	Summer semester
Person in charge of module	Prof. Dr. Steffen Risius, University of Applied Sciences Kiel
Lecturer/s	Prof. Dr. Steffen Risius, University of applied Sciences Kiel Prof. Dr.-Ing. David Schlipf, Flensburg University of Applied Sciences
Status within the curriculum	Master course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Sound knowledge of undergraduate Mathematics
Use of the module in other degree programmes	Master degree programme Energy and Environmental Management, Europa-Universität Flensburg. The module is relevant for those of the students from the sub-programme Energy and Environmental Management in Developing/Industrial Countries who want to expand existing knowledge in the field of wind energy. It is also of interest to a smaller number of students who, in the course of their studies in Energy Management, become involved with the certification, planning and operation of wind turbines, or who seek employment in the field of wind energy following their studies. The Energy and Environmental Management degree programme at the European University of Flensburg has no comparable courses of its own, so that there is good supplementary potential if there is interest and demand.
Learning outcomes: aims of the module, acquired skills	• Introduction into the classical methods of low-speed aerodynamics and blade-element and momentum (BEM) theory, its use and application
Subjects covered	• Basics of atmospheric flow and the atmospheric boundary layer • Basic concepts of fluid dynamics and its governing equations • Stream lines, potential theory, Navier-Stokes and the influence of friction • Boundary Layers, aerodynamic lift and turbulence • Simple momentum-theory of wind-turbine and the Betz limit • General momentum theory and vortex-theory of wind-turbine • The Blade Element Momentum (BEM) theory
Form of examination	Written Examination (120 min) or oral examination
Media used	black board, power point presentation, internet
Recommended literature	• A. P. Schaffarczyk, Introduction to Wind Turbine Aerodynamics, 2. ed., Springer 2020 • White FM. Fluid Mechanics 5. ed., International ed. McGraw-Hill 2003

Module number [11]: Certification, load assumptions and simulations

Course	Master of Science – Wind Energy Engineering
Module name	Certification, load assumptions and simulations
Abbreviation (if applicable)	CERT
Subtitle (if applicable)	Basic knowledge about loads, certification, standards and guidelines of wind turbines
Seminar (if applicable)	
Semester	Summer semester
Person in charge of module	Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences Andreas Manjock, DNV
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	2 SH lectures, 2 SH exercises
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	General knowledge in undergraduate mechanics, general ability to use computers, basic experience in the use of engineering software
Use of the module in other degree programmes	Master degree programme Energy and Environmental Management, Europa-Universität Flensburg. The module is relevant for those of the students from the sub-programme Energy and Environmental Management in Developing/Industrial Countries who want to expand existing knowledge in the field of wind energy. It is also of interest to a smaller number of students who, in the course of their studies in Energy Management, become involved with the certification, planning and operation of wind turbines, or who seek employment in the field of wind energy following their studies. The Energy and Environmental Management degree programme at the European University of Flensburg has no comparable courses of its own, so that there is good supplementary potential if there is interest and demand.
Learning outcomes: aims of the module, acquired skills	• Knowledge and understanding of general items about loads, standards and guidelines, type and project certification • Possibility to connect this knowledge about loads and certification with practical background of the person who is teaching this course • Introduction to load simulation for wind turbines. • The students will understand and learn about the design processes of wind turbines. They will be able to understand the importance of dynamic load simulations for wind turbines and can calculate different load cases.

Subjects covered	• General Items
	• Extreme and fatigue load calculations
	• Standards and Guidelines
	• Type Certification:
	  o Numbering systems
	  o Certification Report
	  o Statement of Compliance
	  o Type Certificate:
	    - Design Assessment
	    - Quality Management

	- IPE - Prototype Testing • Project Certification: o Site Assessment o Site Specific Design Assessment o Manufacturing Surveillance o Surveillance of Transport, Installation and Commissioning • Physics and Aerodynamic Principles • Guidelines and Standards • Wind Turbine Design Process o Load Case Definitions o Turbine Design o Load case simulation • Extreme Loads (for Example DLC 1.3) o Fatigue Loads
Form of examination	Written Examination (120 min) or oral examination
Media used	black board, power point presentation, projector, PC
Recommended literature	• Understanding Wind Energy Technology, Wiley, 2021 (expected) • Hau, E.: Windkraftanlagen. Springer Verlag, Berlin, 2008 • Manwell, J.F. et.al.: Wind Energy Explained. Wiley Ltd, Chichester, 2009 • Heier, S.: Windkraftanlagen im Netzbetrieb, Vieweg u. Teubner Verlag, Wiesbaden, 2009 • Gasch, R., Twele, J.: Windkraftanlagen. Vieweg u. Teubner Verlag, Wiesbaden, 2010 • CEwind eG, Alois Schaffarczyk: Einführung in die Windenergietechnik, Carl Hanser Verlag, München, 2012 • Guideline for the Certification of Wind Turbines On- and Offshore • DIBt Regulations • Germanischer Lloyd, Guideline for the Certification of Wind Turbines, Edition 2003/2004 • Germanischer Lloyd, Guideline for the Certification of Wind Turbines, Edition 2010 • IEC 61400-1:1999 (Edition 2) • IEC 61400-1:2005 (Edition 3) + Amendement 2010 • DIN EN 61400-1:2006 / DS EN 61400-1:2006 (Denmark) • DIBt, German Typenprüfung TAPS2000 (India)

Module number [12]: Control and automation of wind power plants

Course	Master of Science – Wind Energy Engineering
Module name	Control and automation of wind power plants
Abbreviation (if applicable)	CSAWPP
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Summer semester
Person in charge of module	Prof. Dr.-Ing. Reiner Schütt, University of Applied Sciences Westküste
Lecturer/s	Prof. Dr.-Ing. Reiner Schütt, University of Applied Sciences Westküste
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	4 SH lectures, exercises, project work
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	general knowledge of undergraduate mathematics, general knowledge of automation and control, general knowledge of electrical drives and power electronics, admission to the M. Sc. in Wind Energy Engineering
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• The students know and understand the control systems for pitch, azimuth, speed and power adjustment, the automation as well as the possibilities of process control, remote control and maintenance systems. • They can layout and optimize the subsystems. They can judge, which can be fulfilled tasks in which automation level and with which characteristics.
Subjects covered	• Introduction: defining control systems and automation, basics in wind energy conversion systems, their definition and standards • Feedback control systems: objectives and strategies, system description, application to motion control systems • Feedback control in wind energy conversion systems: overview, generator systems, yaw-, pitch-, rotor-power- and speed-control, dc-voltage-control and electrical power control • Process management: open loop control, operating states, supervisory control, grid integration management, communication systems • Summary
Form of examination	Oral or written examination (120 min)
Media used	Blackboard, overhead, beamer, internet
Recommended literature	• Heier, Siegfried: Grid Integration of WECS, John Wiley & Sons, 2008 • Hau, Erich: Wind Turbines, Springer Verlag, 2006 • Gasch, Robert: Wind Power Plants, Springer Verlag, 2006 2008 • CEwind: Understanding Wind Power Technology, John Wiley & Sons, 2014 • Garcia-Sanz, Mario: Wind Energy Systems Control Engineering Design, Taylor & Francis, 2012 • Schütt, Reiner: Control Systems and Automation of Wind Power Plants, lecture notes, 2013 • Leonhard, Werner: Control of Electr. Drives, Springer Verlag, 2001

Module number [13]: Tower and rotor structures

Course	Master of Science – Wind Energy Engineering
Module name	Tower and rotor structures
Abbreviation (if applicable)	ToRo
Subtitle (if applicable)	Basic knowledge about towers and rotor blades of wind turbines
Seminar (if applicable)	
Semester	Summer semester
Person in charge of module	Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences Prof. Dr. Steffen Risius, University of Applied Sciences Kiel Prof. Dr.-Ing. Christian Keindorf, University of Applied Sciences Kiel
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	2 SH lectures, 2 SH exercises
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	Master degree programme Energy and Environmental Management, Europa-Universität Flensburg. The module is relevant for those of the students from the sub-programme Energy and Environmental Management in Developing/Industrial Countries who want to expand existing knowledge in the field of wind energy. It is also of interest to a smaller number of students who, in the course of their studies in Energy Management, become involved with the certification, planning and operation of wind turbines, or who seek employment in the field of wind energy following their studies. The Energy and Environmental Management degree programme at the European University of Flensburg has no comparable courses of its own, so that there is good supplementary potential if there is interest and demand.
Learning outcomes: aims of the module, acquired skills	• Knowledge and understanding of general items about structures of towers and rotorblades • Possibility to connect this knowledge about loads and certification with practical background of the person who is teaching this course
Subjects covered	• General items • Relevant standards & materials used • Tower and rotor types • Safety Concept and design calculation • Detail calculations • Modal Analysis
Form of examination	Written examination (120 min) or oral examination
Media used	black board, power point presentation, beamer
Recommended literature	• Understanding Wind Energy Technology, Wiley, 2021 (expected) • Hau, E.: Windkraftanlagen. Springer Verlag, Berlin, 2008 • CEwind eG, Alois Schaffarczyk: Einführung in die Windenergietechnik, Carl Hanser Verlag, München, 2012 • Guideline for the Certification of Wind Turbines On- and Offshore • DIBt Regulations

	• Germanischer Lloyd, Guideline for the Certification of Wind Turbines, Edition 2003/2004 • Germanischer Lloyd, Guideline for the Certification of Wind Turbines, Edition 2010 • IEC 61400-1:1999 (Edition 2) • IEC 61400-1:2005 (Edition 3) + Amendement 2010 • DIN EN 61400-1:2006 / DS EN 61400-1:2006 (Denmark) • DIBt, German Typenprüfung TAPS2000 (India)

Module number [14]: Mechanical drive train

Course	Master of Science – Wind Energy Engineering
Module name	Mechanical drive train
Abbreviation (if applicable)	MDT
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Summer semester
Person in charge of module	Prof. Dipl.-Ing. Peter Quell, University of Applied Sciences Kiel
Lecturer/s	Prof. Dipl.-Ing. Peter Quell, University of Applied Sciences Kiel
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	4 SH lectures / exercises
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• The students have a profound knowledge of the general set-up, tasks and functionalities of wind turbine drive trains and their components. • They do understand the technological and economical aspects of different solutions and are able to select preferred technical concepts for given conditions and demands. • The students are able to describe the operational und environmental conditions and their impact on the wind turbine drive trains. • They know the methods and processes of calculating and designing the main components and to integrate them in the drive train system. • The students do understand the operation and maintenance requirements and the applied processes to achieve a successful and economical efficient operation throughout the whole life cycle. • In parallel they know how to analyze and solve specific tasks and assignments given to them within a team. They know how to present their results effectively and convincingly.
Subjects covered	• Tasks and functionalities of wind turbine drive trains • Variants, technology and economics of drive trains • Design of gearboxes • Geared and directly driven generators • Rotor bearing solutions • Couplings • Brake systems
Form of examination	Assignments with presentation and written examination (90 min.) or oral examination
Media used	Blackboard, beamer,
Recommended literature	• Germanischer Lloyd (GL): Guideline for the Certification of Wind Turbines, 2010 • EN 61400-1: Design Requirements for Wind Turbines, 2011 • Schaffarczyk, A.: Introduction to Wind Energy Technology, 2013, Wiley • Gasch, R.: Wind Power Plants, 2011, Springer-Verlag • Hau, E.: Wind Turbines, Springer-Verlag, 2013

Module number [15]: Electrical engineering for wind turbines

Course	Master of Science – Wind Energy Engineering
Module name	Electrical engineering for wind turbines
Abbreviation (if applicable)	EE for WT
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Summer semester
Person in charge of module	Prof. Dr. Ingmar Leiße, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr. Ingmar Leiße, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Bachelor degree in an electrical engineering biased discipline, or successful completion of Module “Electrical engineering for mechanical engineers”
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• To have basic knowledge on steady state performance of three phase AC mains • Getting to know the electrical components of a wind turbine power plant and being able to calculate their performances • Understanding the electrical systems related to wind turbines
Subjects covered	• Three phase AC power systems • Basic applications of electrical machines for wind turbines in steady state mode including performance calculations: generators for wind turbine power generation, motors for auxiliary systems and power transformers • Introduction to power electronics used in wind turbines: rectifiers, frequency converters and soft starters in the main power circuit and in auxiliary equipment • Basics about pitch and yaw systems • Cables of different voltage levels and for different purposes in wind turbines and wind parks • Switch gear components (contactors, circuit breakers, fuses, relays) • Lightning protection in wind turbines • Condition monitoring • Safety issues in electric installations • Reading and understanding wiring diagrams
Form of examination	Written examination (120 min) or oral examination
Media used	black board, power point presentation
Recommended literature	Burton, T. et al.: “Wind Energy Handbook”, 2nd Ed., Wiley, Mai 2011 Ackermann, T.: “Wind Power in Power Systems”, Wiley-Blackwell, Mai 2012 Schaffarczyk, A.: “Understanding Wind Power Technology: Theory, Deployment and Optimisation”, Wiley, 2014 Stiebler, M.: “Wind Energy Systems for Electric Power Generation: Green Energy and Technology”, Springer, 2010 Heier, S.: “Grid Integration of Wind Energy: Onshore and Offshore Conversion Systems”, Wiley, 2014

Module number [16]: Finite elements (FE) & fatigue analysis

Course	Master of Science – Wind Energy Engineering
Module name	Finite elements (FE) & fatigue analysis
Abbreviation (if applicable)	FFA
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dr.-Ing. Frithjof Marten, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr.-Ing. Frithjof Marten, Flensburg University of Applied Sciences Dr.-Ing. Lidija Stanković, DNV
Status within the curriculum	Master Course Wind Energy Engineering mandatory optional course
Language	English
Type of course and hours per week	2 SH lectures 2 SH exercises
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• basic use of ANSYS Workbench • performing a static linear FE Analysis • validation of mesh quality • validation of stress results • Using FKM guideline for fatigue analysis • Performing fatigue analysis of forged steel and cast iron for wind turbine components
Subjects covered	• linear static analysis • influence of mesh quality at regions with high stress gradients • comparison of FEM stress results with stresses calculated with analytical approach • minimize stresses at hot spots by modifying local geometry definitions • calculation of stress concentration factor on the basis of FEM results • introduction to fatigue analysis • calculation of synthetic SN curves according FKM guideline for wind turbine rotor shaft • influences of size, mean stress, roughness and notches on SN curves • using the safety factors of FKM and DNV GL guidelines • analysing the damage sum according to Palmgren/Miner and safety margin or stress reserve factor • fatigue analyses of different materials like forged steel with different strength and nodular cast iron
Form of examination	documentation of analytical fatigue calculation and FE Analysis of main shaft WEC "Optimus"
Media used	black board, power point presentation, PC, beamer
Recommended literature	• FKM - Analytical Strength Assessment of Components Edition-6/2012, VDMA • DNVGL-ST-0361-2016-09 - Machinery for wind turbines DNV GL Hamburg

Module number [17]: Machinery components

Course	Master of Science – Wind Energy Engineering
Module name	Machinery components
Abbreviation (if applicable)	
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dipl.-Ing. Peter Quell, University of Applied Sciences Kiel
Lecturer/s	Prof. Dipl.-Ing. Peter Quell, University of Applied Sciences Kiel Falco Ingwersen Boy Dario Kraemer, Siemens Gamesa Renewable Energy GmbH & Co. KG
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English
Type of course and hours per week	4 SH lectures/practice
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• The students have a profound knowledge of the general set-up, tasks and functionalities of wind turbines and their sub systems with focus on o rotor hubs o pitch systems o couplings o yaw systems o machine beds • They do understand the technological and economical aspects of different solutions and are able to select preferred technical concepts for given conditions and demands. • They know the methods and processes of calculating and designing these sub systems and to integrate them into the whole wind turbine. • The students do understand the operation and maintenance requirements and the applied processes to achieve a successful and economical efficient operation throughout the whole life cycle. • They know how to analyze and solve specific tasks and assignments given to them within a team. They know how to present their results effectively and convincingly.
Subjects covered	• Tasks and functionalities of main sub systems of wind turbines: o Rotor hubs o Pitch systems (hydraulically and electrically driven) o Couplings o Yaw systems o Machine beds (casted and welded) • Variants, technology and economics of these sub systems • Static and dynamical loads • Methods and calculation processes
Form of examination	Written examination (120 minutes) or oral examination
Media used	black board, power point presentation, PC, beamer
Recommended literature	• Schaffarczyk (Ed.) Understanding Wind Power Technology: Theory, Deployment and Optimization, Wiley, 2014 • Hau, Erich: Wind Turbines, Springer, 2013

	• Germanischer Lloyd: Wind Turbines, 2003 • Germanischer Lloyd: Regulations for the Certification of Wind Energy Conversion Systems. Germanischer Lloyd, 1999 • IEC 61400-1: Wind Turbine Generator Systems, 2019 • Nisbett, K.; Budynas, R.: Shigley’s Mechanical Engineering, 2019, McGraw-Hill Education Roark: Formulas of Stress and Strain, 1975 • Szilard: Theory and Analysis of Plates, 1978 • International Organization for Standardization: ISO 6336 - Calculation of load capacity of spur and helical gears 2019 • Deutsches Institut für Normung e.V.: DIN 3990-1 - Calculation of load capacity of cylindrical gears; introduction and general influence factors, 1987

Module number [18]: Electrical machines, power electronics, control

Course	Master of Science – Wind Energy Engineering
Module name	Electrical machines, power electronics, control
Abbreviation (if applicable)	
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dr.-Ing. Rajesh Saiju, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr.-Ing. Rajesh Saiju, Flensburg University of Applied Sciences
Status within the curriculum	Master course Wind Energy Engineering mandatory-optional course
Language	English
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Basic knowledge in electrical engineering, especially electrical power engineering
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• To have basic knowledge on dynamic state performance of electrical machines: induction generators, synchronous generators • Basic analysis and application of power electronic converters for AC machines as used in wind power stations and be able to calculate their performance. • To have basic knowledge on different control strategies used in wind turbines
Subjects covered	• Induction generators • Synchronous generators • Power electronic converters for AC machines • Different electrical control structures of wind turbines
Form of examination	Written examination (120 min) or oral examination
Media used	Black board, power point presentation, beamer
Recommended literature	• Schaffarczyk, J (Editor).: *Understanding Wind Power Technology – Theory, Deployment and Optimization*, Wiley, 2012 • Heier, S.: *Grid Integration of Wind Energy – Onshore and Offshore Conversion Systems,* 3rd Edition, Wiley, 2014 • Heier, S.: *Windkraftanlagen: Systemauslegung, Netzintegration und Regelung*, Teubner + Vieweg Verlag, 2009 • Stiebler, M.: *Green Energy and Technology: Wind Energy Systems for Electric Power Generation*, Springer, 2012 • Kundur, P.: Power System Stability and Control, McGraw-Hill, 1994 • Wood, A. J. and Wollenberg, B. F.: Power Generation, Operation and Control, 2nd Edition, Wiley and Sons, 19196

Module number [19]: Grid integration

Course	Master of Science – Wind Energy Engineering,
Module name	Grid integration
Abbreviation (if applicable)	GI
Subtitle (if applicable)	Mutual effects between wind turbines and power systems
Seminar (if applicable)	seminar
Semester	Winter semester
Person in charge of module	Prof. Dr. Clemens Jauch, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr. Clemens Jauch, Flensburg University of Applied Sciences Marc Nottrott, Moeller Operating Engineering GmbH
Status within the curriculum	Master Course Wind Energy Engineering mandatory-optional course
Language	English
Type of course and hours per week	4 SH lectures supplemented by exercises
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	Master degree programme Energy and Environmental Management, Europa-Universität Flensburg. The module is relevant for those of the students from the sub-programme Energy and Environmental Management in Developing/Industrial Countries who want to expand existing knowledge in the field of wind energy. It is also of interest to a smaller number of students who, in the course of their studies in Energy Management, become involved with the certification, planning and operation of wind turbines, or who seek employment in the field of wind energy following their studies. The Energy and Environmental Management degree programme at the European University of Flensburg has no comparable courses of its own, so that there is good supplementary potential if there is interest and demand.
Learning outcomes: aims of the module, acquired skills	• understanding the fundamental principles of power systems • understanding the behaviour of grid connected wind turbines • understanding the effects grid connected wind turbines have on power systems • understanding the effects transient and dynamic events in power systems have on wind turbines

Subjects covered	• power system basics
	  o basic characteristics and quantities
	  o 3-phase systems
	  o equivalent circuits of power system components
	  o dynamic and transient events in power systems
	  o
	  o power system stability
	• power system simulation
	• wind farms in power systems
	• interactions between wind turbines and power systems
	  o long term effects
	  o feed-in management
	  o inertial response
	  o fast frequency response
	  o flicker

	○ low voltage ride through and other transient events •
Form of examination	Written examination (120 minutes) or oral examination
Media used	projector based presentation, blackboard
Recommended literature	• B.M. Weedy, B.J. Cory; Electric Power Systems; John Wiley • S. Heier; Grid Integration of Wind Energy Conversion Systems; John Wiley & Sons

Module number [20]: Structures – rotor blades and civil engineering

Course	Master of Science – Wind Energy Engineering
Module name	Structures – rotor blades and civil engineering
Abbreviation (if applicable)	
Subtitle (if applicable)	In-depth knowledge about tower design and dimensioning
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences Prof. Dr. Steffen Risius, University of Applied Sciences Kiel Francesco Previtali, Siemens Gamesa
Status within the curriculum	Master Course Wind Energy Engineering mandatory-optional course
Language	English
Type of course and hours per week	2 SH lectures, 2 SH exercises
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	• Certification and load assumptions • Tower and rotor structures
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	Students • know to design, dimension and optimise the (sub-)structures of a wind turbine and tower in consideration of structural safety, serviceability and economic efficiency • know what materials can be used (steel, reinforced concrete, GRP, wood etc.) • can evaluate what materials are applicable under specific conditions
Subjects covered	• Design Calculation • Verification against Material Failure • Verification against Stability Failure • Verification against Fatigue Failure • Verification of Serviceability • Detail Calculation • FEM Calculation • Prevention of Resonance • Internal resistance – Dimensioning of concrete and reinforcement steel • External resistance – Assessment of soil, respective interaction between soil and foundation • Dynamic behaviour – Validation of natural frequencies which were assumed within load calculation
Form of examination	Written examination (120 min) or oral examination
Media used	black board, power point presentation, beamer and FEM Lab
Recommended literature	• Guideline for the Certification of Wind Turbines On- and Offshore • DIBt Regulations • Civil Engineering Eurocode-Standards • Civil Engineering DIN-Standards • Eurocodes for civil engineering • Understanding Wind Energy Technology, Wiley, 2014

Module number [21]: Project: development of a wind turbine

Course	Master of Science – Wind Energy Engineering
Module name	Project: development of a wind turbine
Abbreviation (if applicable)	P_WT
Subtitle (if applicable)	Focus: A Mechanical engineering B Electrical engineering C Structural engineering D Project development
Seminar (if applicable)	Project
Semester	Winter semester
Person in charge of module	Prof. Dipl.-Ing. Peter Quell, University of Applied Sciences Kiel Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences
Lecturer/s	• Dipl.-Ing. Andreas Manjock, DNV-GL • Prof. Dipl.-Ing. Peter Quell, University of Applied Sciences Kiel • Prof. Dr.-Ing. David Schlipf, Flensburg University of Applied Sciences • Prof. Dr.-Ing Steffen Risius, University of Applied Science Kiel • Prof. Dr.-Ing. Rajesh Saiju, Flensburg University of Applied Sciences • Prof. Dr.-Ing. Torsten Faber, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering mandatory-optional course
Language	English
Type of course and hours per week	3 SH project discussion 1 SH self-dependent project work
Student workload	attendance: 105 h private study: 195 h
Credit points	10 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• The students gain deep insight into complex R&D projects. • They know about required processes and methods in project management and do understand the importance of interface management • The students are able to identify the components needed to build a wind turbine under consideration of varying site conditions • They know how to dimension, calculate and design relevant mechanical, constructional or electrical components of a wind turbine and related controller systems (relating to the team focus) • The students know how to work and communicate efficiently in interdisciplinary team and are able to present their results convincingly •
Subjects covered	• Project planning and project management • Interdisciplinary project team work interacting between mechanics team, electrics team and structures team
	A • Conception of the mechanical drive train • Designing the rotor bearing, gearbox, couplings and brakes • Aerodynamical and structural design of the rotor blades
	B • Conception of the electrical system • Dimensioning transformer, generator, converter and cable system for the wind turbine • Conception of the control system

	C	• Load simulation and calculation • Conception of the tower and foundation • Designing and dimensioning tower and foundation
Form of examination	Presentation and project report	
Media used	-	
Recommended literature	• Schaffarczyk, Alois: Understanding Wind Power Technology, Wiley, 2014, ISBN: 978-1118647516 • Hau, Erich: Wind Turbines, Springer, 2013, ISBN: 978-3642271502 • S. Heier; Grid Integration of Wind Energy Conversion Systems; John Wiley & Sons • DNV-GL: Guideline for the Certification of Wind Turbines, 2010 DIN EN 61400: Wind turbines, 2010	

Module number [22]: Advanced wind farm planning

Course	Master of Science – Wind Energy Engineering
Module name	Advanced wind farm planning
Abbreviation (if applicable)	AWFP
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Eva-Maria Nikolai, Pavana GmbH
Lecturer/s	Eva-Maria Nikolai, Pavana GmbH Dr. Jörg Winterfeldt, Nordex SE
Status within the curriculum	Master Course Wind Energy Engineering mandatory optional course
Language	English
Type of course and hours per week	4 SH practical laboratory exercises in a computer lab, attendance at all minus one laboratory dates is mandatory, otherwise the claim for grading expires
Student workload	Attendance: 60 h Private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Basics in wind properties Basics in wind energy theory Basics in wind turbine systems
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• In the first lecture (introduction) the computer capacity is distributed (no students attendance no claim to one of the limited computer workstations) and students will learn what they should have learned in their first and second semester of master Wind Energy Engineering concerning wind and energy and if they have gaps what they have to learn by self-reliant learning, doing the exercises and asking the lecturer. • Working in the computer lab the students will learn to use the most important wind park planning programs WAsP and WindPRO. At predefined projects with extended lab manuals students are lead trough annual energy productions, the use of wind measurements done with the university own wind tower at the campus and its long term correction. A resource map is generated. Environmental impacts are considered by calculation of noise and shadow emission, visual impact and photomontage. The economy of the wind project is calculated. Possible are park optimization, electrical grid lay out and others if time is left. • Finally, the students will be able to evaluate prognoses of wind-energy potential. They will be able to calculate and evaluate emissions.
Subjects covered	• Energy meteorology, annual energy production calculations, met-tower, short-term long-term measurements, own and public wind resources, wake models, programs WindPRO, WAsP et al. e.g. Windfarmer • Emissions and influences on the environment, noise, shadow, programs Windpro, (Windfarmer) et al. • Visual impact, visibility, photomontage, programs Windpro, (Windfarmer) et al. • Electrical layout of windpark, programs Windpro, (Windfarmer) et al. • Optimisation of a windpark layout, programs Windpro, (Windfarmer) • Evaluation of economic efficiency of a wind farm • Load response (turbine live time and extension) • Design your wind farm from the scratch
Form of examination	Written laboratory report

Media used	Computer lab, laboratory experiments, whiteboard, PC and video projector, e-learning platform, lecture notes, program manuals Power Point Presentations In Online terms licenses for students computer, reduced number of exercises, clear descriptions and auxiliary files online
Recommended literature	• CEwind, ed. (2014): Understanding Wind Power Technology, Theory, Development and Optimization. Wiley Ltd., Chichester. Chapter 3, van Radecke et.al: Wind resources, site assessment, ecology. • CEwind, Hrsg. (2012): Einführung in die Windenergietechnik. Carl Hanser Verlag, München, Kapitel 3, van Radecke et.al: Windressourcen, Standortbewertung, Ökologie • Manwell, J.F., McGowan, J.G., Rogers, A.L.: Wind Energy Explained. Wiley, Chichester, 2009 • Troen, I. and E.L. Petersen: European Wind Atlas. Risø National Laboratory, Roskilde, 1989 • Manual program Windpro in the lab and online

Module number [23]: Offshore wind energy: operation and maintenance

Course	Master of Science – Wind Energy Engineering
Module name	Offshore wind energy: operation and maintenance
Abbreviation (if applicable)	OWE; O&M
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Dr.-Ing. Axel Birk, Hanseatic Renewable Consulting GmbH
Lecturer/s	Dr.-Ing. Axel Birk, Hanseatic Renewable Consulting GmbH
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	4 SH lectures
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	none
Use of the module in other degree programmes	Master degree programme Energy and Environmental Management, Europa-Universität Flensburg. The module is relevant for those of the students from the sub-programme Energy and Environmental Management in Developing/Industrial Countries who want to expand existing knowledge in the field of wind energy. It is also of interest to a smaller number of students who, in the course of their studies in Energy Management, become involved with the certification, planning and operation of wind turbines, or who seek employment in the field of wind energy following their studies. The Energy and Environmental Management degree programme at the European University of Flensburg has no comparable courses of its own, so that there is good supplementary potential if there is interest and demand.
Learning outcomes: aims of the module, acquired skills	• The students have a profound knowledge of the general set up and the functionalities of offshore wind power plants (OWPP) • They understand the market, the potential and the economics of offshore wind energy. They are able to select technical solutions based on a balanced evaluation of yield and costs. • The students are able to describe the operational und environmental conditions offshore and their impact on the OWPP. • They know the different types of offshore foundations and are able to select the best solution for given environmental conditions. • The students are able to describe the logistical processes for construction, transport, installation and servicing of OWPPs. • The Module will create general understanding to manage processes to operate and maintain wind turbines • The competence to use planning methods for intervention (scheduled and unscheduled) will be taught • The students will learn to create documentation and use life cycle management techniques • In the course the ability to identify and influence main cost elements of O&M phase will be explained
Subjects covered	• Differences between onshore and offshore applications • Offshore markets and potential

	• Economics of offshore wind parks • Operational and environmental conditions offshore • Types of fixed and floating foundations • Construction and installation of offshore WECs • business process O&M (elements, interfaces) • scheduled interventions (ressources, timing and cost) • unscheduled intervention (ressources, timing and cost) • Health and Safety • Documentation needs for Life Cycle Management • Spare part management for tear and wear parts or regular spares • work instructions for O&M • RDS-PP as tool to describe wind power plants
Form of examination	Oral examination
Media used	Beamer based presentation
Recommended literature	• Heier, S.: Grid Integration of WIND ENERGY CONVERSION SYSTEMS. 2nd Edition, John Wiley & Sons Ltd. Chichester, New York, Weinheim, Brisbane, Singapore, Toronto, 2006. Translated by Rachel Waddington, Swadlincote, UK • Lesny, Kerstin: Foundations for Offshore Wind Turbines, VGE, 2010 • Det Norske Veritas (DNV): Regulations for the Design of Offshore Wind Turbine Structures, 2005 • Praxishandbuch Schnittstellenmanagement Offshore Wind EEHH, Maritimes Cluster ISBN: 978-3-00-05402024-0 • VGB Power Tech: RDS-PP Guidelines • O&M modelling for Large scale offshore wind farms Burcu Özdirik et.al. 01-2013

Module number [24]: Experimental and computational fluid dynamics

Course	Master of Science – Wind Energy Engineering,
Module name	Experimental and computational fluid dynamics
Abbreviation (if applicable)	EFCD
Subtitle (if applicable)	Introduction to flow measurement technology and computational fluid dynamics
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Prof. Dr. Steffen Risius, University of Applied Sciences Kiel
Lecturer/s	Prof. Dr. Steffen Risius, University of Applied Sciences Kiel
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	short introduction with large amounts of practice (2)
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Sound Knowledge of Wind Turbine Aerodynamics, Basic knowledge of Linux and C++ or Matlab is helpful
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• Introduction to experimental method in fluid dynamics • Measurement of flow properties and important quantities • Advantages and disadvantages of different experimental methods • Basic concepts of Computational Fluid Dynamics (CFD) • Overview over open source solvers for fluid dynamics • Application and usage of CFD in wind turbine aerodynamics
Subjects covered	• Experimental methods for the investigation of wind turbine aerodynamics • Anemometers (e.g. cup, vane, hot-wire, laser-doppler, ultrasonic) • Optical measurement techniques (e.g. Particle Image Velocimetry (PIV), Temperature-Sensitive Paint (TSP), Pressure-Sensitive Paint (PSP)) • Background and basic concepts of Computational Fluid Dynamics (CFD) • Usage of XFOIL (XFLR5) and its application to wind turbine aerodynamics • Introduction to OpenFOAM, Q-Blade and other open source codes
Form of examination	Oral examination
Media used	Numeric exercises on a PC, lab experiments and slide show presentations
Recommended literature	• A. P. Schaffarczyk, Introduction to Wind Turbine Aerodynamics, 2nd Ed., Springer 2020 • Cameron Tropea, Alexander L. Yarin, John F. Foss: Springer Handbook of Experimental Fluid Mechanics, Springer 2016 • Moukalled, Mangani: The Finite Volume Method in Computational Fluid Dynamics: An Advanced Introduction, Springer 2016

Module number [25]: Modelling & simulation of wind turbines

Course	Master of Science – Wind Energy Engineering
Module name	Modelling & simulation of wind turbines
Abbreviation (if applicable)	MaS
Subtitle (if applicable)	Modelling wind turbines in a commonly used simulation environment for simulating the general behaviour of wind turbines during normal operation
Seminar (if applicable)	seminar
Semester	Winter semester
Person in charge of module	Prof. Dr. Clemens Jauch, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr. Clemens Jauch, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	2 SH lectures 2SH laboratory exercise
Student workload	attendance: 60 h private study:90 h
Credit points	5 ECTS
Preconditions according to examination regulations	General knowledge in undergraduate mathematics, general ability to use computers, basic experience in the use of engineering software
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• The students learn the general functionality of a wind turbine system: The interrelation between wind speed, pitch angle, rotor speed, torque and power in a wind turbine are discussed to the extent so the students can apply this knowledge in the laboratory • The lab exercise comprises modelling a general wind turbine system with the simulation tool Matlab/Simulink. • Goal of the lab exercise is a running simulation model in Matlab/Simulink that reproduces the response of a wind turbine in terms of pitch angle, rotor speed, torque and power, when subject to variations in the wind speed and variations in grid quantities
Subjects covered	An Introduction to Modelling and Simulation • Fields of Application and Advantages of Modelling and Simulation • Simulation Environments for Engineering • Time-Dependent and Time-Independent Simulations • Time-Invariant and Time-Variant Systems • Linear and Non-Linear Systems • Differential Equations • Numerical Integration • Block Diagram Representation • Transfer Functions and State Space Approach Modelling Wind Turbines • Models of Wind Turbine Subsystems o Wind Model o Aerodynamics o Pitch System o Mechanics o Tower o Drive Train o Generator and Converter o Control o Interface to Power System • Block Diagrams of Different Wind Turbine Systems

	Further Topics of Modelling and Simulation • Per Unit Representation • Initialisation • Anti-Windup of Integrators • Lookup Function
Form of examination	Written examination (120 minutes) or oral examination
Media used	Projector based presentation, blackboard, computer laboratory with Matlab/Simulink software
Recommended literature	• Documentations and examples on the Matlab homepage http://www.mathworks.de/support/

Module number [26]: Turbine measurements

Course	Master of Science – Wind Energy Engineering
Module name	Turbine measurements
Abbreviation (if applicable)	Meas
Subtitle (if applicable)	---
Seminar (if applicable)	---
Semester	Winter semester
Person in charge of module	Dipl. -Ing. Axel Sachse, DNV Energy Systems Germany GmbH
Lecturer/s	Dipl. -Ing. Axel Sachse, DNV Energy Systems Germany GmbH
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	4 SH lecture
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	Basics in wind energy theory Basics in wind turbine systems
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• Knowledge and understanding of general items about the respective international standards and the different types of 3rd party and R&D measurements • Characteristics of wind turbines • Market relevance • Possibility to learn from the experience and expertise of the lecturers, who come from one of the leading 3rd party testing companies worldwide with more than 30 years of experience.
Subjects covered	• General overview • Standards and Guidelines for Wind Turbine Measurements • Prototype testing for certification proposes • Power Performance • Loads • Acoustics • Power Quality • Test of Turbine Behavior
Form of examination	Written examination (120 min) or oral examination
Media used	Power Point Presentations
Recommended literature	• Wind Turbines - Fundamentals, Technologies, Application, Economics - 2nd edition, E Hau, Springer 2013, Hardcover XVIII, 879 ISBN 978-3-642-27150-2, Softcover ISBN 978-3-662-49577-3, eBook ISBN 978-3-642-27151-9 • Wind Power Plants - Fundamentals, Design, Construction and Operation, Edited by Prof.Dr.-Ing.Robert Gasch and Dr.-Ing.Jochen Twele James and James October 2012, Softcover 548 pp ISBN 978-3-642-22937-4, eBook ISBN 978-3-642-22938-1 • Wind Power in Power Systems, Edited by Thomas Ackermann, Wiley January 2012, Hardcover 1120 pp ISBN 978-0470974162 • Wind Energy - The Facts, European Wind Energy Association (EWEA) Routledge, August 2015Hardback, 592 pages, ISBN: 9781138881266 • Aerodynamics of Wind Turbines (2nd Edition), Martin O.L. Hansen Earthscan, Hardcover 181pp ISBN 978-1844074389 • Wind Energy Explained: Theory, Design and Application By James Manwell, Jon McGowan, Anthony Rogers, Hardcover, 704 Pages, 2009. Wiley & Sons, publisher. ISBN 978-0470015001

Module number [27]: Controller design for wind turbines and wind farms

Course	Master of Science – Wind Energy Engineering
Module name	Controller design for wind turbines and wind farms
Abbreviation (if applicable)	CWT
Subtitle (if applicable)	Design and evaluation of basic feedback and feedforward control loops for wind turbines. Overview on wind farm control.
Seminar (if applicable)	seminar
Semester	winter semester
Person in charge of module	Prof. Dr.-Ing. David Schlipf, Flensburg University of Applied Sciences
Lecturer/s	Prof. Dr.-Ing. David Schlipf, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	2 SH lectures 2 SH laboratory exercise
Student workload	attendance: 60 h private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	General basic knowledge in Matlab, undergraduate mathematics and mechanics
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	• The students are able to describe the basic dynamics of wind turbines. • The students are able to design a basic controller, basic filters and additional control loops for wind turbines and test and evaluate them in Matlab/Simulink. • The students are able to process lidar data and use them for feedforward control. • The students are able to reproduce the challenges in wind farm control and to explain basic wind farm control approaches.
Subjects covered	• Controller design model • Baseline pitch and torque control • Additional control loops and filter design • Individual pitch control and other concepts • Lidar-assisted control • Wind farm control • Floating wind turbine Control
Form of examination	Individual oral examination (30 min)
Media used	Beamer based presentation, blackboard, computer laboratory with Matlab/Simulink software
Recommended literature	• T. Burton, N. Jenkins, D. Sharpe, and E. Bossanyi, Wind Energy Handbook – Chapter 8 - The Controller. New York, USA: John Wiley & Sons, 2011. • A. Scholbrock, P. Fleming, D. Schlipf, A. Wright, K. Johnson, N. Wang, Lidar-Enhanced Wind Turbine Control: Past, Present, and Future, DOI: 10.1109/ACC.2016.7525113 • D. Schlipf, Lidar-assisted control concepts for wind turbines, Ph.D. dissertation, University of Stuttgart, 2016. doi: 10.18419/opus-8796. • G. J. van der Veen, I. J. Couchman and R. O. Bowyer, "Control of floating wind turbines," 2012 American Control Conference doi: 10.1109/ACC.2012.6315120

Module number [28]: Wind energy challenge project

Course	Master of Science – Wind Energy Engineering
Module name	Wind energy challenge project
Abbreviation (if applicable)	WEP
Subtitle (if applicable)	a) Mechanical & electrical engineering b) System design (modeling & optimization) c) Physical prototyping d) Project management
Seminar (if applicable)	project
Semester	Currently not offered
Person in charge of module	N.N.
Lecturer/s	N.N.
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	Individual: 2 SH project discussion, 2 SH project work
Student workload	Attendance: 60 h Private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	None, but recommended: • handcraft skills • interest in research • creativity in engineering
Use of the module in other degree programmes	No use in other degree programmes
Learning outcomes: aims of the module, acquired skills	Acquire practical research, developing and manufacturing experience by participating in a wind-specific engineering competition or challenge
Subjects covered	Design Theory • Practical aerodynamic design (Rotor design tradeoffs, surface finish effects, fairing design, manufacturing) • Project-specific theory (e.g. competition) Virtual Prototyping • CFD: 2D boundary layer code (XFoil), 3D panel method (XFLR5), and rotor BEM (QBlade) • Performance Modeling • Numerical Optimization Physical Prototyping • Geometric Dimensioning and Tolerancing (GD&T) • Hot wire cutting, 3D printing Measurement • System characterization (Friction, Drag, etc.) • Wind tunnel testing • Site assessment • Performance measurement • Optional: telemetry
Form of examination	Periodic design reviews (33%), simulation report (33%), physical prototype (34%)
Media used	n/a
Software	Eventually: • Microsoft Excel

	• Matlab/ Octave • QBlade • Solid Works • openFoam (linux Based) • BEM Code • XFOIL
Recommended literature	• Gaunaa, M., Øye, S. & Mikkelsen, R. (2009). *Theory and Design of Flow Driven Vehicles Using Rotors for Energy Conversion.* In EWEC 2009 Proceedings online. Brussels: EWEC • Marten, D., Wendler, J., Pechlivanoglou, G., Nayeri, C. & Paschereit, C. (2009). QBlade: An open source tool for Design and Simulation of horizontal and vertical axis wind turbines. *International Journal of Emerging Technology and Advanced Engineering 3 (Special Issue* 3), 264-269. • Meschia, F. (2008). Model analysis with XFLR5. *Radio Controlled Soaring Digest 25(2),* 27-51. • Competition-/challenge-specific material (TBD) • Contest Regulations latest release • Anderson, J. D.: Fundamentals of aerodynamics. McGraw-Hill series in aeronautical and aerospace engineering. Boston: McGraw-Hill 2001 • Søren Gundtoft: Wind Turbines, 2009 • Manwell, J. F., McGowan, J. G. u. Rogers, A. L.: Wind energy explained. Theory, design and application. Chichester: Wiley 2011

Module number [29]: Green entrepreneurship

Course	Master of Science – Wind Energy Engineering
Module name	Green entrepreneurship
Abbreviation (if applicable)	
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Currently not offered
Person in charge of module	Dr. Thomas Neumann, Flensburg University of Applied Sciences
Lecturer/s	Dr. Thomas Neumann, Flensburg University of Applied Sciences
Status within the curriculum	Master Course Wind Energy Engineering Compulsory elective course
Language	English
Type of course and hours per week	4 SH lectures, workshops & meetings
Student workload	Attendance: 45 h Private study: 105 h
Credit points	5 ECTS
Preconditions according to examination regulations	Sound knowledge of business administration and accounting
Use of the module in other degree programmes	Master degree programme Energy and Environmental Management, Europa-Universität Flensburg, sub-programmes Developing/Industrial Countries.
Learning outcomes: aims of the module, acquired skills	Students should learn how to start a business and to judge foundations of enterprises of others Students learn how to identify new business ideas and to conceptualize, to plan, to finance and to manage them successfully Competencies covered: • ability to think entrepreneurial • ability to act strategically • problem solving competence • ability to act target-oriented • ability to deal constructively with criticism • interdisciplinary knowledge • interdisciplinary communication • economic competence • ecological competence • methodical competence • social and ethical sense of responsibility • self-organization • project organizing skills • ability for project organization • ability to deal constructively with criticism • collaborative skills • teamwork skills
Subjects covered	This unit introduces the students to the field of entrepreneurship and planning for new business initiatives in the global business environment. The focus of the course are green business foundations and how to harvest green opportunities. Topics include: • Entrepreneurial theory • Idea generation techniques • Value proposition, customer definition and market analysis • Key resources, activities and partnerships required • Cost structure, revenue models and financing strategies • Vision, mission and strategy development • Basics of business plan writing • Pitch-presentation workshop

	• The focus of the course are green business foundations and how to harvest green opportunities.
Form of examination	Oral examination / team project presentation (pitch) Project paper (business plan)
Media used	Power point, blackboard, business model canvas, internet
Recommended literature	• Arend, C., Dietrich, M., Maass, D., Pärschke, L. Quehl, P. & Urbach, Y.: The 2019 Berlin-Brandenburg Business Plan Competition Manual, Businessplan – Wettbewerb Berlin-Brandenburg, Berlin, 2019. • Hisrich, R. D., Peters; M. P. & Shepherd, D.A.: Entrepreneurship, 10th Edition, McGraw Hill, 2016. • Westhead, P., Wright, M. & McElwee, G.: Entrepreneurship: Perspectives and Cases, Prentice Hall, 2011. • Hall, Carl: The Environmental Capitalist, 2015 • Faltin, Guenter: Brain versus Capital, 2018 • Current Articles

Module number [30]: Wind Farm Project Development

Course	Master of Science – Wind Energy Engineering
Module name	Wind Farm Project Development
Abbreviation (if applicable)	WFPD
Subtitle (if applicable)	
Seminar (if applicable)	
Semester	Winter semester
Person in charge of module	Dr. Marina Blohm
Lecturer/s	Dr. Marina Blohm
Status within the curriculum	Master Course Wind Energy Engineering mandatory-optional
Language	English
Type of course and hours per week	4 SH lectures supplemented by exercises and group work
Student workload	Attendance: 60 h Private study: 90 h
Credit points	5 ECTS
Preconditions according to examination regulations	
Use of the module in other degree programmes	Elective course in the Master Sustainable Energy at the Europa-Universität Flensburg
Learning outcomes: aims of the module, acquired skills	• Students understand and analyse the current state of knowledge in relation to the various stages of wind farm project development • Students apply their acquired knowledge to new topics and create solutions independently and in groups • Students critically analyse existing wind farm projects and reflect on existing problems and obstacles • Students analyse and critically reflect on the social and ecological consequences of wind energy and wind farm planning • Students create alternative solutions, which have not necessarily been used as standards up to now, to consider social and environmental concerns. • Students get to learn a toolkit to justify decisions made and explain their professional actions • Students will work independently and in groups and will learn to present and justify their standpoints • The knowledge acquired is consolidated through various recurring learning tests • Finally, students are able to plan their own wind farm project, assess the feasibility of new project locations and carry out the entire planning process independently.
Subjects covered	• Introduction to wind farm project development • Basics of project management tools • Planning and permitting (national requirements, legal aspects, approval procedures, land securing models) • Social participation and involvement (stakeholder management, participation processes, financial participation possibilities) • Economic analysis / financing of wind farm projects (financial requirements, support mechanisms for renewable electricity) • Wind energy and sector coupling (business models beyond renewable electricity such as storage or hydrogen production, legal and regulatory requirements) • Design your wind farm along the entire planning process
Form of examination	Written report (~10 pages) and oral presentation (10 minutes)
Media used	PowerPoint presentations, whiteboard, e-learning platform, lecture notes

Recommended literature	• Meier and Rietz (2019) *Projektmanagement in der Windenergie – Strategien und Handlungsempfehlungen für die Praxis. Springer Gabler*. URL: https://link.springer.com/book/10.1007/978-3-658-27365-1 • Wytrzens (2023) *Projektmanagement – Der erfolgreiche Einstieg*. 6. Auflage. ISBN 978-3-7089-2311-6 • AstonEco Management ltd (2019) Earning Local Support for Wind Energy Projects in Ireland. URL: https://www.astoneco.com/earning-local-support-energy-projects-ireland# • EWEA (2009) The economics of wind energy. • Stiftung Umweltenergierecht (2024) Betriebsbeschränkende Nebenbestimmungen bei der Genehmigung von Windenergieanlagen. ISSN 2365-7146 • Selected scientific papers made available by the lecturer

Module number [31]: Master thesis

Course	Master of Science – Wind Energy Engineering,
Module name	Master thesis
Abbreviation (if applicable)	-
Subtitle (if applicable)	-
Seminar (if applicable)	-
Semester	4th semester (or 3rd for students having been registered for the 2nd semester of the programme immediately)
Person in charge of module	2 professors of the course of study
Lecturer/s	-
Status within the curriculum	Master Course Wind Energy Engineering mandatory course
Language	English, German (if an application is filed accordingly)
Type of course and hours per week	• Writing of final thesis • Preparation and realisation of colloquium • The thesis is to be produced in a time period of five months.
Student workload	attendance: - private study: 900 h
Credit points	30 ECTS
Preconditions according to examination regulations	For students having been registered for the 2nd semester of the programme immediately, pursuing the programme as a three-semester course of study, a minimum of 45 credit points (CP) is the prerequisite for admission to the thesis. For students having started with the first semester of the programme, pursuing the programme as a four-semester course of study, a minimum of 75 credit points (CP) is the prerequisite for admission to the thesis.
Aims of the module, acquired skills	• With the Master's thesis the students show that they are able to independently compose a comprehensive work that complies with high methodological, conceptual and scientific demands. • They are also able to present the results in written and oral form.
Subjects covered	The topic of the thesis has to be related to one of the taken modules of the study and has to be supervised by at least one professor of the study program. Subjects covered: • Conception of a work plan • Independent study of related literature and methodology • Application of methodology • Compilation of the thesis • Presentation of results • Colloquium
Form of examination	The colloquium is scheduled to take 60 minutes for each candidate (20-30 minutes presentation of thesis and 20-30 minutes oral exam). The grade of the master’s thesis is made up of the grade for the written thesis counting 70% and the grade for the colloquium counting 30%.
Media used	-
Recommended literature	-