Module Handbook Wind Energy Athens

Fakultät 5: Mathematik und Naturwissenschaften Institut für Physik *Subject:* European Master in Renewable Energy Summer Term 2017	*Category:* - Master Module *Degree award:* - Master
Emphases: -	*Sections:* -
Module reference number/Title: **pre325 - Wind Potential, Aerodynamics & Loading of Wind Turbines**	
Duration: 1 semester *Cycle:* once a year *Type of module:* mandatory *Level:* MM (master module) *This module should be taken in* 2nd semester	*Type of program:* - Lectures, Tutorials, Workshop, Laboratory *Language:* English *Attainable credit points:* 7,50 CP *Workload:* 187,5 hours *Required attendance:* 92 hours
Person responsible for the programme: Prof. Arthouros Zervos	*Person responsible for this module:* Prof. Arthouros Zervos
Alternative person(s) responsible for this module: A. Zervos, P. Chaviaropoulos, S. Voutsinas, V. Riziotis, G. Sieros, G. Caralis	*Examiner(s):* All listed persons
Objective of the module / skills: At the completion of this module, the student will: - possess advanced knowledge on wind potential, aerodynamics and loading of wind turbines - be skilled in simulation programs for design and control of Wind Turbines (GH Bladed), practical experience - be skilled in wind potential evaluation, wind farm design and environmental impacts using simulation programs (GH WindFarmer), - have an understanding of economic parameters for a successful project realisation	
Content of the module: 1. Introduction - Status of Wind Energy - Status of European Wind Energy and R&D 2. Advanced Wind Structure and Statistics - Gusts and gust probability distributions - Effects of topography	

3. Evaluation of Wind Energy Potential
- Wind modelling in flat and complex terrain
- Wind energy siting approaches

4. Wind Turbine Aerodynamics
- Advanced methods
- Aerodynamic stall
- Unsteady aerodynamics
- Vortex wake structure
- Advanced wake models
- Optimum design of wind turbine blades

5. Static and Dynamic Loading of Wind Turbines
- Aerodynamic and gravity loading
- Inertial and structural loads
- Aeroelastic modelling
- Fatigue of wind turbine blades

Suggested reading:

European Wind Energy Association: Wind Energy - The Facts. 2004.

J.F. Manwell, J.G. McGowan, A.L. Rogers, J. Willey and Sons: Wind Energy Explained – Theory, Design and Application. 2002.

R. Gasch, J. Twele, James and James: Wind Power Plants - Fundamentals, Design, Construction and Operation. 2002.

M.J. Pasqualetti, P. Gipe, R.W. Righter (eds): Wind Power in View. Academic Press, 2002.

R.Y. Redlingen, P.D. Andersen, P.E. Morthorst: Wind Energy in the 21st Century. UNEP, 2002.

T. Burton, D. Sharpe, N. Jenkins, E. Bossanyi: Wind Energy Handbook. John Wiley and Sons, 2001.

P. Gipe: Wind Energy Comes of Age'. John Wiley and Sons, 1995.

Comments:

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Weblink:

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Prerequisites for admission:

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Helpful previous knowledge:

Basic Understanding in
- Mathematics and Algebra
- Aerodynamics
- Fluid Mechanics
- Computational fluid dynamics

Associated with the module(s):

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Maximum number of students / selection criteria:

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Types of examinations:

Written exam (3 hours)

Examination periods:

Exam week (end of May)

Registration procedure:

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Fakultät 5: Mathematik und Naturwissenschaften Institut für Physik *Subject:* European Master in Renewable Energy Summer Term 2017	*Kategorie:* - Master Module *Degree award:* - Master
Emphases: -	*Sections:* -

Module reference number/Title:

pre326 - Wind Turbine Design, Electrical & Control Issues, Certification

Duration: 1 semester *Cycle:* once a year *Type of module:* mandatory *Level:* MM (master module) *This module should be taken in* 2nd semester	*Type of program:* - Workshop, Lectures, Laboratory, Tutorial *Language:* English *Attainable credit points:* 7,50 CP *Workload:* 187,5 hours *Required attendance:* 92 Hours
Person responsible for the programme: Prof. Arthouros Zervos	*Person responsible for this module:* Prof. Arthouros Zervos
Alternative person(s) responsible for this module: V. Riziotis, R. Builds, G. Caralis, N. Stefanatos, D. Lekou, F. Kokkalidis, S. Tenzerakis, S. Papathanasiou, P. Ladakakos (ENTEKA), F. Van Hulle (EWEA), S. Voutsinas	*Examiner(s):* All listed persons

Objective of the module / skills:

At the completion of this module, the student will:
- possess advanced knowledge on wind turbine design, electrical and control issues
- be skilled in Wind potential evaluation, Wind farm design and environmental impacts using simulation programs (GH WindFarmer), practical experience
- be skilled in performance testing and modelling of wind turbines

Content of the module:

1. Electrical Conversion Systems
- Synchronous and induction generators
- Direct drive generators
- Constant and variable speed systems

2. Wind turbines control
- Aerodynamic power control (stall, pitch, yaw)
- Electromagnetic torque control
- Control – dynamic analysis and stability
- Control strategies

3. Design of wind turbines

- Important factors
- Design options
- Design parameters
- Design of components
- System design
- Megawatt scale design
- Offshore design

4. Performance Testing and Modelling
- Measurements under controlled conditions
- Field testing instrumentation

5. Measurements - anemometers - calibration

6. Electrical Integration
- Weak grids
- Power quality
- Network costs and benefits

7. Large scale integration
- Technical, economical and policy issues
- Grid connection requirements, infrastructure
- Economic aspects

8. Standards and Certification
- WT certification
- International standards

Suggested reading:

European Wind Energy Association: Wind Energy - The Facts. 2004.

J.F. Manwell, J.G. McGowan, A.L. Rogers, J. Willey and Sons: Wind Energy Explained – Theory, Design and Application. 2002.

R. Gasch, J. Twele, James and James: Wind Power Plants - Fundamentals, Design, Construction and Operation. 2002.

M. J. Pasqualetti, P. Gipe, R.W. Righter (eds): Wind Power in View. Academic Press, 2002.

R.Y. Redlingen, P.D. Andersen, P.E. Morthorst: Wind Energy in the 21st Century. UNEP, 2002.

T. Burton, D. Sharpe, N. Jenkins, E. Bossanyi: Wind Energy Handbook. John Wiley and Sons, 2001.

P. Gipe: Wind Energy Comes of Age'. John Wiley and Sons, 1995.

S. Heier: Grid Integration of Wind Energy Conversion Systems. John Wiley and Sons, 1998.

L.L. Freris (ed): Wind Energy Conversion Systems. Prentice Hall, 1990.

Comments:

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Weblink:

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Prerequisites for admission:

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Helpful previous knowledge:

Basic Understanding in
- Electric Circuits and Systems
- Electromechanical Power Conversion Systems
- Aerodynamics
- Physics

Associated with the module(s):

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Maximum number of students / selection criteria:

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Types of examinations:

Written exam (3 hours)

Examination periods:

Exam week (end of May)

Registration procedure:

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Fakultät 5: Mathematik und Naturwissenschaften Institut für Physik *Subject:* European Master in Renewable Energy Summer Term 2017	*Kategorie:* - Master Module *Degree award:* - Master
Emphases: -	*Sections:* -

Module reference number/Title:

pre327 - Wind Farm Technology, Economics & Environmental Issues

Duration: 1 semester *Cycle:* once a year *Type of module:* mandatory *Level:* MM (master module) *This module should be taken in* 2nd semester	*Type of program:* - Lectures, Workshop, Tutorial, Excursion *Language:* English *Attainable credit points:* 7,50 CP *Workload:* 187,5 hours *Required attendance:* 92 hours
Person responsible for the programme: Prof. Arthouros Zervos	*Person responsible for this module:* Prof. Arthouros Zervos
Alternative person(s) responsible for this module: G. Caralis, D. Diakoulaki, J. Beurskens, T. Kouremenos (ROKAS), C. Aggelopoulou (GH), P. Papastamatiou (ENTEKA), S. Voutsinas, J. Prospathopoulo, D. Bouris	*Examiner(s):* All listed persons

Objective of the module / skills:

At the completion of this module, the student will:
- possess advanced knowledge on wind farm design
- possess advanced knowledge on economics and environmental issues
- be skilled in wind farm design and environmental impacts using simulation programs (GH WindFarmer), practical experience
- have an understanding of economical parameters to successful project realisation

Content of the module:

1. Wind Farm Technology Issues
- Wind exploitation in wind farms
- Energy predictions and optimization
- Balance of plant
- Wind farms electrical design
- Wind Farm design, wake effect (simple and advanced wake models, numerical methods - CFD approach)

2. Economics of WT and Externalities
- Calculation methods

- Current plant costs
- Wind energy prices
- The value of wind energy
- External costs
- Future price trends

3. Environmental Issues
- Environmental benefits
- Environmental effects
- Amenity (land use, visual impact)
- Technical analysis of noise and electromagnetic interference
- Ecology (birds)
- Consumption of energy and materials

4. Market development and status of industry
- Characteristics of the EU industry
- Present status of wind power
- Market description
- Market predictions
- Wind energy targets
- Wind energy market incentives in Europe

5. Offshore
- Turbine modelling
- Support structures – foundation
- Wind farms aspects
- Grid connections

6. Wind energy in urban areas

7. Wind forecast
- Introduction to Coupled Ocean / Atmosphere Mesoscale Prediction System (COAMPS)

Suggested reading:

European Wind Energy Association: Wind Energy - The Facts. 2004.

J.F. Manwell, J.G. McGowan, A.L. Rogers, J.Willey and Sons: Wind Energy Explained – Theory, Design and Application. 2002.

R. Gasch, J. Twele, James and James: Wind Power Plants - Fundamentals, Design, Construction and Operation. 2002.

M. J. Pasqualetti, P. Gipe, R.W. Righter (eds): Wind Power in View. Academic Press, 2002.

R.Y. Redlingen, P.D. Andersen, P.E. Morthorst: Wind Energy in the 21st Century. UNEP, 2002.

T. Burton, D. Sharpe, N. Jenkins, E. Bossanyi: Wind Energy Handbook. John Wiley and Sons, 2001.

P. Gipe: Wind Energy Comes of Age'. John Wiley and Sons, 1995.

S. Heier: Grid Integration of Wind Energy Conversion Systems. John Wiley and Sons, 1998.

L.L. Freris (ed): Wind Energy Conversion Systems. Prentice Hall, 1990.

T. Ackermann: Wind Power in Power Systems. Wiley, 2005.

EWEA: Large scale integration of wind energy in the European power supply: Analysis, issues and recommendations. December 2005.

Comments:	*Helpful previous knowledge:*

- *Weblink:* - *Prerequisites for admission:* -	Basic Understanding in - Mathematics and Algebra - Aerodynamics - Fluid Mechanics *Associated with the module(s):* -
Maximum number of students / selection criteria: - *Types of examinations:* Written exam (3 hours) *Examination periods:* Exam week (end of May) *Registration procedure:* -	

Fakultät 5: Mathematik und Naturwissenschaften Institut für Physik *Subject:* European Master in Renewable Energy Summer Term 2017	*Kategorie:* - Master Module *Degree award:* - Master
Emphases: -	*Sections:* -

Module reference number/Title:

pre328 - Mini Project

Duration: 1 semester *Cycle:* once a year *Type of module:* mandatory *Level:* MM (master module) *This module should be taken in* 2nd semester	*Type of program:* - Self-study *Language:* English *Attainable credit points:* 7,50 CP *Workload:* 187,5 hours *Required attendance:* -
Person responsible for the programme: Prof. Arthouros Zervos	*Person responsible for this module:* Prof. Arthouros Zervos
Alternative person(s) responsible for this module: V.Riziotis, G.Caralis	*Examiner(s):* All listed persons

Objective of the module / skills:

This module is split in two parts. The first one is the Mini Project and the second is the Wind Farm Study.

During the mini-project students are skilled in preparation, writing and presentation of a scientific project, of their choice. They learn how to make a bibliographic research, organise their references, focus on a special topic, describe the problem, collect data, and draw conclusions. Finally, they gain experience on presentations. Students are encouraged to connect their mini-project topic with their internship.

In parallel, during the wind farm study, students make their own study on the design of a wind farm. Individual data are provided, together with the necessary computational tools to be used in the various steps of the study (Wind data, wind turbine, energy calculations, Wind farm layout, Integration issues and financial evaluation)

Content of the module:

1. Mini Project

Students are encouraged to realize a mini project in a subject of their interest. Through this project, students are focus on a special topic of wind energy:

- Aerodynamics / Aero-elasticity / Aero-acoustics / Loads,
- Wind forecasting / capacity credit (short term – long term),
- Hybrid solutions for isolated systems,
- Wind farms design / wake effect,

- Small scale wind turbines for rural/urban applications
- Financial issues / External costs / Green certificates / CO2 Emissions taxes
- Control
- Analysis of market development
- Off shore (design, development, wind assessment)
- Measuring methods and monitoring
- Grid integration / electrical issues
- Operation and damages
- Environmental issues

The typical form of the mini-project's report submitted is:

- Abstract – key words
- Introduction / scope /objectives
- Bibliographic research
- Methodology
- Computational part
- Results
- Discussion / conclusions

2. Wind Farm study

The steps of the wind farm study is consists of:

- Wind data analysis (statistics, wind rose design),
- Wind turbine design for the specific site using Blade Element Momentum theory
- Energy calculations for the specific wind turbine and wind data, using a cost model for the minimization of the LCOE
- Wind farm's layout and wake effect calculation
- Integration issues for specific autonomous power system (wind energy curtailment, capacity credit)
- Financial evaluation (IRR, NPV, PBP)

Suggested reading:

European Wind Energy Association: Wind Energy - The Facts. 2004.

J.F. Manwell, J.G. McGowan, A.L. Rogers, J. Willey and Sons: Wind Energy Explained – Theory, Design and Application. 2002.

R. Gasch, J. Twele, James and James: Wind Power Plants - Fundamentals, Design, Construction and Operation. 2002.

M. J. Pasqualetti, P. Gipe, R.W. Righter (eds): Wind Power in View. Academic Press, 2002.

R.Y. Redlingen, P.D. Andersen, P.E. Morthorst: Wind Energy in the 21st Century. UNEP, 2002.

T. Burton, D. Sharpe, N. Jenkins, E. Bossanyi: Wind Energy Handbook. John Wiley and Sons, 2001.

P. Gipe: Wind Energy Comes of Age'. John Wiley and Sons, 1995.

S. Heier: Grid Integration of Wind Energy Conversion Systems. John Wiley and Sons, 1998.

L.L. Freris (ed): Wind Energy Conversion Systems. Prentice Hall, 1990.

T. Ackermann: Wind Power in Power Systems. Wiley, 2005.

Comments:	*Helpful previous knowledge:*
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Weblink: - *Prerequisites for admission:* -	*Associated with the module(s):* -

Maximum number of students / selection criteria:

-

Types of examinations:

Mini Project (50%): Written report up to 3,500 words, Presentation (15-20 minutes presentation plus discussion)

Wind Farm Study (50%): Written report (15-20 pages)

Examination periods:

Mini Project: Submission deadline end of May

Wind Farm Study: Submission deadline end of April

Registration procedure:

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