Syllabus:

Mechanical Aspects of Wind Energy

(3 ECTS-Credits)

Module: Design of Mechanical and Electrical Components (6 ECTS-Credits)


Instructor

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Course goals

After successfully completed the course Mechanical Aspects of the design of Wind Energy Converters, the student should be able to describe the principles how to design and compute different kind of wind turbine components and how to take decisions on the material and e.g. the kind of power control.

Pre-requisites

There are no pre-requisites for the course Mechanical Aspects of Wind Energy.

Seminar structure, seminar location and times

All seminars and exercises will be held on Monday at 12:30 pm - 2.00 pm (German time) on the dates following in this syllabus. All seminars and exercises will be held with the conference tool Adobe Connect in ecampus. The duration of an online session is 90 minutes.

All questions on understanding the material should be directed to your fellow students in the online forums first.

Participation requirements

There will be seven online class seminars, which students are required to attend.

Texts, reading and other materials


All additional reading Materials will be posted in Moodle. Each online session will be recorded. Each recorded online session with the presentation slides of the session will be provided in ecampus (recorded online sessions) and in Moodle (presentation slides).

Hardware and software requirements

Each student needs a headset, a computer and an internet connection for the online sessions.
Art of Examination

Written exam (60 minutes) followed by a discussion with the Professor on selected issues of the exam. The final grade is composed of the examination mark.

Grading policy

The Lecture “Mechanical Aspects of Wind Energy” contains one grading assignment for the end exam. The grading scale used in this course is the same as for all WES courses. For all single assignments, the following scale is used:

<table>
<thead>
<tr>
<th>Category</th>
<th>Grade range</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>1,0 1,3</td>
<td>Excellent performance</td>
</tr>
<tr>
<td>Good</td>
<td>1,7 2,0 2,3</td>
<td>Performance significantly above average</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>2,7 3,0 3,3</td>
<td>Average performance</td>
</tr>
<tr>
<td>Sufficient</td>
<td>3,7 4,0</td>
<td>Performance which, despite some shortcomings, meets the minimum standards of the course</td>
</tr>
<tr>
<td>Fail</td>
<td>5,0</td>
<td>Does not meet minimum course requirements</td>
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Course content

Unit 1  
November 17  
**Online Session, 12.30 - 2.00pm**

**Content**  
Introduction  
- History of modern wind turbines  
- Development of wind energy  

Introduction to wind energy specific meteorology  

**Homework**

Unit 2  
November 24  
**Online Questioning 12.15 - 12.30pm**  
**Online Session, 12.30 - 2.00pm**

**Content**  
Wind turbine types, concepts and sizes  
- Towers and foundation  

Energy from the wind  
- Power in the wind  
- Optimum power extraction  
- Power coefficient  
- Power curve  
- Optimisation of power output  

**Homework**

Unit 3  
December 1  
**Online Session, 12.30 - 2.00pm**

**Content**  
Rotor and aerodynamics
Mechanical Aspects of Wind Energy
Online M.Sc. Wind Energy Systems / Semester 1

- Basics of fluid mechanics
- Lift and drag forces
- Boundary layer
- Rotor blade airfoil geometry and characteristics
- Affects on the rotor blade aerodynamics
- Aerodynamically induced noise

Homework

Unit 4
December 8
Online Session, 12.30 - 2.00pm

Content
- Power control by aerodynamics
  - Stall control, pitch control, active stall control

Rotor blade design
- Twist, shape, airfoils, number of blades
- $c_p$ - $\lambda$ Diagram

Homework

Unit 5
December 15
Online Session, 12.30 - 2.00pm

Content
- Drive train of different horizontal axis wind turbines

International Standards and recommendations
- External conditions and operation
- Load cases
- Measurement and test procedures
**Homework:**

<table>
<thead>
<tr>
<th>Unit 6</th>
<th>Online Session, 12.30 – 2.00pm - December 22</th>
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</thead>
<tbody>
<tr>
<td>Content</td>
<td>Design philosophy and load assumptions</td>
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<tr>
<td></td>
<td>▪ Limit state design</td>
</tr>
<tr>
<td></td>
<td>▪ Fatigue loads</td>
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<tr>
<td></td>
<td>▪ Rotor blade structures</td>
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<tr>
<td></td>
<td>▪ Rotor blade material</td>
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<tr>
<td></td>
<td>▪ Wind farm effects on loads</td>
</tr>
<tr>
<td>Wind turbine dynamics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Campbell diagram</td>
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<tr>
<td></td>
<td>▪ Vortex induced vibrations on towers</td>
</tr>
</tbody>
</table>

**Homework:**

<table>
<thead>
<tr>
<th>Unit 7</th>
<th>Online Session, 12.30 – 2.00 pm - January 5</th>
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</thead>
<tbody>
<tr>
<td>Content</td>
<td>Learning from incidents</td>
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<td>Harvest factor of wind turbines</td>
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**Homework:**

<table>
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<tr>
<th>Final Exam</th>
<th>19. January</th>
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**Written exam will be held in January.**