Syllabus: Fundamentals of Electrical Engineering

Online M.Sc. Wind Energy Systems // Summer semester 2015

Instructors

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Pre-requisites

There are no pre-requisites for this course.

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All questions on understanding the material should be directed to your fellow students in the online forums first! At the beginning of each class session, we will discuss readings and have time to answer any questions which could not be answered already by your classmates.

Course goals and materials

The goal of the course is to teach participants how the power grids work and what are the relevant parts/elements in the grid (for example transformer, inverter, electrical machines). The course will deal also with some basics of electrical engineering however, we will focus on system understanding. Therefore, the content and the lectures of this course are based on the instructors’ experience what are the most helpful information to understand the global principles and challenges. Script and readings, which provide more in-depth information about the topics covered in class, will be available.

Grading policy

This class contains some graded assignments for several reasons: we want to encourage students to engage in the class and with the material over the entire duration of the class and we believe that is a fairer evaluation of students' overall performance to consider, say, ten assignments rather than two.

The grading scale used in this course is the same as for all WES courses. For all single assignments, the following scale is used:
### Category and Grade Range

<table>
<thead>
<tr>
<th>Category</th>
<th>Grade range</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>1.0</td>
<td>Excellent performance</td>
</tr>
<tr>
<td></td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>2.0</td>
<td>Performance significantly above average</td>
</tr>
<tr>
<td></td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>Satisfactory</td>
<td>3.0</td>
<td>Average performance</td>
</tr>
<tr>
<td></td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>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>
</tr>
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</table>

The following assignments will be considered and weighted in your overall course grade:

1. Short assignments: collectively 20%

Four short assignments, which should take about two to three hours to complete, will be assigned at regular intervals during the semester. Each assignment has equal grading weight. Details can be found later in this syllabus.

2. Reading presentations: collectively 20%

In total two reading presentations will be assigned. A schedule will be given out at the end of the lectures class, detailing who is to present which reading on the next date. Your assignment is to prepare the readings (using literature given by lecturer and additional materials), to present them in a proper manner (using your preferred media) and to discuss with your colleague students afterwards what were the challenges in preparing “your” lecture, and your lessons learned. (If it is not possible for you to attend the seminars, you must give notice two days before the scheduled date and you will be given an alternate assignment.

2. Final exam: 60%

The final exam is a half an hour oral examinations scheduled at the end of the lecture period.
Participation requirements

There will be twelve, real-time class seminars, students are required to attend six. Additional two, real-time reading presentations will be scheduled.

These seminars will be scheduled in a way that between “standard" readings a real-time “discussion-hours”, where all the questions regarding the topics and assignments will be answered both by lecturer and students. Of course attendance of these Q&A sessions is strongly recommended but no longer mandatory. However, there will be few chances to ask questions outside of these Q&A sessions.

This class is not about memorizing information, but about problem understanding and system thinking. Please not that the concept of this lecture is not only a "standard" lecture but also contains open discussion seminars. Students are required to keep up with the readings so that everyone can participate in the seminar.

Two day before the start of each Q&A sessions, students are required to submit two questions over Moodle. The first question should be a question to your classmates, which reviews some of the material from the readings. The second question should be directed at the instructors and be either a transfer question (How would you apply the principles of x to y?) or pose a problem.

The deadline for the delivery of assignments must be observed! We scheduled enough time for the students to prepare their assignment, so that no prolongation will be possible.

If you cannot attend the seminar, you must post your reading questions in the seminar’s forum, ideally a few days ahead of time.

Seminar location and times

Seminars will be held on Thursdays at 18:00 Central European time on the dates following in this syllabus. All seminars will be held over Adobe Connect and are 90 minutes long. Most of the seminars will be “live" sessions except two recorded sessions indicated in syllabus

Texts, reading and other materials

All the available materials will be posted on Moodle. All seminars will be recorded and made available.

Hardware and software requirements

All students will need a computer for this course; only the usual Microsoft office programs will be used.
The fundamentals of electrical engineering could be understood as the explanation of the DC- or AC-circuits or for the master level as solving of Maxwell's equations. We would like to take more practical approach: Because the students' background can vary significantly and basics can be learned as homework, we will focus on creating and following the system concept and discuss which are the elements/devices used or necessary for the operation of the system.

Therefore, we have opted to structure the course around teacher online lectures, student-presentation or office hours. The assignment of the student-presentation's topic will be week before it is scheduled. We will assign them in a way, that the group presentation is possible and the workload for each student is approximately 1.5 to 2 hours.

Today in class we will introduce ourselves as teachers, give an overview of the themes of the entire course and begin with our first topic:

1. Energy Sources, Forms, Carriers and Conversion
2. Energy statistics

The goal of this introduction lecture is to explain the relationships and how to find and understand the information in the "energy world".

Homework

Read Chapter 1 "Introduction" (22 pages)

Student presentation #1: During the first seminar the topic for each student will be assigned – see content of seminar 2.

Short assignment #1: research and write (or provide tables, graphs) a 400-word essay comparing the energy statistics (power demand, power generation) of three countries: one in Europe, one in Americas and one Asian country. This short assignment must be sent for evaluation latest on May 15th.

Seminar 2
Apr 23

Student presentation

The assignment of the student-presentation's topic will be done in the first seminar. Each student should present his topic in a
following way

a. Introduction of the student including his background
b. Presentation of the assignment
c. What were the major challenges, if any?

The presentation is to be provided to all students afterwards. The content as well as the presentation will be the evaluated by the teachers. The grades will be announced before seminar 3.

Homework

The students should read the chapter DC-Circuits provided in a script (or consult other literature) and prepare their questions for seminar 3 two days before.

Seminar 3 April 30

Q+A Session: DC-circuits

Content

In this seminar no “standard” lecture is planned. Moreover, the students should read the chapter DC-Circuits provided in a script (or consult other literature) and prepare their questions two days before.

Furthermore in this session students should answer the questions from lecturer side. These are:

a. Which DC-Sources do you know?
b. What is the basic principle of their operation?
c. What are the “typical” DC-Voltages used? Why?
d. Which DC-Loads do you know?
e. How big is the share of DC-Loads in “typical” power grid?

Homework:

Checking all answers provided in this session or answering open questions.

Short assignment #2: research and write (or provide tables, graphs) a max. 3 to 4 pages essay on a DC-Source of your choice. This short assignment must be sent for evaluation latest on May 30th

The students should read the chapter AC-Circuits provided in a script (or consult other literature) and prepare their questions two days before

Seminar 4 May 7

Q+A Session: AC-Circuits

Content

The electricity world is AC-based. In this lecture mainly the “mathematical” way of describing AC-systems such as complex numbers and phasors will be introduced. Moreover, the power terms related to AC-systems such as reactive power, apparent
power are to be discussed.

In this seminar no “standard” lecture is planned. Moreover, the students should read the chapter AC-Circuits provided in a script (or consult other literature) and prepare their questions two days before.

**Homework:** Checking all answers provided in this session or answering open questions.

### Seminar 5
**May xy**

**Converting DC into AC and vice versa**

**(recorded)**

**Content**
In the seminar 3+4 the DC and AC-world were discussed and in this lecture we want to explain how these two words interact. The main types of converters are going to be introduced and the basic operation of inverters will be explained.

**Homework:** **Short assignment #3:** research and write (or provide tables, graphs) a max. 3 to 4 pages about the application of inverters in industry. This short assignment must be sent for evaluation latest on June 11th.

### Seminar 6
**May 21st**

**Q+A Session: Summarizing the previous seminars**

**Content**
With this seminar the “basic” part of the lecture will be summarized. The students will have a chance to address their questions regarding their assignments (or to answer lecturer questions on this topic).

**Homework:**

### Seminar 7
**May 28th**

**Transformers**

**Content**
A transformer is a static device that by electromagnetic induction allows for changing the alternating voltage form one to another level without changing a frequency. In this lecture the basic principles are explained, the main components, the behavior and equivalent circuit will be discussed,

**Homework:** **Short assignment #4:** research and write (or provide tables,
If you analyze the power systems, than you will note that majority of power plants transformers mechanical energy (in conventional power plants the thermal energy is "converted" in mechanical, in wind power plant the rotor movement) into electrical. So basically, without electrical machines (almost) no power supply would be possible.

On the other hand electric motors consume approximately 50% – 60% of all electricity produced. This means that on the both sides of the power system (generation and demand) electrical machines are involved.

In the first part of electrical machines lectures the main parts of the machines will be discussed. As the most common used machines are the rotating ones, the rotating magnetic field and how to create it will be explained.

After this more general information the lecture will focus on inductance (asynchronous) machines. During the lecture

- Basic operation
- Equivalent circuit
- Torque development
- Power flow and efficiency of induction machines

will be introduced.

Homework: The students should read the chapter single-phase induction machines provided in a script (or consult other literature) and prepare their questions two days before.

Synchronous machines or rather synchronous generators are the "workhorse" of the power generation arena. During the lecture

- Basic operation
- Equivalent circuit
- Torque development
- Power flow and efficiency of synchronous machines

will be introduced.

After that the discussion about the advantages and disadvantages of induction and synchronous machines is planned.
**Homework:**  
**Student presentation #2:** During the seminar the topic for each student will be assigned – contents will cover specific topics regarding the electrical machines and transformers.

<table>
<thead>
<tr>
<th>Seminar 10</th>
<th>Student presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 18</td>
<td></td>
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</table>

**Content**  
The assignment of the student-presentation’s topic will be done in the seminar 9. The presentation is to be provided to all students afterwards. The content as well as the presentation will be the evaluated by the teachers. The grades will be announced before seminar 11.

This seminar is planned in a way that it summarizes the seminars 7 to 9.

**Homework:**

<table>
<thead>
<tr>
<th>Seminar 11</th>
<th>Power grid</th>
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<tbody>
<tr>
<td>June 25</td>
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</table>

**Content**  
The last seminar will deliver an insight about the power grid: How it is set-up, “conventional” grid, weak/bad grid, what is smart-grid.

**Homework:**

**Final oral Exam**

**Oral exams will be scheduled in end of June/Beginn of July**