220625 - Microgrids

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 709 - EE - Department of Electrical Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN AUTOMATIC SYSTEMS AND INDUSTRIAL ELECTRONICS (Syllabus 2012).
(Teaching unit Optional)
ECTS credits: 5
Teaching languages: English

Teaching staff
Coordinator: ALVARO LUNA ALLOZA
Others: ALVARO LUNA ALLOZA - JOAN ROCABERT DELGADO

Opening hours
Timetable: Wednesday 11:00 - 12:00 TR.14
Monday 9:00 - 11:00 TR.14

Degree competences to which the subject contributes

Specific:
1. Capacity to use different Power electronics systems to achieve a more complex one.
2. Improve self-learning capacity
3. Improve technical communication of results.
4. Modeling and simulation of electric machines electromecanic behavior.
5. Research, characterize and evaluate the concepts involved in decision taking quantitative and experimental methods.
6. Research, design and development of advanced control systems that will tuned the system performance till the required one.
7. Research, design and development of energy management systems integrated in the electric grid, with its data systems.
8. Research, design, development and characterization of electric energy quality. Capacity to diagnose the different equipment that requires electromagnetic compatibility validation.
9. Research, design, development and characterization of electric microgrids, that use renewable energy sources and the general grid and the implementation of supervision, control and diagnosis algorithm.
10. Research, development and design of control system and energy flux optimization in electrical microgrid to ensure its stability.

Transversal:
1. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
2. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
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Teaching methodology

The lectures will be continuously referred to simulation experiments, providing thus a problem-based learning approach to this subject. The theory and laboratory classes will be conducted in a computer lab, in order to combine the contents of the lectures with simulation exercises during the theory classes, and also to clarify any issue during the lab session. The students will be asked to deliver laboratory reports, solving specific issues related to microgrids control or design. As the model of this kind of systems are quite complex partial models will be build during the theory classes, in order to permit the students to train its modelling and control skills within an atmosphere where they can be supported by the lecturer.

Learning objectives of the subject

The operation of isolated networks and their relationship with large scale grids are currently of great interests. The high controllability of new distributed generation systems, together with the application of TIC within the field of energy, opens the door for further applications based on low scale networks which can handle their operation in island and grid connected mode.

This subject will be focused on this low scale networks, so-called microgrids. Taking advantage of the previous approach to this field, provided by another subject in the master, the main objective of these lectures will be to go deeper in the analysis of operation and control of the microgrid in different operating conditions.

First of all a review of the operation of classical networks will be conducted, in order to analyze the main parameters that should be controlled in a network. After closing this review the basic characteristics and operation details of an isolated systems will be studied, together with the main features of distributed generation systems.

Due to the importance of power processing a specific section will be devoted to this area, introducing some sizing and design criteria. After introducing this topic, the main control structures for these converters in microgrids applications will be tested and evaluated.

Finally a review of grid synchronization systems will be pursued, which are useful not only for the operation of the conversion stages themselves, but also for the overall operation of the microgrid.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 31h</th>
<th>24.80%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours small group: 14h</td>
<td>11.20%</td>
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<tr>
<td></td>
<td>Self study: 80h</td>
<td>64.00%</td>
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</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Unit</th>
<th>Title</th>
<th>Learning time</th>
<th>Theory classes</th>
<th>Laboratory classes</th>
<th>Self study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fundamentals of grid operation</td>
<td>16h</td>
<td>4h</td>
<td>2h</td>
<td>10h</td>
</tr>
<tr>
<td>2.</td>
<td>Microgrids and isolated systems</td>
<td>16h</td>
<td>4h</td>
<td>2h</td>
<td>10h</td>
</tr>
<tr>
<td>3.</td>
<td>Power conversion in microgrids</td>
<td>16h</td>
<td>4h</td>
<td>2h</td>
<td>10h</td>
</tr>
<tr>
<td>4.</td>
<td>Control of grid-connected converters for microgrid applications</td>
<td>32h</td>
<td>7h 40m</td>
<td>3h 20m</td>
<td>21h</td>
</tr>
<tr>
<td>5.</td>
<td>Grid converter structures for microgrids</td>
<td>33h</td>
<td>7h 40m</td>
<td>3h 20m</td>
<td>22h</td>
</tr>
<tr>
<td>6.</td>
<td>Grid synchronization in microgrids</td>
<td>11h</td>
<td>2h</td>
<td>2h</td>
<td>7h</td>
</tr>
</tbody>
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### Qualification system

- First Exam 25%
- Second Exam 25%
- Laboratory reports 30%
- Short project 20%

In case of not passing the first exam the students have the possibility to solve a list of exercises, which will be delivered the same day of the final exam. These exercises will be considered for evaluation instead of the first exam and will have the same weight, 25%, in the overall mark.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.

If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

### Regulations for carrying out activities

In both exams the students will be given a simulation case in a PC, where they should address some problem, implement a controller or evaluate the performance of a certain microgrid or element belonging to the microgrid. The student will be evaluated in the classroom through the answer that he/she will provide to the questions made by the evaluator. The total time of this test will be 30 minutes and the students are allowed to bring all kind of support material.
Bibliography

Basic:


Complementary:


Others resources:

Hyperlink

National Renewable Energy Laboratory