Course guides
820156 - GEO - Wind Energy Generation

Last modified: 04/06/2021

Unit in charge: Barcelona East School of Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).

Academic year: 2021 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: ÁNGEL SILOS SÁNCHEZ

Others: ÁNGEL SILOS SÁNCHEZ

PRIOR SKILLS

- Basic knowledge about generation and distribution of electric energy as well as applied knowledge of renewable energy.

REQUIREMENTS

- It is not necessary to have completed another previous subject.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEELE-25. Understand the applications of power electronics.
CEELE-28. Understand the applications of renewable energies.
CEENE-250. Knowledge of the principles of operation of electric power transmission and distribution systems.

TEACHING METHODOLOGY

- In the theory classes, will be exposed and develop the theoretical foundations of programmed materials. They consist of theoretical explanations complemented by activities to encourage participation, discussion and critical analysis by students.
- In the classes of problems will arise and solve exercises related to the matters. Students should meet individually or in groups these problems and to deliver a report at the end of the course.
- At laboratory students will conduct laboratory practices as required and submit the relevant report with all practices along with appropriate calculations and critical considerations at the end of the course.
- A research report about a specific topic related to the subject will be done during the course with oral presentation.

LEARNING OBJECTIVES OF THE SUBJECT

- Understand world wind generation market.
- Understand the different technologies of wind generation of electricity.
- Know how to determine the location of wind resources.
- Understand the different possibilities of control of wind turbines.
- Understand its operation in the power system.
- Know how to model, simulate the whole farm system.
- Learn to perform a pre-dimensioning of wind systems.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Self study	90,0	60.00
Hours large group	45,0	30.00

Total learning time: 150 h

CONTENTS

1. General concepts

Description:
1.1 Overview of wind energy conversion systems
1.2 Wind energy technology
1.3 WECS configurations
1.4 Grid code
1.5 National and international wind generation market

Full-or-part-time: 24h
Theory classes: 6h
Laboratory classes: 2h
Self study : 16h

2. The wind resource

Description:
2.1 General concepts
2.2 Variation in height and space
2.3 Variability of wind in time
2.4 Determination of gross energy yield
2.5 Assessment of resources
2.6 Wind measurements
2.7 Special offshore effects

Full-or-part-time: 30h
Theory classes: 6h
Laboratory classes: 4h
Self study : 20h

3. Fundamentals of wind energy conversion system control

Description:
3.1 Wind turbine aerodynamics
3.2 Maximum power point tracking (MPPT) control
3.3 Wind turbine components

Full-or-part-time: 24h
Theory classes: 6h
Practical classes: 2h
Self study : 16h

4. Wind generators and modelling

Description:
4.1 Reference frame transformations
4.2 Induction generator models
4.3 Synchronous generators

Full-or-part-time: 11h
Theory classes: 3h
Self study : 8h

5. Power Converters in wind energy conversion systems

Description:
5.1 Two-level voltage source converters
5.2 Three-level neutral point clamped converters
5.3 Comparison 2-level and 3-level converters
5.4 Converter control

Full-or-part-time: 11h
Theory classes: 2h
Practical classes: 1h
Self study : 8h

6. Wind Energy Conversion System Configurations

Description:
6.1 Fixed speed WECS
6.2 Variable speed induction generator WECS
6.3 Variable speed synchronous generator WECS

Full-or-part-time: 30h
Theory classes: 6h
Laboratory classes: 4h
Self study : 20h

7. Wind farm layout

Description:
7.1 Wind farm layout design
7.2 Electrical grid collector design
7.3 Wind farm connected to high voltage alternative current (HVAC)
7.4 Wind farm connected to high voltage direct current (HVDC)

Full-or-part-time: 19h
Theory classes: 6h
Self study : 13h

8. Grid Integration

Description:
8.1 Power system concepts
8.2 Wind power variability and limited predictability
8.3 Grid codes for Wind Turbines
8.4 Grid code requirements

Full-or-part-time: 9h
Theory classes: 3h
Self study : 6h

GRADING SYSTEM

- Research report with oral presentation (30%)
- Exercise report (10%)
- Test done at the end (35%)
- Laboratory report (25%)

EXAMINATION RULES.

- The written test is face-to-face and individual.
- The laboratory report is in group and exercise report is individual.
- The research report with oral presentation is individual
- In exercise and laboratory report will be assessed, where appropriate, the prior work with the presentation of results of each activity.

BIBLIOGRAPHY

Basic:
- Wu, B.. Power conversion and control of wind energy systems. Hoboken: Wiley-IEEE Press, 2011. ISBN 9780470593653.

Complementary:
- Ackerman, Thomas. Wind power in power systems [on line]. Second edition. Chichester, United Kingdom: John Wiley & Sons, 2012 [Consultation: 05/10/2020]. Available on: https://onlinelibrary.wiley.com/doi/book/10.1002/9781119941842. ISBN 0470855088.
- Lubosny, Zbigniew. Wind turbine operation in electric power systems : advanced modeling. Berlin [etc.]: Springer, 2003. ISBN 354040340X.
- Freris, L. L. Renewable energy in power systems. Chichester, U.K: John Wiley & Sons, 2008. ISBN 9780470017494.
- Heier, Siegfried. Grid integration of wind energy conversion systems. 2nd ed. Chichester [etc.]: John Wiley & Sons, cop. 2006. ISBN 0470868996.
- Teodorescu, Remus. Grid converters for photovoltaic and wind power systems [on line]. Chichester, West Sussex: John Wiley & Sons, 2011 [Consultation: 27/05/2020]. Available on: https://onlinelibrary.wiley.com/doi/book/10.1002/9780470667057. ISBN 9780470057513.
- Stiebler, Manfred. Wind energy systems for electric power generation [on line]. Berlin: Springer, cop. 2008 [Consultation: 27/05/2020]. Available on: http://dx.doi.org/10.1007/978-3-540-68765-8. ISBN 9783540687658.
- Hau, Erich. Wind turbines : fundamentals, technologies, application and economics [on line]. 2nd ed. Berlin [etc.]: Springer, 2006 [Consultation: 27/05/2020]. Available on: http://dx.doi.org/10.1007/3-540-29284-5. ISBN 9783540292845.
- Burton, Tony. Wind energy handbook [on line]. 2nd ed. Chichester [etc.]: John Wiley & Sons, cop. 2011 [Consultation: 05/10/2020]. Available on: https://onlinelibrary.wiley.com/doi/book/10.1002/9781119992714. ISBN 9781119992714.

RESOURCES

Other resources:

- Papers, documentation and web pages of interest which will be delivered during the course.