Universidad Zaragoza

Academic Year/course: 2022/23

66373 - Power Generation and control in wind energy systems

Syllabus Information

Academic Year: 2022/23
Subject: 66373 - Power Generation and control in wind energy systems
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 636 - Master's in Renewable Energies and Energy Efficiency
ECTS: 6.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

The course has as objectives...

- Knowledge of the power conversion schemes from the electric machine to the electric network.
- Know the different types of electric generators for application in renewable energies, identifying their advantages and disadvantages for each application.
- Ability to model and analyse the operation of various electric generators to optimize the use of the energy source, with special attention to wind energy.
- Knowledge of how electronic conversion systems are applied in generating systems from renewable sources.
- Applications in wind energy.
- Ability to perform the basic design of a generator in particular those that work at variable speed

These approaches and objectives are aligned with some of the Sustainable Development Goals, SDG, of the 2030 Agenda (https://www.un.org/sustainabledevelopment/es/) and certain specific goals, in such a way that the acquisition of the Learning outcomes of the subject provides training and competence to the student to contribute to a certain extent to their achievement:

- Goal 7: Affordable and clean energy
  - Target 7.1. By 2030, ensure universal access to affordable, reliable and modern energy services
  - Target 7.2. By 2030, significantly increase the share of renewable energy in the energy mix
  - Target 7.3. By 2030, double the global rate of improvement in energy efficiency.
- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
  - Target 9.5. Increase scientific research and improve the technological capacity of industrial sectors in all countries, in particular developing countries, including by fostering innovation and significantly increasing, by 2030, the number of people working in research and development per million inhabitants and public and private sector spending on research and development.

1.2. Context and importance of this course in the degree

The subject expands the competences acquired in the subject "Wind, hydroelectric and marine energy", focusing on the analysis of the different types of electric generators and on how the resource (analyzed in this subject) can be optimized using the most appropriate configuration and control.

1.3. Recommendations to take this course

In order to study this module, advanced knowledge of electrical engineering, control and electrical machines is required (level of industrial technical engineer, electrical branch or industrial and automatic electronics).

2. Learning goals

2.1. Competences

Upon passing the subject, the student will be more competent to ...

Basic and General

CB6.- Possess and understand the knowledge that provides a base or opportunity to be original in the development and/or application of ideas, often in a research context.

CB7.- That students know how to apply the knowledge acquired and their ability to solve problems in new or little-known environments within broader (or multidisciplinary) contexts related to their study area.

CB8.- That students can integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to applying their knowledge and judgments.

CB10.- That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

CG1.- Carry out research, development and innovation in products, processes and methods concerning energy efficiency.

CG2.- Carry out research, development and innovation in products, processes and methods concerning renewable energies.

CG4.- Follow the technological evolution of renewable energies and have prospective knowledge of this evolution.

CG5.- Apply knowledge of advanced sciences and technologies to the professional or investigative practice of efficiency.

CG6.- Identify current legislation and regulations applicable to the renewable energy and energy efficiency sector.

CG7.-Assess the application of emerging technologies in energy and the environment.

CG9.- Solve complex problems in the field of energy efficiency and sustainability.

Specific competences:

CE1.- Use and develop methodologies, methods, techniques, programs for a specific use, norms and computing standards.

CE3.- Assess the importance and implications of energy use in the development of society.

CE15.- Project energy storage systems.

CE17.- Calculate electric power generation, transport and distribution systems, and the integration of renewable energies in each.

2.2. Learning goals

The learning outcomes acquired by the student within this subject are...

- Know the different types of electrical generators for application in renewable energies, identifying their advantages and disadvantages for each application.
- Being able to model and analyze the operation of various electrical generators to optimize the use of the energy source, with special attention to wind energy.
- Be able to carry out the basic generator design, particularly those that work at variable speed.

2.3. Importance of learning goals

The energy conversion from the renewable source is mainly done through a generator. A deep understanding of the operation of this element, of the different types and their control will make it possible to take advantage of the available energy in each moment.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate that he has achieved the expected learning outcomes through the following assessment activities.
Two assessment options are available. These options are exclusive: Global Evaluation and Continuous Evaluation.

Option 1: (Global assessment)
Students who choose this option of assessment will take a written and individual final exam with several theoretical-practical

questions and problems to demonstrate that they have achieved the proposed learning competences. This test will be scheduled within the exam period corresponding to the first or second call.

Option 2: (Continuous assessment)
Students will be evaluated throughout the period of the subject by performing different exercises:

- Small theoretical-practical tests of the basic concepts of each subject.
- Realization and comment on the laboratory practices.
- Realization and discussion of practical cases.
- Development of different teaching activities.
- Tutored works of introduction to research.

This option can only be selected in the first call (ordinary call). In the second call (extraordinary call) only option 1 is available.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented toward achieving the learning objectives. The theory sessions explain fundamental concepts and problems on the board. In the practice sessions, simulations of different generation systems are introduced, and the students can check the operation of these systems in different conditions and understand better the concepts studied. In other tasks, the student can deepen the topics explained in theory and practice sessions.

4.2. Learning tasks

The course includes the following learning tasks:

- Theory and practice sessions. These are sessions to explain the basic concepts and to make problems and cases of practical applications of such contents. Student participation through questions and brief discussions will be encouraged.
- Lab practice sessions. The student will receive guidelines for the practice session at the beginning of the session, which will accompany the explanation and instructions necessary for completing the tasks.
- Guided assignments. During the first weeks of the course, students solve a set of problems and cases or conduct an assignment based on the practical application of the course contents.
- Autonomous work. During the whole year, the continuous work of the student will be promoted by the proposed learning activities.
- Assessment tests. They have both a grading function and a learning function with which the student checks the degree of understanding and assimilation of knowledge and skills.
- Tutorials. Hours for student guidance, identification of learning problems, orientation in the course, attention to exercises and assignments, etc.

4.3. Syllabus

Based on the state of technology, the following list of contents is proposed...

- Electric generators in wind systems. Modelling and simulation.
- Control models in electrical machines
- Pitch and yaw control in wind turbines
- Design of wind turbines
- Introduction to power electronics in wind turbines
- Inverters and grid power control in wind systems

4.4. Course planning and calendar

Further information concerning the timetable, classroom, assessment dates and other details regarding this course, will be provided on the first day of class or refer to the course webpage.

4.5. Bibliography and recommended resources

See the webpage,

http://biblos.unizar.es/br/br_citas.php?codigo=66373&year=2022