Universidad Zaragoza

Academic Year/course: 2022/23

66376 - Power quality in Electric Power Systems with renewable generation

Syllabus Information

Academic Year: 2022/23
Subject: 66376 - Power quality in Electric Power Systems with renewable generation
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 636 - Master's in Renewable Energies and Energy Efficiency
ECTS: 3.0
Year: 1
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

The objectives of the course are the following:

- To be able to select appropriate sensors and devices in order to perform electrical measurements and tests
- To be able to describe the power quality phenomena, its basic parameters and the current standards
- To analyze power quality measurements and decide if a given installation fulfil the standards and requirements
- To provide possible solutions to real power quality problems
- To plan power quality measurements by selecting appropriate instrumentation and their situation based on the description of the installation
- To know the national and international Grid Codes, specifically the Spanish operation procedures (PO 12.3 and PO 12.2)

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 learning outcomes of the subject provides training and competence to the student to contribute to some 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, considerably increase the proportion of renewable energy in all energy sources
- Target 7.3 By 2030, double the global rate of improvement in energy efficiency

Goal 9: Industry, Innovation and infrastructure.

- Target 9.4. By 2030, modernize infrastructure and convert industries to be sustainable, using resources more efficiently, promoting the adoption of clean and environmentally sound technologies and industrial processes, and ensuring that all countries take action according to their respective capabilities.

Goal 13. Climate action

- Target 13.3 Improve education, awareness and human and institutional capacity regarding climate change mitigation, adaptation, reduction of its effects and early warning.

1.2. Context and importance of this course in the degree

The electrical sector is experiencing a transformation caused by the problems of the current centralized system and the

growth of new technologies linked to distributed renewable generation, storage systems, power electronics and new communication technologies.

In previous courses, students have studied several renewable energy sources, traditional electrical network characteristics and basic power electronic converters. In this course, the power quality problems originated mainly due to power electronics and the requirements for the connection to the grid of renewable sources will be studied.

The course is mainly technical and no other courses of the master are needed as a pre-requisite.

1.3. Recommendations to take this course

The student must have knowledge of electricity and electrical networks as well as various cross-disciplinary knowledge. Specifically:

- Advanced knowledge of circuit theory, electrical machines and electrical networks.
- Basic knowledge of power electronics-based control systems.
- Capability for autonomous looking up technical and scientific databases.
- Good English level for reading technical documentation

2. Learning goals

2.1. Competences

The following skills are developed in this subject:

BASIC SKILLS

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.

GENERAL COMPETENCIES

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.

SPECIFIC COMPETENCES

CE1.- Use and develop methodologies, methods, techniques, programs for a specific use, norms and computing standards.
CE8.- Describe the smartgrids associated with energy management and distribution.

2.2. Learning goals

In order to pass this subject, the student must demonstrate the following results...

- Is able to select the most suitable sensors and devices to carry out electrical measurements and tests.
- Is able to describe the phenomenology of power supply quality, its basic parameters and current regulations.
- Is able to critically analyse the results of power supply quality measurements, correctly interpreting whether the installation in which they have been carried out complies with the requirements given by the regulations in force and providing possible solutions to the problems found.
- Can plan a power quality measurement, selecting the appropriate instrumentation as well as the measurement point(s) according to previous information on the installation to be studied.
- Knows, based on the concepts of network quality, what the response to disturbances in an electrical network should be.
- Knows the different international Grid Codes and, especially, the national operating procedures (PO12.3 and PO12.2) that regulate the connection of RES-E to the grid.

2.3. Importance of learning goals

Knowledge of both power quality issues and the requirements for grid integration of new generation sources is crucial for an expert in electricity systems with renewable sources. Planning new generation plants, wind farms, solar photovoltaics, biomass, etc., requires knowledge of their possible consequences on systems already in operation and on-grid users. Likewise, it is essential to know the requirements for the grid integration of these new plants, as this is a fundamental prior step for their commissioning.

3. Assessment (1st and 2nd call)

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

The student must demonstrate that he/she has achieved the expected learning outcomes through the following assessment activities.

Subject work (20%)

Carrying out an introductory research project on topics agreed upon with the lecturers using specialised bibliography. Submission of a report and presentation to classmates. The evaluation of the work will take place in the last fortnight of the course. The work will be carried out individually.

The presentation in class of the work and the written report will be assessed. The following will be assessed: demonstrate understanding of the subject, relationships between concepts, an extension of the concepts presented in class, present a coherent work outline (introduction, development and conclusions), adequate reference to the work of others, clarity of the oral presentation, adequate response to questions and correctness of the report.

Practical work (40%)

Practical laboratory work and/or computer simulation will be carried out.

Students must be able to carry out the practical work on the basis of a brief script provided by the lecturers. With this script and the material provided, the students will carry out the practical work in the laboratory and will prepare a report which they will hand into the teacher for evaluation.

Final exam (40%)

At the end of the course, a final exam will be held to evaluate the knowledge acquired by the student. It will consist of short theoretical and practical questions on the material taught during the course.

Assessment options

The evaluation may be carried out by each student, progressively by the evaluation of the practical reports, which will have a total weight of 40%. By the completion of course work on a subject related to the same, agreed with the teacher and defended publicly, whose value is 20% and by the completion of a theory exam whose value is 40%.

The student who does not opt for the procedure described above or does not pass these tests during the teaching period will have the right to take a global subject test in the period established by the centre.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The development of the course will have both theory sessions and practical sessions.
The theory sessions will be based on the lecture methodology where the basic concepts of the subject will be explained, and short practical exercises will be carried out under the guidance of the teacher.
There will also be practical sessions where the knowledge acquired in the theory sessions will be put into practice. These practical sessions may be based on problem-solving, case analysis or laboratory practice.
The course work may be of different types:

- Introductory research work where students must study and analyse new documentation on a specific topic assigned by the teacher and present their own conclusions on specific aspects of the subject.
- Work to expand on the concepts of the subject that for reasons of time cannot be considered during the teaching period of the course.
- Resolution of case studies in which the student must express their own criteria and draw their own conclusions.

4.2. Learning tasks

In order for students to achieve the learning outcomes described above and acquire the competences designed for this subject, the following training activities are proposed:

- A01. Lecture (12 hours): presentation of contents by the teaching staff or external experts to all students of the subject.
- A02. Problem solving and case studies (15 hours): practical exercises with all students in the course.
- A03. Laboratory sessions (8 hours): practical exercises in small groups of students of the subject.
- A06. Teaching assignments (12 hours).
- A07. Study (25 hours).
- A08. Assessment tests (3 hours).

The hours indicated are for guidance only and will be adjusted depending on the academic calendar of the course.

The calendar of practical sessions will be announced at the beginning of the course and will be fixed according to the progress of the programme and the availability of laboratories and computer rooms.

4.3. Syllabus

The programme of the course will have the following contents:

1. Introduction, classification and types of sensors
2. Measuring transformers
3. Current measurement
4. Introduction to the quality of supply
5. Frequency variations
6. Voltage dips and short interruptions
7. voltage fluctuations and flicker
8. Harmonics
9. Harmonic analysis
10. Power quality monitoring
11. Grid connection of renewable sources

4.4. Course planning and calendar

The subject is taught three hours per week in the spring semester, in which theory and practical sessions will alternate.
At the beginning of the semester, the professors will inform about the planning of the teaching activities, the key dates of delivery of exercises and the final evaluation test of the subject.