Last update: 13-06-2014

820753 - QSIRX - Quality of Power Supply and Integration of Renewables in the Network (DRAFT VERSION)

Coordinating unit: 820 - EUETIB - Barcelona College of Industrial Engineering

Teaching unit: 709 - EE - Department of Electrical Engineering

Academic year: 2014

Degree: MASTER IN ENERGY ENGINEERING (Syllabus 2013). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: Joan Montañá Puig

Others: Luis Sainz Sapera

Prior skills

- Basic knowledge of electrical systems.
- Solve circuit theory problems.
- Formulate Fourier series.
- Knlowledge of electric power systems.

Requirements

Degree competences to which the subject contributes

Specific:

CEMT-1. Understand, describe and analyse, in a clear and comprehensive manner, the entire energy conversion chain, from its status as an energy source to its use as an energy service. They will also be able to identify, describe and analyse the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.

CEMT-4. Efficiently collect data on renewable energy resources and their statistical treatment and apply knowledge and endpoint criteria in the design and evaluation of technology solutions for using renewable energy resources, for both isolated systems and those connected to networks. They will also be able to recognise and evaluate the newest technological applications in the use of renewable energy resources.

CEMT-6. Employ technical and economic criteria to select the most appropriate electrical equipment for a given application, dimension thermal equipment and facilities, and recognise and evaluate the newest technology applications in the field of production, transport, distribution, storage and use of electric energy.

CEMT-7. Analyse the performance of equipment and facilities in operation to carry out a diagnostic assessment of the use system and establish measures to improve their energy efficiency.

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Teaching methodology

- Lecture or seminar (EXP): Teacher and invited lectures.
- Participatory classes (PART): Exercises solved by groups and debates. Presentations of activities (individual or in groups).
- Theoretical and practical work (TD): Solution of exercises or case studies with the assessment of the teacher.
- Short project work (PR): short project or case study where the student will apply the studied contents.
- Project work (PA): in this case the student will work in group. A report with a description of the problem, the proposed solutions and conclusions will be submitted.
-Evaluation activities (EV).

Learning objectives of the subject

Ath the end of the course the students should be able to:
- Identify the effects of differnt types of disturbances and the most common mitigation techniques.
- Understand the origin of the harmonics, assess its effects and propose solutions.
- Understanding the origin, magnitude and effects of transients. Study of mitigation.
- Know the quality parameters of the voltage supply. Study of variations in voltage and frequency.
- Identify the origin, modelling and understand the impact of interruptions and voltage sags.
- knowing the regulatory framework, with special attention to the renewable generation.

Study load

Total learning time: 125h	Hours large group:	0h	0.00%
	Hours medium group:	0h	0.00%
	Hours small group:	30h	24.00%
	Guided activities:	15h	12.00%
	Self study:	80h	64.00%

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Content

1. Introduction

Learning time: 13h

Large group/Theory: 3h
Self study : 10h

Description:
This module describes the concepts of power quality in electrical systems, electromagnetic compatibility, a general classification of the disturbances and the related regulations will be introduced. The emphasis will be on systems with renewable energy sources.

Contents:
1.1 Concepts of power quality.
1.2 Types of disturbances in electrical systems.
1.3 Origin and classification of disturbances (EMC).
1.4 Effects of the integration of renewable energy into the grid.
1.5 Current regulatory framework.

Related activities:
Activity 1
Activity 2

Specific objectives:
- Understand the concepts related to the power quality.
- Know the types and sources of the disturbances affecting the quality of supply.
- To characterize the disturbances.
- Understand the current regulatory environment.

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3. Periodic perturbations

Learning time: 39h 30m

Large group/Theory: 4h 30m
Small group/Laboratory: 5h
Guided activities: 5h
Self study : 25h

Description:
In the second module periodic disturbances will be studied. The origin of harmonics and their effects on the quality of supply and consumption will be considered. Identification and mitigation techniques will be presented. The cases of renewable energy sources integrated to the power network will be exposed.

Related activities:
Activity 1
Activity 2
Activity 5

Specific objectives:
- To identify the source of harmonics.
- To Frequency domain modeling of power systems and evaluate the effects to the power quality
- To know the most common mitigation techniques.

3. Non-periodic disturbances

Learning time: 72h 30m

Large group/Theory: 7h 30m
Small group/Laboratory: 10h
Guided activities: 10h
Self study : 45h

Description:
The third module is devoted to non-periodic disturbances. First, temporary and transient over voltages will be discussed. Over voltages caused by direct and indirect lightning will be evaluated. Lightning effects to wind energy will be presented. Second, voltage and frequency variations will be studied. Finally, interruptions and voltage sags will be exposed. How renewable energy sources affects to the non-periodic disturbances will be described during this module.

Related activities:
Activity 1
Activity 3
Activity 4
Activity 5

Specific objectives:
-To understand the source, magnitude and effects of transient over voltages. To know the most common mitigation techniques.
- To know the quality characteristics of the voltage supply. To study the variations of voltage and frequency.
- To identify the origin, model and understand the impact of interruptions voltage sags.

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Qualification system

- Test (Activity 5): 50 %
- Exercises and works (Activity 1): 25 %
- Laboratory and practices (Activities 2, 3 i 4): 25 %

Regulations for carrying out activities

Rules will be available in Atena

Bibliography

Basic:

M. H. J. Bollen. Understanding Power Quality Problems: Voltage Sags and Interruptions. . Wiley-IEEE Press, 2013. ISBN 978-0-7803-471.

Roger C. Dugan, Surya Santoso, Mark F. McGranaghan, H. Wayne Beaty. Electrical power systems quality. 3. McGraw-Hill, 2012. ISBN 0071761551.

A. Moreno-Muñoz, . Power Quality: Mitigation Technologies in a Distributed Environment. Springer, 2007. ISBN 1846287715.

J. Arrillaga, D. A. Bradley, P. S. Bodger. Power system harmonics. 2. John Wiley & Sons, Ltd, 2003. ISBN 0-470-85129-5.

Complementary:

UNE-EN 50160: Características de la tensión suministrada por las redes generales de distribución. AENOR,

UNE-EN 61000 Compatibilidad electromagnética (CEM). AENOR,

IEEE Std 1410 Guide for Improving the Lightning Performance of Electric Power Overhead Distribution Lines. IEEEE, 2010.

IEEE Standard 1250 Guide for Service to Equipment Sensitive to Momentary Voltage Distrurbances, . IEEE, 1995.

IEEE Standard 1159: Recommended practices for monitoring electric power quality,. IEEE, 1995.

IEEE Standard 519: Recommended practices and requierements for harmonic control in electrical power systems,. IEEE, 1992.

REAL DECRETO 661/2007, de 25 de mayo, por el que se regula la actividad de producción de energía eléctrica en régimen especial.. 2007.