Storage in Electrical Systems

Academic Year: (2024 / 2025) **Review date: 18-03-2024**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: GARCIA PLAZA, MANUEL

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is recommended that students have knowledge of electrical engineering such as: circuit theory, electrical systems and drives. It is also desirable, although to a lesser extent, that they have programming and control theory skills.

OBJECTIVES

The general objective of the course is for students to acquire technical experience in energy storage projects.
Specific objectives are:
- That students acquire knowledge of the different storage technologies applicable to electrical systems and specific services and applications in renewable energy plants.
- That students understand the constituent parts, control systems and operation of a storage system.
- That they be able to design the energy management system of a storage system.
- That they acquire the capacity to dimension a storage system for applications of renewable energy plants integration and services to the electricity grid.

DESCRIPTION OF CONTENTS: PROGRAMME

1) Control devices in electrical networks: with and without energy storage systems.
   a) Hierarchical control of electrical systems.
   b) Common control devices in electrical systems.
   c) Modes of operation.
   d) Connection topology of storage systems.
   e) EMS market and specifications.

2) Modes of operation with accumulation systems.
   a) Systems with energy storage devices.
   b) Energy storage for electrical networks.
   c) Opportunities for the application of storage systems in electrical grid.
   d) Description of the applications of storage systems in electrical grid.
   e) Energy and power applications.
   f) Utility perspective of storage systems in electricity grids.
   g) ¿Peak power reduction¿ project example.

3) Energy storage systems in electrical networks.
   a) Introduction
   b) Comparison of the properties of the storage systems.
   c) Storage systems description.

4) Electrochemical batteries.
   a) Basic concepts about electrochemical batteries.
   b) Characterization and modeling of electrochemical batteries.
   c) Effects on dynamics.
   d) Advanced battery concepts.
   e) Example of advanced characterization and modeling.

5) Electrochemical battery types.
   a) Electrochemical batteries comparison.
   b) Electrochemical battery types description.

6) Battery sizing.
   a) Economic metrics in sizing.
   b) Sizing methodologies.
   c) Variables to be dimensioned.
   d) Energy sizing / State of charge estimation algorithms.
   e) Battery sizing exercise for photovoltaic systems.
   f) Power sizing / Maximum power algorithms.
   g) Longevity sizing / State of Health algorithms.

LEARNING ACTIVITIES AND METHODOLOGY

The assessment method will consist of the next activities:
- Lectures by proffesionals.
- Practical activities.
- Student presentations.
- Visit to pilot facilities.

ASSESSMENT SYSTEM

% end-of-term-examination:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

Continuous assessment based on homework, laboratory practices, multiple-choice quizzes, participation and oral presentations in the classroom.

BASIC BIBLIOGRAPHY

- D. Andrea Battery Management Systems for Large Lithium Ion Battery Packs, Artech House, 2010

- D. Linden and T. B. Reddy Handbook of Batteries, McGraw-Hill (third ed.), 2002

- K. C. Divya and J. Østergaard Battery energy storage technology for power systems - An overview, Electric Power Systems Research, vol. 79, no. 4, pp. 511-520, Apr. 2009

- P. T. Moseley, J. Garche, C. D. Parker, and D. A. J. Rand Valve-Regulated Lead-Acid Batteries, Elsevier, Feb. 2004

- R. A. Huggins Energy Storage, first ed. ed. New York: Springer, Sep. 2010

- T. B. Reddy and D. Linden Linden's Handbook of Batteries, McGraw-Hill (fourth ed.), 2011