Course guide
205218 - ESCA - Energy Storage and Conversion Application

Last modified: 11/04/2025

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2025 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Joan Rocabert Delgado

Others:

TEACHING METHODOLOGY

The course is develops through lectures including theoretical sessions imparted with the aid of powerpoint presentations and more applicative and more visual sessions with videos, stellar catalogues and simulations.

LEARNING OBJECTIVES OF THE SUBJECT

Obtain the basic knowledge for operation with the main storage technologies in applications of electromobility and electrical grid integration, including domestic and industrial applications. The technologies in which the subject will work, will be focus on electrochemical systems, super-capacitors and fuel cells.
The most used batteries in the last decades will be studied with a comparative study of the benefits that each one of them will provide. These knowledge will allow us to compare the batteries with other types of devices used for storing and supplying electric power, such as super-capacitors.
Therefore, this subject will provide students with a global knowledge about electrical energy generation and storage systems, as well as their potential industrial applications, which encompass the automotive sector, storage of energy generated in wind power plants or photovoltaic, naval applications and others.
At the end of the course, the student will have acquired a knowledge of the operating characteristics of the main storage system technologies, which tools are used to convert the stored energy, the main models that characterize their operation and tools for the dimensioning of installations.

STUDY LOAD

Type	Hours	Percentage
Self study	45,0	60.00
Hours large group	30,0	40.00

Total learning time: 75 h

CONTENTS

Module 1: Electrochemical Batteries

Description:
Battery Classification.
Fundamental aspects of batteries.
Primary batteries.
Rechargeable Batteries.
Capacitors and Superâ□□capacitors.

Related activities:
In this first sessions the student will learn the main concept in order to fully understand the manufacturer's specifications and industrial projects.

Full-or-part-time: 8h
Theory classes: 2h
Self study : 6h

Module 2: Batteries for Electromobility

Description:
Charging and discharging patterns.

Related activities:
Understand and selection capabilities of the main charging and discharging patterns according with the battery technology and driving profile.

Full-or-part-time: 10h
Theory classes: 4h
Self study : 6h

Module 3: Energy Storage Power Processing

Description:
Power conversion to optimize the power flow.

Related activities:
Understand and design capabilities of the main topologies to convert the dc energy storage into any voltage waveform required by the final user.

Full-or-part-time: 17h
Theory classes: 8h
Self study : 9h

Module 4: Energy Storage modelling

Description:
- Modeling of batteries in stationary and electromobility applications
- Llifetime modeling
- Aging Mechanism

Related activities:
Simulation of the power – energy profile of energy storage systems

Full-or-part-time: 20h
Theory classes: 8h
Self study : 12h

Module 5: Photovoltaic Energy Storage Sizing

Description:
- Mobility and net zero photovoltaics with battery storage systems
- Balance of Systems

Related activities:
Integration of batteries in standalone and grid connected applications. New contractual forms of self-consumption photovoltaic with energy storage.

Full-or-part-time: 14h
Theory classes: 5h
Self study : 9h

Module 6: Fuel Cells and Supercapacitors

Description:
Definition of the main features, types of technologies and modes of operation.

Related activities:
Sizing and modelling of other relevant storage technologies.

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

GRADING SYSTEM

First and second block exam (25%, inside the large group sessions) + Exercises during laboratory (30%) + Exercises performed during the development of the theory / problem sessions (20%).

BIBLIOGRAPHY

Basic:
- Linden, D.; Reddy, T.B. Handbook of batteries. 3rd ed. New York: McGraw-Hill, 2002. ISBN 0071359788.
- Equipo Técnico de Marketing de Gates Energy Products. Baterías recargables: manual de aplicaciones. Madrid: Paraninfo, 1999. ISBN 8428326037.
- Weicker, Phillip. A systems approach to lithium-ion battery management [on line]. Norwood, MA: Artech House, 2014 [Consultation: 09/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1463546. ISBN 9781608076598.
- Díaz-González, F.; Sumper, A.; Gomis Bellmunt, O. Energy storage in power systems. Chichester: John Wiley & Sons, 2016. ISBN 9781118971321.

Complementary:
- López Sastre, J.A.; Díaz García, J.I.; Romero-Ávila García, C. La Pila de combustible. Valladolid: Universidad de Valladolid, 2004. ISBN 8484482952.
- Dell, R.M.; Rand, D.A.J. Understanding batteries. Cambridge: Royal Society of Chemistry, 2001. ISBN 0854046054.