Course guide
205260 - DASE - Digitalisation for Energy Systems

Last modified: 08/09/2025

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

Degree:
BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Optional subject).
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: Pablo Alexander Moreno Kübel, Álvaro Luna

Others: Jaume Asensio, Marc Girona & Jaime Tarrasó

TEACHING METHODOLOGY

Digitalization in engineering is not just a tool-it's a fundamental shift in how engineering is practiced. It creates smarter, faster, and more efficient systems that are critical for modern innovation, sustainability, and competitiveness. Digitalization is not limited to IT or computer science profiles; engineers have a lot to contribute regarding the integration of digitalization in different fields. Due to their deeper knowledge of designs, physics, control, and operation of systems, the perspective of engineers is of great importance. Moreover, the current tools available in the market and the accessibility of advanced programming systems have paved the way for the entry of industrial engineering profiles.

Due to this, engineers should master basic knowledge about digitalization, which involves communications, basic database knowledge, IoT integration, edge/cloud programming, programming architectures, data analysis, and monitoring. This subject, worth 3 ECTS credits, will not make you an expert in all these fields; however, it has been designed as an introductory course with a strong practical focus, providing the foundation for your digital competencies.

As the application of digitalization is aimed at specific contexts, this course will utilize energy systems as the case study for experimental validations. However, all the knowledge and competencies you will acquire are applicable to mechanical, chemical, architectural, electronic, etc., fields, as the tools provided are relevant across all engineering branches. In this case, energy has been selected because of its transversal impact on all engineering sectors; regardless of the application, industry, or country, energy will be one of your primary resources and, in many cases, one of the most significant costs that you need to manage. Hence, it serves as a good 'sparring' ground for applying all the knowledge and tools you will learn in this course.

This subject will cover only half of the semester, approximately six weeks, and will follow a hands-on learning approach. The lectures will be in English, allowing you to improve your third language skills. Additionally, it is a suitable subject for international students who come to our campus and do not have yet mastered either Catalan or Spanish.

Teaching methodology

This subject follows a problem-based learning approach, so it is almost 100% practice -based . In the lectures, we will combine theoretical content with experimental implementations. In fact, all the lectures are conducted in a digitalization lab, where we will code what we are learning in class and test it in a real environment.
Short report labs and two deliverables (in the form of small projects) will be used for evaluation. Additionally , at the end of the subject, a short exam will be conducted to assess whether all the concepts have been properly understood.
• 30% Final Exam
• 35% Deliverable I
• 35% Deliverable II
The main aim of this subject is to introduce students to the field of digitalization, allowing them to later pursue more specialized courses or focus their Master 's thesis on a specific application.

LEARNING OBJECTIVES OF THE SUBJECT

• Understand the role of digitalization in engineering, specially in energy applications
• Get introduced in IoT, AI/ML, cloud computing, and edge computing as applied to energy.
• Get introduced in the programming of edge computing systems based on node-red
• Understand the basics of databases
• Understand software platforms used for energy management.
• Interpret and monitor real-time and historical data from energy systems
• Apply basic data analytics and visualization techniques for energy efficiency and decision-making.

STUDY LOAD

Type	Hours	Percentage
Hours large group	15,0	20.00
Hours small group	15,0	20.00
Self study	45,0	60.00

Total learning time: 75 h

CONTENTS

Chapter 1: Introduction to digitalization

Description:
1.1. Introduction to Digitalization
1.2. IaaS, PaaS, and SaaS
1.3. Digitalization and Industrial Systems
1.4. Cloud vs. Edge Computing

Related activities:
P1.- Introduction to PickData, Node-Red and measurement equipment
• Introduction to Pickdata datalogger
• Introduction to Node-Red

Full-or-part-time: 6h
Theory classes: 1h 30m
Laboratory classes: 1h
Self study : 3h 30m

Chapter 2: Communications and networks

Description:
2.1.- Introduction to network communication
2.2.- Field communications
2.3.- Introduction to embedded PCs
2.4.- Introduction to Node-Red

Related activities:
P2.- Introduction to communications with Node-Red
• Communications with Modbus
• Configuration of a power analyzer

Full-or-part-time: 14h 30m
Theory classes: 2h 30m
Laboratory classes: 2h
Self study : 10h

Chapter 3: Communications MQTT, APIs, HTTP and Databases (DB)

Description:
3.1.- MQTT the backbone of IoT
3.2.- Introduction to the APIs
3.3.- HTTP: Web protocol, how to access data from APIs.
3.4.- Introduction to data bases

Related activities:
P3.- Introduction MQTT with Node-Red
• Connecting with MQTT
• Connecting with APIs
• Connecting with an InfluxDB database
• Deploying and defining a Grafana dashboard

Full-or-part-time: 14h 30m
Theory classes: 3h 30m
Laboratory classes: 3h
Self study : 8h

Chapter 4: Introduction to data analysis and dashboards

Description:
4.1.- Definition of the data model
4.2.- Introduction to data analysis and R
4.3.- Basic introduction to data-driven modeling
4.4.- Introduction to control panels and dashboards

Related activities:
P4.- Introduction to HTTP, Databases and Grafana
• Connecting with API(HTTP)
• Connecting with a database
• Deploying and defining a Node Red dashboard
• Deploying and defining a Grafana dashboard

Full-or-part-time: 13h 30m
Theory classes: 2h 30m
Laboratory classes: 3h
Self study : 8h

Chapter 5: Time series, most common data

Description:
5.1.- What are time series?
5.2.- Validation of the most important processes based on AI and statistics
5.3.- Introduction to time series analysis

Related activities:
P5.- Introduction to R and linear regression
• Introduction to programming and environment of R
• Analyzing and visualizing data through R
• First linear regression with R

Full-or-part-time: 13h 15m
Theory classes: 2h 30m
Laboratory classes: 3h
Self study : 7h 45m

Chapter 6: Data-based modelling

Description:
6.1.- Introduction to regression models
6.2.- Data based modeling examples

Related activities:
P6.- Validation and Time Series
• Implementing validation methodologies in R
• Time series analysis in R

Full-or-part-time: 13h 15m
Theory classes: 2h 30m
Laboratory classes: 3h
Self study : 7h 45m

GRADING SYSTEM

• 30% Final exam (Test the last day of lectures)**
• 35% Delivarable I
• 35% Deliverable II
** Those with a mark below five at the final exam will be able to retake it on the day scheduled by the school for bimonthly subjects (the mark will be between 0 and 10). The best mark will be considered