

Course guide

820771 - CAPUEE - Control and Automation for the Efficient Use of Energy

Last modified: 15/06/2025

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 709 - DEE - Department of Electrical Engineering.

Degree: MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN ELECTRIC POWER SYSTEMS AND DRIVES (Syllabus 2021). (Optional subject).
MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2022). (Optional subject).

Academic year: 2025 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: ANDREAS SUMPER

Others: Sumper, Andreas
Caprara, Adriano

PRIOR SKILLS

Knowledge of basic energy equipment.

REQUIREMENTS

Energy efficiency basics

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

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.

Transversal:

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT1a. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

TEACHING METHODOLOGY

Teaching methodology:

The course teaching methodologies are as follows:

- Lectures and conferences: presentation of knowledge by lecturers or guest speakers.
- Participatory sessions: collective resolution of exercises, debates and group dynamics, with the lecturer and other students in the classroom; classroom presentation of an activity individually or in small groups.
- Theoretical/practical supervised work (TD): classroom activity carried out individually or in small groups, with the advice and supervision of the teacher.
- Homework assignment of reduced extension: carry out homework of reduced extension, individually or in groups.
- Homework assignment of broad extension: design, planning and implementation of a project or homework of broad extension by a group of students, and writing a report that should include the approach, results and conclusions.
- Evaluation activities (EV).

Training activities:

The course training activities are as follows:

- Face to face activities
 - o Online Lectures and conferences: learning based on understanding and synthesizing the knowledge presented online by the teacher or by invited speakers.
 - o Participatory sessions: learning based on participating in the collective resolution of exercises, as well as in discussions and group dynamics, with the lecturer and other students in the classroom.
 - o Presentations (PS): learning based on presenting in the classroom an activity individually or in small groups.
 - o Theoretical/practical supervised work (TD): learning based on performing an activity in the classroom, or a theoretical or practical exercise, individually or in small groups, with the advice of the teacher.
- Study activities
 - o Project Work (PW)
 - o Homework assignment of reduced extension (PR): learning based on applying knowledge and presenting results.
 - o Homework assignment of broad extension (PA): learning based on applying and extending knowledge.
 - o Self-study (EA): learning based on studying or expanding the contents of the learning material, individually or in groups, understanding, assimilating, analysing and synthesizing knowledge.

LEARNING OBJECTIVES OF THE SUBJECT

The learning objectives of this subject are to

1. Gain a comprehensive understanding of energy automation systems and their role in achieving efficient energy use.
2. Develop the ability to conceptualise and design energy automation systems to optimise energy use in various applications.
3. Acquire knowledge and skills related to rapid prototyping techniques for developing energy-efficient solutions.
4. Explore different strategies and technologies for improving energy efficiency in different systems and processes.
5. Analyse and evaluate the performance of systems in terms of energy consumption and efficiency.
6. Demonstrate the ability to propose innovative solutions to improve energy efficiency by applying automation principles.

By the end of this subject, students will have a solid foundation in understanding energy automation systems, rapid prototyping techniques and energy-efficient solutions. They will be equipped with the knowledge and skills necessary to contribute to developing and implementing sustainable energy solutions.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	30,0	24.00
Hours small group	15,0	12.00

Total learning time: 125 h

CONTENTS

Introduction

Description:

This module provides an introduction to the subject, highlighting its objectives and logistics. It also covers the basic concepts and principles of Kanban and Scrum project management. Students will learn how to effectively manage projects using these methodologies.

Related competencies :

CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

CT1a. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Full-or-part-time: 8h

Theory classes: 2h

Guided activities: 1h

Self study : 5h

Rapid prototyping with ESP32

Description:

- Basics of C++ programming language.
- Basics of sensors and actuators implementation.
- Code design and structure.
- AC current measure and RMS calculation.

Related competencies :

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Full-or-part-time: 24h

Theory classes: 6h

Guided activities: 3h

Self study : 15h

Ideation and project definition

Description:

- Conceptualisation of the course project.
- Planning and responsibilities
- Risk evaluation.

Related competencies :

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.

CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

CT1a. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Full-or-part-time: 21h

Theory classes: 4h

Guided activities: 2h

Self study : 15h

Communication

Description:

- Basics of communication.
- Serial port communication.
- HTTP communication.
- Python and data processing.

Related competencies :

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.

CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

CT1a. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Full-or-part-time: 24h

Theory classes: 6h

Guided activities: 3h

Self study : 15h

Visualization and APIs

Description:

- Basics of APIs and their management
- Basics of HTTP requests
- Basics of plotting in python (matplotlib, plotly, ...)
- Basics of python-based web development with streamlit

Related competencies :

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.

CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

CT1a. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Full-or-part-time: 24h

Theory classes: 6h

Guided activities: 3h

Self study : 15h

Product presentation

Description:

- Pitch and report.
- Integration of different steps.
- Define the next steps.

Related competencies :

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.

CEMT-9. Undertake projects related to energy management in production and service sectors, recognise and value advances and developments in the field and contribute innovative ideas.

CT1a. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Full-or-part-time: 24h

Theory classes: 6h

Guided activities: 3h

Self study : 15h

GRADING SYSTEM

In order to be able to have an evaluation of the subject, it is a necessary condition to have attended, carried out and delivered the reports of all the laboratory sessions and of the project. In case this necessary condition is not met, the grade will be NP (Not Presented). If the necessary condition is met, then the calculation will be as follows:

Project Work Report. 20%

Final project pitch. 40%

Deliverables performed individually or in groups. 20%

Attendance and participation in practical activities and class project work. 20%

EXAMINATION RULES.

Assistance mandatory, presentation via PPT and delivery of reports

RESOURCES

Computer material:

- Nombre recurso. ESP32

Other resources:

ESP32 and electronic material will be provided during the course.