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

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).

Academic year: 2022  ECTS Credits: 5.0  Languages: English

LECTURER

Coordinating lecturer: ANDREAS SUMPER
Others: Sumper, Andreas

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:

- Online 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, analyzing and synthesizing knowledge.

LEARNING OBJECTIVES OF THE SUBJECT

To understand and be able to develop automation systems for efficient use of energy

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guided activities</td>
<td>15,0</td>
<td>12.00</td>
</tr>
<tr>
<td>Self study</td>
<td>80,0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>24.00</td>
</tr>
</tbody>
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Total learning time: 125 h
INTRODUCTION TO AUTOMATION AND CONTROL THEORY REVIEW

Description:
- Automated systems, automatic control and PLCs
- Sensors and instrumentation, drives, actuators
- Control theory, design process, system representation

Specific objectives:
Flipped classroom-project based learning

Full-or-part-time: 32h
Theory classes: 10h
Guided activities: 2h
Self study: 20h

SIGNAL CONDITIONING AND ENERGY MEASUREMENT

Description:
- Online sessions + laboratory sessions
  - Introduction to sensors: transducer, sensor, detectors, etc.
  - Basic sensors: light, position, speed, humidity, ...
  - Voltage and current transformers
  - Signal conditioning: voltage reference
  - Main concepts & definitions: energy, power, AC vs DC, single phase vs three-phase, RMS value, etc.
  - Voltage sensoring
  - Current sensoring
  - Measuring DC current with CHIP ACS 712
  - Measuring AC current with CHIP ACS712.
- Practical session: measurement of different types of current with ACS712.

Specific objectives:
Knowing the techniques for signal conditioning and measurements

Full-or-part-time: 16h
Theory classes: 2h
Practical classes: 2h
Guided activities: 2h
Self study: 10h
Programming for energy efficiency applications

Description:
- Arduino microcontroller programming
- Arduino starter kit, functions and components
- Building an Arduino project
- Main concepts: ISO OSI Reference model
- Physical medium:
- Data link layer: error detection, network topologies
- Data link layer II: Communication models (hierarchy, exchange methods,...)
- TCP/IP: DataGram, MAC/IP, Networks and routing, ...
- Communications Arduino Library. Example.
- Introduction to
- Introduction to NodeRed
- Introduction to Embedded systems: Raspberry Pi, ...
- Big Data
- Cloud storage, data bases: (MySQL, MongoDB)
- Integration with NodeRed

Specific objectives:
Knowing the most important programming and data storage tools for energy efficiency applications

Full-or-part-time: 77h
Theory classes: 3h
Practical classes: 3h
Laboratory classes: 10h
Guided activities: 11h
Self study: 50h

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 (PW). 40%
Work performed individually or in groups (TR). 30%
Attendance and participation in practical activities and class project work (AP). 30%

EXAMINATION RULES.

Assistance mandatory, presentation via PPT and delivery of reports