Course guide
240294 - 240EN47 - Artificial Intelligence in Energy Systems

Last modified: 13/06/2024

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

Degree: MASTER'S DEGREE IN ENERGY ENGINEERING (Syllabus 2022). (Optional subject).

Academic year: 2024 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Aragüés Peñalba, Mònica

Others: Aragüés Peñalba, Mònica

PRIOR SKILLS

Programming
Statistics
Machine learning
Power systems

TEACHING METHODOLOGY

The course teaching methodologies are as follows:
- Theoretical/practical supervised work (TD): classroom activity carried out individually or in small groups, with the advice and supervision of the teacher.
- 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.
- Lectures and conferences: presentation of knowledge by lecturers or guest speakers.
- 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, lectures, and conferences: learning based on understanding and synthesizing the teacher's or invited speakers' knowledge.
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.
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.
- Study activities
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

1) Understand the main concepts around Deep Learning and artificial neural networks
2) Understand the potential applications of Deep Learning in the electrical energy sector
3) Learn how to develop Deep Learning models
4) Explore the main Deep Learning architectures (MLP, RNN –LSTM-, Convolutional)
5) Practice Python coding for Deep Learning applications

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	100.00

Total learning time: 45 h

CONTENTS

Artificial Intelligence for sustainable energy systems

Description:
This course focuses on artificial intelligence applied to energy systems, primarily emphasizing deep learning and artificial neural networks.

Specific objectives:
- Introduction to Deep Learning and its Applications in Energy Systems
- Building Neural Networks from Scratch Using Python
- Hands-on Experience with Deep Learning Frameworks (e.g., TensorFlow, PyTorch)
- Implementation of Machine Learning Algorithms for Energy Forecasting
- Time Series Forecasting Techniques for Energy Consumption Prediction
- Understanding and Implementing Convolutional Neural Networks (CNNs)
- Non-intrusive Load Monitoring Techniques using Deep Learning Models
- Fraud Detection and Classification in Electricity Systems using AI Techniques
- Battery State of Charge (SOC) Prediction using Deep Learning Models
- Customer Segmentation and Price Analysis using Machine Learning Clustering Algorithms
- Exploring Green Computing Techniques and their Application in Energy Efficiency
- Participation in Industry and Doctorate Seminars on AI in Sustainable Energy Systems

Full-or-part-time: 125h
Theory classes: 30h
Guided activities: 15h
Self study : 80h

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 assignments and final 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:
70 % Exam_mark
30 % Lab_reports_mark
There is no re-take exam.

BIBLIOGRAPHY

Basic:
- Chollet, François. Deep Learning with Python [on line]. 2021. Shelter Island: Manning Publications, 2021 [Consultation: 05/07/2024]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6798497. ISBN 9781617296864.
- Haben, Stephen ; Marcus Voss ; William Holderbaum. Core Concepts and Methods in Load Forecasting: With Applications in Distribution Networks [on line]. Cham: Springer International, 2023 [Consultation: 05/07/2024]. Available on: https://link.springer.com/book/10.1007/978-3-031-27852-5. ISBN 3031278526.
- Jason Brownlee. Deep Learning for Time Series Forecasting. 2018. [s.l.]: Machine Learning Mastery, [s.d.]. ISBN 9781548804576.