Subject	SIMULATION AND OPTIMIZATION SOFTWARE FOR PHOTOVOLTAIC SYSTEMS
Credits	3 ECTS (1T+2P)
Cahracter	Elective
Semester	1st
Language	Spanish/English

<u>Competences</u>

CG3 - Creativity: To conceive, develop and validate new systems that can increase the quality of life of people; to carry out, inacademic and professional contexts, innovations or technological advances that can advance the state of the art.

CG5 – Information management: to search for and manage appropriate bibliographic resources efficiently, to learn to continue studies in a largely autonomous way as a basis for future research and innovation activity.

CG8 - Apply methodologies,procedures, tools and state-of-the-art standards for the creation of new technological components; build new hypotheses andmodels, evaluate them and apply them to problem solving

CG9 - Communicate judgments and knowledge to specialized and non-specialized audiences in a reasoned, clear andunambiguous manner.

CB6 - Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context

CB7 - Students should be able to apply their acquired knowledge and problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

CB8 - Students are able to integrate knowledge and face the complexity of making judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities related to the application of their knowledge and judgments.

CB9 - Students should be able to communicate their conclusions and the ultimate knowledge and rationale behind them to specialized and non-specialized audiences in a clear and unambiguous manner.

CB10 - That students possess the learning skills that will enable them to continue studying in a manner that will be largely self-directed or autonomous.

CT3 - Use of the English language: understand the contents of lectures, conferences and seminars in English; write reports and scientific-technical articles in English using computer tools; make public presentations in English of research work, results and conclusions,for example, in the subjects of the Master or in congresses of a mostly international nature or in stays in foreign centers, all with thehelp of audiovisual computer media.

CE2 - Knowledge, analysis and proposals of new concepts, methods or devices for photovoltaic conversion.

CE5 - Design, analysis, characterization, planning and installation of general purpose, stand-alone orgrid-connected photovoltaic components and systems.

CE7 - Analyze, design and implementphotovoltaic systems of medium-high complexity.

Outcomes

RA02 - General training on applications, practical use of photovoltaic systems and an overview of photovoltaic technology

RA03 - Knowledge of the most commonly used simulation tools for photovoltaic cells and systems.

RA04 - Ability to analyze the results

RA05 - Relate the basic principles with practical aspects

RA19 - Know the practical aspects of installation

RA48 - Apply the services and tools available in the market to the design of photovoltaic systems

RA89 - Know the specific engineering tools to design and evaluate photovoltaic systems

Description and syllabus

The main objective of the course is to develop the student's capabilities for the analysis, design and optimization of photovoltaic systems and their components, introduced in parallel by the course Fundamentals of Photovoltaic Systems. The course introduces some of the main commercial and open source software tools used in the modeling of PV systems, which will be useful in the rest of the courses of the itinerary.

The methodological approach is based on a series of short theory lectures on modeling concepts and analysis of PV systems and components, supported by practical sessions using open source (e.g. PVLIB Python or SISIFO) and commercial software tools (e.g. PVSyst, HOMER Pro or RETScreen) in which realistic case studies will be developed. Students will be tasked to develop a series of individual assignments or small projects throughout the course to put into practice the concepts seen in class and acquire sufficient mastery of the tools.

The delivery of the individual assignments with the software tools will be the most important part of the student's dedication and evaluation. The evaluation will be completed with a final exam to assess the student's understanding of the modeling concepts seen during the course, and their ability to apply them properly.

The theoretical-practical class syllabus includes:

1. Meteorological and solar resource data sources.

    - Evaluation of data quality.

    - Generation of synthetic series.

2. Solar resource modeling.

    - Component estimation.

    - Transposition to the generator plane.

    - Solar tracking and backtracking modeling.

3. Electrical and thermal modeling of photovoltaic panels.

    - Identification of 1 diode model parameters.

- Modeling the effect of irradiance and temperature.
- Estimation of model accuracy.
- Empirical I-V parameter variation models.
- Cell temperature estimation models.

4. Loss modeling in a grid-connected PV system.
    - Partial shading modeling.
    - Modeling of optical (IAM) and spectral losses.
    - Effect of fouling
    - DC and AC loss modeling
    - Inverter performance modeling
5. Stand-alone and hybrid system modeling
    - Battery modeling
    - PV pumping modeling

Tutorial sessions will train students on the software tools to be used and develop realistic case studies with open source and commercial software:

1. implementation of a PV system modeling chain with open source libraries (e.g. PVLIB Python)
2. Production estimation of grid-connected PV systems with PVSyst 3.
3. Sizing and simulation of a stand-alone or hybrid PV system.