Subject	STAND-ALONE PHOTOVOLTAIC SYSTEMS AND MICROGRIDS
Credits	5 ECTS (3T+2P)
Character	PV-systems track
Semester	2nd
Language	Spanish/English

Competences

CG5 - Informationmanagement: to search for and manage appropriate bibliographic resources efficiently, to learn to continue studies in a largelyautonomous way as a basis for future research and innovation activity.

G6 - Economic and administrative management: critically analyze and design complex systems and solutions, apply technologies to manage and dealwith complexity with a systemic approach; make judgments on the economic, social, ethical and environmental implications linkedto the application of their knowledge (respecting the principles of equality and universality of access); analyze, select, design andintegrate technologies with appropriate technical-economic criteria.

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.

CT4 - Team leadership: tocarry out team work (such as those of some of the evaluation activities of the subjects), to integrate into a research group by activelyparticipating in its meetings,

collaborating with own initiative in R+D+i works or projects; to interact effectively with the membersof the multidisciplinary work team.

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

Outcomes

RA01 - To know how a photovoltaic systems engineering project is carried out.

RA02 - General training on applications, the 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

RA20 - Knowing the components of photovoltaic systems

RA21 - Apply the knowledge acquired in electrical engineering of photovoltaic systems

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

Description and syllabus

The course covers specific engineering knowledge and tools for the design, simulation, analysis, construction, operation and maintenance of photovoltaic systems that operate independently from the electrical grid, from small stand-alone installations for domestic services or applications in urban environments (street lights, parking meters, etc.) to local mini-grids that include other energy sources (wind, hydro, generators, etc.).

Lectures will be alternated with laboratory practices so that students have a direct experience of the concepts presented.

The most important part of the evaluation will be the completion of a complete study of the installation of a stand-alone system, from demand estimation, through system sizing and design, to component selection and modeling, to optimization and simulation of the complete system, including protection elements.

In addition to this work, the evaluation will be complemented with individual or group assignments throughout the course and with a final written exam on the concepts presented in the course.

The syllabus includes the following chapters:

1. Types of stand-alone systems

    - Small power home PV systems for rural electrification (PicoPV, microPV and SHS). Energy access. Management, operation and maintenance models.

    - Medium-sized PV systems with AC supply.

    - PV microgrids.

    - Hybrid PV systems with other energy sources.

2. Components, Characteristics, selection and modeling of stand-alone system components:

- Energy storage in batteries.
- Power converters.
- Generating sets.
- Standards and norms.

3. Design and sizing methods
   - Energy consumption estimation and modeling.
   - Sizing methods. Probability of failure concept.
   - Design aspects
     - o Stand-alone PV systems.
     - o PV microgrids.
     - o Hybrid systems.
   - Electrical safety and protections.
   - Standards and norms.
   - Modeling and simulation.

4. Photovoltaic pumping
   - Types of systems and applications.
   - Components:
     - o Types of pumps. Characteristic curves. Similarity laws.
     - o Frequency variators.
     - o Hydraulic elements and protections. System curve. Tanks.
   - Sizing, design, modeling and simulation.

5. Integrated PV in products
   - Design considerations.
   - Applications (PV street furniture, energy harvesting, PV integrated in vehicles, etc.).

Practical and laboratory

1. Characterization of stand-alone system components.
   - Charge controllers.
   - Electrochemical batteries. Charging methods and capacity estimation.
   - Small power stand-alone inverters.
2. Characterization of stand-alone photovoltaic systems.
3 Exercises on design, sizing and simulation of stand-alone systems.