Subject	FUNDAMENTALS OF PHOTOVOLTAIC SYSTEMS
Credits	6 ECTS (3T+3P)
Character	Compulsory
Semester	1st
Language	Spanish

Competences

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 - 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.

CG7 - Work in international contexts: To carry out asubstantial research process with academic seriousness and integrity, integrated in an R+D+i group with international projection.

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.

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.

CE1 - Understanding, analyzing and judging the relevance of any contribution in this field, in relation toits social, energetic and scientific-technical environment.

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

CE8 - Design and build a functional prototype of a photovoltaic system going through all the phases of theprocess within a teamwork scheme.

CE9 - Apply the services and tools available in the market to the design of photovoltaic systems

Outcomes

RA1 - To know how a photovoltaic systems engineering project is carried out.

RA2 - General training on the applications, the practical use of photovoltaic systems and a perspective on photovoltaic technology.

RA13 - Knowing the necessary tools for the design, analysis and evaluation of grid-connected photovoltaic installations.

RA18 - Learn how to characterize photovoltaic systems

RA19 - Know the practical aspects of installation

RA20 - To know the components of photovoltaic systems

RA89 - Knowing the specific engineering tools to design and evaluate PV systems

RA90 - Ability to analyze I-V curves of photovoltaic modules and systems.

Description and syllabus

Fundamental principles of photovoltaic systems engineering. All the elements that make up a photovoltaic generator, both stand-alone and grid-connected, are described, as well as the most widespread applications. The tools for the design of photovoltaic installations are described. As the course is common to all students of the master's degree, it is intended to provide students with a general knowledge of the applications, the practical use of photovoltaic systems and a perspective on photovoltaic technology.

The methodological approach is oriented to the realization of a photovoltaic systems engineering project, which is the main procedure to verify the acquired knowledge. The dynamics of the class is based, fundamentally, on the lecture, supported by audiovisual means. Throughout the course, exercises will be proposed to help the understanding of the different elements that make up a photovoltaic installation and the interaction between them. The course is complemented with laboratory practices so that students have a direct experience of the concepts presented. In this sense, the main components of a photovoltaic system are measured, as well as the characterization of the operating conditions of modules and inverters.

Schematically, the syllabus includes:

1. Solar radiation: Nature of solar radiation. Basic parameters and components. Apparent movement of the sun. Path diagram. Calculation of the hourly irradiation on an arbitrarily oriented surface. Optimal orientation optimization criteria.
2. The photovoltaic module: constructive characteristics of the module. Series-parallel cell association. Dependence on temperature and solar irradiance. Module connection. Parameter dispersion. Effect of irradiance non-uniformity.

3. Electrochemical storage: Operating principles of lead acid batteries. Basic parameters. Lead acid and lithium battery technology. Operation in an isolated PV system.
4. Control and management elements: General block diagram of a photovoltaic system. Battery charge controller. DC/DC converters. Maximum power point tracking. DC/AC converters. Special equipment: power optimizers, inverters/chargers. All-in-one equipment.
5. Grid-connected photovoltaic generators. Basic design concepts. Main applications: Self-consumption and photovoltaic plants.
6. Autonomous photovoltaic systems: Typology of installations. Design and sizing. Pumping. Rural electrification.
7. Hybrid systems: Capacity of hybrid systems. Introduction to wind and hydro generation. Diesel generators. Hybrid system architectures. Simulation and optimization tools.

Practical and laboratory:

1. Measurement of solar irradiance.
2. Measurement of the VI curve of modules.
3. Inverter measurements
4. Design of a Diesel PV hybrid system
5. Assembly and characterization of an isolated photovoltaic system.