Subject	ADVANCED CONCEPTS OF PHOTOVOLTAIC CELLS
Credits	6 ECTS (5T+1P)
Character	PV-cells track
Semester	2nd
Language	Englixh

Competencess

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.

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 and models, 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 actively participating in its meetings,

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

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

CE3 - Realization,development and innovation of technological processes for the manufacture of photovoltaic devices..

Outcomes

RA4 - Ability to analyze results

RA5 - Relate the basic principles to practical aspects.

RA24 - Knowledge of the physical fundamentals of solar cells

RA25 - Ability to understand the basic operation of different types of solar cells, both current and those that will emerge in the near future.

RA27 - Critical ability to analyze the different models in terms of basic principles of physics.

RA34 - To know the manufacturing processes of solar cells.

RA36 - Know the physical effects that allow the use of solar energy.

RA37 - Understand the relevant physical principles that affect the operation of solar cells.

RA39 - Ability to understand the physical fundamentals of current and new generation solar cells.

RA56 - Training in quantum physics and thermodynamics as applied to solar cells

RA57 - Ability to analyze the feasibility and potential of novel solar cell designs

Description and syllabus

This course deepens the level of understanding of the fundamentals of solar cell operation while reviewing the latest solar cell proposals, usually called new generation, with the aim of strengthening this understanding. To this end, first the Schokley and Queisser model of a solar cell is explained, a model that allows the calculation of its efficiency limit and allows the student to abstract the operation of a solar cell from almost all the properties that characterize the material with which it is implemented. Then, the concept of photon recycling is explained so that the student understands that when this phenomenon is negligible is when the conventional model of a solar cell is reached, by which its properties are described on the basis of the model of a diode. Thirdly, this diode model is deduced so that the student will be able to deduce the characteristic of a solar cell from heats such as doping, thicknesses, lifetimes, etc., which characterize both the structure and the material from which the cell is made. Finally, new generation cells are described.

Schematically, the syllabus includes:

1. Photovoltaic conversion efficiency limits.
    a. Detailed balance of Shockley & Queisser.
    b. Thermodynamics applied to the calculation of the photovoltaic conversion efficiency limit.
2. The phenomenon of photon recycling.
3. Analytical modeling of solar cells.

a. Review of the parameters that characterize a semiconductor.

b. Continuity equations.

c. Dark curve.

d. Illumination curve and quantum efficiency.

e. BSF and equivalent surface recombination velocity.

f. Distributed series resistance.

4. Solar cells and new generation concepts.

a. Solar cells based on perovskites.

b. Advanced multi-junction solar cells.

c. The hot carrier solar cell.

d. The intermediate band solar cell.

e. Transistor-type solar cells.

f. Thermophotovoltaic cells.

g. Flat concentrators