Course guide
230934 - DIFO - Photovoltaic Devices

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.
Degree: BACHELOR'S DEGREE IN ELECTRONIC ENGINEERING AND TELECOMMUNICATION (Syllabus 2018).

Academic year: 2022   ECTS Credits: 6.0   Languages: Catalan, Spanish

LECTURER
Coordinating lecturer: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Others: Consultar aquí / See here:
https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idoma

PRIOR SKILLS
Semiconductor devices, power electronics and Control Theory

TEACHING METHODOLOGY
* Classroom lectures
* Laboratory practices
* Coursework

LEARNING OBJECTIVES OF THE SUBJECT
Photovoltaic solar energy fundamentals. Working principles and technology of solar cells and photovoltaic modules. Other involved in photovoltaic systems: charge regulators, DC-DC converters, Inverters and maximum power point trackers. Sizing of grid and off-grid PV systems.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>98,0</td>
<td>65.33</td>
</tr>
<tr>
<td>Hours large group</td>
<td>39,0</td>
<td>26.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>13,0</td>
<td>8.67</td>
</tr>
</tbody>
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Total learning time: 150 h
# CONTENTS

## 1. Photovoltaic solar energy fundamentals

**Description:**
- 1.1 Renewable and non-renewable energies
- 1.2 Energy and power units
- 1.3 Solar irradiance and irradiation
- 1.4 Spectral Irradiance. Reference solar spectrums AM0 and AM1.5
- 1.5 Direct, diffuse and albedo solar irradiation terms
- 1.6 Apparent movement of the sun. Solar paths maps
- 1.7 Irradiation on solar collectors. One and two-axis tracking systems
- 1.8 Status of the photovoltaic solar energy

**Full-or-part-time:** 15h 50m  
Theory classes: 5h  
Self study: 10h 50m

## 2. The solar cell

**Description:**
- 2.1 Working principles. Photogeneration and light absorption
- 2.2 Electrical model of the ideal solar cell under monochromatic light
- 2.3 External and internal quantum efficiencies. Spectral response
- 2.4 The solar cell under spectral light

**Full-or-part-time:** 15h 50m  
Theory classes: 5h  
Self study: 10h 50m

## 3. Electrical parameters of the solar cell

**Description:**
- 3.1 The ideal solar cell. Characteristic photovoltaic parameters
- 3.2 The non-ideal solar cell.
- 3.3 Concentration and temperature impact on photovoltaic parameters
- 3.4 Limits of the photovoltaic conversion efficiency

**Full-or-part-time:** 24h 20m  
Theory classes: 8h  
Self study: 16h 20m

## 4. Modules, arrays and photovoltaic plants

**Description:**
- 4.1 Scaling rules of the photovoltaic parameters in modules, arrays and photovoltaic plants
- 4.2 Temperature and concentration impact on photovoltaic performance
- 4.3 The non-ideal module. Blocking and bypass Diodes

**Full-or-part-time:** 12h 50m  
Theory classes: 4h  
Self study: 8h 50m
5. Materials and solar cell fabrication technology

Description:
5.1 Introduction to solar cell technologies
5.2 Crystalline and multicrystalline silicon solar cells
5.3 III-V solar cells
5.4 Thin film solar cells

Full-or-part-time: 7h 10m
Theory classes: 4h
Self study : 3h 10m

6. Balance of System (BOS) components

Description:
6.1 Grid and off-grid photovoltaic (PV) systems
6.2 Batteries and charge regulators
6.3 CC-CC and CC-CA converters
6.4 Control strategies in photovoltaic conversion applications
6.5 Sizing of PV systems

Full-or-part-time: 38h 50m
Theory classes: 13h
Self study : 25h 50m

Practices of Photovoltaic devices

Description:
P1. PC-1D simulations of a solar cell (two sessions)
P2. PSpice/Orcad simulations of a photovoltaic system (two sessions)
P.3 Study of a mpp tracker system using Simulink/Matlab (two sessions)

Full-or-part-time: 35h 10m
Laboratory classes: 12h
Self study : 23h 10m

GRADING SYSTEM

Final Mark = Maximum(Ctrl_1*0.45+Ctrl_2*0.25+Prob*0.05+ Lab*0.25, Exa_final*0.75+Lab*0.25)

Ctrl_1 : Mark of the course exam 1
Ctrl_2: Mark of the course exam 2
Exa_Final: Final exam mark
Prob: coursework
Lab: Laboratory mark

BIBLIOGRAPHY

Basic: