340243 - ENRE-K7P10 - Renewable Energy

**Coordinating unit:** 340 - EPSEVG - Vilanova i la Geltrú School of Engineering

**Teaching unit:** 710 - EEL - Department of Electronic Engineering

**Academic year:** 2017

**Degree:**
- BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
- BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional)

**ECTS credits:** 6

**Teaching languages:** Catalan, Spanish

### Degree competences to which the subject contributes

**Specific:**
1. CE16. Basic knowledge and application of environmental technologies and sustainability.
2. CE2. Comprehension and containment of basic concepts concerning general rules of mechanic, thermodynamic, field of shafts and electromagnetism; and its diligence to solve engineering problems.
3. CE20. Fundamental knowledge and application of analogue electronics.
4. CE22. Applied knowledge of power electronics.

**Transversal:**
7. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
8. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.
9. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
Learning objectives of the subject

1. To know the energy resources, current panorama and tendency of the energy.
2. To be able to solve an energy system based on the photovoltaic solar conversion - thermal and eolic assisting to the energy requirements of a certain application.
3. To know and to know how to use hardware and software for the simulation and optimization of photovoltaic-thermal and eolic systems.
4. To know the normative one and legislation as regards renewable energy.
5. Analysis and synthesis of projects for the development of systems of renewable energy.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 30h</th>
<th>20.00%</th>
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</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
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<tr>
<td>Hours small group:</td>
<td>30h</td>
<td>20.00%</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th>Module 1. - Global Aspects of the energy and energy resources.</th>
<th>Learning time: 15h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
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<td></td>
<td>Laboratory classes: 3h</td>
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<td></td>
<td>Guided activities: 1h</td>
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<tr>
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<td>Self study: 8h</td>
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## Description:
1. Historical panorama of the energy.
3. Limitation of the conventional resources and their problem.
4. Renewable energy resources. Maps and atlas.

## Related activities:
- To know the energy resources.
- To know on the current panorama and tendency of the energy.
- To differ between dispersion and energy accumulation.
- To know the basic operation of the devices energy transducers.

## Specific objectives:
- To contribute knowledge on the current historical panorama of the different energy resources.
- To know the real limitations of the traditional energy sources in connection with the renewable considered energy.
- To introduce the student in the basic operation of the most important renewable energy.
Module 2. - Photovoltaic solar Energy.

Learning time: 37h
- Theory classes: 8h
- Laboratory classes: 8h
- Guided activities: 1h
- Self study: 20h

Description:
1. Current state of the photovoltaic energy in the world.
2. Characteristic of the solar radiation.
3. The photovoltaic convection. Theory of the semiconductors guided to the photovoltaic production.
5. The photovoltaic panel. Association of panels.
6. Essential elements in the photovoltaic system.
7. Optimal tracking of the point of maximum power.
8. Autonomous photovoltaic installations and of sale to grid.
11. Systems of electric protection.
12. Processed of the energy for the sale to grid.
13. Structural considerations and architectural integration.

Related activities:
To know how to distinguish the different parts of the photovoltaic system.
To use the design methods by means of appropriate software tools for photovoltaic installations.
To apply the different photovoltaic protection appropriately.
To know different photovoltaic technologies for a correct architectural integration.

Specific objectives:
To know the basic characteristics of the photovoltaic technology.
To make the analysis and design of a photovoltaic cell.
To know the characteristics of the panels and their interconnection.
To know how to distinguish the different modules of the photovoltaic system appropriately.
To know how to design an autonomous photovoltaic system and of sale to grid.
To know the different structures of architectural integration.
## Module 3. - Thermoelectric Energy and combustible piles.

### Learning time: 15h
- Theory classes: 3h
- Laboratory classes: 3h
- Guided activities: 1h
- Self study: 8h

### Description:
1. Operation of the thermoelectric cell.
2. Applications of the thermoelectric cells.
3. Basic electric model of the thermoelectric structure.
5. Photovoltaic and thermoelectric combined model.
6. Type of piles of fuel. The pile of hydrogen.

### Related activities:
- To know how to distinguish between the operation peltier and seebeck of a thermoelectric cell.
- To make the basic design of a thermoelectric structure.
- To know how to use a pile of hydrogen based on solid electrolyte.

### Specific objectives:
- To know the basic characteristics of the thermoelectric energy and you pound of fuel.
- To make use of the mathematical model that describes the operation of the thermoelectric cells and to know their main applications.
- To know the operation of the piles of fuel and their technological development.
- To have knowledge of the interaction between the thermoelectric technology and the photovoltaic technology.
- To make practical experiences in this environment.
**Module 4. - Eolic Energy.**

<table>
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<tr>
<th>Learning time: 23h</th>
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<tbody>
<tr>
<td>Theory classes: 4h</td>
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<tr>
<td>Laboratory classes: 4h</td>
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<tr>
<td>Guided activities: 1h</td>
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<tr>
<td>Self study: 14h</td>
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</table>

**Description:**
1. Eolic potential.
2. Types and characteristic of wind turbine.
3. Eolic parks.
5. Data of the eolic system.
7. Electric lines.
8. Control systems and auxiliary elements.
10. System of pumping by means of eolic energy.

**Related activities:**
- To know how to calculate the eolic potential starting from the characteristics of the wind.
- To know how to distinguish the different wind turbines types.
- To know all the elements of the wind turbine and the system of control of speed.
- To develop the aerodynamics of the shovels.
- To develop different exercises related with the topic to seat concepts.

**Specific objectives:**
- To know the eolic technology as source of alternative energy.
- To know the main characteristics of the wind turbine and their interconnection in eolic parks.
- To develop the design of shovels appropriately.
- To know the systems of processed energy from wind turbines.
### Module 5. - Development of the electronic equipment power used in systems of renewable energy.

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<tr>
<td>Theory classes</td>
<td>8h</td>
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<tr>
<td>Practical classes</td>
<td>8h</td>
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<tr>
<td>Guided activities</td>
<td>1h</td>
</tr>
<tr>
<td>Self study</td>
<td>20h</td>
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### Description:

1. Electric models of a photovoltaic cell, modules and photovoltaic groupings: concept of power source.
2. Definition of the photovoltaic system.
3. Algorithms of maximum power point tracking (MPPT).
4. Design and control of convertors DC/DC.
5. Battery loaders.
6. Structures of connected systems to grid.
7. Design and control of convertors DC/AC.
8. Design and control of the teams of power in eolic-electric conversion.

### Related activities:

- To know how to model the cell and the photovoltaic panel mathematically.
- To know different algorithms of maximum power point tracking (MPPT).
- To know how to design the AD-AD and AD-AC convertors in connection with the current injection grid.
- To know the development of power equipment in eolic-electric systems.

### Specific objectives:

- To know different mathematical models of the photovoltaic cell.
- To know the concept of source of power in photovoltaic system.
- Optimization of the flow energy in the photovoltaic system.
- To know how to design convertors AD-AD and AD-AC.
- To know the different structures of the one processed of power in the current injection to net.
### Module 6. - Other renewable energy.

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<td>Guided activities: 1h</td>
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<tr>
<td>Self study : 14h</td>
</tr>
</tbody>
</table>

**Description:**

**Related activities:**
To know how to relate the studied renewable energy and to differentiate their different energy potentials starting from the advantages that offers each one of them.

**Specific objectives:**
- To know other renewable energy.
- To know how to make basically the installations.
- To take conscience of the energy possibilities in function of the objective that is wanted to get in the mark of the environmental respect and energy efficiency.
Theory qualification (NTe) = (EX1 + EX2)/2

Thematic activities and of laboratory (NATL) = 0,2(NAT) + 0,8(NL)

Project (Presentation and report) (NP):

The project will be exposed by the group. The rest of students that don't belong to the group that exposes puts a note in a reasoned way and in writing that will be given to the professor. This note together with the professor's corrected valuation will configure the note of appreciation of the exhibition (NExpos). The qualification of the report the professor will value it.

NExpos = 0.4(qualification students) + 0.6(Nota correction professor)

NP = 0.4(NExpos) + 0.6(Nreport)

Tests qualification (NTest). It conforms with the autoevaluation test student's and evaluation on the part of the professor (restricted time).

Final qualification (NF) = 0.4(NTe) + 0.2(NATL) + 0.2(NP) + 0.2(NTest)
Bibliography

Basic:


Complementary:


Others resources:

Energía solar fotovoltaica : conceptes i aplicacions. Barcelona: Institut Català d'Energia.
Electrónica de Potencia, Daniel Hart. Ed Prentice Hall
Electrónica de Potencia: Circuitos, Dispositivos y Aplicaciones, M. Rashid.
La Biomasa : fuente de energía y productos para la agricultura y la industria.- Madrid : Ciemat.
Class notes.
Subject notes.