

# Course guide

## 340243 - ENRE-K7P10 - Renewable Energy

**Last modified:** 12/04/2019

**Unit in charge:** Vilanova i la Geltrú School of Engineering  
**Teaching unit:** 710 - EEL - Department of Electronic Engineering.

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

**Academic year:** 2019    **ECTS Credits:** 6.0    **Languages:** Catalan, Spanish

### LECTURER

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**Coordinating lecturer:** ANTONIO MIGUEL LOPEZ MARTINEZ

**Others:** ANTONIO MIGUEL LOPEZ MARTINEZ  
RAFAEL RAMÓN RAMOS LARA

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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#### 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.
5. CE7. Knowledge of applied thermodynamics and heat transfer. Basic principles and its application in solving engineering problems.
6. CE8. Knowledge of basic principals of fluid mechanic and its application to resolve problems in engineering area. Calculus of channels, canals and fluids.

#### 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.

### TEACHING METHODOLOGY

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Teaching-learning activates - participative and masterful with support multimedia with a continuous tutor action.

Objectives of the used methodology

- To promote the knowledge for comprehension.
- To create the necessity to continue learning.
- To create an atmosphere of personal and collaborador work and between the students.
- That the student assumes the responsibility and protagonism of the learning.

## 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

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours small group	30,0	20.00
Self study	90,0	60.00

**Total learning time:** 150 h

## CONTENTS

### Module 1. - Global Aspects of the energy and energy resources.

#### Description:

1. Historical panorama of the energy.
2. Energy plans. Energy, economy and environment.
3. Limitation of the conventional resources and their problem.
4. Renewable energy resources. Maps and atlas.

#### 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.

#### 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..

#### Related competencies :

- . CE16. Basic knowledge and application of environmental technologies and sustainability.
- 05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
- 02 SCS. 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.
- 07 AAT N2. 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.

#### Full-or-part-time: 15h

- Theory classes: 3h
- Laboratory classes: 3h
- Guided activities: 1h
- Self study : 8h



## Module 2. - Photovoltaic solar Energy.

### 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.
4. Components of the photovoltaic installation. The photovoltaic cell: analysis and design.
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.
9. Desenvolopment of the photovoltaic installation by means of the energy balance and good use of the solar reception.
10. Normative and legislation.
11. Systems of electric protection.
12. Processed of the energy for the sale to grid.
13. Structural considerations and 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.

### 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.

### Related competencies :

- . CE16. Basic knowledge and application of environmental technologies and sustainability.
- . 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.
- . CE20. Fundamental knowledge and application of analogue electronics.
- . CE7. Knowledge of applied thermodynamics and heat transfer. Basic principles and its application in solving engineering problems.
- . CE22. Applied knowledge of power electronics.

### Full-or-part-time: 37h

Theory classes: 8h

Laboratory classes: 8h

Guided activities: 1h

Self study : 20h



### Module 3. - Thermoelectric Energy and combustible piles.

#### Description:

1. Operation of the thermoelectric cell.
2. Applications of the thermoelectric cells.
3. Basic electric model of the thermoelectric structure.
4. The thermoelectric material. Use in Seebeck function and Peltier function. Design of a thermoelectric structure.
5. Photovoltaic and thermoelectric combined model.
6. Type of piles of fuel. The pile of hydrogen.
7. Reactions basic of the pile of H<sub>2</sub>. General constitution. The efficiency of Faraday. The energy efficiency. Applications.
8. Systems of production of H<sub>2</sub>.

#### 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.

#### 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.

#### Related competencies :

- . CE8. Knowledge of basic principals of fluid mechanic and its application to resolve problems in engineering area. Calculus of channels, canals and fluids.
- . CE16. Basic knowledge and application of environmental technologies and sustainability.
- . 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.
- . CE20. Fundamental knowledge and application of analogue electronics.
- . CE7. Knowledge of applied thermodynamics and heat transfer. Basic principles and its application in solving engineering problems.
- 05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
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- 07 AAT N2. 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.

#### Full-or-part-time: 15h

Theory classes: 3h

Laboratory classes: 3h

Guided activities: 1h

Self study : 8h



#### Module 4. - Eolic Energy.

##### Description:

1. Eolic potential.
2. Types and characteristic of wind turbine.
3. Eolic parks.
4. Planning of projects. Normative i legislation.
5. Data of the eolic system.
6. Aerodynamics of the shovels. Push in the turbines. Number of shovels of the rotor.
7. Electric lines.
8. Control systems and auxiliary elements.
9. Energy tracking of facilities and maintenance problems.
10. System of pumping by means of eolic energy.

##### 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.

##### 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.

##### Related competencies :

- . CE8. Knowledge of basic principals of fluid mechanic and its application to resolve problems in engineering area. Calculus of channels, canals and fluids.
  - . CE16. Basic knowledge and application of environmental technologies and sustainability.
  - . 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.
  - . CE20. Fundamental knowledge and application of analogue electronics.
  - . CE22. Applied knowledge of power electronics.
- 05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
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- 07 AAT N2. 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.

##### Full-or-part-time: 23h

- Theory classes: 4h
- Laboratory classes: 4h
- Guided activities: 1h
- Self study : 14h



## Module 5. - Development of the electronic equipment power used in systems of renewable energy.

### 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.

### Specific objectives:

- To know different mathematical models of the photovoltaic cell.
- To know the concept of source of power i 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.

### 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.

### Related competencies :

- . CE16. Basic knowledge and application of environmental technologies and sustainability.
  - . 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.
  - . CE20. Fundamental knowledge and application of analogue electronics.
  - . CE22. Applied knowledge of power electronics.
- 05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
- 02 SCS. 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.
- 07 AAT N2. 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.

### Full-or-part-time: 37h

- Theory classes: 8h
- Practical classes: 8h
- Guided activities: 1h
- Self study : 20h



## Module 6. - Other renewable energy.

### Description:

1. Thermal solar energy. The thermal solar technology. Applications. It dilutes hot sanitary. Heating facilities. Development. Architecture bioclimatic.
2. Hydraulic energy. Types of hydroelectric power station smalls. Study hydrological. Design approaches. Flow, height and power to install. Hydraulic turbines. Generators. Equipment electric.
3. Geothermal energy. Systems of electricity generation by means of geothermal fluids. Use of the geothermal fluid for thermal uses.
4. Biomass and urban solid residuals. Types of biomass, treatments and energy use. Energy cultivations and biocombustibles. The biogas. Application fields. The RSU.

### 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.

### 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.

### Related competencies :

- . CE8. Knowledge of basic principals of fluid mechanic and its application to resolve problems in engineering area. Calculus of channels, canals and fluids.
  - . CE16. Basic knowledge and application of environmental technologies and sustainability.
  - . 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.
  - . CE20. Fundamental knowledge and application of analogue electronics.
  - . CE7. Knowledge of applied thermodynamics and heat transfer. Basic principles and its application in solving engineering problems.
- 05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
- 02 SCS. 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.
- 07 AAT N2. 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.

### Full-or-part-time: 23h

- Theory classes: 4h
- Laboratory classes: 4h
- Guided activities: 1h
- Self study : 14h

## GRADING SYSTEM

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Theory qualification (N<sub>Te</sub>) = (EX1 + EX2)/2

Thematic activities and of laboratory (N<sub>ATL</sub>) = 0,2(N<sub>NAT</sub>)+0,8(N<sub>NL</sub>)

Project (Presentation and report ) (N<sub>P</sub>):

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 (N<sub>Expos</sub>). The qualification of the report the professor will value it.

N<sub>Expos</sub> = 0,4(qualification students) + 0,6(Nota correction professor)

N<sub>P</sub> = 0,4(N<sub>Expos</sub>)+0,6(N<sub>report</sub>)

Tests qualification (N<sub>Test</sub>). he conforms with the autoevaluation test student's and evaluation on the part of the professor (restricted time).

Final qualification (N<sub>F</sub>) = 0,4(N<sub>Te</sub>) + 0,2(N<sub>ATL</sub>) + 0,2(N<sub>P</sub>) + 0,2(N<sub>Test</sub>)

## BIBLIOGRAPHY

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### Basic:

- Izquierdo Toscano, José Manuel. Energía eólica y territorio. Sevilla: Universidad de Sevilla, 2008. ISBN 9788447209323.
- Alcor Cabrerizo, Enrique. Instalaciones solares fotovoltaicas. 4a ed. Sevilla: PROGENSA, 2008. ISBN 9788495693457.
- Hart, Daniel W. Electrónica de potencia. Madrid [etc.]: Prentice Hall, 2001. ISBN 8420531790.
- Méndez Muñiz, Javier María; Rodríguez Rodríguez, Luis Manuel. Energía eólica. Madrid: Fundación Confemetal, 2012. ISBN 9788493961817.
- Méndez Muñiz, Javier María; Cuervo García, Rafael. Energía solar fotovoltaica. 7a ed. Madrid: Fundación Confemetal, 2011. ISBN 9788492735778.

### Complementary:

- Fuel cell technology : handbook. Boca Raton [etc.]: CRC, 2003. ISBN 0849308771.
- Energías renovables para el desarrollo. Madrid: ITES-Paraninfo, 2002. ISBN 9788428328647.

## RESOURCES

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### Other resources:

Energía solar fotovoltaica : conceptos 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.  
Agua caliente solar : manual práctico / McCARTNEY, Kevin / FORD, Brian. Madrid : Blume.  
Energía solar : construcción y montaje de equipos para aplicaciones eléctricas / RÖBKE-DOERR, Peter. Barcelona  
ARMSTEAD, D. (1989). Energía geotérmica.  
CASTRO M. (1997). Energía hidráulica Edit: Progensa. Sevilla  
Class notes.  
Subject notes.