Wind and photovoltaic generation

Academic Year: (2022 / 2023) **Review date: 13-05-2022**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: CHINCHILLA SANCHEZ, MONICA

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Electric Engineering Fundamentals

OBJECTIVES

It will result in:
1. Have a knowledge and understanding of isolated or grid-connected electrical systems with wind and photovoltaic generation (RA1.2). To evaluate this RA, exercises are carried out on the systematic analysis of circuits with renewables, evaluation tests and laboratory practices (2 projects, midterm exam, final exam, 3 laboratory practices).
2. Be aware of the multidisciplinary context of renewable energy systems (RES) in electrical systems (RA1.4). By evaluating this RA with exams, projects, and labs, the links between electrical engineering and other industrial engineering disciplines such as electronic, thermal, mechanical, and environmental engineering are revealed.
3. Have the ability to apply their knowledge and understanding to identify, formulate and solve electrical engineering problems with RES using established methods (RA2.1). To evaluate this RA, evaluation tests are carried out and specific projects are proposed for the complete dimensioning of photovoltaic generators in various demand and solar resource scenarios; also energy calculation projects for wind turbines in many different locations.
4. Have the ability to design and carry out experiments, interpret data and draw conclusions (RA4.2). To evaluate this RA, three practices are carried out in the laboratory, two of dimensioning by means of specific SW tools from RES and one with various solar cells. This knowledge is evaluated in the exams, partial and final.
5. Have the ability to combine theory and practice to solve electrical engineering problems (RA5.2). To evaluate this RA, a series of scripts and laboratory practices are carried out in which real problems are solved, in addition to the dimensioning projects of wind and photovoltaic plants that must comply with current regulations. Also knowing the United Nations Sustainable Development Goals (SDG), and in particular SDG 7 regarding access to affordable, reliable, sustainable and modern energy for all (solar or wind in this case).
6. Necessary skills are acquired for the practice of engineering at the design and implementation level of photovoltaic systems, both for grid connection, self-consumption and isolated from the grid, designs highly required by today's society (R6).They must acquire the ability to develop a specific project in practice, from the use of device selection, use of regulations, catalogs and commercial technical documentation, to its implementation in the field.

DESCRIPTION OF CONTENTS: PROGRAMME

MODULE 1: PHOTOVOLTAIC (PV) SYSTEMS
PV 1-Introduction to solar energy
1.1- Solar energy all over the world
1.2-Resource
PV 2. Basic Technology.
2.1- Solar cell. Basic principles and current technology.
2.2- Characteristic of the solar cell. Exercises solar cell, cell temperature.
PV 3. Solar panels
3.1- Solar panels.
3.2-Generators electrical characteristic of photovoltaic solar panels. Varying voltage of the photovoltaic panels. Testing.Characteristic curve with variation of irradiance and cell temperature.
3.3 Architectural integration.
3.4 Solar tracking
PV 4-Inverters.
4.1-Types and functions. Performance.

4.2-Regulation
4.3- Tracking the maximum power point of photovoltaic generrador (MPPT)
PV 5- Autonomous photovoltaic systems.
5.1 -Components. Batteries. Charge regulators. Inverters.
5.2- Autonomous photovoltaic systems: and dimensioning schemes.
5.3-Sizing exercises depending on the location and energy requirements.
5.4- Project; complete sizing
PV 6. Photovoltaic Systems PV grid connected.
6.1 Schemes
6.2-Photovoltaic systems connected to the grid. Protections.
6.3-Regulations.
6.4- Sizing with specific software (PVSYST).
PV 7 Net balance.
7.1- Schemes
7.2- Characteristics. Examples

MODULE 2. WIND POWER
WIND 1. Wind Energy. Current status and resources.
1.1- Current status of wind power around the world
1.2- Wind resource. Factors affecting wind production.
1.3-Models of assessing wind potential in a wind site.Atlas IDAE.

WIND 2. Energy Production
2.1- Power curve. Defining FC, HE.
2.2- Basic exercise for energy calculation (programs and web Alwin IDAE)
2.3- Energy calculation; project focused to a wind generator and site (selected by the student)
2.4- Project for a wind park electric energy production.

WIND 3. Wind Technology
3.1- Wind turbine. Types. Components: turbine, tower, hub, generator, gearbox, converter, protections.
3.2- Wind turbine. Sizing wind generators.
3.3- Wind generators.Miniwind.Wind energy from the sea.
3.4- Wind generators. Speed variation associated with the variation of the blade pitch of the turbine.
3.5- Energy calculation as a function of wind speed, blade pitch,¿
WIND 4. Wind energy systems connected to the grid .
4.1 Evolution of the control systems: fixed speed and speed. Tracking the maximum power point with maximum efficiency at part load. Speed control systems and power at part load and full load.
4.2- Wind farms.Sizing. Network Attached Project wind farm. Using specific software (RETScreen).
4-3. Network integration
4.4- Voltage Dips. Stability. Regulations.
4.5-Exercise voltage network nodes
WIND 5. Autonomous wind systems.
5.1-Types and functions.
5.2-Windpumps.
5.3- Selection.

WIND 6. Regulation
6.1-Regulation in the field of renewable energies.
6.2-Spanish case.

MODULE 3- Hybrid systems.
3.1-Microgrids with photovoltaic generation, wind and accumulation systems. Types and functions.
3.2- Regulations.
3.3- Dimensioning with specific software (Homer Pro).

MODULE 4. SUSTAINABILITY
4.1- Sustainability.
4.2-RREE. Summary by technologies.
4.3- Energy efficiency
4.4-Energy from the sea.

LEARNING ACTIVITIES AND METHODOLOGY

- Teacher lessons, doubts resolution classes -in reduced groups-, students presentations, individual mentorship and student work to acquire theoretical concepts (3 ECTS credits).
- Experimental lessons in the Laboratory, exercise classes in reduced groups, students presentations, individual mentorship and student work to acquire experimental concepts (3 ECTS

credits).

ASSESSMENT SYSTEM

Continuous evaluation based on assignments, tests and assessment of skills and knowledge.
FIRST PART (50%) (Photovoltaic and Self-consumption)
PV plant dimensioning project connected to the network. Exercise with PVSyst (40 out of 100 points for this part)
Practices 1 and 2 (compulsory)
FV exam (60 out of 100). Theory questions, test, practice and problems. Minimum mark: 4 points. If >5 is obtained Free matter, for the ordinary and extraordinary call.
Questions and tests during classes (to raise grades)

SECOND PART (50%) (Wind, sustainability, hybrid systems)
Project with Wind Turbines (40 out of 100).
Review of this part Wind (60 out of 100). Theory questions, test and problems.
Minimum exam mark: 4 points out of 10.
Practices 3 and 4 (compulsory)
Other tests (to raise grade)

Total assessment of the evaluation system:
50% continuous evaluation
50% final exam (in ordinary call).
Final exam minimum mark: 4 points out of 10.

In short, naming:
A= Photovoltaic Project
B= Midterm exam Part 1 (Fv) (Minimum grade: 4)
C= Wind Project
D= Wind and Photovoltaic Practices (see explanatory Note)
E= Exam of part 2 (Wind and hybrid systems) (the day of the ordinary exam (Minimum mark: 4))
F= Test and short questions in class (to raise grade: 0.1 each test or question)
G= Fv exam (on the day of the ordinary or extraordinary exam (*)):
Final mark of the subject:
- For those who have released the First part:
0.2*A+0.3*B+0.2*C+0.3*E+F
- For those who have not released the First part:
0.3*G+0.2*A+0.2*C+0.3*E+F
- June session, extraordinary: examination of the Modules that have not been approved (Be careful, there is a minimum mark (4) in each part):
30% exam of each part, 20% each work

% end-of-term-examination:	30
% of continuous assessment (assigments, laboratory, practicals…):	70

BASIC BIBLIOGRAPHY

- Deutsche Gesellschaft Für Sonnenenergie Planning and Installing Photovoltaic Systems, EarthScan, 2008
- E. Lorenzo Energía Fotovoltaica, Progensa, 2014
- Jose M. Fernandez Salgado Guia Completa de la Energía Solar Fotovoltaica, AMV Ediciones, 2007
- Rodríguez Amenedo, José Luis Sistemas eólicos de producción de energía eléctrica , Rueda, 2003

ADDITIONAL BIBLIOGRAPHY

- Ecofys Planning and Installing Photovoltaic Systems: A Guide for Installers, Architects and Engineers, Earthscan, London, , 2005
- Trevor M. Letcher Wind Energy Engineering, Academic Press, 2017

BASIC ELECTRONIC RESOURCES

- IRENA . International Renewable Energy Agency: http://www.irena.org/
- NASA . NASA Surface meteorology and Solar Energy - Location: https://eosweb.larc.nasa.gov/cgi-bin/sse/grid.cgi?email=skip@larc.nasa.gov
- PVGIS . Photovoltaic Geographical Information System: http://re.jrc.ec.europa.eu/pvgis/
- United Nations . Sustainable Development Goals (SDGs): http://https://www.un.

org/sustainabledevelopment/