Wind and photovoltaic generation

Academic Year: (2022 / 2023) **Review date: 07-09-2022**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: CHINCHILLA SANCHEZ, MONICA

Type: Compulsory ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Electrical Power Egineering Fundamentals, AC Electrical Machines, Electrical Systems

OBJECTIVES

1. Knowledge and understanding of the fundamentals of wind and photovoltaic generation systems. To evaluate this item, systematic analysis exercises of basic circuits with wind and photovoltaic generation systems are carried out, specifically on wind and photovoltaic resources, basic components of wind turbines and solar cells
2. Have cutting-edge knowledge of current wind and photovoltaic generation systems
Information on the latest materials in the formation of the components of a wind turbine or of a photovoltaic system, leading control systems and use of the latest software for the location of the resource and the analysis of the systems
3. Be aware of the multidisciplinary context of electrical engineering. The integration of industrial engineering disciplines such as control, electronic, thermal, mechanical and environmental aspects, all essential for the knowledge of wind and photovoltaic generation systems, are revealed.
4. The ability to apply their knowledge and understanding to identify, formulate and solve problems of analysis of wind and photovoltaic generation systems using established methods
5. The ability to apply their knowledge and understanding to identify, formulate and solve problems of sizing of wind and photovoltaic generation systems that meet specific requirements. For this, problems of dimensioning of photovoltaic systems connected to the grid, isolated and hybrid systems with different requirements and in different locations will be formulated.
6. The ability to perform bibliographic searches, use databases and other sources of information
7. The ability to design and conduct experiments, interpret the data and draw conclusions.
8. Technical and laboratory skills. Three practices are carried out, one of them in the laboratory to measure the current voltage behavior in various irradiance conditions on photovoltaic cells.
9. The ability to combine theory and practice to solve problems of dimensioning and analysis of wind and photovoltaic generation systems. To evaluate this item, a series of practice scripts will be completed in which circuits with renewables are designed and the resolution techniques taught in the subject are applied.
10. The understanding of methods and techniques applicable to the sizing and analysis of wind and photovoltaic generation systems and their limitations depending on the data and restrictions. Demonstrate awareness of the responsibility of engineering practice and its environmental impact.
11. Know 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).

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
- Experimental lessons in the Laboratory, exercise classes in reduced groups, students

presentations, individual mentorship and student work to acquire experimental concepts

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
- 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
- Trevor M. Letcher Wind Energy Engineering, Academic Press, 2017

BASIC ELECTRONIC RESOURCES

- IDAE . energias-renovables: http://https://www.idae.es/tecnologias/energias-renovables
- NREL . Acceso datos.Laboratorio Energias Renovables de USA: http://https://data.nrel.gov/
- REN 21 . RENEWABLES 2020 GLOBAL STATUS REPORT: https://www.ren21.net/gsr-2020/
- UNEF . Union Española Fotovoltaica: https://unef.es/

- United Nations . Sustainable Development Goals (SDGs): http://https://www.un.org/sustainabledevelopment/