Wind and photovoltaic generation

Academic Year: (2023 / 2024) **Review date: 27/04/2023 19:49:55**

Department assigned to the subject: Electrical Engineering Department

Coordinating teacher: CHINCHILLA SANCHEZ, MONICA

Type: Electives ECTS Credits : 6.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Electric Engineering Fundamentals

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.
RA6. Transversal Skills: To have the necessary skills for the practice of engineering in today's society.

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
7.3- Regulation
7.4 Energy Communities

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.

WIND 2. Energy Production
2.1- Power curve. Defining FC, HE.
2.2- Basic exercise for energy calculation
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

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

CALIFICATION OF EACH PART OF THE SUBJECT:
FIRST PART (50%) (Photovoltaic and Self-consumption)
A1-PV plant sizing project connected to the grid. Exercise with PVSyst (40 out of 100 points in this part)
B1- Practices 1 and 2 (mandatory) (10 out of 100 points of this part)
C1-FV Exam (50 out of 100). Theory questions, tests, practices and problems. Minimum calification: 4 points. If >5 is obtained, it releases matter, for the ordinary and extraordinary call.

SECOND PART (50%) (Wind power, sustainability, hybrid systems)
A2-Project with Wind Turbines (40 out of 100).

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

B2- Practices 3 and 4 (mandatory) (10 out of 100 points of this part)
C2-Wind Power Exam (50 out of 100). Theory questions, test, practice and problems. Minimum calification: 4 points. If >5 is obtained, it releases matter, for the ordinary and extraordinary call.

Test in class (to raise grade: 0.1 points each test on the final grade of each part)

FINAL NOTE: the average of the two parts

In short, naming:
A1= Photovoltaic Project
B1= Practices 1 and 2
C1= Partial exam Part 1 (Fv)

A2= Wind Project
B2= Practices 3 and 4
C2= Part 2 exam (Wind power and hybrid systems) (on 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:
First part: 0.4*A1+0.1*B1+0.5*C1
- Final note for those who have released the First part:
(0.2*A1+0.05*B1+0.25*C1+0.2*A2+0.05*B2+0.25*C2)+ F
- For those who have not released the First part:
(0.2*A1+0.05*B1+0.25*G+0.2*A2+0.05*B2+0.25*C2)+ F
- June call, extraordinary: exam of the Modules that have not been approved (Note, there is a minimum grade (4) in each part) [25% exam of each part, 20% each work, 10% practical]+ Test

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/