Wind and photovoltaic generation

Academic Year: (2023 / 2024) **Review date: 12-02-2024**

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)

Electrical Power Egineering Fundamentals, AC Electrical Machines, Electrical Systems

SKILLS AND 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.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CG7. Undertake further specialized studies, both in physics and in the various branches of engineering.
CE6. Solve problems of applied thermodynamics, heat transmission and fluid mechanics in the field of engineering.
CE20. Understand and address the general problems of the field of Energy, as well as the scientific and technological foundations of its generation, conversion, transport and storage.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA4. To be able to successfully manage themselves in the complex situations that might arise in their academic or professional fields of study and that might require the development of novel approaches or solutions.

RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

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

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
- Experimental lessons in the Laboratory, exercise classes in reduced groups, students presentations, individual mentorship and student work to acquire experimental concepts

ASSESSMENT SYSTEM

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).
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

% 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/