INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Hybrid Systems and Micronetworks			Field of study	Energy		
Bachelor in	Renewable Energy Engineering			School	School of Technology and Management		
Academic Year	2023/2024	Year of study	3	Level	1-3	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9910-743-3204-00-23		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	-	30	-	-	-	-	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): João da Rocha e Silva, Luis Miguel Silva Correia, Ângela Paula Barbosa da Silva Ferreira, Paulo Cicero Fritzen

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Identify technological solutions for the implementation of hybrid systems based on distributed energy sources;
2. Know and use available tools for syzing islanded systems with integration of conventional energy sources and renewable generating units;
3. Understand and evaluate the integration of hybrid systems, taking into account technical and economic criteria, typify the cost per production unit and analyse the competitiveness between systems;
4. Understand the concept and strategies of microgrid operation and control resulting from the integration of significant quantities of distributed energy sources;
5. Identify and quantify the benefits resulting from the integration of hybrid systems into actual electrical energy systems;
6. Integrate microgeneration systems on low-voltage networks.

Prerequisites

Before the course unit the learner is expected to be able to:
1. know the fundamentals of Chemistry-Physics and Applied Thermodynamics;
2. understand the working principles of the technologies commonly used for power generation;
3. analyse both the steady state and dynamic behaviour of power systems.

Course contents

Hybrid systems: conceptual solutions, technological and microgeneration systems. Microgrids: architectures and operation principles, management and control. Economic assessment of investment projects concerning hybrid systems. Planning and operation of energy systems with integration of intermittent generation.

Course contents (extended version)

1. Hybrid systems.
   - Conceptual and technological solutions.
   - Microgeneration systems.
   - Gas, hydro and wind microturbines.
   - Fuel cells.
   - Photovoltaic systems.
   - Combined heat and power systems.
   - Energy storage devices.
2. Microgrids.
   - Architectures and operation modes.
   - Forecasting of the load and generation from renewable energy sources.
   - Management of storage systems.
   - Load shedding strategies
3. Simulation of hybrid systems and microgrids.
   - Operating strategies.
   - Economical, environmental and reliability criteria.
   - Sensibility analysis.
   - Economical and financial evaluation of investments.
4. Quality of energy and service provision.
   - Voltage profile.
   - Imbalances.
   - Harmonics.
   - Continuity of service.
   - Voltage and frequency control.
5. Planning and operation of energy systems with integration of intermittent generation
   - Legislation.
   - Coordination of dispersed and centralized generation.

Recommended reading

1. R. C. Bansal, T. S. Bhatti, Small Signal Analysis of Isolated Hybrid Power Systems: Reactive Power and Frequency Control Analysis, Narosa Publishing House, 2007
2. B. Sorensen, Renewable Energy: its Physics, Engineering, Use, Environmental Impacts, Economy and Planning Aspects, Elsevier Academic Press, 2004
3. National Renewable Energy Laboratory, US Department pf Energy, Manual for the Economic Evaluation of Energy Efficiency and Renewable Energy Technologies, Creative Media Partners, LLC, 2015
4. A. -M. Borbely, J. F. Kreider, Distributed Generation: The Power Paradigm for the New Millennium, CRC Press, 2001
5. H. Knati, Economic Evaluation of Projects in the Electricity Supply Industry, Institution of Engineering and Technology, Energy Engineering, 2003

Teaching and learning methods

Theoretical classes: Explanation lectures of concepts and methodologies to understand the course contents. Practical and laboratory classes: problem solving and critical analysis of the results obtained. Individual or group study will be carried out to realize experiments and to simulate study cases through available laboratory equipment and simulation tools.

Assessment methods

1. Distributed assessement - (Regular, Student Worker) (Final, Supplementary)
   - Work Discussion - 50%
   - Final Written Exam - 50% (It is required a minimal 30% rating to aproval)

Assessment methods

2. Global assessement - (Regular, Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100%

Language of instruction

Portuguese

Electronic validation

Ângela Paula Barbosa da Silva Ferreira, João da Rocha e Silva, Luis Miguel Silva Correia	José Luís Sousa de Magalhaes Lima	João Eduardo Pinto Castro Ribeiro	Ana Maria Alves Queiroz da Silva	José Carlos Rufino Amaro
19-02-2024	27-02-2024	27-02-2024	03-03-2024	09-03-2024