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	2021/2022	Year of study	3	Level	1-3	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9910-743-3204-00-21		

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): Luis Miguel Silva Correia, Ângela Paula Barbosa da Silva Ferreira, Catarina Maria Marques Goncalves

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. identify technological solutions for hybrid systems considering both grid connected and islanded operation;
2. know and use available tools for syzing islanded systems with integration of conventional energy sources and renewable generating units;
3. analyse the operation and management of hybrid systems;
4. evaluate hybrid systems concerning technical and economical criteria and analyse the competitiveness between systems;
5. assess the dynamic security of hybrid systems;
6. integrate microgeneration systems on low voltage grids.

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, technological solutions and microgeneration systems (gas and wind microturbines, fuel cells, photovoltaic systems and combined heat and power systems). Management and control of hybrid systems: load and generation forecasting, storage and reserve management, dynamic security, system protections, load shedding strategies and social well being. Economic assessment of investment projects concerning hybrid systems.

Course contents (extended version)

1. Hybrid systems: state of the art
   - Definitions
   - Configurations of hybrid systems
   - Conceptual solutions: combining different technologies and microgeneration systems
   - Characterization of both energetic resources and consumptions
   - Energy reserve systems
   - Storage devices
   - Introduction to hybrid systems sizing
2. Management and control of hybrid systems
   - Load forecasting
   - Forecasting of generation from renewable energy sources
   - Management of reserve systems
   - Management of storage devices
   - Load shedding strategies
   - Social well being
   - Frequency and voltage control
   - Special protection systems
   - Introduction to dynamic security assessment
3. Simulation of hybrid systems
   - Operating strategies
   - Economical, environmental and reliability criteria
   - Sensibility analysis
   - Examples of hybrid systems
4. Investment projects concerning hybrid systems
   - The value of electricity
   - The changing scene of power generation industry
   - Integrated resources planning
   - Power generation investments and projects
   - Considerations that will influence future investments in electricity generation
   - Power generation investments and projects
5. Economical and financial analysis
   - The time value of money
   - The cost of power generation
   - Economical and financial evaluation of investments
6. Environmental considerations and cost estimation in investment projects concerning hybrid systems
   - Environmental impact of power generation from fuels
   - Evaluation of environmental costs regarding the several energy sources
   - Health and environmental effects of power generation
   - Investment costs in reducing dangers concerning both health and environmental impacts

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. S. N. Bhadra, D. Kastha, S. Banujer, Wind Electrical Systems, Oxford University Press, New Delhi, 2006
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)
2. Global assessement - (Regular, Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100%

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Ângela Paula Barbosa da Silva Ferreira, Luis Miguel Silva Correia	José Luís Sousa de Magalhaes Lima	João Eduardo Pinto Castro Ribeiro	Ana Maria Alves Queiroz da Silva	Paulo Alexandre Vara Alves
26-02-2022	02-03-2022	04-03-2022	08-03-2022	22-03-2022