INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Electrical Power Systems			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	1	Code	9910-743-3102-00-23		

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

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): Susana Sofia Alves Freitas, Ângela Paula Barbosa da Silva Ferreira

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. model the power system components under steady state conditions;
2. use the "per unit" system for power systems analysis;
3. formulate the load flow problem through Gauss-Seidel, Newton-Raphson and fast decoupled load flow methods;
4. solve load flow problems using computational tools;
5. use computational tools to simulate symmetrical and unsymmetrical faults;
6. understand the technological context related to the actual trends of DC-based energy systems and microgrids.

Prerequisites

Before the course unit the learner is expected to be able to:
1. analyse linear circuits in direct current and alternate current (single-phase and three-phase);
2. understand numerical methods to solve nonlinear equations;
3. understand the fundamentals of electrical machines;
4. use programming languages.

Course contents

Transmission and distribution systems. The "per unit" system. Power systems analysis: mathematical models, load flow formulation (Gauss-Seidel, Newton-Raphson, fast decoupled load flow methods and the linearized model). Symmetrical faults.

Course contents (extended version)

1. Introduction to power systems
   - Historical evolution of electrical energy
   - Energy sources: classical generation and distributed generation
   - DC and AC energy transmission systems
   - Electrical energy grids and micro grids
   - The Portuguese utility
2. Basic concepts
   - Load diagrams
   - Balanced three-phase power analysis
   - Load characteristics
3. The per unit system
   - Definitions
   - Base quantities
   - Change of base
   - Fundamental laws of power systems in per unit system
4. Transmission and distribution lines
   - Series resistance and inductance
   - Capacitance and admittance
   - Equivalent circuit under steady state conditions
   - Thermal limit
   - Power transmission capability
5. Load flow analysis
   - Mathematical model
   - Bus classification
   - Solving load flow problems
   - The Gauss-Seidel method
   - The Newton-Raphson method
   - The fast decoupled load flow method
   - The linearized model
6. Symmetrical faults
   - Models of network components under fault conditions
   - Fault calculations

Recommended reading

1. J. Paiva, Redes de Energia Eléctrica, uma Análise Sistémica, IST Press, 4th edition, 2015
2. J. Grainger, W. Stevenson, G. Chang, Power System Analysis, McGraw-Hill Education, 2nd edition, 2015
3. A. C. Zambroni de Souza, M. Castilla, Microgrids Design and Implementation, Springer, 2018
4. J. H. Chow; J. J. Sanchez-Gasca, Power System Modeling, Computation, and Control, John Wiley & Sons Ltd., 2019
5. L. Powell, Power System Load Flow Analysis, McGraw-Hill, 2005

Teaching and learning methods

Theoretical classes: presentation of the course contents. Practical and laboratory classes: presentation of practical examples to support the expected learning outcomes; problem solving and critical analysis of the results. Non-presential hours: specific proposals on problem solving and accomplishment of evaluation work.

Assessment methods

1. Distributed assessment - (Regular, Student Worker) (Final, Supplementary)

Assessment methods

- Practical Work - 15%
- Intermediate Written Test - 15%
- Final Written Exam - 70%

2. Global assessment - (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, Susana Sofia Alves Freitas	José Luís Sousa de Magalhaes Lima	Ana Maria Alves Queiroz da Silva	José Carlos Rufino Amaro
29-09-2023	11-10-2023	14-10-2023	31-10-2023