Ficha de Unidade Curricular (FUC)

1. Unidade curricular

Advance studies on electric machines

2. Docente responsável e respetiva carga letiva na unidade curricular (preencher nome completo)

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3. Outros docentes e respetivas cargas letivas na unidade curricular

Pedro Miguel Neves da Fonte	
Ricardo Jorge Ferreira Luís	

4. Objetivos da aprendizagem (conhecimentos, aptidões e competências a desenvolver pelos estudantes)

- Modeling and application of the dynamic behavior of electrical machines.
- Analysis and application of electric machines mathematical and physical transformations.
- Application of observers in electric machines.
- Analysis of magnetic saturation effect in electric machines behavior.

5. Conteúdos programáticos

Dynamic equations determination of electric machines: electric machines classic theory vs generalized theory, system state function, state variables of conservative systems, conservative lagrangean, lagrange equation of motion.
Bondgraphs: variables definition, system power flow, bondgraph elements, system dynamic equations, causality, controllability, observability, activation.
Electric machines generalized models: physical transformation of a salient pole synchronous and DC machine; commutator primitive – Machine model; transformations: abc-dqo, abc – alpha betha 0, dqo-alpha betha 0, complex transformed machined model, time-domain model.
Modeling and analysis of the dynamic behavior of DC machines: Equations of motion, Steady-state and dynamic behavior. Electromagnetic and electromechanical transients, small disturbances transients. Magnetic saturation analysis.
Synchronous machines: The basic model, electromagnetic and electromechanical transients, small disturbances transients. Magnetic saturation analysis.
Induction machines: General equations, electromagnetic and electromechanical transients, small disturbances transients. Magnetic saturation analysis.

6. Demonstração da coerência dos conteúdos programáticos com os objetivos da unidade curricular

These programmatic contents aim students 'competence acquirement on following domains:
- electromechanical energy conversion modeling
- electrical machines dynamic behavior modeling and analysis
- General machines models based on mathematical and physical transformation analysis
- Study of magnetic saturation effect in electric machines modeling

In this sense, the curricular unit goals clearly summarize the competencies to be acquired by students, which are in agreement with the presented syllabus

7. Metodologias de ensino (avaliação incluída)

Lectures have 3 components: theory, exercises and laboratory. In theory component, the fundamental syllabus theory is discussed in bidirectional way between teacher and students. The knowledge application is put into practice by solving math problems solving and in laboratorial analysis.
In problem solving some techniques of problem-based learning are used as well as other active learning techniques, during exercises classes.
In laboratory classes the goals and competencies to be acquired by students are presented. Each work has some predefined time scheduling that could be used as guideline for the successful accomplishment of those goals.
The assessment of the theoretical component is accomplished through final exam.
Laboratorial assessment component is accomplished through presentation and discussion of 4 laboratorial problems. For Students final grade calculus, a weight of 60% of theory component and 40% of laboratory component, are considered. Theory and laboratory components are pedagogically fundamental for student's approval.

8. Demonstração da coerência das metodologias de ensino com os objetivos de aprendizagem da unidade curricular

To accomplish the learning objectives of the course, students should be motivated and able to apply theoretical knowledge into practical and laboratorial problems. There is a high coordination between the theoretical, exercises and laboratorial components. This coordination helps students to achieve a proper and logical articulation between knowledge and know-how.
One way of demonstrating the consistency between teaching methodologies and learning objectives are accomplished through student's motivation (hardly measurable) associated with approvals numbers (easily measured). In this sense students who undergo theoretical evaluation and attend all lectures have an approval ratio around 72% (data from 2014/2015).
The methodologies used in exercises lectures indicate some increase in students' motivation, accordingly to students' attendance numbers measured along the semester (statistics between 2008 and 2015).
The adopted methodology for the laboratory classes contributes to consolidation and construction of knowledge. Students must define and chose the process, methodology and apply theoretical knowledge, contributing to the synergy between exercise and laboratorial lectures.
The theory lectures are those which had a lower attendance rate, however this attendance rate is increasing in the last years. The students who attend these classes with some regularity are those who submit into theoretical evaluation. It is considered that teaching methodology is in line with the Bologna process definition.

9. Bibliografia principal

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Amalendu Mukherjee; Ranjit Karmakar, Modelling and Simulation of Engineering Systems Through Bondgraphs, Alpha Science International Ltd, 2000

Chee-Mun ONG, Dynamic Simulation of Electrical Machinery Prentice, Hall PTR, 1998