E-LEARNING IN POWER ELECTRONICS STUDIES USING WEB TECHNOLOGIES

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***Abstract* – This paper describes a new educational technological tool. Power Electronics education is a potential field for e-learning application. A specific software module is under development, and can be include in a compatible e-learning platform for Web environment. This kind of approach is a quite new methodology, being only necessary the utilization of a browser and an Internet connection. With this tool the student can simulate different Power Electronic topologies, previously defined by the teacher, and take conclusions about the topologies.**

***Keywords* - E-learning, Power Electronics, Virtual Lab, New Simulation Tool.**

I. INTRODUCTION

The most recent information technologies open the way to include in engineering education new pedagogical methodologies [1], [2], and [5]. In this scenario, a new software package to Power Electronics studies is under development by the authors, in the University of Beira Interior, Portugal. This package doesn't intend to substitute practical classes, where the student makes contact with real power electronics components and topologies, but for support the student work in Power Electronics, allowing him to verify and analyze, in a fast, attractive and efficient way, one studied topology in particular.

Development of educational contents is now based in web applications, especially in engineering domain. Engineering schools are introducing this kind of tools to support their students with. Main goal is to improve quality and flexibility of the education system.

Traditionally, most of the commercial available tools handle only administrative tasks as account management, documents sharing and handling, or discussions board support, but never give the real necessary and needed educational support. Education agents need to have access at powerful learning tools devoted to support them on the learning process. At authors institution, project Samurai developed an e-learning platform where beyond traditional platform tools are also include specific modulus for learning on specific knowledge areas. Authors are contributing in that learning platform with their Power Electronic e-learning tool. This specific module is described next, and an application example is included to show real world application.

II. NECESSITIES AND ADVANTAGES IN THE USE OF E-LEARNING METHODOLOGIES

E-learning platforms provides students to an easy and fast information and knowledge access, independently of time and place where he or she wants to get it. The constant technological evolution requires an always-continuous formation. Today, engineering staff fills that their needs are changing quickly, so they must have access to any form of long distance electronic learning systems, and with it they can develop their skills in new technologies, products and services. This new scenario demands for e-learning, that can now be defined as an electronic tools for knowledge transference using internet, intranets, or extranets, breaking the time and space limitations. With this kind of tool, students, enterprises, and schools can achieve benefits like cost reduction with better support.

The justification for the existence, and use, of e-learning platforms is taken from the staff technician learning necessities observation. Several factors, as for example incompatibility of schedules or long distance to physical learning location, contribute to make difficult the technician knowledge actualization. Many times students are not able to be present, with the necessary regularity, in places where this knowledge is available.

The relative easy access to the educational contents gives origin to privacy and security issues as in the e-commerce. Information like student personal data, educational classes material, or evaluation results must also to be protected in e-learning systems. The main problem concerns intellectual property rights; the school must define who own the material rights. Will be the teacher that elaborated it, will be the student or enterprise that buy it, or will be the school that provides access to it? An answer must be found to this question.

The software here described is used in Power Electronics courses, and nevertheless connected with practical classes provided in proper laboratories. In this classes, the student carries out a set of experiences, allowing him to acquire practical sensitivity. However, and due to complexity of this kind of works, sometimes the only way to get pedagogical success in experimental job is carrying out a previous theoretical analysis of the topologies. This analysis becomes something complex and tiring for students, being therefore one considerable motivation less reason. Using this module, author's intent to provide to students a tool, simple and fast, for validation of both theoretical and practical results. In addition, the software can be used so that the student acquires sensibility in Power Electronics studies.

III. RELEVANT ASPECTS OF THE E-LEARNING PLATFORM

The flexibility of the teaching process maintaining a quality of high scientific and pedagogic level becomes a categorical imperative for any academic institution of the modern times. The integration of the Portuguese superior education system in an international structure created by the Agreement of Bologna implicates a growth of teaching effectiveness. It is supposed that the largest weight of the study is transmitted for the student's individual work (accompanied by a Tutor), without losing the quality of the acquired knowledge.

The called new technologies have in this area a very large application and are proved to be a task auxiliary and an optimal work tool. Besides their help to combat distances between student and school and other impediments, they are also a good form of resources use.

There are several reasons to pay attention to the *e-learning* methodology [7], [8]. It is more and more necessary to focus the teaching process on the student and to turn the learning process more attractive and effective using multimedia. It is important to increase the dynamics of the contents and to promote their permanent actualisation, so as to respond to the students' needs. It is necessary that the students can be able to study beyond the period of classes, during the vacations and intervals. For the expansion of the high education level, it becomes indispensable that people can have access to an education system far away from the cultural and scientific centers of the country.

Currently, it is more and more common to exist, inside education institutions, an e-learning platform. These platforms can assume a great variety of forms and performances, including a large diversified set of functionalities. However, some of these forms and functionalities are directly related to better use of the platform, from both student and teacher points of view. Of great added value is the fact that of the developed is open, allowing modules introduction, which can be made by different entities.

For beyond, this new technology must add in a set of functionalities, common to any type of e-learning platforms, such as management of accounts users, discussion groups, news, management of contents, etc.

The UBI/DEM e-Learning platform [9], [10], whit aspect like the own shown in Fig. 1, was developed with in a project funded by Portuguese organization PRAI/CENTRO. It was developed using Open-Source technologies. The chosen group of technologies, usually denominated by LAMP, was the **L**inux+**A**pache+**M**ySQL+**P**HP.

This software architecture permits that the student only need a personal computer connected to the Internet with a Web browser and a Java Client installed, because most part of the processing is done on the central server. The Java client is necessary mainly to use the Power Electronics module.

One of the great advantages of the use of the LAMP technology is its cost. In the development of the described platform system, and also for the Power Electronics module, no money was spent on licences. Another aspect that was taken into account was the need to use stable and constantly developed technologies.

The e-learning platform has the of great importance characteristic of been modular; this fact means that his basic philosophy was the possibility to reach every necessity in the various University courses. Everyone could use the main modules that nowadays include evaluation modules, automatic creation of exercises, automatic correction of exercises, automatic creation and correction of worksheets and homework, download and upload of files, classroom forums, various statistics including student performance, etc.

Because of the modular implementation, it is very easy to develop other modules, as the way we do for this specific power electronics module.

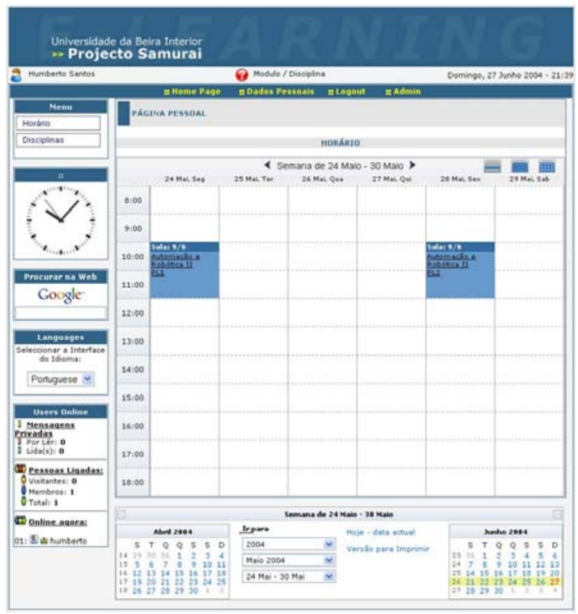

Fig. 1. UBI/DEM e-Learning platform aspect

IV. POWER ELECTRONICS SOFTWARE MODULE SPECIFICATIONS

The Power Electronics module uses different programming languages (php, java, and python), where each one of them contributes to a specific development area. This specific module is developed such a way that his adoption by another e-learning platform only requires quite simple modifications.

Till now, only three topologies are been completely developed by the authors and are ready to use. This is because first of all several factors need to be tested, before undertaking a large development work. Factors related with front ends layouts must be first well established and proved.

This module is based on two different front ends. The first is devoted to teacher parameterization and configuration. On it, the teacher can specify what kind of topologies that student can have access. All education process is developed around this specific topology. Using other platform tools teacher can also orient the student work, or different works for different student levels. For example using Followed Exercises (aspect of this page is shown in Fig. 2), teacher can orient student work. On this view one or several questions can be putted to the student. Also, existing Help Module can be used to give some support during exercise resolution, and this support can also be given in different levels of exercise solving process. On-line help, at any moment, given guidance for study, and the teacher recommends bibliographic references, immediate help, linking for sites in the Internet with relevant contents, or, finally, teacher can give the necessary steps to solve the problem.

Fig. 2. Back-end, Teacher View

Students use the second module during e-learning process. With that, they have access to topology under study and also to the proposed exercises by the teacher. When Student Front End is visualized, user is allowed to change several topologies parameters like: voltage, load, firing angles. User is also free to choose what signal does he want to be shown graphically (as can be seen in Fig. 3).

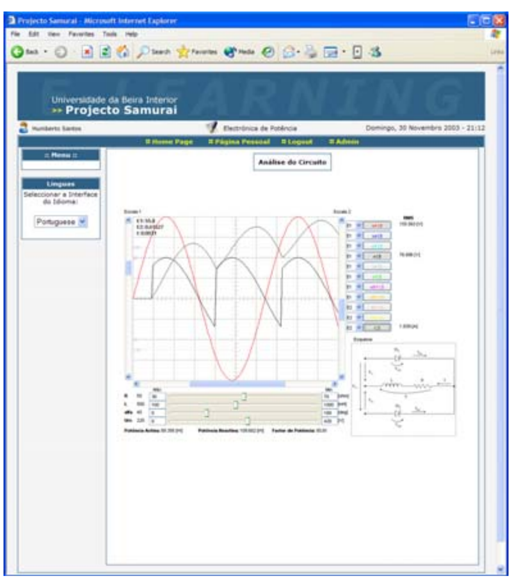

Fig. 3. Front-end, Student View

With waveform signals visualization also RMS values are shown; yet, it is possible to calculate active and reactive powers.

V. TOPOLOGY EXAMPLE

Power Electronic I (subject of 4^{th} year Electrical Engineering curriculum) will be used here as an example. During this course, students must realize several experimental works in the laboratory, in a total of six [3],[4]. The goal of this application is to provide the student a learning tool that allows him to take some skills before he or she goes to the laboratory. One application example is used to describe e-learning platform usage.

The class starts with protocol experiment presentation. Power electronic topology under study is theoretically analysed. As an example, a full rectifier with transformer middle point is showed in Fig. 3.

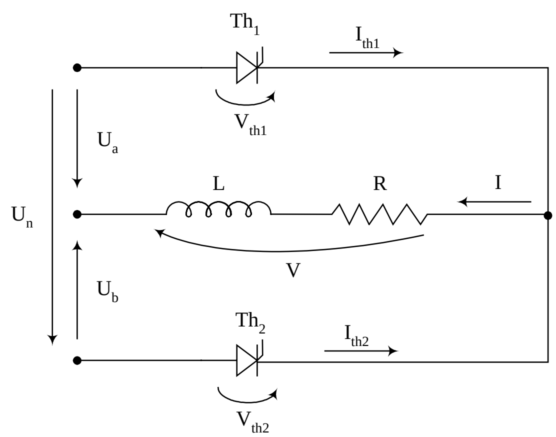

Fig. 3 - Full rectifier topology.

The theoretical analysis of topology is performed on blackboard. Follow and understand this explanation is sometimes difficult for students. Topology complexity, allied to the need of draw simultaneously, with precision, several signal curves is a major factor concerning student weak motivation.

For circuit complete understanding students needs to experiment different situation and see what happens when a circuit parameter is changed. So, theoretical study only observes topology behaviour. After that, e-learning platform is used to explore circuit behaviour. Experimental procedure defined by the teacher is followed, and several tasks are performed.

Students must obtain rectifier static control characteristic. To complain this first experimental procedure task, rectifier mean value output voltage must be obtained for several thyristors firing angles. This can be easily done, changing the angle cursor on java applet that will re-simulate and exhibit results instantaneously.

Second experimental procedure task demands to student to observe, record and analyse several results for different thyristor firing angles, as by example:

- RMS input voltage;

- thyristor 1 RMS current;
- active power.

This procedure must be performed for two different loads: the first purely resistive (R=50 Ω) and the second a resistive--inductive load.

Figure 4 shows a simulation result for the second load case, with a thyristor firing angle of π/4 radius. Student Front End web page beyond graphical result also exhibits measured data, needed to fulfil report requirements. Simulation task also allow student to observe transitory circuit evolution to the stationary regimen.

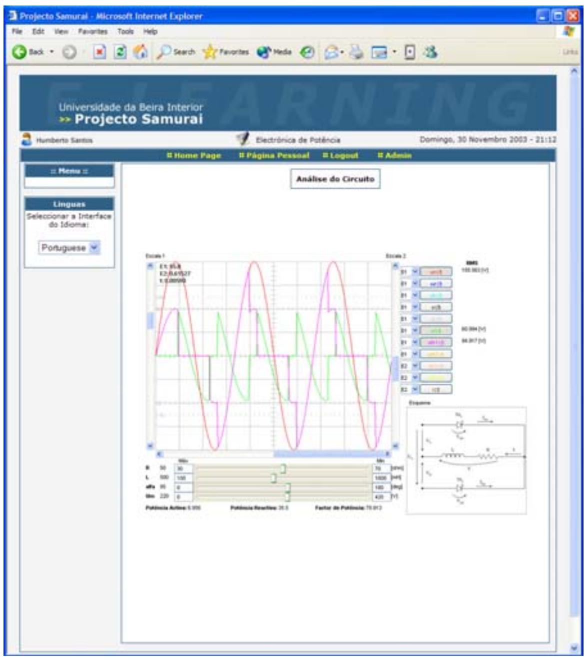

Fig. 4 - Simulations results for a RL load and $\alpha=\pi/4$.

Finally, experimental procedure asks for student to find thyristor firing angle that promotes continuous circuit conduction regimen. For that, student must change firing angle cursor to find the required situation. For that, student only needs to read angle value on java applet.

With results obtained from the simulations, students must obtain circuit control characteristic, conversion characteristics, and power factor characteristics. All the required characteristics must be determined based on 8 to 10 values.

This work can be executed on a short period of time, or at home, without the need of going to the laboratory. Students can also perform this and other tasks in a secure environment, avoiding hazard situations to them or to the laboratory equipment.

After the complete study, and understanding of topology, students go to laboratory department facilities, and perform real experimental work. At this point emphasis is put on practical aspects, like the development of circuit assembly skills and practical measurements. The Fig. 5 shows setup experimental assembly used on practical study. Mounted on the laboratory facilities.

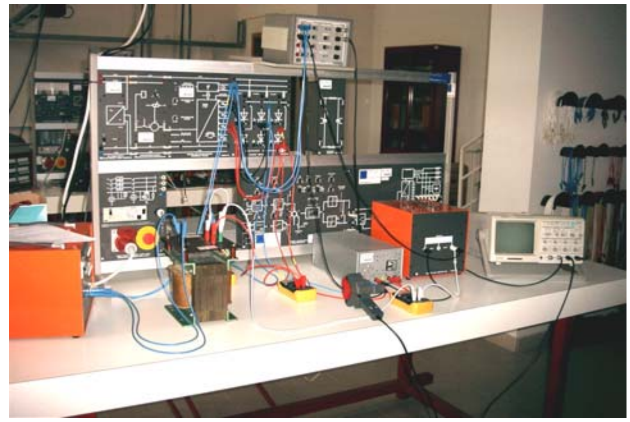

Fig. 5 – Hardware setup experimental assembly.

VI. CONCLUSION

The described developed software tool is used in Power Electronic subjects study. This module is accessible on-line through an e-learning platform, developed in the Electromechanical Engineering Department (within the SAMURAI project). With this tool the students have access to a new educational methodology, which reflects in better subjects approval rates. The next contribution task will be the enlargement of the module topologies database.

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