E-ENVIRONMENT FOR BASIC ELECTRONIC LEARNING (E-BEℒL): A WEB TOOL FOR COMPLEMENTARY AUTONOMOUS STUDY

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This paper reports on an e-tool that is being developed at University of Porto under the scope of a major project that seeks a framework, assisted by information and communication technologies, to teach electronics to undergraduate students at introductory levels. The project aims, simultaneously, at a more efficient way to deliver knowledge and to keep the students motivated in a true continuous learning environment. The e-tool embodies a main web text with multiple links to complementary documents containing mathematical proofs and deeper analysis or concepts that may not be essential on a first read. Consequently a soothed main text results, allowing a lighter and more attractive reading experience. A strong emphasis is put on circuit analysis by inspection, of which the circuit transformation procedure is an example [1]. Animated pictures and guided examples are also included to illustrate some circuit transformations techniques. Online and interactive circuit simulations, as well as illustrative audio and video clips are being prepared. This e-tool will be integrated with other software environments in order to create a complete e-learning experience.

1   Introduction

The fast development and general availability of the information and communication technologies (ICT) and the fast evolution of the personal computers seen in the last decade has brought new tools and means to enhance the teaching process [2]. These facilities were first used for distance learning but, subsequently, multimedia tools have also been used as an aid in conventional teaching attempting to overcome a manifold of problems such as big number of course attendees [3] or resources optimisation [4] or even calling for the complete substitution of traditional lectures by computer-aided learning [5].

However, ICT also allows the improvement of conventional teaching efficiency aiding to eliminate habitual deficiencies and provides innovative tools that keep the students motivated prompting a more effective study.

Teaching Engineering, at university level, is normally achieved through lectures, tutorial classes and laboratory classes. The latter two, provided that they are well structured and organized, are usually well accepted by the students that engage in these activities with enthusiasm. In opposition, conventional lectures tend to be relegated by today's students and, knowing that lectures are usually facultative (at least, in Portuguese universities), the students frequently do not attend them.

Many professors persist in comprehensive expositions of the subjects following the established principle that only the matters extensively explained in the lectures can be included in tests and exams. This practice is a legacy of the past, when the books were scarce, the libraries were poor and, consequently, the professors were almost the sole sources of knowledge: the students had to attend the lectures to take notes that subsequently were used for studying. It would be superfluous explaining that the present situation is completely different.

Nowadays, as it is more or less useless to take notes, most students attend the lectures in a very passive posture. It may be said that attending the expositions helps to understand the matters under study, but even that seems to be questionable. The depth and breadth of the subject matters, at university level, require a great deal of personal effort from the students to understand and assimilate them. Only afterwards are they able to ask sensible questions and then indeed the role of the teacher may become really important. Therefore, a more fruitful procedure would be reducing the lectures to the minimum necessary to give a first orientation for the students to start studying and gain time for subsequent contacts [6].

2   Students' self-study

According to the reasoning expressed above, the student's individual study gains more expression and should be articulated in a learning process (that takes into account each student learning rhythm) where frequent professor/student contacts need to be included in a flexible manner.

At introductory levels of university undergraduate courses, a good textbook and some complementary references should be recommended to the students to support their self-study. To be efficient, self-study requires flexible asynchronous learning tools to allow the students to establish their own learning pace and path. Although the books are easy to use asynchronously, in most course textbooks sequential presentations are privileged, leaving little freedom to model the study defined by the student's own specific interests.

Being aware of these problems students should be provided with new materials and methods, aiming simultaneously to a more efficient way to deliver knowledge and to keep the students motivated in a true learning environment.

This is the motivation for the project the authors have been developing, the core of which is an e-tool built around a main web text with multiple links to complementary documents. The text is not yet intended to be a substitute of a textbook; instead it should be seen as a guide to the students in their self-study.

3   The web tool

The most powerful feature of a web text is certainly the use of hyperlinks. Combined with the complementary texts, it allows a comfortable and less bulky main text and therefore permits a lighter and more attractive first reading experience.

In this web tool, most mathematical proofs and deeper analysis or concepts that may not be essential on a first read have been moved out of the main text. This gives the reader flexibility to use the text according to his or her preferences, level of knowledge or degree of learning progression, following the existing links or disregarding them. Those links are also used to recall some previous definitions and/or concepts that are important to understand the new ones.

Other features made possible by the multimedia tools – like animated gifs and conditioned sequence exercises – have been used to illustrate analysis procedures and techniques. Online and interactive circuit simulations, illustrative audio and video clips are also being prepared.

Being a complement to the recommended bibliography for the course, this web text has been written emphasising the authors' point of view about teaching Electronics, developed upon their experience. Accordingly, specific methods of electronic circuits analysis, such as the circuit transformation procedure found in [1], are suggested. These methods to analyse electronic circuits are based on the concept that keeping track of the circuit transformations, when compared to a straight system of equations solving, give a better insight to the circuit behaviour.

The web text is complemented with a printable text allowing the students to have a adequately formatted paper version that basically covers what they can find in the electronic version.

This experience started focusing on multistage differential amplifiers, a chapter that takes place after the students have studied the transistors basic configurations. However, we go far enough to cover frequency response as well as feedback amplifiers fundamental notions, because many circuit solutions can only be properly understood taking into account these two aspects. Also, many references to basic electronics and circuit theory have been included.

The authors intend to extend the reach of this web tool to the whole program of the two-semester Basic Electronics course taught in the University of Porto for the Electrical and Computers Engineering undergraduate students.

The web tool was first written in Portuguese and has been tested during 2001/02 school year with good results. Now, in the scope of the GENIUS Project funded by the European Commission, the text is being translated into English and will be integrated with other software tolls in order to create a complete e-learning experience and tested in several European universities.

4   Some details

In the design of this web tool a special care has been taken to facilitate the navigation of the web text. Different backgrounds are used for the main text, complementary texts and exercise solutions; a return arrow remains permanently in the right lower corner of the screen, allowing a fast come back to the starting screen, from which the reader can access two different indexes.

The main index (Fig. 1) provides links to each of the sections of the main text as well as to the exercises.

Figure 1. The main index

To facilitate the access to the several complementary texts an annex index (Fig. 2) has also been provided.

Figure 2. The index of annexes

A set of selected exercises has been included in the main text to illustrate the application of the subjects under study. The reader can access the answer and/or the solution to make sure of the correctness of his own method. The answer opens in a small window (Fig. 3) and the complete solution appears in a separate one (Fig. 4).

Animated gifs are an interesting feature that suits very well the purpose of explaining how to proceed to simplify a circuit with successive transformations. Fig. 5 shows a set of images from an animated example of application of the method.

Figure 3. Answer of Exercise 3

Figure 4. Solution of Exercise 3

Figure 5. Set of images from an animated example

Another appealing application of multimedia tools refers to conditioned sequence used in an exemplifying exercise. The student is guided through the solving methodology but is required to perform some calculations to proceed to the next step. Fig. 6 shows two steps of the procedure suggested in a guided example.

These features will be used for other examples that could be enhanced with this kind of presentation. Still, some other sophisticated means, such as the use of short audio and video clips are being prepared and will be included soon.
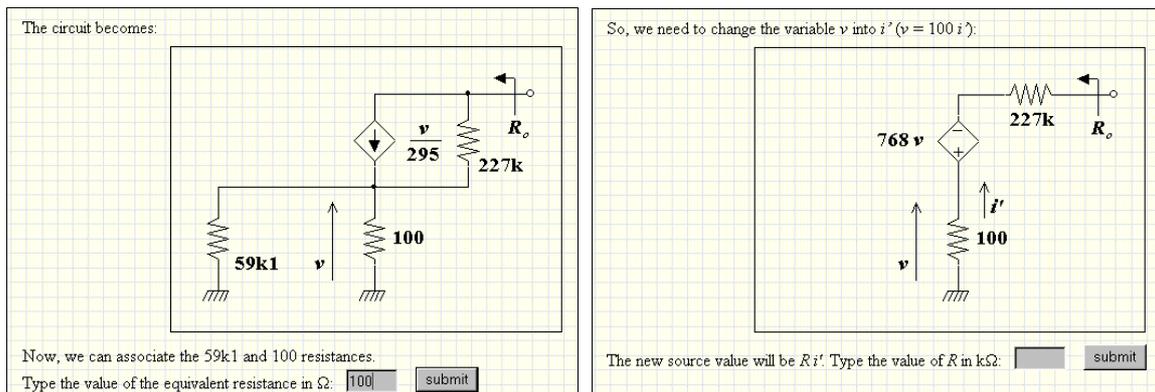
Figure 6. Two steps of a guided example

5   Validation of the work

This work has been used in the regular teaching of Electronics at the University of Porto [6] with good acceptance from the students. Under the GENIUS Project, the work will also be tested in other European universities, which will be an invaluable experiment to inquire the effectiveness of the tool under a different learning and cultural environment.

6   Conclusions and future work

The work presented here is in continuous development in close collaboration with the students that play an important role with their insightful comments and encouraging feedback. The main short-term development is the inclusion of the simulator as well as the audio and video clips. The e-tool integration with other software tools to allow a complete e-learning environment experience will be done under the scope of the GENIUS Project.

The authors are also engaged in other projects, which will provide the necessary means to extend the scope of this pilot work, first, to the whole program of Basic Electronics and then to other topics.

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