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Easy-E – Home Schooling in Electronic Devices and Circuits

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ABSTRACT

Students with special needs often require special teaching tools; physical and sensory impaired students can benefit from using computer-aided assessment methods that address their fully developed abilities.

Easy-E is an assessment software tool designed to improve the learning abilities in the field of basic electronics. The friendly user interface provides easy access to all sections (circuits with diodes, resistors, capacitors, operational amplifiers). Theoretical presentations, schematics, waveforms, and transfer characteristics are available and the user can change the values of components and signal parameters.

The acquired knowledge can be tested, in the Test section. The tests cover the entire area, and consist of ten multiple choice questions.

The proposed software tool is a standalone application with low computational requirements, which can be used for both online and offline learning. Due to the fact that our tool offers theoretical fundamentals, active learning through solved problems and final testing, it can be seen as a complete instrument for home schooling in the field of basic electronics.

KEYWORDS: *active learning, electronics, home schooling, Matlab, software tool, testing.*

1. INTRODUCTION

The popularity of computer assisted learning and testing tools has increased together with the aggressive intrusion of the Internet and smart phones in our daily lives. Students seem to be more attracted to studying using advanced technological tools, which boost the learning experience [1].

Active learning significantly expands the educational opportunities for various groups of students, both the strong and the weak ones [1]. The students build their own knowledge acquirement system, through learning skills, exploration, feedback evaluation, and reflection, based on their own experience [2], [3].

Computer assisted learning and testing requires a shorter time than traditional methods, when it comes to understanding new and/or difficult concepts, and the allocated time can be self-imposed. The structure of the study material is rigid and sequential for traditional methods, whereas for computer assisted learning, the student can go back and forth through the study material. Another major advantage of using computer assisted learning and testing is that it enhances the development of critical and creative thinking, which is not a priority for traditional learning methods. Moreover, the student's involvement in the learning process is higher for computer assisted methods, because the student interacts with the software tool in real time, and any changes that he makes will have an instant effect.

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Computer assisted software tools are also suitable for physical and sensory impaired students [4], because they do not require physical attendance in the class/lab and there is no need for an instructor, which would be compulsory for traditional methods. However, active learning methods, integrated in computer assisted tools, can become a part of the lectures, making them more attractive to students, as stated in [5].

Open source software tools designed for active learning and testing various subjects and/or skills are either available online or inside university locations. The electronic devices and circuits domain is one of the most exploited, when it comes to software tools, because the basic concepts are fairly easy to understand, and the learning process can benefit from graphical visualization. Currently available software tools for electronic devices and circuits can either be circuit simulators (online: PartSim®, CircuitLab®, Circuit Simulator Applet by Paul Falstad, etc., or offline: OrCAD®, Cadence®, etc.) or online lessons (LearnElectronicsOnline.com, 101science.com, etc.) and custom designed e-learning platforms, such as UCOMoodle® [6].

More than often, the circuit simulators are isolated from the theoretical concepts, making it difficult for a student to fully comprehend certain aspects. Ideally, the circuit simulator part and the theoretical background should be merged, so that the student is able to acquire both theoretical and practical knowledge, simultaneously.

The aim of this paper is to present *Easy-E*, a home schooling software tool, designed for the study and assessment in the field of basic electronic devices and circuits. The outline of the paper is as follows: Section 2 describes the structure of the application, Sections 3 and 4 present the active learning and testing part in detail, and Section 5 concludes the paper.

2. DESCRIPTION OF THE APPLICATION

Easy-E is a home schooling application, developed using the Matlab integrated environment. The application is designed to facilitate the learning and testing process of stay at home or physical and sensory impaired students, that want to acquire knowledge in the basic electronic devices and circuits field. *Easy-E* was built as a standalone application, with low computational requirements. The user-friendly interface provides easy navigation.

Easy-E is structured into two parts, *Active learning* and *Testing* (Fig. 1). The *Active learning* section contains chapters, while the *Testing* section consists of randomly generated tests, with multiple choice questions.

The main interface of *Easy-E* is presented in Fig. 2. The user can select either *Active learning* or *Testing*; both sections are always available, that is, the user is not required to go through the learning part before testing, although it is highly recommended.

3. EASY-E ACTIVE LEARNING

When the user accesses the *Active learning* section, he can further select one of the four chapters: switching circuits with diodes and resistances *(DR switching circuits, Two-port and multi-port networks*), switching two-port networks with diodes and capacitors *(DC switching two-port networks),* comparators with operational amplifiers *(Op-Amp comparators),* and amplifiers with operational amplifiers *(Amplifiers with Op-Amp)*, with one or more subchapters each, as depicted in Fig. 3.

Fig. 1 – Easy-E structure

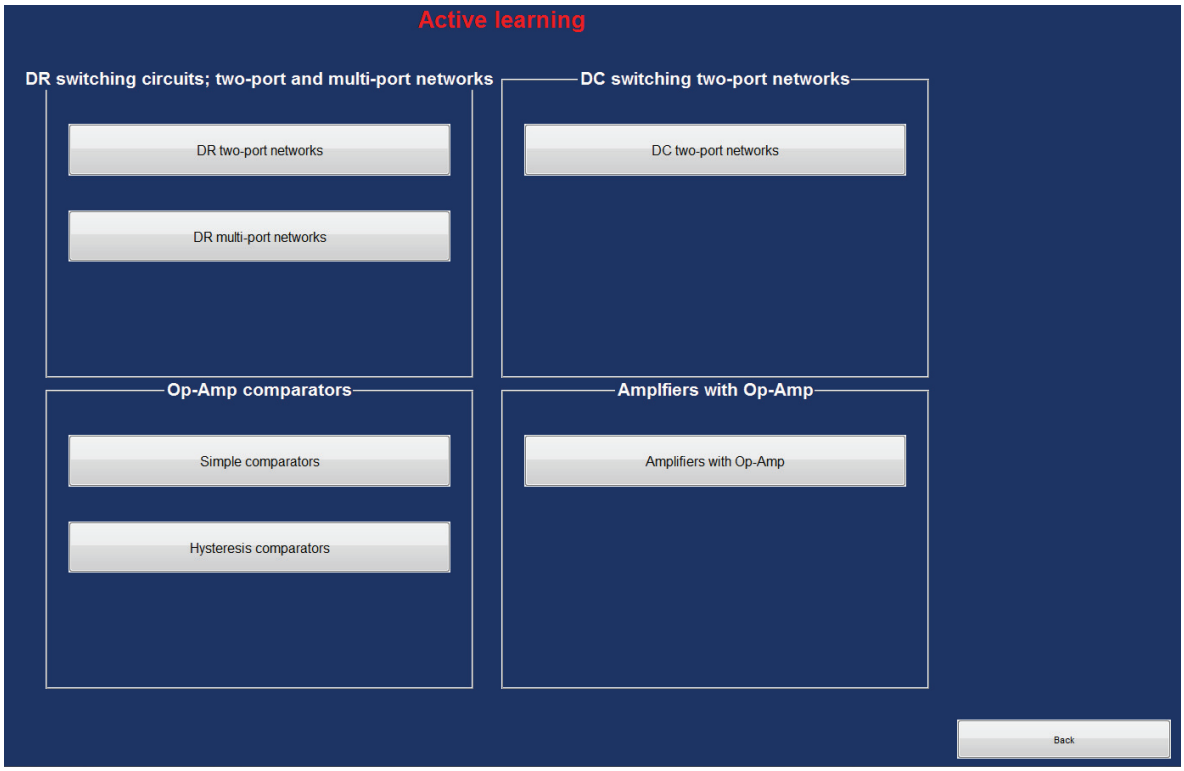

Fig. 2 – Easy-E main interface/screen

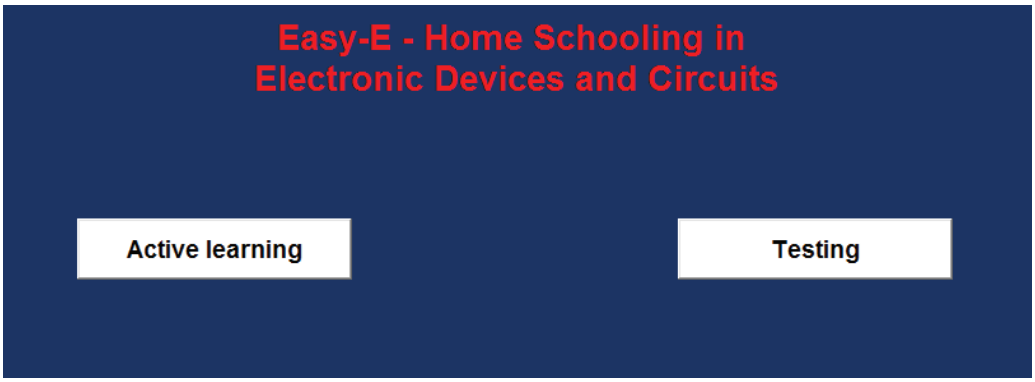

Fig. 3 – Easy-E *Active learning* section

The subchapters are activated by pushing their corresponding button. Theoretical presentations, circuit diagrams, waveforms and transfer characteristics are available for each subchapter. There is no predefined order for the chapters, so the user can access them, however he sees fit. The *Back* button, in the bottom right part of the window, takes the user back to the main window.

As an example, the *Simple comparators* subchapter is detailed (Fig. 4). The red button in the upper right corner, *Theoretical presentation,* provides basic theoretical aspects, in a *.pdf* file, which can be useful, especially if the user intends to obtain a deeper understanding of the subject. The questions below the circuit diagrams refer to all and any circuit. The user can attempt to answer these questions by himself, using the concepts and relationships from the *Theoretical presentation.* Any of the four available circuits can be selected, by pushing the *OK* button, which will open the answers window (Fig. 5). Here, the user can both see the static type answers (like for question *a) What is the application of the circuit?*), and can input various values for the amplitude of the input voltage, the power supplies and the threshold voltage. The effects of the changed values instantly appear on the waveforms and transfer characteristic (Fig.5).

In *Easy-E,* the user can input new values (for the amplitude of the input voltage, the power supplies and the threshold voltage), as many time as he wants, until the subject of the chapter/subchapter is fully understood.

4. EASY-E TESTING

The *Testing* section consists of randomly generated tests, with ten multiple choice questions each, covering the entire subject area available in the *Active learning* section.

The first questions of a test are presented in Fig. 6. The questions can either be purely theoretical (e.q. *What is the application of the circuit?*), may require short computations or a choice between given plots (waveforms, voltage transfer characteristics). The questions are very similar to the ones met in the *Active learning* section.

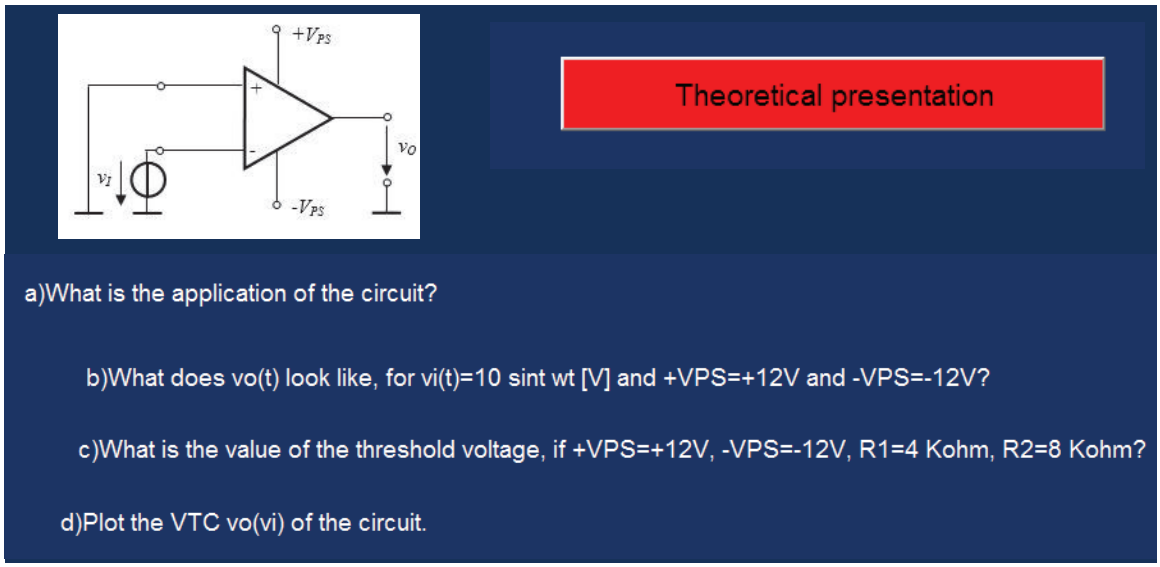

Fig. 4 – Easy-E *Active learning* – example from the Simple comparators subchapter

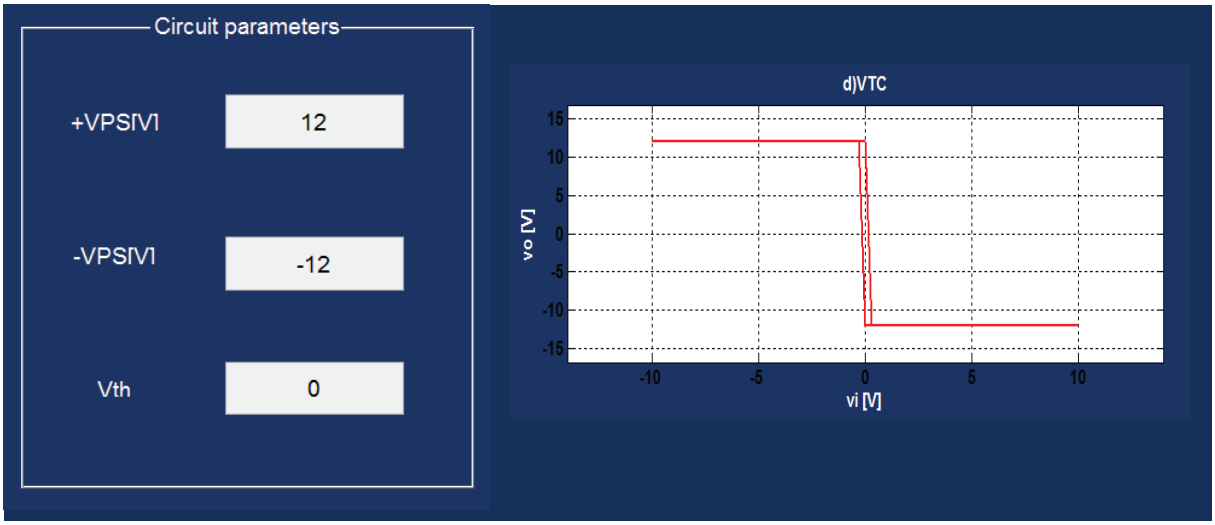

Fig. 5 – Easy-E *Active learning* – example from the Simple comparators subchapter: user input and voltage transfer characteristic

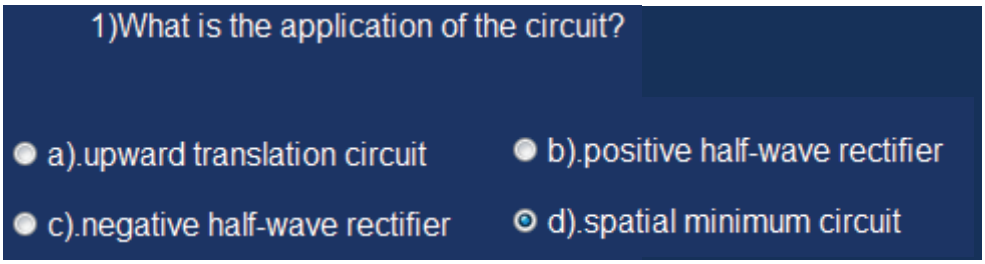

Fig. 6 – Easy-E test question example

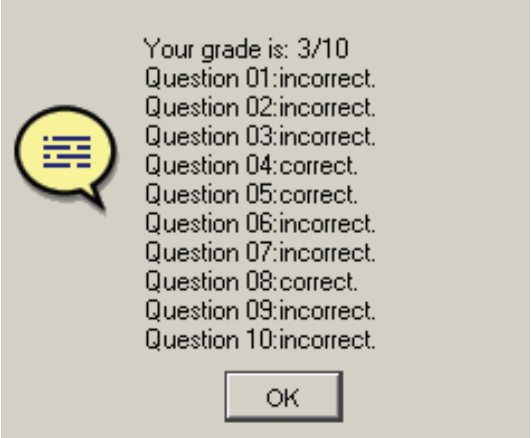

Fig. 7 – Easy-E test feedback example

When a test is completed, a window displaying the results appears (Fig. 7); here the user can see the final grade, as points out of 10, considering 1 point for each correct answer, and 0 points for an incorrect one.

The status for each answer can be seen, so that the user will be able to evaluate their own knowledge level and to identify the chapters/subchapters that are not fully understood.

5. CONCLUSIONS

Computer assisted tools are more and more present in the learning and testing processes, as they bring multiple advantages over traditional methods, such: adaptive learning, self-imposed amount of study time, development of critical and creative thinking. Also, these software tools do not require physical attendance in the class or in the lab, and there is no need for an instructor.

Easy-E is a home-schooling software tool, implemented in Matlab, and designed for learning and testing in the field of basic electronic devices and circuits. The application's purpose is to facilitate the learning and testing process of stay at home or physical and sensory impaired students. The user-friendly interface provides easy navigation through the sections of *Easy-E*.

Easy-E is structured into two parts, *Active learning* and *Testing*. The *Active learning* section contains four chapters, with theoretical presentations, circuit diagrams, waveforms and transfer characteristics. The user can interact with the application by changing component and voltage values; all the changes are instantly reflected on the waveforms and transfer characteristics plots. The *Testing* section consists of randomly generated tests, with multiple choice questions that cover all the chapters from *Active learning,* and provides feedback regarding the user's level of understanding.

Easy-E is a comprehensive instrument for home schooling in electronics devices and circuits, as it provides theoretical knowledge, active learning through examples, and testing through randomly generated questions.

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