

Building and Using Multimedia Tools for Electrical Engineering – a Concern and a Solution

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Abstract — The modern multimedia techniques seem to appear very attractive as aid in electrical engineering teaching. If for the scientific research the opinion is in unanimity favourable to the necessity of European co-operation within large teams, in the field of teaching, this necessity is less evident. However, it is important that the universities join their forces in this area too, especially for using the facilities of the information and communication technologies in the field of teaching. The development of multimedia tools requires important human resources, available only within teams of teachers from more institutions. The paper presents the experience gained within such a European co-operation.

Index Terms — electrical engineering, multimedia, teaching tools, association.

I. INTRODUCTION

The development and the implementation of the e-learning is one of the most important concerns of the European programs. Starting from 2007 a new action, “e-learning”, will be started for the member countries.

The disciplines within the electrical engineering need a higher level of abstract knowledge and understanding. This why, they are more difficult to be learned (and teach). The information and communication technologies could prove to be a useful tool. They give to the students the possibility to display the evolution of different phenomenon.

The paper deals with the experience achieved by the four teams within the affiliated institutions, in the field of developing and using multimedia tools in electrical engineering.

An evaluation has been performed, in order to know if the developed resources have effectively been used by the students and if they help them. It showed that the using of the tools widely depend on the teacher behaviour: how much he tells about the resources during classes, how much he shows examples, how much the students are visiting the site. Despite of a high expectation level, the students that have use the resources, show also a high satisfaction level.

II. CONTEXT

Based on the previous contacts with European universities, starting with 2003, October 1st, a European program was settled within the frame of the European Community Minerva action. The two years program carried out the experiment of developing and using of the multimedia resources for electrical engineering teaching. It involved four partners from different countries:

- Université Catholique de Louvain, Belgium – coordinator of the project;
- École des Hautes Études d'Ingénieur, Lille, France;
- Instituto Superior Técnico - Universidade Tecnica de Lisboa, Portugal;
- Faculty for Electromechanical Engineering, University of Craiova, Romania

Each of the four partner was fully responsible for one of the four thematic developed within the project. The resources were developed in the native language of each partner and then translated in the languages of the other partners. Most of them are also translated into English, so the developed resources are carried out in four languages: English, French, Portuguese and Romanian. The concerned thematic within the electrical engineering are:

- Electrical circuits;
- Power electronics;
- Electromechanical converters;
- Renewable energies.

Two of the thematic cover general topics of the electrical engineering: electric circuits and power electronics. The other two are more specialized: electromechanical conversion and electrical machines, with a spotted interest on rotating field electrical machines (synchronous and asynchronous) and renewable energies respectively.

Based on the experience of the architect of the program, Université Catholique de Louvain, each package is organized as an integrated tool, containing lessons, virtual laboratories and self evaluation, based on multiple choices questionnaires (MCQ).

All the developed resources are finally fully available on-line, on the Internet site of the program, **www.e-lee.net**, Fig. 1. The access is totally free, even for students and teachers from other institutions than the members.

The site presents also the eLEE Association that was created following the initiative of the four members, but that counts in the present more members that share the wish to use and develop multimedia lessons for electrical engineering.

Within the collaboration, a special component of the program is the evaluation of the students face to face the multimedia tools. The evaluation was trusted to an independent evaluator. The evaluation does not have as aim the quantification of the students' knowledge, but their "feeling" about the proposed teaching resources and to propose indications for better use of the tools. Later in the paper, it will be given some observations and conclusions concerning this evaluation that are also available on the mentioned site.

III. TUTORIALS CONTENT

The tutorials developed within the four thematics are conceived as an aid, both in the teaching process, as a teaching tool, but also, for self-learning activity of the students, both for current activity and the exams' preparation. They cover key lessons within the four thematics. It will be not detailed here all the table of content of the site, only the main chapters and several representative resources.

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The "Electric circuits" thematic is organized in four chapters. It treats:



Figure 1. The home page of the site www.e-lee.net

- General aspects (Concept of dipole, Kirchhoff's Laws, Basic components);
- Linear circuits (Resistive circuits, First order circuits, Second order circuits);
- Sinusoidal regime (Sinusoidal signals, Sinusoidal regime of the circuits, Powers in sinusoidal regime);
- Tri phased systems (Basic concepts, Load connections, Powers, Power factor compensation).

More resources have suggestive interactive animations that highlight the concepts described in lessons. As an example, in Fig. 2 is presented the animation that plots the sum of two sinusoidal signals. The amplitude and the phase of the two signals can be easily changed and the result displayed.

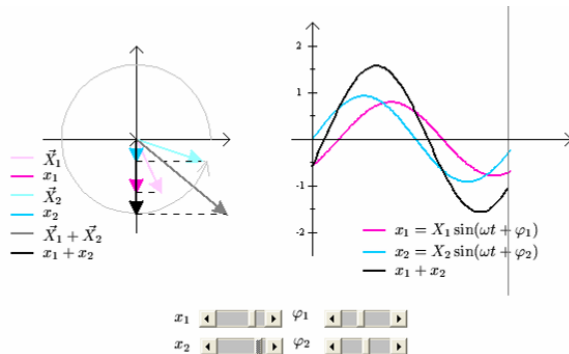


Figure 2. Example of animation within the Electric circuits thematic

More resources have a final section exercises that incite to apply the notions presented within the lesson.

The "Power Electronics" thematic was developed mostly oriented to the DC to AC conversion, but finally will cover all the main areas: general principles and conversion structures, choppers, inverters, rectifiers and special applications.

The "Electrical machines" thematic is organized in four chapters that covers both general principles of the electromechanical conversion, but also specific lessons and virtual laboratories for expressing the operation of the rotating field machines, synchronous and asynchronous respectively:

- Electromagnetic conversion with two attractive examples for obtaining the electro-dynamic force and reluctant force respectively (Electromagnet, Speaker, Reluctant motor for an electric razor);
- Rotating field machines that explains, based on attractive animations how a rotating field is obtained within the tri phased AC machines (synchronous and asynchronous), Fig. 3. The section presents also, within an applicative laboratory, with questions, answers and demonstrations, the principle of obtaining sinusoidal distributed windings;
- Synchronous machine (Parameters measurement, Autonomous operation, Grid connection, Voltage regulation);
- Asynchronous (induction) machine with more lessons (Realization and operation principles, General operation equations and equivalent diagrams, Operation and mechanical characteristics, Classical

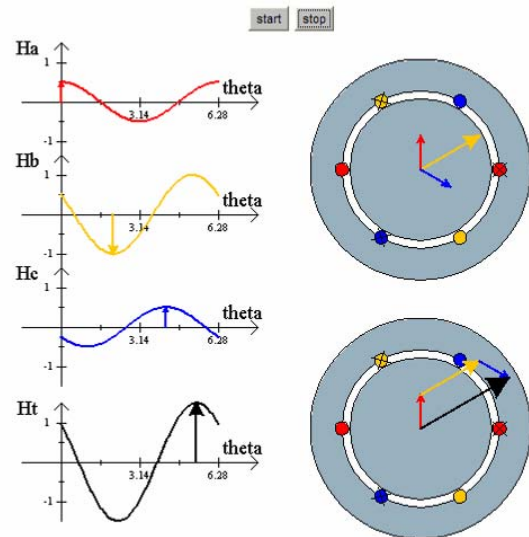


Figure 3. The final animation for obtaining rotating field in the tri phased AC machines

command of the drive, Vector control, Direct Torque Control – DTC) and several virtual laboratories (Measurement of the equivalent diagram parameters, Determining the mechanical characteristics, Applications of the command methods, The influence of the inverter type in vector control, The influence of the variation of the parameters in vector control, Speed regulation with Direct Torque Control);

- MCQs, covering the general theory of the electromagnetic converters, the operation principle of the rotating field machines, the operation as motor or generator of the synchronous machine, the DC machine.

As could be seen, the developed resources within the asynchronous machine chapter, cover both the classical approach of the applications (construction, operation – Fig. 4, characteristics), but the modern control techniques (vector control, direct torque control).

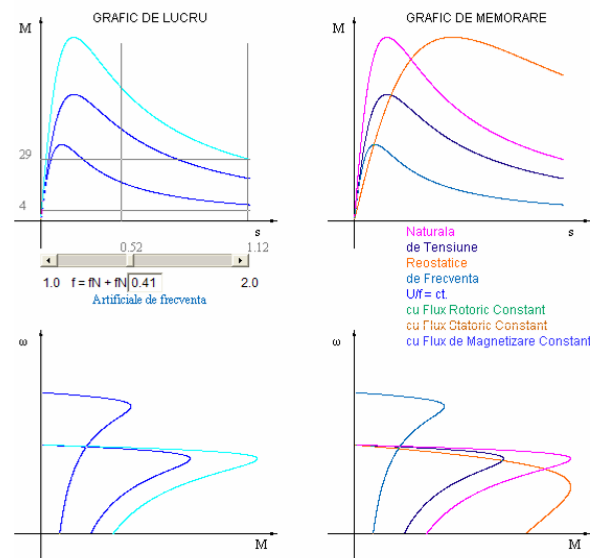


Figure 4. The lesson concerning the mechanical characteristics of the induction machine

As an example, Fig. 5 depicts the animation that illustrates the principle of the DTC of the induction machine, that represents a very good example for the link between the power electronics thematic and electrical machines one.

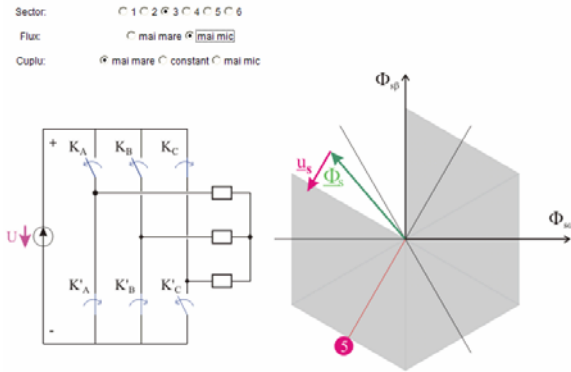


Figure 5. The animation illustrating the principle of the DTC for induction machine

As was specified earlier, virtual laboratories were also settled, in order to allow the students to study themselves different aspects of the induction machine drive. Fig. 6 presents an example of such laboratory: plotting of the mechanical characteristics of the induction machine.

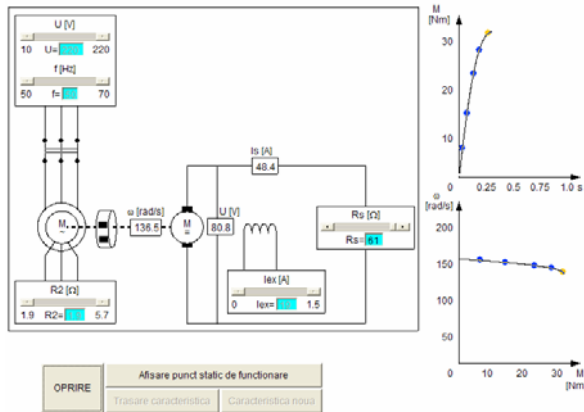


Figure 6. The laboratory for plotting the mechanical characteristics of the induction machine

The users are able to choose the type of the mechanical characteristic (rated parameters, voltage, resistive, frequency characteristics) and following, they obtain different points of the characteristic, by changing the mechanical load of the motor, the load resistance of the DC generator respectively. Finally, based on several “experimental” points, the characteristic is plotted.

The “Renewable energies” thematic is organized in four chapters, not of them totally developed yet:

- Generalities (Premises and perspectives, Renewable sources of energy, Electricity production based on renewable energies);
- Wind generation / induction generator (Different technologies, Study of the induction generator);
- Solar energy (Photo electric cells and panels, Maximum Power Point Tracking Systems, Design of an installation);
- Implementation concerns (Grid connection, Energy

storage, Hybrid generation).

Within the Wind generation chapter, a special attention is given to the doubly fed induction machine as electric generator within a wind generator. For now, three interesting virtual laboratory are proposed, concerning a wind generator with doubly fed induction machine. The laboratories use several interactive animations that allow the user to follow the influence of the different parameters on the power delivered by the wind generator. An example is Fig. 7, where the influence both of the wind and generator speed and orientation angle is highlighted.

Within the Solar energy chapter, a special attention is given to the study of the Maximum Power Point Tracking (MPPT) systems. More animations allow the users to highlight the influence of different parameters (illumination, temperature, transformation ratio) on the power transfer of the photo voltaic panels (Fig. 8).

For the solar generation of electric power, two interesting interactive applications are proposed, one for dimensioning an insulated site, another for a site connected to the grid. The exercises allow the user to follow a basic approach that highlights the key points of such applications. The user can interact with the applications, by choosing different conditions (location and consequently the exposure conditions, number and types of loads, types of PV generators) and on this basis obtaining the economic analysis of the proposed solution.

IV. EVALUATION

Within the collaboration, a special component of the programme was the evaluation of the students face to face the multimedia tools. The evaluation does not have as aim the quantification of the students’ knowledge, but their “feeling” about the proposed teaching resources.

The evaluation had three main phases, that could be iterated more times, in order to obtain valuable information: a “quantitative” questioning, before the using of the resources, another “quantitative” questioning, after the using of the proposed lessons and laboratories and a “qualitative” evaluation, consisting of individuals interviews with the most representative (from the point of view of their profile) students. All the process of the evaluation was trusted to an independent specialist, for all the four participant institutions.

The quantitative evaluations were performed by asking all the involved students to answer to a specific MCQ. The total confidentiality of the answers was assured by multiple means.

The evaluation before using the multimedia tools highlighted different perception and expectations of the students from the four implied institutions. Some of them were such enthusiasts for using such tools; others expressed certain reserves and fears.

The evaluation after the using of the tools revealed some interesting observations.

First of all, it was quite evident that the resources are visited and useful only if they are in the mother tongue. Even generally, the applications are technique and the “equations language” is a universal one, the differences between the symbols and conventions used in different

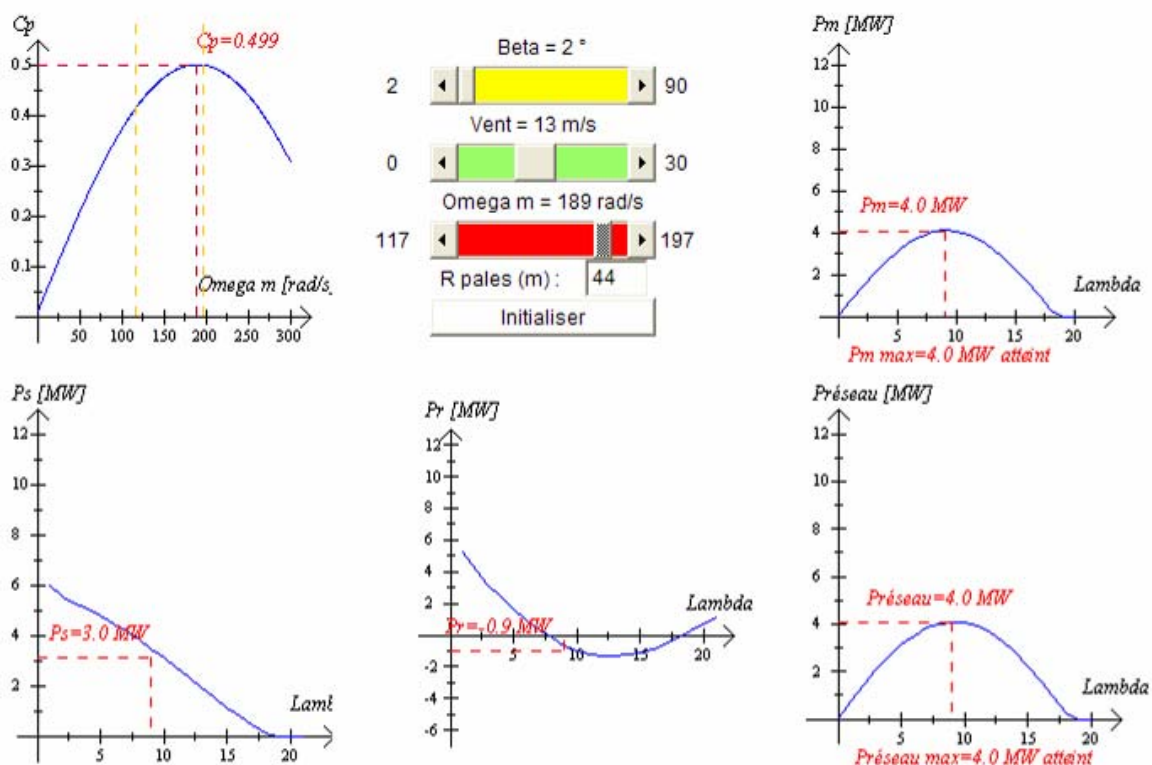


Figure 7. The behaviour of a wind generator with a doubly fed induction machine

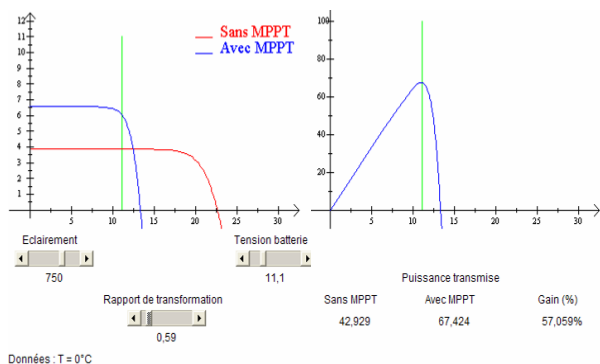


Figure 8. The power transfer of the photo voltaic panels

languages, rise serious problems of adaptation. On the other hand, naturally, the comments are easily assimilated if the reader is focused on the content only.

Secondly, even the developed resources are available on an open site, the users appreciated the presence of the teacher who pointed out during surfing the “red line” of the information. In fact, this was one the “fears” expressed in the initial phase of the evaluation: these tools will substitute the “classical” courses and laboratories.

The more appreciated resources were, as was expected, the animations and the interactive applications, but also the MCQ, for different reasons.

It is important that the enthusiasm expressed before using the tools was generally kept, that means that the resources met the expectations of the users.

Both the MCQ and the results are presented on the site, within the section “Evaluation”.

V. CONCLUSIONS

The paper presented the two years experience of four European institutions in developing and using multimedia tools for electrical engineering.

There were developed different types of resources (lessons, laboratories, MCQ) for four thematics. The most part of them use various types of multimedia: pictures, videos, animations and interactive applications. All the animations are Java applications developed by the own effort of the participants.

All the resources can be accessed fully free within the site developed by the association settled by the four institutions. The association is opened to any moral or physical person that wishes to use the resources off-line (CD copy) or intend to participate to the development of new resources. For the last ones, the association offers support and the acquired know-how.

The evaluation of the developed resources and ways of using them offered useful information for improving them and raise their efficiency.

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