

# Didactic Videos About Basic Concepts on Alternating Current Circuits

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**Abstract**—This work emphasizes the importance of the formulation and application of didactic videos mainly in subjects where the classes are exclusively theoretical, as in the case of the subject ET016 – Electrotechnics, taught at the School of Electrical and Computer Engineering – UNICAMP. It is mandatory and it is offered to the students of the following Colleges: Food Engineering, Agricultural Engineering, Control and Automation Engineering, Mechanical Engineering and Chemical Engineering. In this subject, basic concepts of electricity are taught: single-phase and three-phase circuits; electrical energy production, transmission and application; physical principles and main application of transformers; electrical machinery of induction, asynchronous and direct current; and basic concepts of electric installations and protection devices. Upon elaborating and making these videos available, we aim at arousing a larger interest on the students, causing them to complement and reinforce the content taught at the attended theoretical classes.

**Index Terms**—Alternating Current Circuits, Electrotechnics, Engineering Education, Didactic Videos.

## I. INTRODUCTION

Historically, in the period from 1970 to 1980, there was a subject named ET515 - Electrotechnics at the School of Electrical and Computer Engineering (SECE) - UNICAMP - Brazil, lasting six hours weekly, with four hours in the classroom and two hours in the laboratory. From 1981 on, the subject ET616 – Electrotechnics started being taught using two hours in the classroom and two hours in the laboratory and from 2004 on, we also took the responsibility to teach the subject ET016 – Electrotechnics, with just two hours weekly in the classroom. Detail: all these subjects have the same summary imposed by the respective receiving courses.

Currently, ET616 and ET016 are offered to students from the following Colleges: Food Engineering, Agricultural Engineering, Control and Automation Engineering, Mechanical Engineering and Chemical Engineering. In these subjects basic concepts of electricity are taught: single-phase and three-phase circuits; electrical energy production, transmission and application; physical principles and main application of transformers; electrical machinery of induction, asynchronous and direct current; and basic concepts of electric installations and protection devices. ET616 e ET016 do not have the same level of complexity as similar subjects offered to the students at the SECE.

Before the inescapable quality loss in transmission and the resulting assimilation of the content mentioned above, allied to our taking priority in the activities of the gradua-

tion teaching, and being aware about the students need in having a fundamental knowledge of good quality on alternating current circuits, the means we found to reduce such loss was the production and broadcasting of videos with exhibition of experiments, which are not accomplished by the students who currently attend ET016.

Among the achieved objectives with the formulation and application of the videos up to now, elaborated by us, we stand out:

- Greater interest aroused in the students in complementing and reinforcing the taught content at the attended theoretical classes.
- Flexibility in accessing for the videos and the didactic material are available via Internet.
- The production of didactic videos may be useful in several teaching, researching and extension areas, concerning the information broadcasting in a dynamic way, enabling that real laboratory experiments, which not always may be reproduced whenever one wishes, to be accessed by anyone interested in them.

Other important comments and analyses about the importance of the use of didactic videos, and how the recording must be done with details and precision in its captures, so that it becomes clear, having no illumination and image framing problems may be found at all references [1 – 8].

## II. ELECTROTECHNICS DIDACTIC VIDEOS

From elaborated scripts in experimental rehearsals, we produced didactic videos for the following presented topics, making a brief comment on the presented script.

1. Voltage-Current Characteristic: an experimental procedure to obtain the relationship between the applied voltage and the resulting current (characteristic curve) in a two-terminal device (6'58").
2. Root Mean Square (RMS) Concept: a visual approach about this concept and experimental confirmation of the rms value of a sinusoidal voltage (3'53").
3. RC Series Circuit: sinusoidal steady-state behavior of a RC (resistor-capacitor) series circuit connected to a sinusoidal waveform generator (4'02").
4. RL Series Circuit: sinusoidal steady-state behavior of a RL (resistor-inductor) series circuit connected to a sinusoidal waveform generator (4'28").
5. RLC Series Circuit: sinusoidal steady-state behavior of a RLC (resistor-inductor-capacitor) series circuit

connected to a sinusoidal waveform generator with variable frequency (4'27").

6. Unbalanced Three-Phase WYE-connected Load: the importance of the fourth wire in an unbalanced three-phase wye-connected load (3'00").
7. Three-Phase Voltages: experimental observation of the relation between line and phase voltages on a three-phase system (3'02").
8. Power Factor Correction: the importance of the power factor correction of a single-phase induction motor through the connection of capacitors in parallel (4'48").
9. Rotating Magnetic Field: an elementary experiment shows the operating principle of a three-phase induction motor (5'01").
10. Simple Type Switch: a switch is one of the most basic yet important devices in an electrical installation. This movie teaches how to install a single pole switch to turn on and off one or more lamps from a single location (2'43").
11. Three-way Switch: it is specially designed to work in pairs and this movie call attention how to install this kind of switch to turn on and off one or more lamps from two places (3'17").
12. Four-way Switch: it is designed to work with the three-way switch. This movie teaches how to install two three-way and one four-way switches to turn on and off one or more lamps from three locations (4'05").
13. Residential Connections in the Electrical Network: some concepts about the connection of the residential power grid (3'00").
14. DC Motor Starter: this movie shows how to start a DC motor without large starting current and how to protect against excessive speed when the field current is low (5'20").
15. Starting of Induction Motor: how to use a star-delta device to prevent a large starting current in a three-phase induction motor (5'05").

*Note.* the information in brackets, as in (5'01") for the Electric Motors movie, means the length of the film in minutes and seconds.

For a higher easiness in accessing, these videos have been available at the Youtube Website, with audio in Portuguese. The screens example of the elaborated videos may be seen in Fig. 1.

### III. METHODOLOGY

The movies have been created with the following technical characteristics to make the access over the dial-up connection internet easier:

- Average run up to 5 minutes per video
- 15 frames/s: 320 x 240 pixels.
- Video for broadband connection: 150 Kbps.

The first equipment used was a Digital Nikon Coolpix 7600 - 7MP (Digital Camera) and now we have a camcorder JVC - GZ - HD3U.

The final video image editing has been accomplished through "Windows Movie Make" which is available for Windows XP and Windows VISTA users, Fig. 2.

The main subjects addressed on the videos have been complemented with Circuit Illustrations, Electrical Diagrams and Formulas, placed in before and/or after the exhibition of the experiment shooting, aiming at determining the theme addressed on the video.



Figure 1. Examples of Screen from the Videos

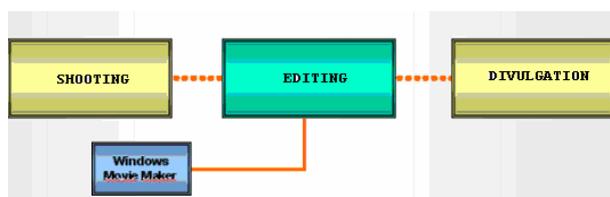


Figure 2. Editing Scheme of the Didactic Videos

IV. RESULTS

As mentioned above, the videos about basic experiments on alternating current have been available at the most popular video website of internet, the Youtube (www.youtube.com) and they can be found through the terminologies ET016 and ET616 (subject acronyms). The receptivity of these movies is presented on Table 1.

The students may watch and comment the content of the movies on the Website. Remarks about the movies, video contents and their didactic means of exhibition have been constant on the received messages. As an example, we present some of the comments:

- “I am an electronic technician and I find these subjects very interesting. Congratulations on the teacher’s explanation!”
- “Very good. This is the kind of video that I enjoy watching. I suggest that you improve the sound of the next videos and also insert subtitles in Spanish. Congratulations.”
- “Very Good!!!!”
- “It helped me a lot, and solved many of my doubts. I admire the work of Professor Barreto very much. I have read his thesis on the manufacturing of an electric vehicle, and I admit that it was one of the best materials I have ever found. The details and technics presented are fantastic.”

We know that these videos are being adopted as didactic material at other Universities and Technical Schools.

The importance of this subject in the professional life of engineers has been evidenced through the messages we have received from former students, as well as requesting access to didactic material available over the internet through the TELEDUC environment:

- “The material will be very useful to review the concepts learned from the subject that you teach”.
- “I would like to ask you if I could access the material of the course since it is indispensable for my activities at work”.
- “I am thankful for the attention given, and I take the opportunity to congratulate you on the excellent organization of the classes”.

The TELEDUC environment is a platform to the implementation of courses (subjects) over the Internet, aiming at the distance education, which has helped us on the connection with the students and on the disclosure and application of the didactic material, besides the attended classes. A master’s degree work, which analyzes the students feelings concerning this tool as a didactic support on the teaching of Electrotechnics may be seen at Castilho, (2005)[2].

V. THE SCHEMATIC DIAGRAM

A didactic video as well as a Virtual Laboratory project can attend several important requirements as cost reduction, easy handling, simulations and destructions in several learning sessions. From theoretical environment up to physical implementation, it is possible to specify some layers in a strategy to divide the design in levels and assure the laboratory usability, Fig 3.

All necessary parts to create a test environment with monitoring resources and a learning system can be seen in

a core system layer. There are Input and Output devices to adjust appropriate income signals and to show the effects in alarms, displays or even a simple point to be measured.

In order to meet the speed, flexibility, portability and high quality demands, it is possible to use popular computer software and an efficient picture format as “FLASH” and vector images, respectively.

The path to the physical environment can be done through the local network or even using the Internet. Nevertheless the great contribution made by a didactic video is the possibility to take experiments in easy way to communities with very low technology availability.

Other advantage is the possibility to transmit, reproduce several turns, stop and go in different moments and situations, not excluding the interaction with virtual laboratory and a physical implementation e validation, Fig 4.

TABLE I.  
NUMBER OF VISUALIZATIONS (SEPTEMBER/2009)

Video	Didactic Videos	Number of visualizations
1	Voltage-Current Characteristic	951
2	Root Mean Square (RMS) Concept	2915
3	RC Series Circuit	27152
4	RL Series Circuit	4787
5	RLC Series Circuit	12081
6	Unbalanced Three-Phase WYE-connected Load	5232
7	Three-Phase Voltages	3237
8	Power Factor Correction	3736
9	Rotating Magnetic Field	5983
10	Simple Type Switch	1880
11	Three-way Switch	4058
12	Four-way Switch	2570
13	Residential Connections in the Electrical Network	878
14	DC Motor Starter	936
15	Starting of Induction Motor	817

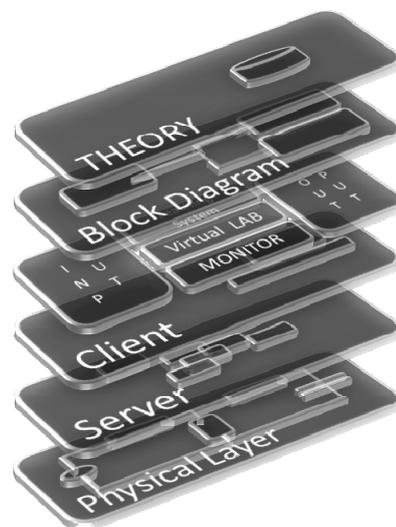


Figure 3. Design and implementation layers



Figure 4. Virtual Laboratory



Figure 5. Basic knowledge Bottleneck

## VI. THE PARADIGM OF 3E

A despite of all educators efforts to improve the learning environment with news resources, creativity and new methodologies; they can face a new reality, Fig 5. The nowadays students, as the current workers, are not the same of few years ago. Besides the basic knowledge, the new student has to develop, in a school time frame, the “paradigm of 3E”, Fig 6. The academics have been discovering that there are much more behind the E from E-Learning expression besides Electronic.

The first “E” is about “Entrepreneur” skill, where his carrier and his personal investments depend on his proactive actions to collect its results in a short term. Not so long there was a time where a good school was enough to launch good students to prominent carriers, making to emerge amazing executives, lapidated by capitalism, in order to support the demand for human capital, one of its fundamentals.

Increasingly its complementary training session has been moved to academic seasons, pushing students and educators to follow an additional agenda. It has created an even more robust curriculum, where good students become potential investors, handling a new theory that consider business and natural resources, as well as ROI (Return of Investments) and stocks, besides other commodities, financial indicators and management programs. This new procedures will transform potential undergraduate “baby juniors” in pre-warmed tires able to jump faster in a start line racing, reducing the time to market and accelerating the productivity. The main issue is the possible high social cost involved in this warm up procedure. The professional learning curve, when moved to academic season, can compromise the education and abbreviate the productive period for each professional life, against the original plan. Since there are confident suppliers for qualified human capital, the restructuring process has been anticipated and even more frequent in work world.

The second “E”, from the “paradigm of 3E”, means “Entertainment”. There is no chance to handle stress, rush, the huge schedule and a competitive usual work environment without good humor and health. One alternative to develop this support comes from Entertainment. In academic season it means much more than a good life support, it means preparation for a social life, where the citizen building and the relationship skill will be mandatory for a well succeeded carrier. With direct impact in self-conscious and self-confident, the entertainment activities can improve the world vision, the general culture and the ability to handle different situations in personal and pro-



Figure 6. The Paradigm of 3E

fessional life. This is not a new concept but the issue comes from a new constraint created by a huge academic schedule responsible to accommodate new and complex procedures. The premature professionalization has pushed several new activities to academic season compromising the social life construction, extremely important for all moments of the citizen, the students and professional lives. As part of relationship program several university's programs include various classroom-specific programs where students in education courses receive diversity training as part of their teacher training, while students in the business school focus on understanding global cultural differences. There is no doubt about importance of diversity and social integration, in fact companies want to hire graduates who are prepared for the real world. Recruiters were once glad to discover that students understood the impact of diversity in the workplace, for instance.

The third “E” means “Expertise”. It is easy to understand and believe in the usual statement:

“Your value is in your unusual skills”

It can explain a well succeed soccer player makes more money than several competent PhDs. This point of view has generated a rally, one student competition to develop new skills as fluency in several languages, specialization, extra scientific tasks and foreign academic programs besides others activities.

Language training programs seems to be a wise idea, but how long do you take to learn Mandarin? Again, there is a time constraint to accommodate the language training with graduate season, for instance. To work in France, you need to learn French, and to work in other countries, such as the Netherlands, Singapore or China, you can get by on English for an extended amount of time. In Japan, your lack of cultural familiarity may prove even more challenging than not being able to read the road signs. There are skills that are more valuable in a global marketplace, like

a language. Beyond language training, future workers who plan to tackle foreign assignments or whose work will require them to collaborate with customers, coworkers or suppliers in foreign place have to enroll in extra executive education courses.

From the point of view of curriculum analyses it certainly represents a positive wave, but there are at least two issues in the horizon:

- In a long term will not be differences between students, it will promote an academic qualification upgrade offering best professionals to companies, but for the same salary. Even if it means an achievement, there is a great chance to create damages in other fundamentals as basic knowledge or even school programs stimuli and retention ;
- There is no time to accommodate so many new tasks without compromise the basic knowledge for professional and personal lives.

## VII. CONCLUSIONS

We have noted through this work that we can use amateur shooting equipments and software that is easy to handle, as it is in "Windows Movie Make" to produce great results, when dealing with didactic video production, and thus contributing to the improvement of the teaching and the knowledge propagation.

The videos answer a claim from the students to make easier the understanding of the electrotechnical theory, for it deals with the practical aspects, and this subject does not include laboratory classes.

The contribution to the teaching and learning process through the videos may be observed through an improvement on the students' performance at the evaluations, as in tests as in exercises available at the TELEDUC environment.

The knowledge disclosed this way is being useful to our students and to students from other teaching institutions, who may watch countless times, a specific concept on fundamental electricity. The videos and the way they are disclosed, bring up conditions so that the learning process happens in a more efficient and faster way, being available for a larger number of people, besides the students having the benefit of being able to watch the experiments when they have time, and be able to review the subject.

The formulation of didactic videos by teachers and/or students to disclose knowledge and to motivate learning is something that must be stimulated and encouraged.

A despite of well succeed initiatives to promote an even better E-Learning quality, there are so many changes to do in order to accommodate so many new tasks in students lives. It seems to be necessary to discuss a new curriculum, new assessments, new values and targets involving the academic institutions, the government, the corporations and society.

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## REFERENCES

- [1] Joni de Almeida Amorim, Educação em Engenharia: O Desenvolvimento de um Aplicativo de Autoria para a Elaboração de Mapas Conceituais e Hipertextos. (Engineering education: the development of an authoring tool for concept mapping and hypertext construction), Masters Degree, the School of Electrical and Computer Engineering State University of Campinas – FEEC-UNICAMP, 2005 (in: <http://libdigi.unicamp.br/document/?code=vtls000361326>).
- [2] Renata A. F. Castilho, A Incorporação de Ambientes Virtuais de Aprendizagem no Ensino Superior; um estudo na Universidade Estadual de Campinas. (The use of virtual learning environments in higher education settings: a study in State University of Campinas). Masters Degree, Arts Institute, State University of Campinas, 2005. (in: <http://libdigi.unicamp.br/document/?code=vtls000378210>).
- [3] J. Gregory and A. Strukov; "Utilization of video conferencing over the Internet to facilitate biological education and research at the University of Maine", Proceedings of International Conference on Computers In Education, vol.2, Dec. 2002, pp. 1315-1316. doi:10.1109/CIE.2002.1186225
- [4] D. E. Hailey Jr. and C. E. Hailey, "Genre theory, engineering education, and circumventing internet bandwidth problems". Frontiers In Education - FIE 2002, vol. 1, Nov. 2002, pp. 6-9.
- [5] Lin Cai; Yafei Yang, and Yixian Yang, "A new idea of e-learning: establishing video library in University Network League", E-Commerce Technology For Dynamic E-Business, IEEE International Conference on E-Business, Sept. 2004, pp. 126-129.
- [6] P. L. Montessoro and S. Caschi, "MTEACH: Didactic Multimedia Production". In IEEE International Conference Multimedia Computing And Systems, Florence, Italy. July, 1999, vol. 2, pp. 1017-1019, ISBN: 0-7695-0253-9.
- [7] N. Osawa, K. Asai, T. Shibuya, K. Noda, S. Tsukagoshi, Y. Noma, and A. Ando, "Three-dimensional video distance education system between indoor and outdoor environments", Information Technology Based Higher Education And Training Ithet., 6th International Conference on, July, 2005 pp. F2C/13 - F2C/18.
- [8] J. M. Pullen, "Applicability of internet video in distance education for engineering", Frontiers In Education Conference, vol. 1, Oct. 2001, pp. T2F - 14-19.

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