The Implementation of Take Home Laboratories Using the NI myDAQ

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Abstract

Every year, new technologies are been discovered, and they affect us in many different ways. They change the way we live, move, think, and learn. Kids these days are very familiar with computers, gaming consoles, the internet, and cell phones. For them, things like encyclopedias, chalk boards, and trigonometric tables are ancient history. That is the reason why they consider the internet the place where most, if not all necessary information can be found. We need to remember that the internet was introduced to the public in the 1990s. That means that most of the kids graduating from high school have been interacting with the internet since they were born. The question is: How we take advantage of all these new technologies to improve, or captivate the attention of this new generation of students in the classrooms and laboratories? We all know that online learning is becoming more and more popular. However, in engineering, learning is not limited to lecture; there are multiple laboratories that require sometimes expensive pieces of equipment. For that reason, the teaching community has been studying different ways to develop online laboratories. The department of electrical engineering at UT Tyler has decided to take a step forward and start testing new technologies that can be used to teach a linear circuit laboratory remotely. In order to keep control and reduce any possible negatives effects from this implementation, it was decided to create a laboratory in which the students will be working experiments in the laboratory, and they will complement their learning by working additional experiments at home. In this paper, the results from such implementation and some examples of the exercises given to the students will be presented.

Introduction

Online learning, that is a word that many of us don't want to hear. For some people, it means a lot of work and efforts preparing the best lecture possible in order to teach a course. It needs to be understood that Online Learning should not be the same in every field. If we consider lectures in the field of social sciences, they may require a big amount of graphs, pictures, tables, and diagrams, in arts, they may require audio, high-quality images, and video. However, it is a different story when STEM courses are considered. Even between the fields that compose the STEM area, there are remarkable differences between the teaching styles. For example, in math, they will need to develop mathematical procedures and make graphs; on the other hand, in chemistry, they may need pictures, videos and some mathematical procedures. For that reason, online teaching techniques need to be adapted for each specific case in order to satisfy all the course requirements. This does not mean that this knowledge cannot be used to develop courses in other areas, but it needs to be carefully analyzed to see whether it will work for the other courses.

Every year, new technologies are been discovered, and they affect us in many different ways. They change the way we live, move, think, and learn. Kids these days are very familiar with computers, gaming consoles, the internet, and cell phones. For them, things like encyclopedias, chalk boards, and trigonometric tables are ancient history. That is the reason why they consider the internet the place where most, if not all necessary information can be found. We need to remember that the internet was introduced to the public in the 1990s. That means that most of the kids graduating from high school have been interacting with it since they were born. Many instructors keep wondering why teaching techniques that used to work 10 years ago are not working as good with this generation of students. Many believe that is related to the way that kids learn now days. For that reason, we need to take advantage of all these new technologies to improve, or captivate the attention of this generation of students in the classrooms and laboratories.

It is well known that in engineering, learning is not limited to lecture; there are multiple laboratories that require sometimes expensive pieces of equipment. For that reason, the teaching community has been studying different ways to develop online laboratories. The department of electrical engineering at UT Tyler has decided to take a step forward and start testing new technologies that can be used to teach a linear circuit's laboratory remotely. In order to keep control and reduce any possible negatives effects from this implementation, it was decided to create laboratory procedures in which the students will be working in experiments inside the laboratory, and they will complement their learning by working additional experiments at home. Some options were studied, and for this purpose, it was decided that the NI myDAQ was the best suited for our necessities. It is realized that this is not the only system capable of this, but for the department of electrical engineering was the most suitable option. The reason is that currently, National Instruments software (Multisim, Ultiboard, LabView) is used all over the curriculum. For this course, the students were required to buy their own NI myDAQ to allow them to perform the experiments at home. At the end of the semester it was found that the students enjoyed the possibility of working the experiments at home and even testing their own circuits.

Previous Work

Engineering courses present great challenges when online lectures or laboratories are developed. Typically, they require considerable amounts of mathematical procedures, proofs and hands-on experience. This imposes a big burden for the professor who is preparing the course. Universities have invested considerable amounts of time and efforts in developing them. The objective is to develop an efficient way to transfer knowledge remotely. Some of these efforts include: videotaping lectures and posting these videos on the web so that students will be able to access them at any time[1], webcasting or video-conferencing lectures so that students will be able to have some level of interaction with the professor[2-3], posting lecture materials like PowerPoint's and lecture notes for the students[4-6], remote laboratories that will allow students to make laboratory practices from any place[7-10]. There are also studies focused on the impact of web-based courses on different groups of students[11].

From all these approaches, the work done by Melkonyan and Chesnutt are the most related to this paper. In the work done by Melkonyan, they used a NI ELVIS in conjunction with the EMONA DATEx board to develop remote laboratory architecture for a radio-communications course. The professor or teaching assistant will need to prepare the experiment before hand, and the students will login from their computers to perform measurements in the previously assembled experiment. The measurements were performed using a LabView Interface and by physically observing the setup with the help of a webcam. It is evident that this approach presents a good solution to provide hands-on experience to the students in communications, by allowing them to observe and manipulate the inputs and outputs of the experiment. However, this system does not allow the students to learn from assembling the system. It is well known that they learn more by making mistakes and debugging the circuit. On the other hand, Chesnutt decided to use the NI myDAQ to provide some hands-on experience to students taking Electric Circuit Theory courses. In this case, they used it to assign homework problems related to the topics seen during the lecture. Definitely, this is a good approach to provide physical demonstration to the concepts covered in the lecture.

All these methodologies were studied and analyzed, and it was decided to include the myDAQ in the Linear Circuit Analysis course, not as a replacement to the current lab procedures and equipments, but as an addition to the current content. The rationale is to provide the students with the opportunity to work with real and virtual laboratory equipment. Even in some cases the results obtained using the physical equipment were compared against the results obtained using the myDAQ.

Linear Circuits Analysis Laboratory

The Linear Circuits Analysis Laboratory is composed eight laboratories. Each of them designed to enhance the student understanding in linear circuits and laboratory equipment. From the eight laboratories, a total of four labs required the use the myDAQ to perform measurements. A list of topics that include the use of myDAQ is shown below.

- Introduction to myDAQ
- Voltage, Current and Resistance
- Thevenin Resistance and Thevenin Equivalent

- Operational Amplifiers

It needs to be noted that all eight laboratories require the used of physical equipment, and only those four laboratories contained extra experiments that require the student to work from home.

The very first myDAQ laboratory familiarizes the students with the unit and the different virtual instruments. They learned about the multiple inputs and outputs available and how to use them. In the second myDAQ laboratory, the students learned how to use the virtual Digital MultiMeter (DMM) and how to measure current, voltage and resistance. The students were given one DC circuit and one AC circuit. From both circuits, they were required to measure voltages and currents. On the AC circuit, they were also asked to use the Virtual O-Scope to observe the voltage at different points in the circuit and measure its frequency and amplitude. On the next laboratory, the students were given an AC circuit, and they were asked to find the Thevenin equivalent using the myDAQ. The last laboratory required the students to build and observe the characteristics of a Difference Amplifier using the myDAQ. For all laboratories, the students were asked to submit a report that includes the work made in the laboratory, and the work made using the myDAQ. Figures 1 and 2 are examples of the circuits given to the students to build and test in myDAQ.

In addition to the laboratory procedures, this course contains two practical exams. The purpose of these is to enforce the understanding of the laboratory procedures, and the use of laboratory equipment. The used of the myDAQ was included in the second practical exam. The students were required to build and test a High-Pass filter given some specifications. They measured the amplitude of the signal at the output of the filter for different frequencies.

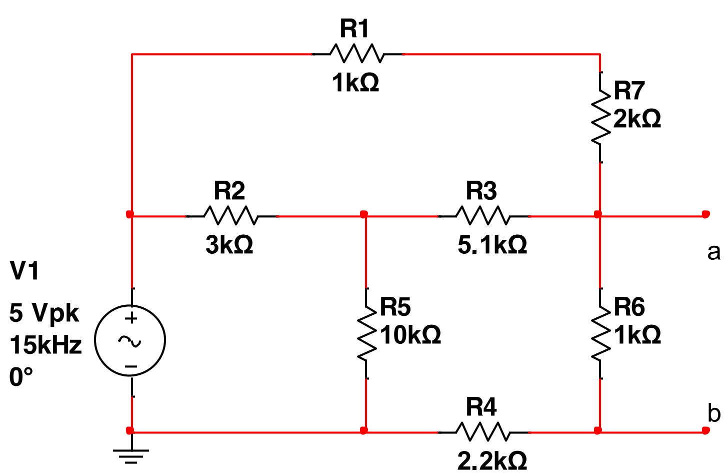

Figure 1. Circuit used in myDAQ to find the Thevenin Equivalent

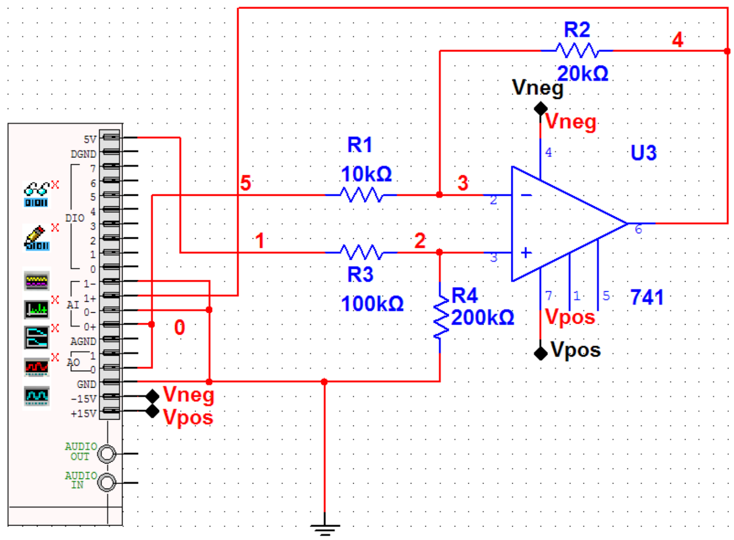

Figure 2. Difference amplifier built using the myDAQ

Results and Comments

By the end of the semester, the students were given a course evaluation survey in which they assess different aspects of the course. One of the sections included the rating of the usefulness of the myDAQ. The average rating for the myDAQ was 3.4/5.0. The instructor considers that the rating was low compared to other elements of the course, because of some problems faced with the equipments at the beginning of the semester. For example, a couple of myDAQs were not working properly, and students never informed the professor about this problem until last week of the semester. The instructor responsible for the course has decided to include an extra laboratory in which the students will check every component of the Data Aquisition Card to ensure the proper functionally of the unit. It is expected that this will reduce the number of problems, and it will create a smother experience for the students. The instructor has also decided to include more experiments that require the use of myDAQ. By doing this the faculty expects to improve the acceptance of this new equipment and technology.

In summary, the implementation of the myDAQ can be considered a success. However, more work is required in order to make the experience more enjoyable for the students, so they can appreciate the advantages of virtual instruments and the ability to perform the experiments at home. By next year, it is expected that an update in regard to this course will be presented.

Conclusions

In the Spring of 2012, the department of electrical engineering decided to include the NI myDAQ as part of the equipment for the Linear Circuit Analysis Laboratory. This was the first time in the department that something of this nature was attempted. The myDAQ was used to assign take home laboratory to the student, so they can work the experiments from home. During this first implementation, it was observed that the students enjoyed the opportunity of working laboratory experiment from home. However, a couple of problems related to the functionally of the unit were observed. In order to avoid problems in the future, an extra laboratory will be added, designed to test the functionally of the unit. It is expected that the laboratory will be offered again during the spring of 2013, and more experiments related to the used of the myDAQ will be included.

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Dr. Hector A. Ochoa currently serves as an Assistant Professor in Electrical Engineering at the University of Texas at Tyler. His research interests include the analysis of radar signals using Fourier and relativistic approaches; application of compressive sensing in chaotic radars; analysis of induced currents on a perfect electric conductor using the current tensor; and the analysis of large time-bandwidth product radar signals when high-velocity targets are considered. Dr. Ochoa has published a total of four conference papers in the field of engineering education. Two of the papers discussed the development of a freshmen course in electrical engineering to improve retention. Another paper is related to the development of an online graduate course in Random Process. And the last paper focuses on the development of an online course in Linear Circuit Analysis for Electrical Engineering Student.