Design of a Microelectronic Circuits Course using interactive methods

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Abstract- This paper presents the Basic Electronic course syllabus needed to obtain the Telecommunications Engineering degree, adapted to the criteria established by the new European Higher Education Area (EHEA). The main objectives are achieved using an e-learning, method, which includes the access to a remote laboratory for the practical work, as well as a Program of Exercises offered by means of WebCT internet tools.

1   Introduction

The University of Cantabria is involved in an adaptation process following the criteria of the European Higher Education Area established by the Sorbonne declaration (1998), consolidated by the Bologna Agreements (1999), affecting Engineering Curricula.

The teaching of the subjects of Microelectronic Circuits, within the syllabus of Telecommunications Engineering needs special attention, given that it is the first contact the students have with these technologies.

Following the principles of learning based on the active participation of the students, we have attempted to use interactive methods [1], in such a way that all the material necessary for the development of the subject is available to every student before the start of the course.

One of the important aspects we have developed is a program of exercises, available in an interactive way through WebCT [2], with an average of twenty exercises per topic, as part of the continuous study the student must do in the study of the subject. These exercises are evaluated in real time using the facilities of internet tools.

At the same time, given that the subjects of electronics have a great practical content and with the aim of extending the period of usage of the laboratory, we have developed a remote method of accessing the measurement laboratory[3], which completes the program of practical exercises in the traditional laboratory.

 The access to the laboratory is complemented with a description in the web page of the subject of all the instruments in the laboratory and the norms of use. It is also possible to simulate the electronic circuits to be measured using Spice or MathLab, with a set of simulations previously done as examples.

The automatic assessment carried out by WebCT of the progress of the students in the exercises about each topic has allowed the control of timing in the subject program, to fulfill the aims of the course, as well as enabling a personalized assignment of the simulation tasks of the different electronic circuits, which precede the practical exercises to be carried out in the traditional laboratory or by remote access.

2   Development of the teaching content and program of exercises

The subject of Microelectronic Circuits in the second year of Telecommunications Engineering in the University of Cantabria has the aim of introducing the student to the basic concepts of analog electronics. The student accesses the theoretical contents of the classes and all the problems dealt with in class, as well as the outlines of the practical exercises in the web page of the subject. This material can be consulted like an electronic book using WebCT.

The teaching material is completed with the incorporation of the program of exercises to be solved by the student and with the use of the remote laboratory.

Figure 1 shows the home page constructed with WebCT for this subject, which demonstrates the accesses to the theoretical content, the set of exercises selected, the exercises prepared for this subject and the communication tools for use with the pages where the students can assess their progress in the subject.
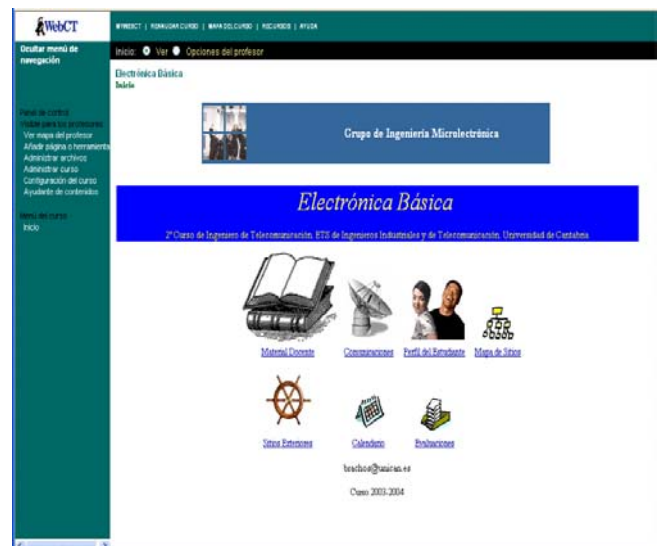

Figure 1: Microelectronic Circuit Course Home Page.

The exercises that the students have to do are divided into modules so they can progress continuously through to the end of the course.

The set of these blocks covers the theoretical program and enables the observation of the progress in the different topics as they are explained in the classes

Through the calendar in the home page opening and closing periods can be established for each block of exercises, in order to oblige the student participating in the program to keep up with the study of the topics in a stepped way throughout the course.

The feedback obtained from the automatic assessment is a valuable element, given that it enables the teacher to follow the systematic progress of each student in a personalized way, even in courses with more than one hundred students.

The inclusion of simulation exercises, in a first version with MathLab and Simulink, and then with Spice, has played an important role as an intermediate step between carrying out the real exercises and the practical exercises with real measurements in the laboratory.

3 Laboratory in the Web Pages

The equipment used is based on a VXI system, controlled by a personal computer through the IEEE 1394 bus. This VXI system includes most of the instrumentation for generation and analysis of the signals of the circuit under test.

As well as the equipment necessary to generate and capture both analog and digital signals, the measurement system has a matrix of analog switches and multiplexers. This enables the inclusion of design considerations in the laboratory work, since the students can remotely select the value of components of the circuits under test.

On the user side, the student connects remotely with a simple web browser (Fig. 2).
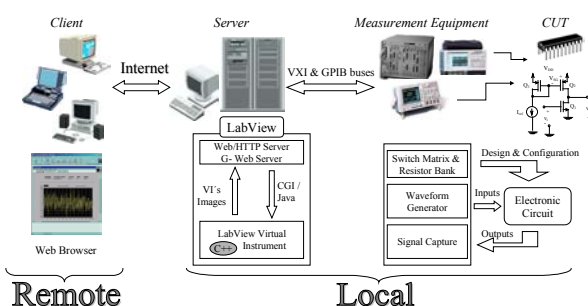

Fig 2, hardware connections and software interactions of the remote test laboratory

There are two interfaces where the user can send commands over the Internet to control the configuration of the laboratory apparatus. The first interface is the standard HTML form, where the student only needs to fill in the desired control values and submit the form. The second, is through an image map.

Both methods call CGI (common gateway interface) programs for use with the G-Web Server. In this way the user will be able to gain control over the physical instrument devices through the web browser.

In the server environment, the commercial software LabVIEW is used to physically manage the measurement system. The web server is able to interact with applications developed in LabVIEW, which run locally. These applications control and act as an interface with the measurement equipment (Virtual Instruments, VI). By sending VI front panel images to the student's browser, the student gains remote access to the test system and can make his/her own measurements.

The user begins configuring the measurement equipment, fills in the form taking into account the requirements of the test to be done. When the web server receives the request it calls a CGI program to change the controls of the VI application, selects only the configuration stage and executes the application. Next, the user needs to capture the data and save it to a file for a later analysis.

To process the obtained data, the user selects the desired analysis in the image map. Generally, the student must verify the data taken, displaying the digital and analog waveforms, before the analysis, and tune the generator instruments if it is necessary.

4. Conclusions

The offer of e-learning courses in engineering subjects is undergoing a great pressure to keep up with the latest technological developments.

This type of course should include a virtual laboratory with the capability of carrying out real measurements on benchmark circuits.

Using the remote laboratory facilities the student can manage the laboratory instruments and carry out measurements on the device under test. In such a way that if the data are not adequate or are meaningless for a desired type of processing, the student may be able to interpret them, and can readjust the instrument control for a new acquisition.

References
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