Microelectronics Distance Program with Extended Practical Work

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ABSTRACT

This paper presents a Microelectronics Course syllabus of Telecommunications and Industrial Engineering, within an adaptation process established by the Bologna Agreements (1999), to adapt to the criteria established by the new European Higher Education Area (EHEA) in the Engineering Curricula of the University of Cantabria. The main objectives are achieved using an e-learning methodology, which includes web access to a remote laboratory for the practical work.

1. INTRODUCTION

Following the principles of learning based on the active participation of the students, we have attempted to use interactive methods [1] for these Microelectronic Engineering Courses, 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 courses, the method includes a sequential program of exercises, and also an interactive forum about the theoretical contents of the courses.

A common tool used within the project by all the participating teachers of the University of Cantabria is Blackboard Learning System 6 (BLS6), originally WebCT from British Columbia University and more recently the free open source educational software package Moodle as well. It allows the integration of graphic, sound and video resources through an object-oriented programming techniques. So, the student accesses the theoretical contents, the application problems explained in class, as well as the outlines of the practical exercises on the web page of the subject. This material can be consulted as an electronic book.

2. THEORETICAL AND EXERCISE CONTENTS

The subjects of a Microelectronics Course, as a basic course in the Electrical and Electronic Engineering syllabus in our University, have the aim of introducing the student to the basic concepts of analog electronics, such as the main device characteristics and modeling to be later applied to the principles of amplification, generation and processing of electrical signals.

Different automatic tutorials have also been included, in which there is no interaction between the application and the user and the learning is achieved by mere observation of the computer screens.

The student accesses the theoretical contents, the application problems explained in class, as well as the outlines of the practical exercises on the web page of the subject. This material can be consulted as an electronic book using WebCT or Moodle facilities.

The electronic book is intended for re-enforcing the

knowledge acquired in the classroom, in such a way that the student can access, from home or from the computer room, the transparencies explained in class, additional exercises and any other material which helps in the preparation of the subject. In this sense, the material supplied to the student is considered to be complementary to the explanations given in class.

This initiative is also intended to improve the quality of the teaching and to achieve a reduction in the time needed by the student for studying the subject.

Furthermore, a part of the teaching time of each teacher participating in this activity is substituted by the preparation of the course materials, such as the slides explaining theory and exercises with solutions for each subject in an electronic format.

One of the aspects we have developed is a sequential exercise program and a forum of theoretical knowledge interchange, in an interactive way using BLS6, with an average of twenty exercises per topic, and a high number of forum entries, as part of the continuous work, that the student must do, to progress in the subject. These exercises, and forum participation, are evaluated in real time using the evaluation facilities of these internet tools.

By means of a calendar in the home page of WebCT, opening and closing periods can be established for each exercises set. This encourages the student participating in the programme 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, because it enables the teacher to monitor the progress of each student in a personalized way, even in courses with large number of students.

The automatic assessment of the student progress in each topic's exercises and the forum participation entries carried out by BLS6, allows the control of timing in the subject programme, to fulfill the aims of the courses. Furthermore, this enables a personalized assignment of circuit specifications to be done in the simulation tasks. The simulation is a requisite before carrying out the practical work in the traditional laboratory or by distance access using the special facilities of these courses.

3. Practical Contents

At the same time, the great practical contents of the microelectronics subject and with the aim of maximizing the laboratory usage and enabling remote access for distance learning, we have developed a remote method of accessing the measurement laboratory [2], [3], which completes the programme of measurements in the traditional laboratory.

A. Remote Laboratory

Most of the test equipment of the remote laboratory is based on a VXI system, controlled by a personal computer through the IEEE 1394 bus. This high speed VXI system includes instruments for generation and analysis of the signals of the circuit under test.

In addition to this, there is another group of instruments connected to the system through the IEEE 488 bus (GPIB) with lower speed but with a high precision measurement capability.

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 parameter values of the circuits under test [4] .

The access to the laboratory is complemented with a description in the subject's web page of all the instruments in the laboratory and its norms of use. It is also possible to simulate the electronic circuits to be measured using Spice or MathLab.

B. Practical tasks

The laboratory contents include, among other topics, an introduction to the instrument functions, the use of operational amplifier in practical circuits, the simulation (using macromodels) of the operational amplifiers, the design of diode circuits and single stage MOS and BJT amplifiers and the design of differential amplifiers.

Within these practical tasks the measurement of the characteristics of the MOS and BJT transistors is done, using advanced instruments (HP 4155B and HP16442A) with a distance learning procedures using the Internet connection facilities of LabView. In these tasks special emphasis is dedicated to the characterization of the differential pair built-in MOS transistors because it has a special relevance in the CMOS comparator design and in the CMOS multiplier circuit design. In this way the matching properties of the MOS transistors in the linear and saturation regions are included in the circuit analysis.

4. Conclusions & Results

As conclusion we can say that we have introduced Internet-related features, through useful tools such as BLS6 and Moodle, or the extensive use of Web pages, as a system to help the students to learn the subjects of Microelectronic Circuits in the Electronic Engineering Syllabus

The sequencing of these subjects achieved through a program of automatically corrected exercises, the interactive use of the results during the course, and a suitable access to the laboratories via Internet, has led to a considerable improvement in the results achieved by the students.

The pass rate of the students of the subjects where we have applied these methodologies has gone up from 38.2% in the 02/03 course to 79.6% currently.

References

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