

E-learning Module for Computer-Aided Design in Moodle Platform

Galia Marinova¹ and Nikolay Stoyanov²

Abstract – The paper describes an E-learning Module for Computer-Aided Design developed in Moodle platform implemented in Bachelor degree course in Telecommunications faculty in Technical University-Sofia. The E-learning Module is assisted by a specially developed online circuit calculator SMARTCircuitCalc which permits to generate parameters for individual projects to be simulated by students with ORCAD/PSPICE. Some observations on students' activities with the E-learning Module are commented.

Keywords – E-learning, Moodle, Computer-Aided-Design, Online circuit calculator, ORCAD/PSPICE.

I. INTRODUCTION

The open source platform Moodle is widely implemented in e-learning environments in universities all over the world. University courses for Computer-Aided Design and PSpice simulations can also be found in Moodle [2-5]. The paper describes an E-learning Module for Computer-Aided Design as a part of the project PROGRES-FTK in the Telecommunications faculty in Technical University – Sofia developed in Moodle Platform. The E-learning Module is created as an additional source of information, exercises, tests and projects for the course “Computer-aided design” for third year Bachelor degree students. The title of the Module is: **Computer-Aided Design of Communication Circuits with ORCAD/PSPICE and Other Tools**.

Since the main subject of the course “Computer-aided design” is focused on ORCAD/PSPICE applications, the E-learning module tends to add information for other CAD tools and to demonstrate wider application of ORCAD/PSPICE for communication circuits simulations in addition to those considered in regular laboratory exercises. An innovation in the E-module is its connection with a new developed online circuit calculator SMARTCircuitCalc which permits the generation of individual projects and tasks for students. Preliminary experiments with online assisted CAD course are presented in [1].

First the structure, the tests and the tasks in the E-learning Module are considered, then the new online circuit calculator SMARTCircuitCalc is described and then some observations on students' activity with the E-module is considered.

¹Galia Marinova is with the Faculty of Telecommunications at Technical University of Sofia, 8 Kl. Ohridski Blvd, Sofia 1000, Bulgaria, E-mail: gim@tu-sofia.bg.

²Nikolay Stoyanov is a student in the Faculty of Telecommunications at Technical University of Sofia, 8 Kl. Ohridski Blvd, Sofia 1000, Bulgaria.

II. STRUCTURE, TESTS AND TASKS IN THE E-LEARNING MODULE FOR COMPUTER-AIDED DESIGN

A. Structure of the E-learning Module for Computer-Aided Design

The E-learning module “**Computer-Aided Design of Communication Circuits with ORCAD/PSPICE and Other Tools**” is developed in Moodle 2.5+ platform and is organized in 5 topics:

Topic 1. Levels of Computer-Aided Design – analog, logical, digital, architectural, microprocessor. Daniel Gajsky Y model and J.P.Calvez classification are in the origin of this topic.

Topic 2. Computer-Aided Design tools – FilterCAD, AADE, PAC Designer, MMICAD, PSOC, WARP 6.2 and ISE WEBPACK. The main possibilities and applications of these tools are presented in this topic.

Topic 3. Simulator ORCAD/PSPICE. The architecture of the simulator ORCAD/PSPICE is presented and the features of ORCAD/Capture and ORCAD/PSPICE are considered in details.

Topic 4. Guidelines for analysis of different types of circuits with the simulator ORCAD/PSPICE – 20 types of circuits are considered: Audio amplifiers, Equalizers, PID controllers, Control system, Controller MAX854C, Circuit regulating the sound in a guitar, Signal oscillators – sinusoidal, pulse, “delay”, triangle, Programmable gain amplifiers, Filters with quartz crystals, Voltage regulator circuits, Circuits with timer 555.

Topic 5. Design of different parts of communication system – RF, digital and analog, with specialized and appropriate CAD tools. This topic includes recommendations and additional tools for PCB design of a communication system and mobile devices; Computer-aided design of communication system using MATLAB, ORCAD/PSPICE and a set of specialized online tools and platforms; Computer-aided design of power supplies, antennas, loudspeakers and microphones in communication systems.

All 5 topics are organized as follows:

- Learning objects, realized as presentations with included audio files for a set of subjects in the topic and additional knowledge units associated to the subjects.
- Learning test and
- Exam test.

In Topic 4 are included Tasks, Virtual simulators and a link with especially developed Online circuit calculator

SMARTCircuitCalc, which allows the personalization of students' projects and tasks.

There are 74 Learning Objects as presentations with audio files, 185 Knowledge units in a Virtual library, developed as a part of the project in the Telecommunications faculty, 5 Learning tests with 50 questions and 5 Exam test with 12 questions each.

Three MS-EXCEL based Virtual simulators and 13 tasks are added in Topic 4 which together with the online circuit calculator permit to define a large number of individual project for students home and/or class exercises. The E-learning Module **“Computer-Aided Design of Communication Circuits with ORCAD/PSPICE and Other Tools: is published on: <http://mdl.tu-sofia.bg/moodle/course/info.php?id=7&lang=en>.**

B. Tests in the E-learning Module

Two types of tests are included in each Topic in the E-Module – Learning tests and Exam tests.

The Learning tests are placed on the last pages of Lessons, realized through the Lesson activity in Moodle. The Learning objects of each topic are converted in SWF format and placed on the Lesson pages. All Lesson pages are accessible in parallel through push buttons. When a student makes an error in the Learning test, a feedback is foreseen to lead him back to the Learning object, which he has to revise in order to correct his error. These feedbacks are developed as a part of the personalization system in the e-learning system in the Telecommunications faculty. For all topics, a result of more than 70% to the Learning test is a precondition for access to Exam tests.

The Exam tests are realized through the Test activity in Moodle with the help of the Question Bank of the platform. The questions in the Exam tests are selected randomly from the Question Bank in Moodle, where an hierarchy of categories is created for each Topic. Four subcategories per Topic are developed with more than 10 questions each. When a concrete Exam test is generated for a student, 3 random questions are selected from each one of the 4 subcategories in the category for the Topic and an Exam test with 12 questions is proposed to the student.

Learning tests and Exam tests are limited in time and they allow no more than three attempts.

C. Tasks in the E-learning Module

The tasks in the E-learning Module are included in Topic 4.

Three MS-EXCEL based Virtual simulators are included in the E-learning Module, as follows:

- Virtual simulator for Audio amplifier design,
- Virtual simulator for Advanced audio amplifier design,
- Virtual simulator for Equalizer design.

Each Virtual simulator in MS-EXCEL is supported by a set of Knowledge units to help the student to design the circuits. The student has to extract himself the formulas and to make the circuit calculation in the MS-EXCEL file. The three circuits to be calculated are included in the Virtual simulators.

Figures 1a and 1b present the circuits of the Audio amplifier and the Advanced audio amplifier to be designed in the MS-EXCEL Virtual simulators. These three Virtual simulators are modifications of the online calculators in [7].

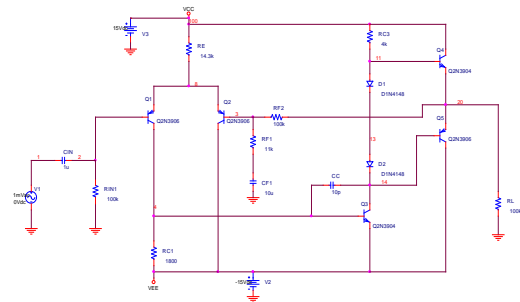


Fig. 1a. Audio amplifier circuit in MS-EXCEL Virtual simulator

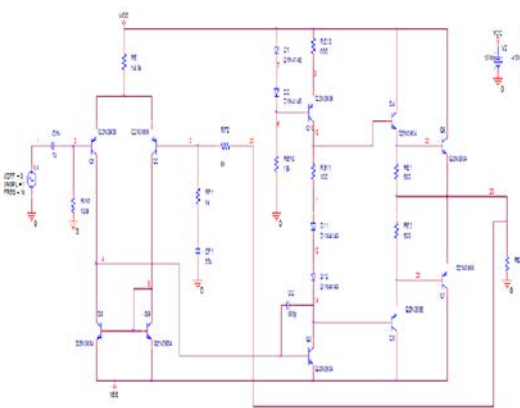


Fig. 1b. Advanced audio amplifier circuit in MS-EXCEL Virtual simulator

Thirteen tasks for analysis of different circuits with ORCAD/PSPICE are included in Topic 4. The MS-EXCEL Virtual simulators permit not only to test student on the corresponding circuits but when combined with the tasks for the audio amplifier, the advanced audio amplifier and the equalizer, to make comparison between calculated and PSPICE simulated results and if necessary to adjust the circuits' parameters. Besides the MS-EXCEL Virtual simulators, an additional tool is developed for personalization of the students' tasks and projects – the Online circuit calculator SMARTCircuitCalc which is described in next point.

III. ONLINE CIRCUIT CALCULATOR SMARTCIRCUITCALC

The Online circuit calculator called SMARTCircuitCalc is developed and associated to the E-module in order to generate personalized tasks and projects for students. SMARTCircuitCalc calculates elements values of circuits and models, as follows:

- Quartz crystal model parameters calculation,
- Calculation of a circuit with timer 555,
- Colpitts oscillator parameter calculation,
- Hartley oscillator parameter calculation.

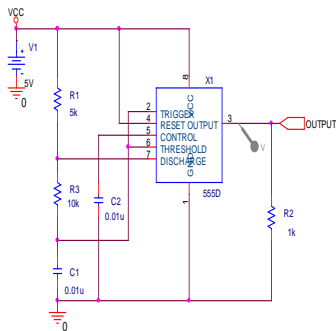


Fig. 2a. Circuit with timer 555 in SmartCircuitCalc

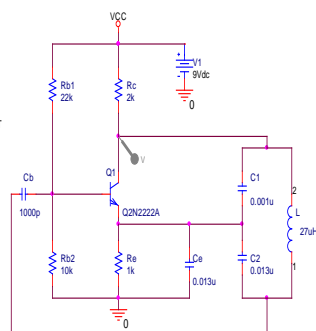


Fig. 2b. Colpitts oscillator circuit in SmartCircuitCalc

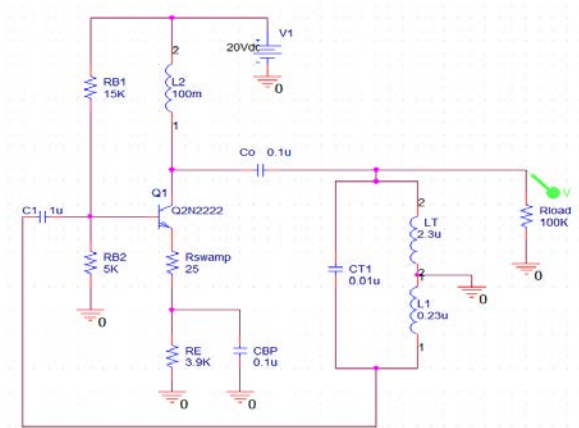


Fig. 2c. Hartley oscillator circuit in SmartCircuitCalc

The circuit with timer 555 and the circuits of the oscillators of Colpitts and Hartley included in SmartCircuitCalc are illustrated on Figs 2a, 2b and 2c.

The online calculation of quartz crystal model parameters is a modification of [9] and its function is to calculate the resonance frequency f_{res} , given the values of $C1$, $C2$ and L , or given f_{res} , $C1$ and $C2$ to calculate the value of L .

The online calculator of a circuit with Timer 555 is a modification of [10] and its function is given $R1$, $R3$ and $C1$ from Fig.2a to calculate the frequency of the generated pulses f , the period T , the pulse width t_1 and the duty cycle – g .

The online calculator of the Colpitts oscillator is a modification of [11] and its function is given $C1$, $C2$, L from Fig.2b to calculate the frequency f of the generated sinusoidal signal.

The online calculator of a circuit of the Hartley oscillator is a modification of [12] and its function is given C , L from Fig.3c to calculates f and given C , L to calculate f .

These 4 online calculators permit to generate different specifications for the circuits with quartz crystals – filters and generators and for the timer 555, Colpitts and Hartley oscillators. Thus individual parameters are generated for the corresponding tasks for each student. The student is supposed to simulate his task with the individual specification and or circuit elements' values obtained from SMARTCircuitCalc. Individual students' projects are created by sets of Tasks.

A. Task on Harley oscillator circuit generated with SMARTCircuitCalc

Figs. 3a and 3b present the simulation of the Harley generator from Fig 2c, calculated for a 1MHz frequency. The circuit is then simulated in ORCAD/PSpice as shown on Fig.3b. The student should then determine the value of the period of the generated sinusoidal signal, which in the case of Fig3b is $1\mu s$ and correspond exactly to the 1MHz frequency determined in SMARTCircuitCalc.

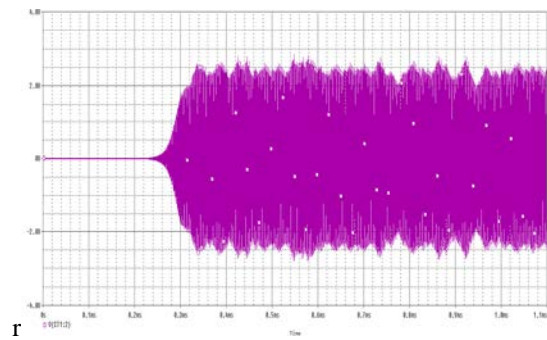


Fig. 3a. Output voltage of Hartley oscillator circuit simulated in ORCAD/PSpice

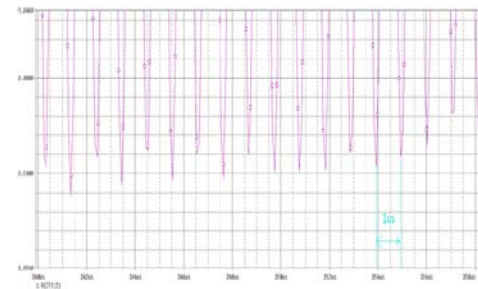


Fig. 3b. Period of the signal generated from Fig. 3a.

B. Task on Filter with quartz crystals circuit generated with SMARTCircuitCalc

Additional tools as AADE Filter Designer [8] are used together with SMARTCircuitCalc and ORCAD/PSpice for quartz crystal filter synthesis, calculation and simulation. On Fig.4a a filter with 2 quartz crystals is entered in AADE Filter Designer. Then the quartz crystal model parameters are calculated in SMARTCircuitCalc for a given resonance frequency 3.6MHz, as shown on Fig.4b. At that stage of personalization the student can simulate the filter from Fig.4a with AADE tool and/or with ORCAD/PSpice and then determine the circuit parameters and performance, as shown on Fig.4c.

The Online circuit calculator SMARTCircuitCalc is developed with PHP, JavaScript, HTML5 and CSS3. Its home page is presented on Fig.5 and its web address is:

<http://niki.heatdesign.net>

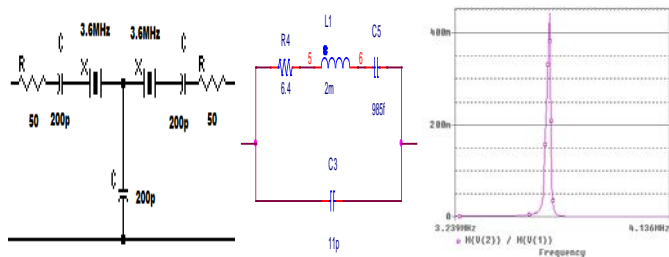


Fig. 4a Filter with 2 quartz crystals entered in AADE filter designer

Fig. 4b. Quartz crystal model with parameters calculated in SMARTCircuitCalc

Fig. 4c. PSpice simulation of the filter gain



Fig. 5. SmartCircuitCalc home page

IV. CONCLUSION

The E-learning Module for Computer-Aided Design was implemented as a part of the individual educational duties of the students in the summer term of the academic year 2013/14 in the Telecommunications faculty. The observations on the students' activity with the E-learning Module show that 165 students have performed Lessons, the Learning tests in the lessons and the Exam tests. The average results for each topic and for the course are shown in Table I.

TABLE I
AVERAGE TEST RESULTS IN THE E-LEARNING MODULE

Topic	Average result for the Learning test	Average result for the Exam test over 10
Topic 1	87,81%	9,12
Topic 2	80.13%	8.99
Topic 3	92.28%	9.75
Topic 4	89.44%	9.42
Topic 5	87.44%	9.26
All topics	87.18%	

All 165 students filled feedback forms at the beginning of the course. At the end of the course 152 students passed all the learning and exam tests successfully, 12 students failed with a score less than 70% to at least one test and 1 student couldn't register until the end of the e-learning course. 160 students filled the feedback forms again at the end of the e-learning

course and all of them declared to be satisfied from their participation in this course. 16 students made comments as follows:

- 6 students wanted a better interface and more friendly environment;
- 2 students wanted more homework and practical work;
- 4 students wanted the correct answers to be given at the end of the Learning test and 1 student wanted no correct answer to be given at the end of the Exam test in order to motivate to study the lessons more deeply.
- 1 student didn't want when failing the Learning test to be driven back to lessons.
- 1 student asked all tests to be open simultaneously from the beginning of the course and during the whole course.
- 1 student reported a special problem with 30 successive low scores on a Learning test.

The average time passed by a student on a test is 1 hour and 40 minutes. These results show that E-learning approach is well accepted by students and they find it useful for improving the quality of their education.

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- [12] Hartley Oscillator Calculator, http://www.ekswai.com/en_ind3.htm