EDUCATION OF ANALOGUE ELECTRONIC CIRCUITS SUBJECT IN ECT BACHELOR FIELD OF STUDY

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Abstract: The subject Analogue electronic circuits plays important role within the framework of three-years bachelor field of study Electronics and communication technology at FEEC BUT in Brno. The paper discusses restructuring and innovative steps implemented in the light of requirements resulting from teaching process in attendance and combined forms of study.

Key words: Analogue electronic circuits, Lectures, Exercises, Computer exercises, Laboratory exercises, Computerized system

INTRODUCTION

The subject Analogue Electronic Circuits (AEC) is a compulsory subject of bachelor field of study Electronics and Communication Technology (ECT) at the Faculty of Electrical Engineering and Communication (FEEC), Brno University of Technology (BUT) in Brno. The aim of this subject is to make students familiar with basic principles of analog electronic circuits, to show an utilization of a personal computer (PC) at their analysis and to verify their properties by means of practical measurements of typical electronic circuits. The going through the course AEC is an essential professional training for successful studying another specialized subjects including those of subsequent magister field of study ECT. Education forms well structured, study materials created synoptically, their composition and linkage are thus very important factors at the arrangement of the high-quality education.

In the paper a current state and proposed changes are discussed while reflecting needs for both attendance and combined forms of study.

1 BASIC STRUCTURE OF THE SUBJECT

The subject Analogue Electronic Circuits is annually opened up for roughly 250 and 25 students at attendance and combined forms of study, respectively. Besides, a few foreign students in a fee-based form of study attend the subject being taught in the English language. Due to specific needs at teaching in the above stated study forms it has been necessary to prepare different forms of tuition accordingly. Firstly, the organisation and syllabi of the basic attendance form of study are discussed.

1.1 Subject organisation and syllabi

To enter the AEC course a subject knowledge on the secondary school level is requested. In addition, for those students who have passed out humanities a passing the seminar Practical electronics (PE) is needed. The subject AEC is covered by 26 lessons of lectures, 13 lessons of exercises, 13 lessons of computer exercises and 26 lessons of laboratory exercises. The following items are evaluated: • performance of all laboratory measurements and passing their reports (up to 15 points), • active participation on all computer trainings (up to 15 points), • verification test within the framework of numerical exercises (up to 10 points), and • written form of the final semestral exam (up to 60 points). The students can obtain at the most 100 points, 50 points is a minimum to pass. Besides, based on a simultaneous completion of both computer and laboratory exercises the obtaining credit is needed to pass out the subject.

In light of contents the following topics are included in the subject regardless of the form of study: • Electronic circuits: basic concepts and classification, • Electronic circuit elements: two-poles, two-ports and multiports, • Modelling of the real circuit elements: semiconductor diodes, bipolar (BJT) and field effect transistors (FET), operational amplifier (OA), • Electronic circuit as a linear dynamical system: stability, feedback, • Circuits with the operational amplifiers: voltage and current amplifiers, converters, • Electrical filters: principle, passive and active filters, applications, • Basic stages with transistors: common-emitter (CE), common-collector (CC) and common-base (CB) connections, frequency properties, • Transistor circuits: current sources, current mirrors,
Darlington circuit, cascode connections of basic stages, differential amplifiers, • Amplifiers: classification and function, wideband, narrowband and power amplifiers, • Power supplies: stabilizers, rectifiers and converters, • Signal converters: shaping networks, multipliers, modulators and mixers, • Signal generators: oscillators.

The syllabi of all the tuition forms are presented in Tab. 1 just for the attendance form of study. In case of the combined form of study there are the same requirements as for knowledge granted to give to students, however, different tuition forms are used to achieve it.

1.2 Specificity in combined form of study

In the combined form of study the tuition is organized in the form of tutorials, computer/laboratory exercises and homeworks. There are 4 tutorials held within the range of 10 lessons per semester covering all the topics from the lectures in Tab. 1. At the end of each tutorial, a homework is submitted having to be solved till specified date. It means that 4 homeworks are evaluated leading to up to 4 × 7 = 28 points. The computer exercises are within the range 2 lessons per semester collected into the only practising, therefore, only 1 topic from Tab. 1 is always selected to be solved. The same is valid for the laboratory exercises. The passing out both practising is mandatory to be able to obtain a credit, and up to 2 × 6 = 12 points can further be obtained. The remaining 60 points is reserved for the written final semestral exam which is held jointly with the attendance form of study to keep the same demands.

1.3 Specificity in education of foreign students

A few foreign students can enter the AEC course as a optional subject in the frame of fee-based form of study. For those students it was necessary to prepare some materials in English. Specifically, the textbook Analogue electronic circuits [4] has newly been written as the electronic text being accessible at www of the faculty. Besides, the English version of the lectures is available in an electronic form in the PowerPoint format.

2 Typical tasks and exams evaluated

As was mentioned above specific tasks and exams are evaluated in each form of tuition within the framework of a particular form of study. Here some examples are only shown to demonstrate typical requirements for students. First the written final semestral exam is jointly organized for students of attendance and combined form of study. It consists of typically 3 examples to be solved (either symbolically or numerically) and 3 theoretical questions to be answered in writing. An example is shown in Fig.1, available time for the solution is 120 minutes. As for the verification test within the framework of exercises it is organized after a half of the semester period, and is composed of 2 or 3 examples to be solved during about 50 minutes. These examples are similar to those in the final semestral exam as for their difficulty. During the computer exercises it is no special exam, however, an active work is observed by a teacher and an evaluation is performed at the end of each session. As a result of the laboratory exercises the reports of all the measurements must be processed. Each report should be handed over till the next session, and preparation of a new measurement is to be shown for the inspection. In the last session a final test is organized mapping knowledge of all the laboratory tasks, and a credit is given.
In case of the combined form of study homeworks are assigned at the end of each tutorial. A typical homework consists of 4 examples being solved in writing, see Fig. 2.

The laboratory exercises are held in the lab of analog circuits of the same department with a capacity of 10 students, each of them working independently, see Fig. 4.

The instrumentation is regularly brought up to date or completed, mostly based on grant projects of the Czech Ministry of Education. For example, this year author’s grant project Restructuring and Innovation of Compulsory Subject Analogue Electronic Circuits solves not only the innovation of the above stated textbooks but also a design of a new demonstrational laboratory exercise.

**Fig. 1: Example of written final semester exam**

**Fig. 2: Example of homework in combined form of study**

**Fig. 3: Computer laboratory at DRE**

**Fig. 4: Laboratory of analog circuits at DRE**
4 COMPUTERIZED MEASUREMENT SYSTEM

Within the framework of an innovation of teaching methods the new computerized measurement system is planned to be included into the introductory laboratory session starting with the winter semester 2007/08. It is intended for demonstrational measurements of electronic functional blocks, namely the frequency characteristics of electrical filters (both passive and active) and amplifiers, DC operating characteristics, and others. A block diagram of such the computerized measurement system is shown in Fig. 5.

![Block diagram of measurement system](image)

**Fig. 5: Block diagram of measurement system**

The system is controlled by a PC with Agilent VEE Pro 8.0 (VEE – Visual Engineering Environment) [5 - 7]. It is a graphical programming language designed for controlling measurements, and collecting and processing data being measured. The USB/GPIB interface Agilent 82357A is used as the only connection to the PC, three remaining instruments are interconnected via the GPIB bus. These are: the 20MHz function/arbitrary waveform generator Agilent 33220A, the 6½ digit multimeter Agilent 33220A and the triple output DC power supply Agilent E3631A (0 – 6V, 5A and 0 – ±25V, 1A). Due to the power supply’s controllable DC voltage outputs, it is possible to test both DC operating characteristics and frequency characteristics of the active functional blocks with voltage-controlled parameters. The built-up system in reality is shown in Fig. 6.

![Built-up computerized measurement system](image)

**Fig. 6: Built-up computerized measurement system**

The Agilent VEE Pro package can also play a role of a powerful computational tool, with many mathematical functions and graphical outputs. A solution of a Campbell passive filter leading to graphing its magnitude and phase characteristics is depicted in Fig. 7, as an example of the VEE Pro environment. The complex voltage transfer ratio which depends on 4 input parameters, R, L, C and M, is defined inside the block Campbell filter [8]. A proper frequency array is generated in the block Frequency by using ramp function inside, blocks Magnitude and Phase, containing respective functions mag(x) and phase(x) inside, treat the output complex array to graph both characteristics using X vs Y Plots, renamed respectively.

The above stated example implies another very useful application of the computerized system. Namely, it will enable to do an immediate comparison of results gained on the basis of measurements of real functional blocks to results gained on the basis of theoretical models defined analytically. To measure phase characteristics, however, the measurement system will be completed by a digital oscilloscope with a specialized module in a near future.

5 REFERENCES


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