

# THE USE OF MODERN INFORMATION TECHNOLOGY IN TEACHING ELECTRONICS

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**Abstract.** *The paper presents systems created in the software environment are tested in terms of operation and the operating parameters. The testing also includes the faithfulness of representing the actual circuit operation. Students work with these circuits during laboratory classes of Introduction to Electronics. The results of measurements obtained during the classes are compared with the results obtained by students when working with simulated electronic circuits. The results of students' work carried out with the two methods were assessed.*

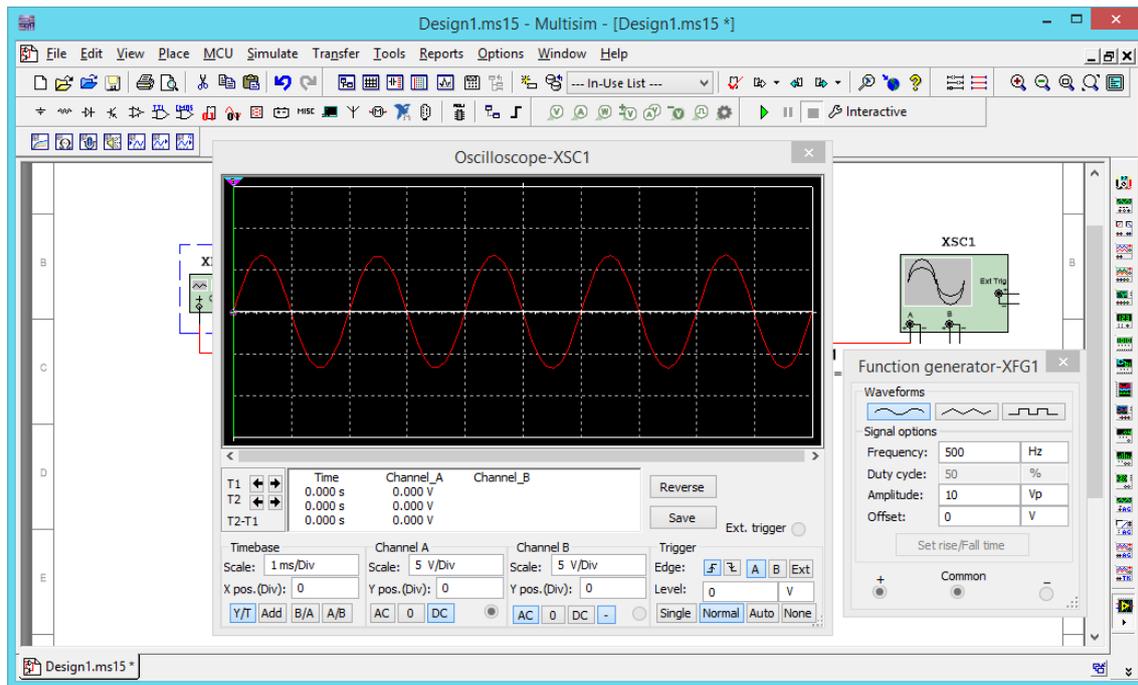
**Keywords:** *electronics laboratory didactics, problem task, simulation.*

## Introduction

In the course of the development of information technology, new tools have been created to support and model analogue and digital electronic circuits (Ptak, 2014b). The tools are designed to check the correct operation of an electronic circuit at the design stage, when it is possible to control the operation of individual blocks of a circuit and to eliminate any errors and imperfections in advance before the testing of actual electronic circuits begins (Winiecki, 2001; Prauzner, 2012a). In this way, by testing virtual systems it is possible to prevent damaging components of the actual circuit (Migo & Noga, 2015; Ptak & Prauzner, 2013). Besides, functional blocks that have not met the expectations can be redesigned or replaced directly in the software environment (Zloto, Ptak, & Prauzner, 2012; Ptak & Prauzner, 2014a).

To achieve the above-mentioned goals, many software environments are available. One of them is the Multisim software package manufactured by National Instruments company. Using this package, it is possible to design a data flow diagram compatible with the flow of data in actual electronic circuits (Prauzner, 2016; Ptak, 2015). The individual elements of the electronic circuit are depicted by icons representing actual electronic components and devices (Noga, 2009; Depesova, Vargova, & Noga, 2008). By combining these icons

with one another, a data flow sheet is created (Ptak, 2018a). Fig. 1 shows an example of the Multisim software simulation screen. The testing stage begins once the circuit has been created with the appropriate icons and pictograms. At this stage, it is possible to check the functioning of individual components and to implement possible changes (Noga, Piaskowska-Silarska, Depešová, Pytel, & Migo, 2014; Prauzner, 2017).



*Figure 1 Simulation screen of an electronic circuit designed in Multisim software*

### **Real and simulated electronic circuit**

Two electronic circuits were designed in Multisim software in order to test a MOS transistor. Figs. 2 and 3 show the diagram of measurement circuits with a transistor, designed in the software.

Once all the necessary modifications and additions were implemented, the circuit was tested in terms of stability of performance of all the designed functions. On the basis of the analysis of the circuit operation, measurement curves showing its functioning and specifications were plotted.

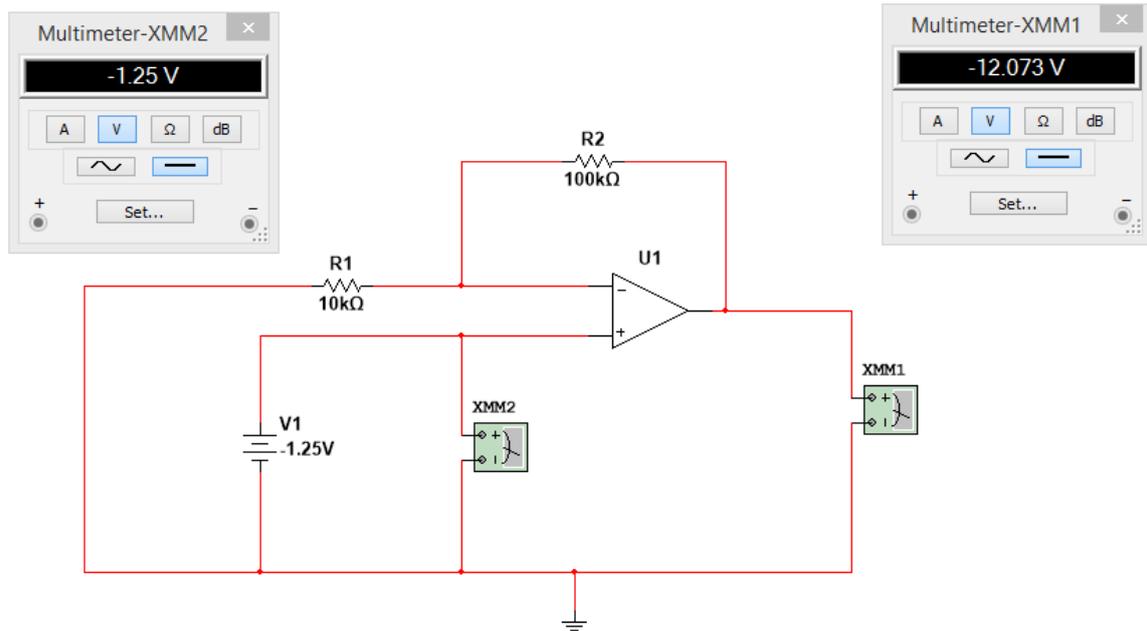


Figure 2 Diagram presenting the first circuit for testing a MOS transistor designed in Multisim software

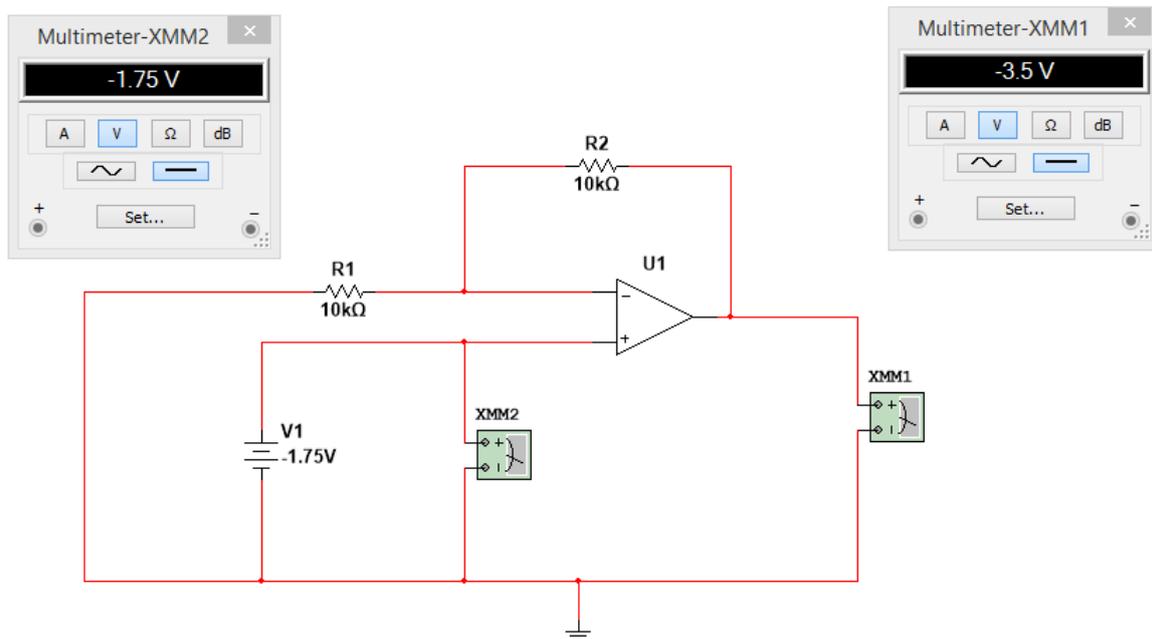


Figure 3 Diagram presenting the second circuit for testing a MOS transistor designed in Multisim software

Figs. 4 and 5 present the characteristics of electronic circuits designed in the Multisim software.

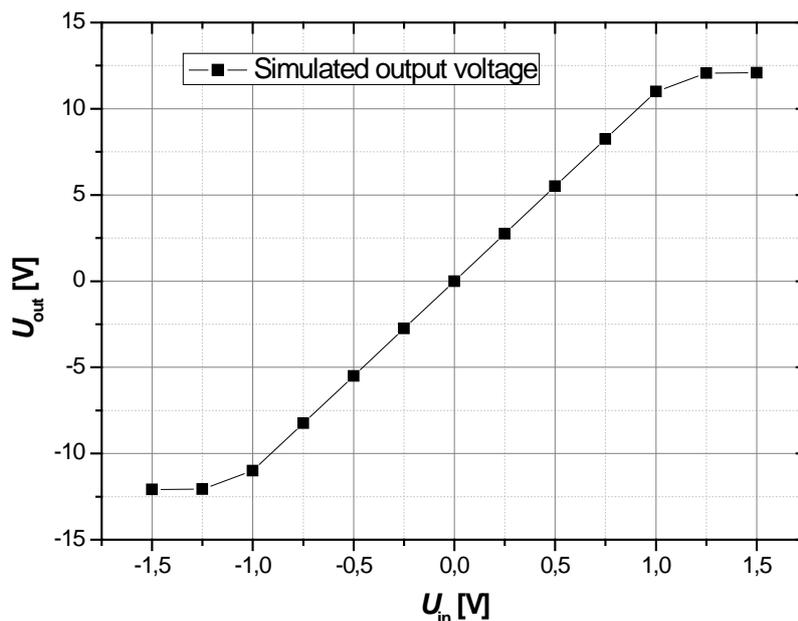


Figure 4 Characteristics of the first electronic circuits for testing a MOS transistor designed in the Multisim software

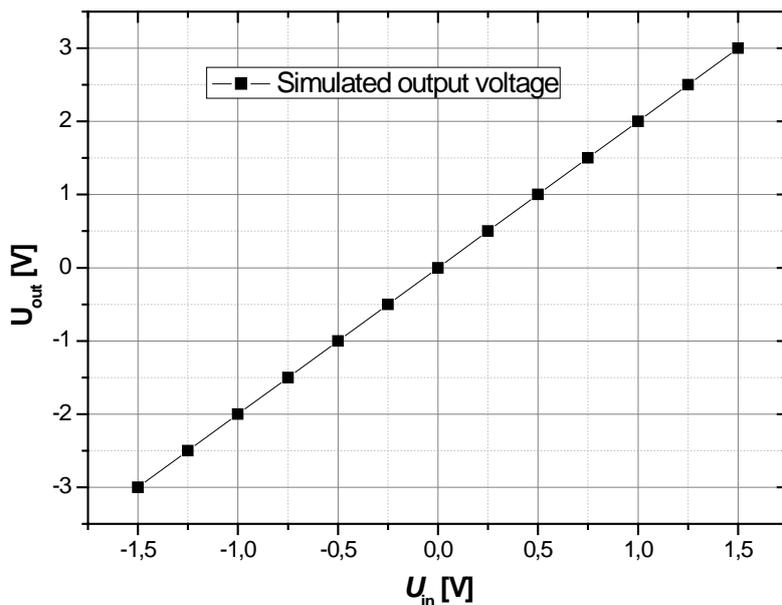


Figure 5 Characteristics of the second electronic circuit for testing a MOS transistor designed in the Multisim software

Next, the circuit designed in the software environment was created from real components and its functioning was verified during laboratory classes. Fig. 4 shows a diagram of this electronic circuit. Measurements of its basic parameters and electrical quantities were carried out by means of measuring instruments, recording, displaying and power supplying devices available in the laboratory. The measurement results were then entered into the appropriate

tables on the basis of which the characteristics of the electronic circuit operation were developed, as shown in Figs. 6 and 7.

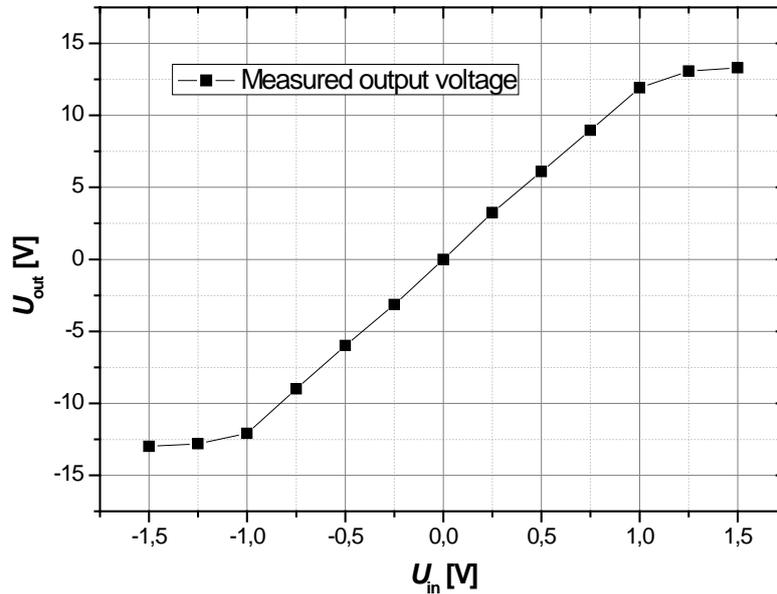


Figure 6 Characteristics of the first real electronic circuit for testing the MOS transistor

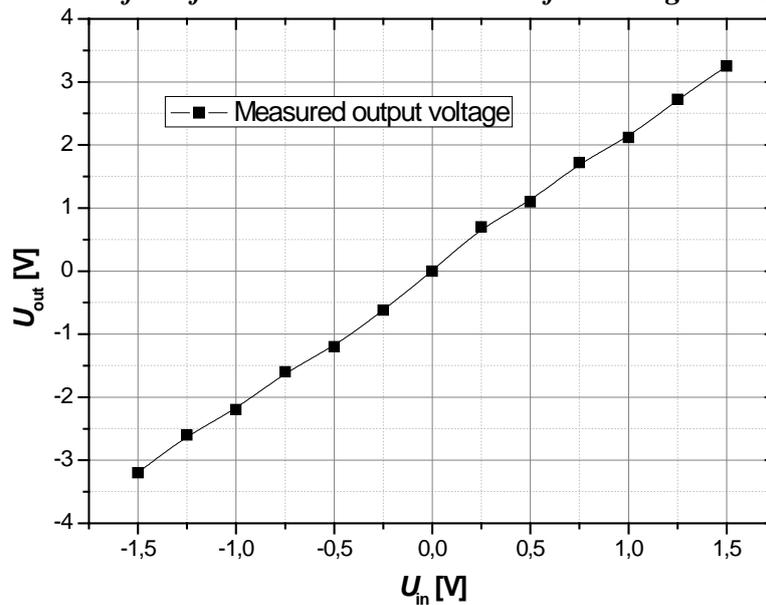
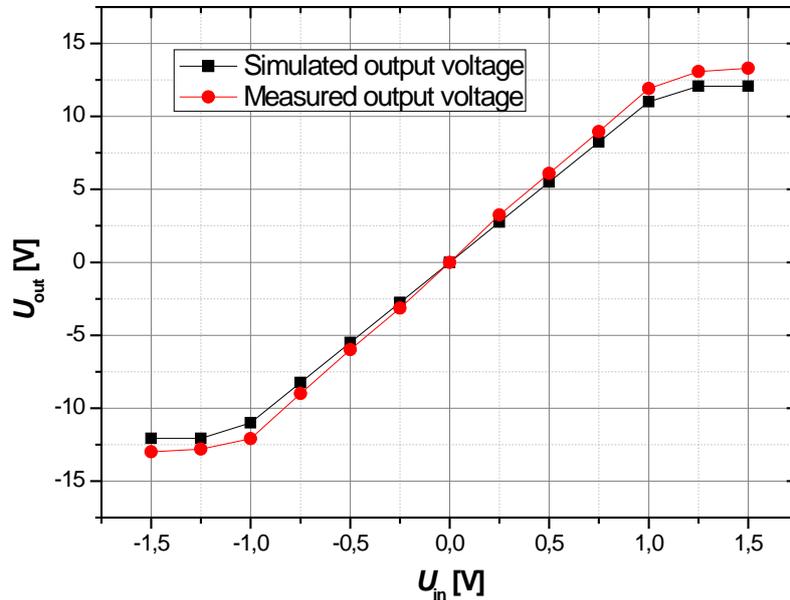


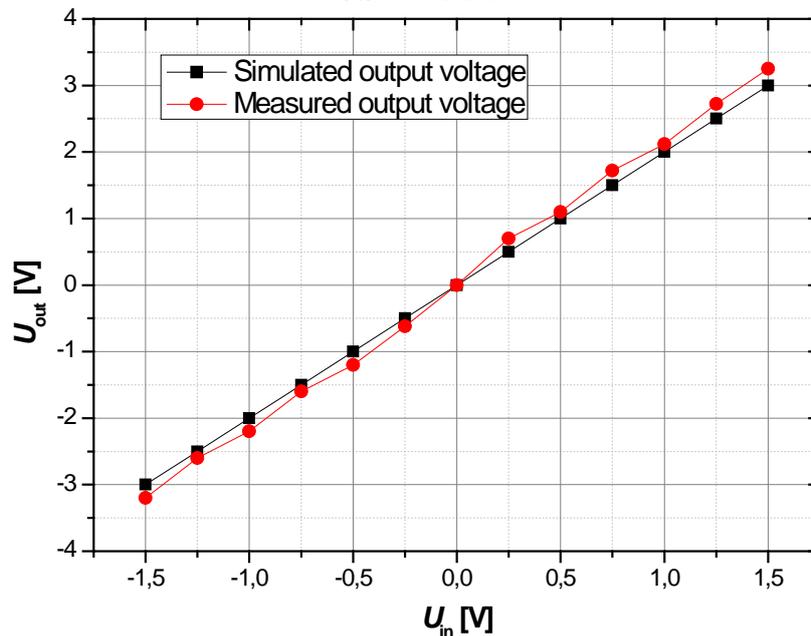
Figure 7 Characteristics of the second real electronic circuit for testing the MOS transistor

Figs. 8 and 9 present the characteristics of the circuit simulated in the Multisim software environment together with with the characteristics developed on the basis of the actual laboratory measurements. It can be noticed that the curves are of highly similar shape, being separated from each other by a certain constant value. The distance between the curves may result from measuring errors of measuring devices or inaccurate data readout during lab classes. Besides, errors resulting from the operation of the simulated circuit in the

Multisim software environment can be caused by incorrect or oversimplified simulation rules prescribed in the software settings.



*Figure 8 Performance characteristics of the real and simulated first circuit for testing the MOS transistor*



*Figure 9 Performance characteristics of the real and simulated second circuit for testing the MOS transistor*

All too often, we think of laboratory classes as of tedious work, involving connecting various systems and measuring devices by means of cables. Such tasks are also useful from the didactic viewpoint, by providing students with direct familiarity with devices and enabling them to learn how to use them in

practice. It was observed that the classes with virtual electronic equipment were met with great interest on the part of students, whose involvement grew significantly.

The direction of innovations is clearly indicated by the research on new educational forms. It has to be noted that the role of information technology is not confined to being only a medium of information transmission but it is supposed to provide a means for creating new teaching methods taking into account an individual student's abilities. A well designed lesson should evoke emotions and interest as well as offer a means of experiencing the world. These objectives are difficult to meet with students sitting at desks and studying course books and exercise books. The idea that a lesson should be attractive and offer some relevant experience to a student was known in classical didactics too, but it has become especially important in the light of ICT. The innovations in didactic methods are to be aided by the recent research on the structure and functioning of the brain.

### **Conclusions**

The experiment carried out during the classes indicates that the Multisim software environment is a useful didactic tool:

- It can be used for designing and testing an electronic circuit and it can to some extent replace a real electronic circuit. In this way it is possible to prevent errors, which could otherwise result in costly failures or damages of electronic components.
- The optimal way to make use of the Multisim software is to combine all of the above-mentioned functions. First, an instructor can design and verify an electronic circuit virtually as part of preparation for laboratory classes. After conducting laboratory exercises, the initial circuit simulation in the Multisim software can serve as the baseline for comparing the results obtained in real measurements with the those of a simulated electronic circuit.
- Such a combination of all the functions of the software offers many advantages in teaching electronics and thus makes the teaching process more attractive.

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