

Development in Education of Electrical Measurements and Circuits Theory

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Abstract – In the paper the authors present the possibilities of preparing modern, educational tools which, in the form of virtual instruments, are very helpful for educational process concerning electrical measurements and circuits theory. These dynamic instruments make it possible to use during the lectures some demonstrations which better explain the presented theory. Main platform is NI ELVIS II, leading educational platform, based on graphical orientated software for programming – LabVIEW. The virtual instruments make it possible to simulate measuring sessions realized later in the university laboratory.

Keywords – Education, NI ELVIS II, LabVIEW, Electrical Measurements, Circuits Theory.

I. INTRODUCTION

The dynamic development of computer technology requires dissemination and implementation of new information technologies in education, combining visibility and simplicity of statement with a high level of material studied. Central place is occupied by modern educational resources as electronic educational centers and methodological tools, computer models of the studied objects and processes, software and hardware automation of laboratory facilities. Large number of publications in recent years [1,2,3,4,5] seen a revolutionary development of the educational process, especially for distance tuition and for anyone who wishes to read lectures in various courses through the Internet.

For this tuition are very useful virtual instruments that better explain the contents, allowing the creation of various applications and implement new priorities in engineering education based on ability to independently solve the tasks of scientific methods. Certainly they should not be treated as a substitute for actual laboratory tasks that are required for technical training but can be used as excellent tools to prepare for practical laboratory work. In Bulgaria, this process is still in its beginning.

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II. STATEMENT

The Department of “Electrical engineering” of Technical University-Varna develops and implements the concept of using education platform ELVIS II of National Instruments company, LabVIEW-based graphical environment such as teaching subjects “Electrical Measurements” and “Electrical Engineering”. As a rule developed educational and methodical complexes include:

- Preparation of lectures in electronic form for direct use of the Internet browser. They contain animations of theoretical models, virtual tools for solving physical problems and issues of self.

- Preparation of experimental laboratory tasks in the form of virtual instruments that can be used as preparation for real practical tasks.

- Preparation of electronic textbooks with tasks, sample solutions and rules for the layout.

- Organize a system for remote connection with opportunities for contacts and consultations with teachers.

It is up to each laboratory exercise to include the following elements:

- Admission to the program tasks, checking knowledge necessary for understanding the experiment implementation and correct interpretation of results.

- Program for visualization of the work assignment and supervision of its implementation.

- Program for visualization of experimental data obtained from real circuit or mathematical model.

- Program to help fill the experimental results in the form.

- Program to detect and display the presence of gross errors, possible reasons for their occurrence and methods to solve the problem.

- Program guidelines and methodical recommendations on the tasks and design of the report.

- Textbook program, ensuring students theoretical knowledge on the subject.

It is recommended that the use of computer labs based on virtual instruments in two modes. The first mode is basic. In him take place lectures laboratory exercises. The second mode is cognitive training featuring some of the basic restrictions and simplifications. It is possible in preparation for the laboratory exercise and it is appropriate to have Internet access. While the basic program mode can be chosen by the instructor to conduct an experiment on actual experimental setup or its mathematical model, the training mode only works with the model.

Schemes, the element parameters, issues and tasks formulated in the two versions are not identical. The basic system program must be given access only to the teacher of the realized task reports, including both the database and the results are received in their treatment. In the training version of this protocol is not needed.

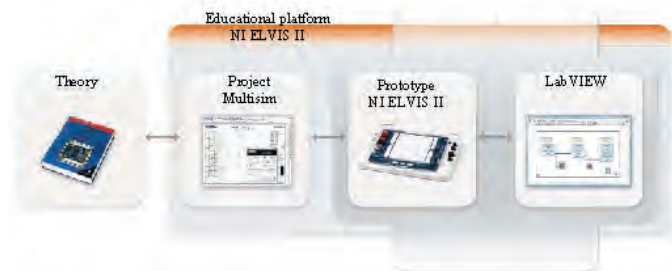


Fig.1. Educational platform NI ELVIS II

Above, at this stage is just an idea because the development of integrated hardware software complex, satisfying all the mentioned requirements is expensive process, requiring more skilled staff and additional equipment mostly global university policy. In practice, currently, the department implements the separate computer laboratory exercises based on ELVIS II, which allows the use of computer programs and hardware resources.

The essence of the educational platform NI ELVIS II is visualized in Fig. 1.

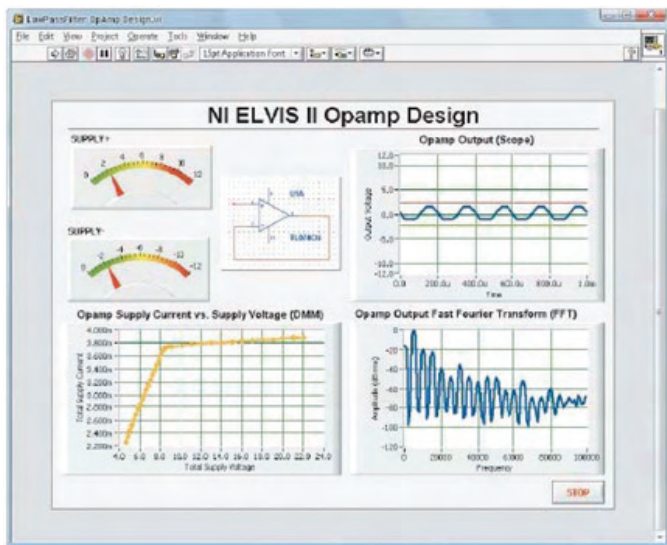


Fig.2. ELVIS II integration with LabVIEW

Its distinguishing feature is the tool of about 12 most commonly used measuring devices integrated into one compact and reliable platform providing a practical purpose of the educational process:

- Arbitrary Waveform Generator;
- Bode Analyzer;
- Digital Reader;
- Digital Writer;
- Digital Multimeter – DMM;
- Dynamic Signal Analyzer – DSA;

- Oscilloscope – Scope;
- Two-Wire Current Voltage Analyzer;
- Three- Wire Current Voltage Analyzer;
- Variable Power Supplies.

ELVIS II e closely integrated with the software Multisim 10.1 - leader in the design and simulation of electrical schemes. Students can simulate the operation of electrical circuits by Multisim to design them using the ELVIS II and explore the simulation model with real measurements through LabVIEW - Fig.2.

The ELVIS II tools are associating with express functions of LabVIEW – Express VI. On Fig.3 is depicted the function palette.



Fig.3. ELVIS II integration with Express VI

Express functions allow development of applications in an environment of LabVIEW, performing in interactive mode configuration of each instrument without a thorough knowledge of programming. With shown integrations educational platform ELVIS II allows the creation of fully ended process - the creation of a simulation model in the construction of prototype measuring the actual signals and parameters by comparing simulation and performing complex analysis - fig.4.

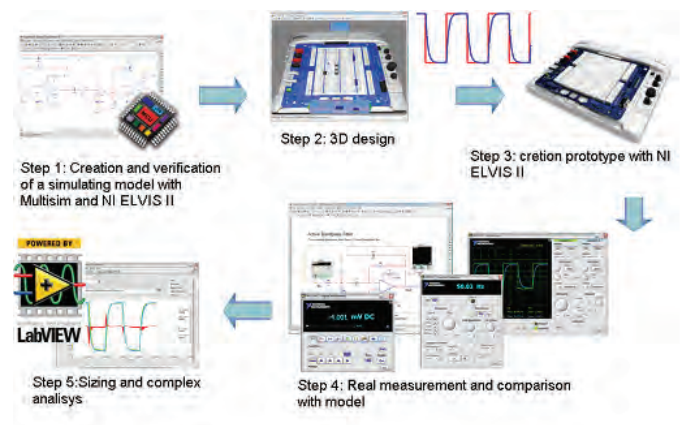


Fig.4. ELVIS II educational process diagram



Fig.5. The electrical circuit creating and analyzing.

In subjects “Electrical Engineering” and “Electrical Measurements”, students engage in examination of the basic laws in electrical engineering, creating loops, their control,

and measurement of different electrical parameters and comparing actual measurements with simulated data of the same instrument - fig. 5 and fig.6.

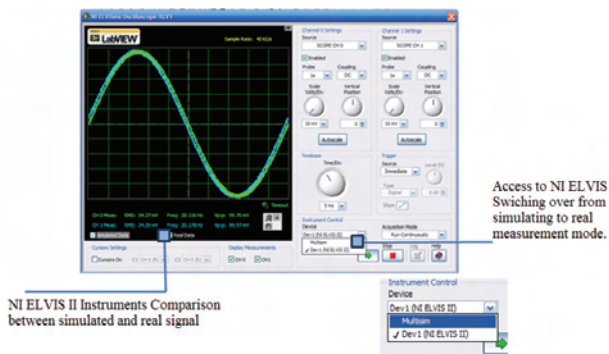


Fig.6. The electrical quantity measurement and comparing with simulating (pilot) signals.

Virtual laboratory stands are very useful for students, and they enable to practice at home the measurements technique. They are equipped with virtual instruments similar to these used in the university laboratory. The virtual stand in Fig. 7 presents principle of temperature measurements using a platinum resistance thermometer Pt100/138,5 and a thermocouple J (iron-constantan). They measure the temperature of liquid in the tank equipped with an electrical heater controlled by on/off switch.

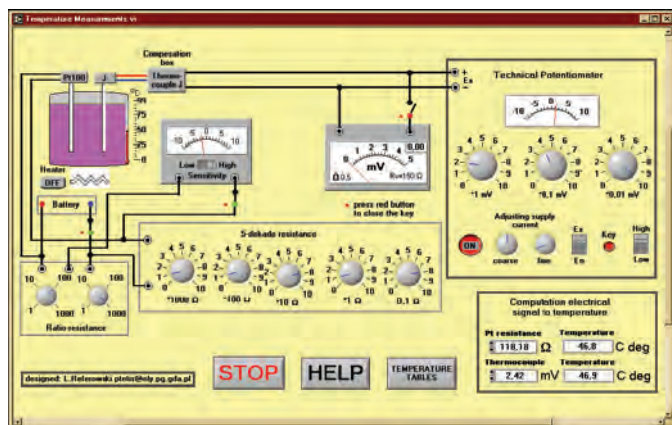


Fig. 7. Virtual stand for temperature measurements using Pt100 resistor and J thermo-couple

The resistance of platinum thermometer is measured by Wheatstone bridge. The bridge is balanced by adjustment 5-decade resistor after choosing the right values of ratio resistance. The key switch activates the galvanometer. The switch Sensitivity changes the galvanometer's sensitivity from low to high level.

The thermo-electric EMF of the thermocouple is measured by means of technical potentiometer, which is fed by an internal dry cell. The proper value of feeding current is adjusted with the help of internal standard Weston cell (Mode switch in position En). The feeding current is controlled using knobs coarse and fine. The measurement of the thermo-electric EMF of thermocouple is realized with mode switch in position Ex. The adjusted values of decade resistor at the

balance state of the potentiometer determine the value of measured thermo-electric EMF in mV. The compensation box with compensation circuit between thermocouple and potentiometer compensates the influences of ambient temperature giving right value of signal for ambient temperature 0 °C.

The influence of the output resistance of the measuring circuit on the value of measuring signal is can be shown by switching a voltmeter into the thermocouple circuit. The value of output signal diminishes. The right value of signal can be calculated knowing the resistances of voltmeter (150 Ω) and thermocouple with leads (2 Ω).

The values of measured resistance and thermo-electric EMF are transformed into temperature with the help of standard temperature tables $R_{\theta}=f(\theta)$ and $E_{\theta\theta_0}=f(\theta-\theta_0)$ activated by TEMPERATURE TABLES switch. It is also possible to make this calculations using Computation of electrical signal to temperature circuit. The HELP button activates window with fundamental information of measuring circuits and measuring procedure.

Fig.8 presents the front panel and the block diagram of a laboratory exercise for temperature measurement.

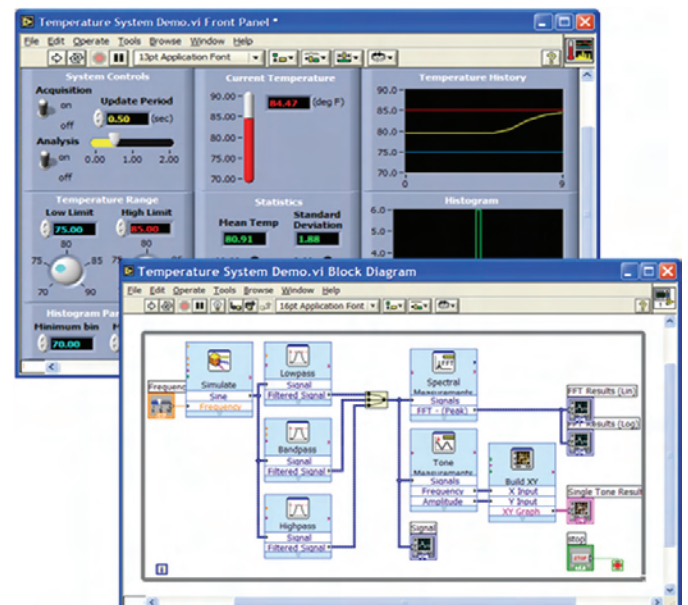


Fig.8. The front panel and the block diagram for a temperature measurement exercise

III. CONCLUSION

In the opinion of the authors, the advantages of application in laboratory practice of measuring complex NI ELVIS are determine by the obvious factors:

- conversion of measurements from separate points of functional dependencies (features or functions of the circuits) to the automated determination in a given range;
- possibility to use while performing a laboratory exercise in work on a comprehensive set of twelve software-implemented hardware measurement devices and hundreds NI virtual instruments libraries;

– use of such virtual tools whose hardware implementation is impossible for mass use in educational laboratories;
– the possibility of using self-developed virtual tools in the LabVIEW environment.

At the same time, NI ELVIS complex use, store all the features of the real experiment, namely:

- ability to verify conformity of theory with the real objects of interest;
- investigation the influence of parasitic parameters and deviations of measurement results;
- training in the creation of electrical circuits and systems, and instrumentation regular connection.

Despite the existing circumstances and difficulties in implementation, education platform ELVIS II is the one of the most promising instruments for the tuition organization in university education.

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