

**Annotations of materials for participation in a competition
for the academic position "professor"
of Associate Professor, PhD, MEgn Slavi Yasenov Lyubomirov**

PhD Thesis

Slavi Lubomirov (2013). RESEARCH OF HARDWARE AND SOFTWARE OF DIGITAL RELAY PROTECTION, dissertation for obtaining the educational and scientific degree "doctor", [professional direction 5.2. Electrical engineering, electronics and automation]. Technical University of Sofia,
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Relay protection plays a crucial and important function for the stable and reliable operation of the power system. It is especially important to accurately determine the type of fault and the distance to the short circuit location. This will help to quickly restore the affected part of the system. The highest stage in the development of electronics and computer systems provides for the implementation of modern technologies in relay protection, which is a prerequisite for reliable operation and allows the implementation of additional functions such as determining the distance to the fault.

After analyzing the existing methods for determining the distance to the fault, it is concluded that there are many unsolved problems in distribution networks due to the branched structure and different modes of inefficient earthing of the neutral. Determining the advantages and disadvantages of the known methods used for transmission networks leads to the correct formulation of the goal and tasks of the doctoral dissertation.

The PhD thesis examines electronic systems (hardware and software) tools for collecting and processing signals from the network. Briefly, theoretical studies of the measured impedance change circuit were performed to determine the distances to the fault.

To achieve the goal, the following tasks are planned: (1) study of existing methods and tools for determining the distance to the short-circuit point in distribution networks, (2) study of hardware means for digital relay protection, including measurement of the distance to a point of short circuit, (3) study of relay protection software performing the function of measuring the distance to the short circuit point, (4) study of the impedance change of the power supply when a short circuit is obtained in order to develop a distance measurement method to short circuit, (5) practical implementation and experimental results.

First, the hardware requirements of relay protection are determined and its various modules are explored. Then the criteria for the development of the program section are selected, various real-time applications serving relay protection are considered and proposed. The final stage of the study is the determination of the relationship between the distance to the location of the short circuit impedance and the power measured at the point where the digital protection is installed with a built-in function to determine the distance to the short circuit.

One of the key elements in setting up digital relay protection is the analog-to-digital converter (ADC) and post-processing of the digital data. The main characteristics of digital protection are determined by the characteristics of the ADC and vice versa, the correct choice of ADC is made according to the desired characteristics of the protection. The quality of digital protection largely depends on the parameters and characteristics of the input data processing: module - overvoltage, speed, accuracy, immunity to interference, etc. This PhD thesis provides a comprehensive overview of the conceptual aspects as well as recent trends in the advancement of current innovations and developments of real-time operating systems (RTOS) used in digital relay protection. In relay protection there are requirements for selectivity, sensitivity, quick response and high reliability.

The variation of the power impedance when a short circuit is obtained is also analyzed analytically, expressions for the distance to a three-phase and two-phase short circuit in medium voltage - distribution networks, the influence of the transient resistance of the short circuit is derived and the load impedance is taken into account. A model of a unit to a digital protection

relay for measuring, is performed with the distance to the short circuit point. The operation of the hardware and software resources achieve the realization of a meter distance to the short-circuit point, which have been experimentally verified.

The doctoral dissertation is useful in practice because it offers a methodology for determining the distance to the short-circuit location in distribution networks. A digital relay protection prototype has been developed and tested.

▪ Articles

Articles that are referred and indexed in worldwide databases with scientific information (group of indicators G7)

- Г7.1. D. Shehova, S. Lubomirov and K. Asparuhova (2020). "Simulation and Experimental Research Strategy for DACs with Proteus and Open Source Platforms", XI National Conference with International Participation (ELECTRONICA), 23-24 July 2020, Sofia, Bulgaria, 2020, ISBN 978-1-7281-7530-0, IEEE Catalog Number CFP20P58-CDR, pp. 265-268, doi: 10.1109/ELECTRONICA 50406.2020.9305158- (Scope)

<https://ieeexplore.ieee.org/document/9305158>

The research described in the paper is aimed at offering software and hardware solutions for studying modern DACs and their applications. Designed and tested the simulation schemes to test the parameters and characteristics of the DAC through simulation analysis in the Proteus Environment. Virtual instruments such as an oscilloscope, a function generator, reference voltage sources have been created, which allows working both remotely in an electronic environment and through real laboratory modules. The proposed DAC teaching strategy provides new opportunities for knowledge organization and new ways of teaching and learning aimed at achieving higher quality learning outcomes in engineering education.

- Г7.2. Angel H. Chekichev, Daniela A. Shehova, Slavi Y. Lyubomirov, Stanislav M. Asenov and Katya K. Asparuhova (2020), "Research and Teaching of Line Coding Using Orcad and Emona Instruments Trainer in Engineering Education". XI National Conference with International Participation (ELECTRONICA), 23-24 July 2020, Sofia, Bulgaria, 2020, ISBN 978-1-7281-7530-0, IEEE Catalog Number CFP20P58-CDR, pp. 269-272, doi: 10.1109/ELECTRONICA50406.2020.9305105.(Scope)

<https://www.scopus.com/record/display.uri?eid=2-s2.0-85099881156&origin=resultslist&sort=plf-f>
<https://ieeexplore.ieee.org/document/9305158>

The report discusses the use of the OrCad environment and Emona Telecoms-Training Lab ETT-101 to research and teach linear coding to help engineering students learn the principles of building digital communications systems. The simulations developed and presented and the lab layout allow the study and comparison of the advantages and disadvantages of NRZ-B coding, RZ and RZB coding, and AMI coding. Simulation and experimental test results are also presented.

- Г7.3. Shehova, D., Asparuhova, K., Lyubomirov, S. (2021). Study of Electronic Circuits with Operational Amplifiers Using Interactive Environments for Design and Analysis, 12th National Conference with International Participation "Electronica 2021", May 27 - 28, 2021, Sofia, Bulgaria, 978-0-7381-1372-2/21/\$31.00 ©2021 IEEE.

The article presents computer models to aid in the study of linear circuits with operational amplifiers. They allow the study of operational amplifier circuits and different variants of

transimpedance amplifiers with photodiodes. The use of the NI Multisim software environment enables simulation studies to be conducted analogous to experimental studies with laboratory models in university laboratories. The developed electronic tools allow the teachers to formulate individual projects for each student, and the students - to conduct independent research on a given project.

The results of the simulation studies are presented and discussed in the paper. They were tested during the training of students in the discipline of Analog Circuit Engineering at the Faculty of Physics and Technology of Plovdiv University "Paisiy Hilendarski" and in Optoelectronics at the Department of Electronics, Faculty of Electronic Engineering and Technologies, Technical University - Sofia during online training during quarantine COVID-19.

Г7.4. Stanislav M. Asenov, Daniela A. Shehova, Slavi Y. Lyubomirov. (2022). "Design and Energy Production Research of a 28.8 kW PhotoVoltaic System", 2022 XXXI International Scientific Conference Electronics (ET), 13-15 September 2022, Sozopol, Bulgaria DOI: 10.1109/ET55967.2022.9920268.

The article presents the design, simulation, construction and research of a 28.8 kW photovoltaic system in the mountainous region of Smolyan, Bulgaria by a team of teachers and students at Paisiy Hilendarski Polytechnic.

Students acquire lasting knowledge and develop skills in working with software for the design and optimization of photovoltaic systems, as well as skills in the design of systems for the production of energy from renewable energy sources. The parameters of the photovoltaic plant were investigated. An analysis of the simulation data from the project was performed with the actual measured and received data for electrical energy production over a period of one year.

Г7.5. A. Parushev, R. Popov, S. Lyubomirov, C. Cristian, G. Ionut and R. Laurentiu. (2023). Laboratory Setup for Studying Heat Transfer through Thermal Insulation Panels, XXXII International Scientific Conference ELECTRONICS - ET2023 September 13 - 15, 2023 (In print - Scopus).

In this report, the authors emphasize the fact that the change of climate conditions, the depletion of the earth's energy resources, the greenhouse effect and the need to reduce carbon dioxide emissions into the atmosphere are the strongest arguments that require adequate training of university students in the direction achieving new energy policies. This necessitates the introduction and application of new approaches and principles for collecting, analyzing and presenting data from measurements of certain processes or phenomena by using laboratory models for training. Modern technologies provide opportunities to apply and search for new teaching methods in universities, which leads to adaptation and change of thinking, both of teachers and students.

Г7.6. R. Popov, A. Parushev, S. Lyubomirov. (2023) Methodology for Determining the Thermal Properties of the Heat Insulation Panels Using a Gray Box Model, XXXII International Scientific Conference ELECTRONICS - ET2023 September 13 - 15, 2023.
<https://ieeexplore.ieee.org/document/10278956?denied=Scopus>

The main methodical steps in determining the coefficient of thermal conductivity of the tested thermal insulation panel are considered. An RC analogy to electric circuits is defined, where heat flow can be modeled as current, temperature as a voltage source, and thermal storage as capacitance. The developed methodology can also be used in the training of students in the field of measuring the properties of thermal insulation materials

Г7.7. Dimitar Tokmakov, Stanislav Asenov, Slavi Lubomirov, Stela Stoyanova, Vesela Yancheva, Slaveya Petrova, Bogdan Nikolov, Elenka Georgieva, Rumens Popov. (2023) "Development and Research of an IoT WSN For Measuring Fine Dust Particles PM10 and

PM2.5". 31th National Conference with International Participation "Telecom 2023", November 16 - 17, 2023, Sofia, Bulgaria.

<https://ieeexplore.ieee.org/document/10409689> Scopus

This report presents a successfully developed and tested state-of-the-art IoT real-time air quality monitoring system tailored for smart cities. The system features low energy consumption and relies on the combined use of LoRaWAN and GPRS wireless communication technologies.

Its flexibility allows for both indoor and outdoor deployment. Key system components include a single-chip microcontroller, air pollution sensors capable of measuring NO₂, CO, PM₁, PM₁₀ and PM_{2.5} levels, and Long-Range (LoRa) and GSM modems. To ensure a sustainable power supply, a photovoltaic and a battery are integrated into the system. In addition, the system has a graphical interface for presenting the collected information. The use of these technologies gives the fine particulate measurement system several notable advantages. These include cost-effectiveness, long-distance communication capabilities, wide coverage, extended device battery life, and ease of operation. Overall, this system represents a significant advance in real-time air quality monitoring, aligning perfectly with the goals of smart cities and IoT-driven urban development.

Г7.8. Slavi Lyubomirov, Stanislav Asenov, Dimitar Tokmakov, Hristo Kanevski, Daniela Shehova, Slaveya Petrova. (2023) "Applying Additive Manufacturing to Engineering Education". 31th National Conference with International Participation "Telecom 2023", November 16 - 17, 2023, Sofia, Bulgaria.

<https://ieeexplore.ieee.org/document/10409762> Scopus

This report outlines the inclusion of education and training in digital fabrication and materials processing within a master's engineering program involving a cohort of 20 students. The program uses additive manufacturing, specifically 3D printing, to provide students with hands-on knowledge of design, manufacturing and performance evaluation. The study focuses on fused deposition modeling (FDM) for the production of a robotic arm, where students evaluate the performance of its components. The installation of drive motors and the provision of related software were also an integral part of the study. A pre- and post-course survey was designed to track the learning experience and obtain feedback from the student participants. The findings show that the inclusion of digital production, self-directed learning and peer collaboration has a noticeable positive effect on engagement and learning outcomes.

Г7.9. Slavi Lyubomirov, Stanislav Asenov, Dimitar Tokmakov, Hristo Kanevski, Daniela Shehova, Slaveya Petrova. (2023) "Case Study of 3D Scanning and Processing to Create Virtual 3D Plant Objects for Education". 31th National Conference with International Participation "Telecom 2023", November 16 - 17, 2023, Sofia, Bulgaria

<https://ieeexplore.ieee.org/document/10409604> Scopus

This article presents the successful application of the EinScan HX 3D scanner in scanning different plant species, resulting in the creation of 3D virtual images of plants. The study involved conducting 3D scans of two plants showing different geometric shapes and sizes. These scans were performed using two different methods: a quick scan and a laser scan. A comprehensive analysis of scanning techniques has been performed, considering their effectiveness in capturing various plant characteristics. The findings are thoroughly documented and presented in the report. Moreover, the obtained results will be instrumental in creating a digital library including 3D virtual representations of protected plant species within their respective ecosystems. In addition, this resourceful approach unlocks opportunities to use the generated 3D objects in fields as diverse as architectural interior design and education.

Г7.10. Ionut Geonea, Cristian Copilusi, Laurentiu Racila, Daniela Shehova, Slavi Lyubomirov, Emil Velev. (2023), Dynamic Study and Structural Optimization of the Connecting Rod from a Thermal Combustion Engine. Physics AUC, vol. 33, pp. 9-20 (2023).

<https://www.scopus.com/record/display.uri?eid=2-s2.0-85180483476&origin=resultslist.....Scopus>

In this paper, we present a study on the structural optimization of a rod in a 1-cylinder in-line thermal engine. To perform this optimization, we use the finite element analysis program, ANSYS. We parametrically model the connecting rod using ANSYS Design Modeler. We consider some geometrical dimensions, such as bond radii and relief channels, as structural optimization parameters. The objective function of this optimization is to reduce the stress concentrators, in order to increase the fatigue strength, but also to reduce the mass of the connecting rod. We present the obtained results in the form of 3D graphics. We will present the optimal solution for the geometric shape of the reel. The study demonstrates the effectiveness of structural optimization programs in achieving the optimal effect of part design shapes.

Г7.11. Racila Laurentiu, Ionut Geonea, Cristian Copilusi, Daniela Shehova, Slavi Lyubomirov, Emil Velev. (2023). Study on Assisting People with Logomotor Disabilities to Climb Stairs with the Help of an Exoskeleton. Physics AUC, vol. 33, pp. 1-8 (2023).

<https://www.scopus.com/record/display.uri?eid=2-s2.0-85180457950&origin=resultslist....Scopus>

In this article, we aim to address the topic of assisting a person with mobility impairments in climbing stairs. This assistance will be achieved using a robotic system such as an exoskeleton. The designed exoskeleton must provide the step length corresponding to the distance between two steps, as well as the leg lift height sufficient to step on the next stair. For this purpose, a solution for designing a robotic exoskeleton system is proposed. Based on this design solution, a virtual prototype of the robotic system will be realized, followed by a dynamic simulation using software for dynamic analysis of multi-body systems, namely ADAMS. The results of the simulation allow us to validate the design decision, on this conclusion we will proceed to the next stage of the research, namely the implementation of an experimental prototype.

Scientific publications in non-refereed peer-reviewed journals or in edited collective volumes (group of indicators Г8)

Г8.1. Shehova D., Sl. Lyubomirov, M. Nedeva. (2013). "An approach for computer simulation of operational amplifier performance", scientific works, SUB - Smolyan, 2013, Scientific works, Volume 1, 2013, ISSN: 1314-9490, pp. 87-95.

In the proposed article, simulation models of various applications of operational amplifiers are considered, by using the NI Multisim simulation program.

The application of the developed models when conducting laboratory exercises in the discipline "Analog circuit engineering" orients the students' training towards developing creative thinking and competencies needed for their future realization as professional bachelors.

When conducting laboratory exercises with real models, students have difficulty in: making an appropriate choice of measuring devices; establishing the correctness of the connections between the elements; the inclusion and adjustment of laboratory instruments.

The development and use of models for computer simulation of the operability of operational amplifiers overcomes the difficulties of the students. It combines virtual and real learning experimentation.

Г8.2. Daniela Shekhova, Petar Yakimov, Slavi Lubomirov. (2017). "Simulation study of generators of rectangular pulses in MULTISIM programming environment", National conference with international participation, ELECTRONICA 2014, 1991-2017, Sofia, p.76-81, ISSN 1313-3985.

In the proposed article, simulation models for studying the operation of radio communication devices with the Multisim programming environment are considered.

The results of the performed simulation studies are reflected and graphically depicted.

The application of the developed models when conducting laboratory exercises in the discipline of Radio communication technology, orients the students' training towards developing creative thinking and competencies.

Г8.3. Peter Yakimov, Daniela Shehova, **Slavi Lyubomirov**, (2014). "Computer Modeling And Simulation Investigation Of A Function Generator", ELECTRONICA 2014, pp.70-75, ISSN 1313-3985.

In the proposed article, simulation models of various applications of operational amplifiers are considered, by using the NI Multisim simulation program.

The application of the developed models when conducting laboratory exercises in the discipline "Analog circuit engineering" orients the students' training towards developing creative thinking and competencies needed for their future realization as professional bachelors.

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The development and use of models for computer simulation of the operability of operational amplifiers overcomes the difficulties of the students. It combines virtual and real learning experimentation.

Г8.4. **Slavi Lyubomirov**, Milena Nedeva, Milena Bundeва and Ivaylo Uzunov. (2015) "Software management of 3D printer", Annual Journal Of Electronics, - Sofia: Technical University, Faculty of Electronic Engineering and Technologies, 2015, ISSN 1314-0078, 96-99 pp.

This current report, "3D Printer Software Control - A Working Model" is a follow-up to another report that looks at a hardware platform for creating a 3D printer. The purpose of this report is to present the software implementation, configuration and firmware programming for the realized working model of the RepRap 3D printer.

The main conceptual aspect discussed in this report is an advanced 3D printing technology that turns a 3D computer model (CAD) into a real physical object depending on the size of the model used. The technology, called FDM (Fused Deposition Modeling), consists of a series of thin layers of molten filament of the material used to achieve the shape of the desired object. This makes three-dimensional (3D) printing completely different from traditional technology, where the shaping of the desired object usually takes material.

Г8.5. Velislava Raydovska, Daniela Shehova, **Slavi Lyubomirov**. (2016). "Research of the coupled tank circuits in programming environments", 15th International Scientific Conference "Renewable Energy & Innovative Technologies", Conference Proceedings, Volume 1, ISBN: 978-619-7180-78-7, 2016, SMOLYAN - BULGARIA, pp. 184-187.

The paper presents the study of coupled oscillating circles in programming environments. A program was developed for calculating the parameters and frequency characteristics of the connected circuits in the Matlab program environment.

Their work is simulated in the Multisim programming environment. There is a comparative analysis of the values obtained through experiments in a virtual environment. The program, which is presented in the article, will be used in the learning process in the course Electrical Engineering or Analog Devices, included in the curricula of the majors "Electrical Engineering" and "Computer and Communication Systems" for the bachelor's degree.

Г8.6. Angel Hristov Chekichev, Daniela Antonova Shehova, Slavi Yassenov Lyubomirov (2016), "Trends in the development of the colorimetric systems until 1830", International Association of Scientific Innovation and Research (IASIR) (An Association Unifying the

Sciences, Engineering, and Applied Research), 2016, ISSN (Print): 2279-0020, ISSN (Online): 2279-0039, pp. 22-25.

The article examines the main trends of different types and forms of colorimetric systems up to 1830 used in the creation and construction of digital images.

Г8.7. Chekichev, A., Shehova, D., Lyubomirov, S. (2016). Creating of 3D graphic forms in the RF-3d and Matlab GUI environment, International Journal of Engineering, Business and Enterprise Applications (IJEBEA), 2015, ISSN (Print): 2279-0020, pp. 63-67, ISSN (Online): 2279-0039

The purpose of the article is to fundamentally visualize the conceptual approaches and methods of creating, modeling and refinement of 3D graphic forms by applying R-functions in communications and practical use of the RF-3D and Matlab GUI programming environments.

Г8.8. Chekichev, A., Shehova, D., Lyubomirov, S. (2016). Trends in the development of the colorimetric systems after 1830, International Journal of Engineering, Business and Enterprise Applications (IJEBEA), 2015, ISSN (Print): 2279-0020, pp. 73-76 ISSN (Online): 2279-0039

The article examines the main trends of different types and forms of colorimetric systems after 1830 used in the creation and construction of digital images.

Г8.9. Raydovska Velislava, Angel Chekichev, Daniela Shehova, Slavi Lyubomirov. (2016). Simulation study of the quadripole via using integrated environments for the design and analysis". International Journal of Engineering, Business and Enterprise Applications, ISSN (Online): 2279-0039 18(1), September- November, 2016, pp. 10-15.

The article presents the study of a quadripole in programming environments. A Matlab program was developed to calculate the frequency response of the quadripole. Their work is simulated in the Multisim programming environment. an analysis was carried out and a comparison was made of the theoretically and simulationally obtained frequency characteristics.

The program, which is presented in the report, will be used in the learning process in the Electrical Engineering course, included in the curricula of the "Electrical Engineering" and "Computer and Communication Systems" majors for a bachelor's degree.

Г8.10. Stanislav Asenov, Daniela Shekhova, **Slavi Lyubomirov**, Dimitar Nedev. (2017). "Application of Arduino PLC (Controllino) in Engineering Education", International scientific conference "UNITECH'17" - Gabrovo, ISSN 1313-230X, 2017, pp. I-218-222.

This article examines key aspects related to the application of ARDUINO-based programmable logic controllers (PLCs), focusing on their implementation in engineering education. The principles and possibilities of Controllino PLC, as a means of control and management of automated processes, as well as prototypes for industrial purposes, have been investigated.

Г8.11. Daniela Shekhova, Velislava Raidovska, Slavi Lubomirov, Stanislav Asenov. (2017). "Teaching programmable amplifiers with modeling in the environment of "TINA-TI" and application of open source platforms", International scientific conference "UNITECH'17" - Gabrovo, ISSN 1313-230X, 2017, pp. I-264-229.

The paper proposes a methodology for simulation and physical investigation of digitally controlled amplifiers. A computer-based model of a programmable amplifier has been created in the "TINA-TI" environment to assist students in learning its parameters.

The results of the study are presented and analyzed. The article emphasizes the possibility of using the "TINA-TI" software environment in the training of analog circuit engineering students from engineering majors.

- Г8.12. Daniela Shehova, **Slavi Lyubomirov**, Katya Asparuhova, Angel Chekichev. (2020), "Use of Software Environments and Open Source Platforms for Teaching Mixed-Signal Circuits", Conference: 12th International Conference on Education and New Learning Technologies, 6th-7th July 2020, Spain, pp. 1637-1643, ISBN:978-84-09-17979-4, ISSN: 2340-1117, doi: 10.21125/edulearn.2020.0529.

Multisim and Proteus are Spice (Simulation Program with Integrated Circuit Emphasis) based and repurposed for simulation and analysis of analog, digital and mixed circuits. Their interface is constantly being improved and their capabilities are expanding. This makes them suitable for teaching and learning mixed circuits through circuit modeling.

An Arduino 2560 integrated environment was chosen as a microcontroller, which is designed for developing applications in various fields. In the presented article, it is used to extend the capabilities of the Texas Instruments Analog System Lab Kit PRO (ASLK PRO) and the ability of learners to develop their own projects.

Proteus is suitable for simulating, testing and analyzing the processes taking place in digital-to-analog converters (DACs), as it keeps the teaching focus on the course concept and provides an opportunity to study the hardware and software aspects of the taught material. Learners learn the process of engineering work: designing and simulating the functionality of circuits using virtual tools.

A voltage-summing DAC simulation model built from an 8-bit R2R matrix is created in the Proteus environment. To demonstrate the resolution capability of the DAC, the input binary combinations are generated by an Arduino Mega 2560.

The oscillograms of the output signal observed with the EasyScope software oscilloscope are visualized on the computer monitor. EasyScope allows management and adjustment of generated signals in order to report their parameters with high accuracy.

A current summation DAC simulation model is created in the Multisim environment. The model provides the possibility to supply different combinations of the bits of the input digital signal through switches, for which the currents and voltages in the branches of the circuit can be measured with measuring probes.

Simulation models provide the possibility to deploy in real hardware (laboratory platform) to conduct physical experiments. Proteus and Multisim train the creative thinking of learners and prepare them to conduct the physical investigation of these types of DACs.

With the created laboratory mock-ups, the students verify the results of the DAC simulation studies. The results of the conducted experimental studies are presented.

- Г8.13. Slavi Lyubomirov, Daniela Shehova, Peter Yakimov, Angel Chekichev. (2020), "Hardware and Software for Teaching Digital-to-Analog Converters in Engineering Education", Conference: 12th International Conference on Education and New Learning Technologies, 6th-7th July 2020, Spain, pp. 1629-1636, ISSN:2340-1117, ISBN: 978-84-09-17979-4, doi: 10.21125/edulearn.2020.0528..

The purpose of the paper is to share our experience in creating experimental modules driven by an open source platform for teaching modern digital-to-analog converters in university digital circuit engineering courses.

The created modules are hardware supported by the Texas Instruments ASLK PRO laboratory kit, Arduino Mega 2560 microcontroller development platform and precise measuring equipment. They are intended for students studying engineering majors at Paisii Hilendarski University of Plovdiv, studying digital-to-analog conversion processes.

In order for students to learn the principles of converting a digital code into an analog value, the first module was developed, with which integral DACs are experimentally investigated. The module is implemented with a researched 12-bit DAC 7821, an OPAMP-TL 082CP working as a current-to-voltage converter and an Arduino Mega 2560 that provides the digital levels of the input signals.

To enable learners to explore the precision of digital-to-analog conversion, the second module has been developed to explore and compare the performance of two DACs simultaneously. The output voltage of the second DAC is filtered using a suitable low-pass filter. Thus, learners can explore and compare the stages of digital-to-analog conversion without filtering the converted signal and in the presence of a low-pass filter, leading to an increase in the precision of the digital-to-analog conversion process. The oscillograms of the two output signals for the same input digital codes generated by the Arduino were analyzed.

The third module is designed for students to develop skills for controlling a DAC with LED display and keyboard. The LED indication provides the possibility to monitor the change of the input bit combination. By connecting the keyboard to the microprocessor module, the parameters of the output signal can be flexibly controlled. With this module, students form practical skills for programmatic control of peripheral devices using microcontrollers.

The proposed hardware and software tools for teaching DAC in engineering education increase students' interest in learning the principles of digital-to-analog signal conversion and motivate their desire to conduct and manage engineering research and present results of experimental work. The skills formed can find application in the educational process and research practice and in other university engineering courses.

Г8.14. I. Bozhikov, R. Popov, S. Lyubomirov, D. Shehova, (2020). "Analyzing the reasons for computer system failures through the focus of engineering training", ICERI2020, Conference, 9th-10th November, 2020, Spain, ISBN:978-84-09-24232-0, doi: 10.21125/iceri.2020.1976, pp :8940-8945.

The main goal of the article is to present the authors' research on the integration of a new approach into the educational process of students of computer majors in higher education. The goal is to overcome the difficulties associated with the study of computer disciplines and to support the personal development of students.

The article examines the main causes of computer system malfunctions and hardware and software failures. The main points that the authors present in the study are component temperatures outside the allowable operating temperature range; abnormal parameters of the voltage, frequency and spectral composition of the supply voltage; incorrectly selected power supply; low-quality computer components; poor packaging of the computer equipment by the manufacturer; natural disasters and accidents. All of these questions are important for trainees to have a good understanding of the causes of hardware failures so that they can successfully participate in engineering teams that design highly reliable power control systems. The continuous development of modern technologies, the demand and supply of new computer systems, lead to the need for in-depth knowledge from students about the proper function of the systems.

A tabular analysis of the obtained results is presented regarding the main causes of computer failures that cause data loss. The failure rate of computer components is indicated. The results of the performed studies related to the causes of hard disk failures are graphically visualized.

Our experience using these approaches shows that they can be successfully used to clarify the nature of these problems. The data obtained from the conducted statistical analysis of the causes of computer failures are used not only for the theoretical training of students, but also serve as a link to their direct application in practical training courses. For example, the analysis of the causes of failures related to the increase in the operating temperature of computer components determines the conduct of practical classes related to the improvement of cooling. The teacher demonstrates the process of cleaning the radiators, replacing the thermal paste of the processor, lubrication, replacing the fans, etc. The learners then perform the same procedures and analyze the errors that were made. Similar practices are carried out with hard drives, RAM, power

supplies, network equipment, etc. Overcoming the difficulties associated with the study of computer systems will support the professional preparation of students and their successful implementation.

Г8.15. Minchev, R., Popov, R., Lyubomirov, S. (2020). "Investigation of the impact of an implemented additional liquefied petroleum gas (LPG) fuel system on gasoline internal combustion engines in engineering training", Conference: 13th annual International Conference of Education, Research and Innovation, 9th-10th November, 2020, Spain, pp : 8940-8945, ISBN: 978-84-09-24232-0, doi: 10.21125/iceri.2020.1969.

This article discusses the development of innovative technologies in (LPG) systems and the impact of propane-butane gas mixture on engine performance. The emphasis is placed on the impact of a learning process in the field of these technologies and applying the acquired knowledge to improving the environmental situation in cities. The main environmental characteristics of the operation and a gasoline engine with internal combustion in a mixture of gas and air are considered.

It is extremely important to obtain results that provide quality training to stakeholders, professionals and students in the field of automotive electronic systems. The interrelationships of the subject under consideration are analyzed with other disciplines in the field of transport engineering and technology.

Guidelines are developed for students to perform process control combustion test setups in both naturally aspirated and positive ignition engines. Emphasis is placed on the methodology for selecting optimal parameters of the system controller, based on the full current sensor information about the engine condition.

Since there is a difference in the octane number of gasoline and gas-air mixtures, their combustion and characteristics are also different. Therefore, LPG engines must carry out a specific setting of program parameters that guarantee the necessary quality of the combustion process and meet environmental standards. This can be done with the help of modern innovative designs of (LPG) systems that have been developed recently. The optimal setting of the controllers of these systems has a beneficial effect on the condition of an internal combustion engine and minimizes harmful emissions. Therefore, students must be trained to perform these procedures correctly based on the analysis of objective control data. This leads to a better understanding of the specifics of the taught material in the field, as well as a better understanding of modern fuel controllers and their application to improve the environmental situation in cities. It is also an additional guarantee for their successful future professional realization. The article presents the results of the study of two control groups of students. The first group was trained using a traditional methodology based on existing LPG systems - the older generation. The second group is based on the new innovative fuel controllers and the LPG methodology for their adjustment.

The methodology is justified in the following sequence:

- 1 Selection of engine type according to fuel system.*
- 2 Selection of suitable LPG systems for the engine with the necessary software.*
- 3 Sequence of action during execution.*
- 4 Testing of the implemented LPG system.*
- 5 Exhaust gas results obtained with a gas analyzer when working with LPG systems.*

During the learning process, students take a series of measurements. The educational emphasis of the students' training is the experience they gain during the training in working with specialized equipment and software related to the new innovative LPG controllers. Based on the presented results, students gain experience, knowledge and skills for analyzing and drawing conclusions.

The results of comparative measurements of the content of harmful emissions in exhaust gases during testing of a gasoline engine and the same engine running on LPG are presented.

Г8.16. Minchev, R., Lyubomirov, S., Popov, R. (2020). "Training in the field of influence of the defects of the systems for neutralization of harmful emissions on the vehicle's operation", Conference: 13th annual International Conference of Education, Research and Innovation 9th-10th November, 2020, Spain, pp: 8940-8945 , ISBN:978-84-09-24232-0, doi: 10.21125/iceri.2020.1972.

Based on the performance of real experiments and measurements, the article analyzes the changes in the operation and environmental parameters of the internal combustion engine in case of failure of any of the systems for reducing the amount of harmful emissions.

Educational and research stands for diesel and gasoline engines were developed in the laboratory of internal combustion engines at the Faculty of Physics and Technology of Plovdiv University "Paisiy" Hilendarski". They were used in the process of practical training of students from the specialty "Automotive Technology".

The training focuses on the complex structure of the EGR, the lambda probe, the catalytic converter and the DPF particulate filter, which ensure the reduction of harmful emissions from the car.

The training methodology examines in detail the exhaust gas recirculation (EGR) system, which serves to reduce nitrogen oxides in the exhaust gases by returning part of the gases to the intake manifold.

The performance of the lambda probe, which is an oxygen concentration sensor used to determine the amount of oxygen in the exhaust gas, is also analyzed. The information from it is used by a controller to dose the amount of fuel in the fuel-air mixture in order to burn it completely.

The principle of operation of catalytic converters (CAT) is indicated. They are designed to convert the harmful components of the exhaust gases emitted by internal combustion engines into harmless gases through a chemical reaction. Therefore, the catalytic converter is an important part of modern emission control systems for SI and diesel engines.

In the process of practical training, a sequence of errors is realized. A diagnosis is made and the causes of their occurrence and their consequences are analyzed. Then their systematization is carried out. Specialized software is available that provides modern methods of system diagnostics.

The training methodology proposed in this article will undoubtedly ensure the application of modern methods of system diagnostics. This will contribute to obtaining valuable information for all specialists and students of the specialty "Automotive electronic systems" and related automotive fields.

Г8.17. D. Shehova, S. Lyubomirov. (2021). "Simulation teaching and research of parameters of integral amplifiers in the multisim environment", INTED 2021, 15th International Technology, Education and Development Conference, CONFERENCE PROCEEDINGS, 8-9 March, 2021, page(s) 8747-8753, ISBN: 978- 84-09-27666-0, ISSN: 2340-1079, DL: V-370-2021.

The paper presents the use of the NI Multisim software platform for teaching and researching integrated amplifier parameters in university electronic circuits courses.

Creating models for the simulation study of the parameters of integrated amplifiers through the analysis of environments directly corresponds to the introduction of new learning technologies that provide knowledge without the limitations of the traditional way of teaching. The main advantages of using operational amplifiers (Op Amps) in electronic circuits are that the addition of a small number of external elements, which allows the creation of various circuits of functional signal processing devices. The wide variety of operational amplifiers, the possibility of implementing analog and digital circuits, together with the small size and low price of a significant part of them have contributed to their transformation into a universal building component. This requires students to develop the skills to determine the parameters of operational amplifiers that are suitable for the considered applications to be appropriate.

Г8.18. D. Shehova, S. Lyubomirov. (2021). "Computer Modeling and Research of Diode Rectifiers and Voltage Regulators", INTED 2021, 15th International Technology,

Courses in which Power Supply Devices are taught are represented in the curricula of almost all technical majors. Due to the unequal level of preparation of the students, a different teaching approach is needed. For some majors, it will be useful for learners to enter the subject through computer-based learning using computer models and simulations. In majors for which the topic is basic, computer simulations support practical training.

The article presents simulation models of single-half-cycle rectifiers and two-half-cycle bridge rectifiers. Their operation with an active load and with the presence of smoothing capacitors is simulated. Computer models allow to observe with a virtual oscilloscope the shapes of the signals in their different operating modes and to measure their main parameters.

A parametric analysis was performed to investigate the influence of the filter capacitor on the value of the rectified voltage and the ripples superimposed on it. The theoretically calculated and simulation-reported values of the investigated electrical quantities are presented in a table: average value of the standing voltage, frequency of pulsations, pulsating voltage.

The computer model of a voltage regulator implemented with IC LM317 LM from National Semiconductors is useful for understanding how the input voltage, which can be up to 40 V, can be regulated at the output in the range of 1.2V to 37V. The model uses measuring probes at nodal points to track the change of electrical quantities in real time. The theoretically calculated and simulation reported values of the modified adjustable output voltage are presented and compared.

The developed models of diode rectifiers and voltage regulators and the research carried out with them, were useful in conducting online training on the discipline "Power supply devices during the quarantine of COVID-19" to bachelors of "Computer and communication systems" and "Hardware and software systems" " at the Faculty of Physics and Technology of Plovdiv University "Paisiy Hilendarski".

Г8.19. N. Paunkov, S. Lyubomirov, R. Popov, D. Shehova, (2021). "Implementation of virtual statistical measuring instruments in engineering education during covid-19", INTED 2021, 15th International Technology, Education and Development Conference, CONFERENCE PROCEEDINGS, 8-9 March, 2021, page(s) 9801-9809, ISBN: 978- 84-09-27666-0, ISSN: 2340-1079, DL: V-370-2021.

A virtual statistical data processing tool was developed and tested, used for teaching bachelors and masters in the discipline of electrical measurements. The data are taken from a real working installation. The virtual instrument is built into a software system for working in real time online.

A statistical virtual tool was also created to check the distribution of data obtained during repeated measurements. The tool is implemented in the LabView programming environment and allows it to be embedded as a module in more complex data processing programs. The statistical virtual instrument is based on the LabView software platform developed by NI - Instrument. It consists of a LabJack UE9 data acquisition (DAQ) module and an expansion card that increases the number of measurement channels through virtualization. With suitable sensors, the measured values can be temperature, voltage and current. The information from the sensors, converted into an electrical signal, enters the input of differential amplifiers on the corresponding channels of the expansion card.

The created virtual tool has the following functions: Construction of the Errorbar of the investigated quantity with or without adding to it the information on the total uncertainty; function to build a histogram of the distribution, quantile by quantile, manually or automatically.

The processing of the results is carried out in the following sequence: exclusion of gross and systematic errors; determining the type of distribution of the results of repeated observations; elimination of uncertainty in the final result due to random errors.

Students conduct statistical tests based on a sample taken from a real working measurement system of an installation for measuring the parameters of photovoltaic panels.

Г8.20. N. Paunkov, S. Lyubomirov, V. Rangelova, R. Popov, (2021). "Virtual system for generating and measuring real time signals used in e-learning", INTED 2021, 15th International Technology, Education and Development Conference, CONFERENCE PROCEEDINGS, 8-9 March, 2021, page(s) 10051-10058, ISBN: 978 -84-09-27666-0, ISSN: 2340-1079, DL: V-370-2021.

This paper presents the development of a virtual system for real-time signal generation and measurement. It is successfully used in the distance education of bachelors from the Technical University of Sofia - Plovdiv branch in the discipline "Electronic measuring devices and primary converters". A virtual function generator equipped with two real output signals is developed using a DAC module that is built into the computer. For this purpose, the built-in sound card of the personal computer is used. Using the RealTek ALC269 sound card, real signals are received in the form of alternating voltage through the audio jack of the sound card. The generator is fully functional and can form three different types of output signals - sine, triangle and square. The virtual measurement tool has also been developed to measure the parameters of the signals generated by the virtual function generator in real time. It can also be used to measure parameters of other signals in real time. This tool contains an oscilloscope and a spectrum analyzer. In this way, learners can solve various tasks related to learning the shape of signals, measuring frequency, amplitude and observing waveforms. Additionally, noise can be added to the signal and some other tasks can be performed.

The accuracy of the measurement is checked with the monitoring tool additional oscilloscope model Siglent SDS1052DL 50MHz. The relative frequency and amplitude measurement errors for the developed instrument are similar to those from Siglent.

The spectrum analyzer implemented in the measuring instrument enables spectral analysis of the generated signals and allows the trainees to become familiar with this type of measurement.

The functionality of the virtual function generator and the virtual measurement tool has been proven with many experiments. According to the results, we can conclude that both based on virtual instrument technology can meet the requirements of high accuracy and stability at low and medium frequencies, in many fields. The different types of frequencies, amplitudes, and waveforms of the output waveforms generated by the developed virtual function generator can be set through the computer control panel, and the parameters of the signals generated through the output of the DAC module can be measured using the developed instrument for measurement.

Oscilloscopes are an integral tool for those who design, test or repair electronic equipment. Their applicability is very wide across various industries, which means that technical students should have a lot of knowledge about this tool. The same goes for the spectrum generator and analyzer. They are used in the field of electronics, measurement systems and automotive electronics, also any school or university in these fields can benefit and teach their students with it, with a progressive method that does not require separate equipment or laboratories, but everything can to think and do from one room and one device. Therefore, such generation and measurement becomes very suitable for distance learning purposes.

From an economic point of view, we have developed a tool that is functional, easy to use and relatively cheap compared to the overall market. It can be easily used in the real workplace or in the classroom without additional components, directly with the most common devices such as the computer and used for distance learning.

Г8.21. Shehova, D., Lyubomirov, S. (2021). "Computer modeling of oscillatory schemes for online learning in engineering education", EDULEARN21: 13th annual International Conference on Education and New Learning Technologies, 5th and 6th of July, 2021, ISSN: 2340-1117, ISBN: 978-84-09-31267 -2, Pages: 6485-6492, doi: 10.21125/edulearn.2021.1321.

In the COVID-19 pandemic, it is important that educational institutions continue to conduct online learning in electronic environments. COVID-19 posed new challenges to the academic

teachers at the University of Plovdiv, so they continued to develop a set of e-learning tools that directly correspond to the curricula of the respective courses.

The authors of this article share their experience in online tuning of oscillator circuits, which are the main nodes of radio transceivers, taught in the course "Fundamentals of Communication Technologies". Creating computer models of oscillator circuits with Multisim supports students in their studies. They acquire a deeper understanding of oscillators with different frequency types, a selective filter used in feedback. Computer models allow demonstration of the performance of these devices under various criteria. Using virtual instruments, learners perform real-time measurements of amplitude, frequency and nonlinear distortions of the generated signals.

The article presents computer models of:

- RC Phase Shift Oscillator, implemented with Op-amp TL 082CD;
- Colpitts oscillator, implemented with Op-amp LM741CH;
- Wien Bridge oscillator with frequency control, realized with Op-amp LM741CH;
- Triangle & Square Wave oscillator, implemented with OPA364ID op-amp.

The calculated and simulated readings of the measured parameters are presented and analyzed. Oscillograms of the generated signals of the investigated oscillators, observed with a virtual oscilloscope, are presented and compared. Time domain analysis is performed. Using the free version of the NI Multisim (Analog Devices Edition) software environment enables students to solve various problems that arise when learning the lecture material and this makes the taught concepts easier to understand.

Г8.22. Lyubomirov, S., Shehova, D., Ismail, S. (2021). "Online teaching of mobile Communication systems during the COVID-19 pandemic using MATLAB/OCTAVE", EDULEARN21: 13th annual International Conference on Education and New Learning Technologies, 5th and 6th of July, 2021, ISSN: 2340-1117, ISBN: 978- 84-09-31267-2, Pages: 7109-7111, doi: 10.21125/edulearn.2021.1435.

In recent years, computer modeling of difficult-to-reproduce processes and phenomena has gained increasing importance in higher education engineering studies.

In this context, we chose the MATLAB/OCTAVE platform because the students have the knowledge to work in the Matlab environment, and Octave is free, freely distributed software licensed under the General Public License (GNU). The language is almost identical to the core Matlab and is suitable for modeling processes in long-term evolution (LTE) networks. The learning strategy based on the interactive use of ATLAB/OCTAVE for teaching LTE communication systems aims to acquire permanent knowledge in this area (radio spectrum flexibility, multi-antenna data transmission). LTE systems contain most of the features that were originally intended for 4G systems.

The article presents simulated block diagrams that reflect the stages of:

- Create a random bitstream;
- Convert a sequence of bits to a sequence of characters;
- Constellation Modulation Symbol Generation;
- Adding noise;
- Convert character to bits;
- Bit Error Rate / Ratio (BER) calculation.

For each of the stages demonstrating the operation of the LTE system, in addition to the presented computer model, there is source code written in MATLAB, which is used for graphical visualization of the step-by-step conversion of bit and symbol streams, noise addition and BER calculation.

Г8.23. Shehova, D., Lyubomirov, S., Ismail, S. (2021). "Structural identification of systems using artificial intelligence algorithms in the training of students", EDULEARN21: 13th annual International Conference on Education and New Learning Technologies, 5th and 6th of

The article focuses on the potential of accessible software environments used in distance learning of masters in university engineering education. An example of such an environment is MATLAB, due to the fact that it combines a work environment created for iterative analysis and design processes with a programming language that expresses itself in the mathematics of matrices and arrays. MATLAB applications allow learners to watch various algorithms work with their input until they get the desired results, after which the program is automatically generated to reproduce or automate the activity.

The authors of the paper share their experience on the possibility of applying stochastic algorithms to identify the structure of linear systems, using genetic algorithm (GA) and particle swarm optimization (PSO) to estimate the order of the augmented autoregressive (ARX) model .

Emphasis is placed on the structural identification methods by model parameters and the criteria used that consider the adequacy and orderliness of the model: Aikake Information Criterion (AIC), Bayes-Schwartz Criterion (BSC) and Residual Model Error Sum of Square (RSS).

Г8.24. Hristo Kanevski, Slavi Lubomirov, Raicho Minchev (2022). "Overview of the problems and solutions related to environmental pollution caused by cars", Third National Scientific Conference "Man and the Universe", Union of Scientists in Bulgaria - Smolyan, November 25-26, 2021, Scientific works, Volume III, part 3, pp. 465 – 471, ISSN:1314-9490 (online).

This article details the composition of automobile exhaust gases and the percentage content of each of the components in diesel and gasoline engines. Information is given on the saturation of harmful components at different engine loads.

The main emphasis in this report is the electronic systems for improving the harmful emissions of cars, for the most common and effective of them, information is provided about their design features and the principle of operation.

As a conclusion of the overview, it can be said that systems for improving the environmental characteristics of cars with an electronic control unit have a major role in reducing harmful emissions from cars.

Г8.25. Sezgin Ismail, Slavi Lubomirov. (2022). "Identification of systems. Problems and modern methods". Third National Scientific Conference "Man and the Universe", Union of Scientists in Bulgaria - Smolyan, November 25-26, 2021, Scientific Papers, Volume III, Part 3, pp. 602 - 610, ISSN:1314-9490 (online).

The authors of the article focus on the issue of identification of processes and phenomena of telecommunication models. It occupies one of the central places in modern management theory. It is generally defined as finding a model of the object, based on a limited number of measurements of input and output quantities that may be subject to random disturbances. It is very relevant and concerns the automation of one of the processes that are difficult to formalize and automate, and is currently carried out mainly subjectively, namely the modeling of systems and processes. This is a problem that has been very actively worked on worldwide in recent years. It is conceptually justified that the basis of the theory is the construction of a mathematical model (identification), which is an informational algorithmic approach. Object statics and object dynamics models are two sides of the same task: creating a mathematical description for optimal object management. While static research aims to determine the optimal established technological mode of the object, the study of its dynamics creates a prerequisite for creating an automatic control system to support this mode. Neglecting either of these two aspects degrades the quality of the resulting solution. The authors put forward the view that it is pointless to create a perfect automatic control system to support a poorly chosen static mode of the object. On the other hand, if we know the optimal technological mode, but we cannot maintain it well enough, the efficiency of the object's work will not be high either.

Г8.26. Hristo Kanevski, Slavi Lyubomirov, Stanislav Asenov. (2022) "Simulation of engine malfunctions and their impact on emissions with an emphasis on engineering education", ICERI2022 (15th annual International Conference of Education, Research and Innovation), Seville (Spain), Publication year: 2022, ISBN: 978-84 -09-45476-1, ISSN: 2340-1095, Pages: 7525-7532, doi: 10.21125/iceri.2022.1917.

The aim of this research presented in the report is to simulate the various faults in the car engine and show their effect on the car emissions. An experimental methodology was implemented and tested for the study of various engine malfunctions during the education of students of engineering majors directly corresponding to automotive technology. A total of 10 different worst-case failures are presented. The obtained tabular data give the students a reason to form knowledge and skills for a better understanding of the material. The graphical results are summarized and analyzed to provide information on the emission performance of motor vehicles. The data can be used to assess the effect of parameters such as engine load and ambient temperature on vehicle emissions. The students performed tests that were simulated and grouped into the following functional areas: air intake, ignition and exhaust aftertreatment. Deterioration of spark-ignition engine emission control systems has been found to be primarily a gradual wear process that occurs with vehicle mileage. To identify the impact of hardware degradation and failures, a Volkswagen Golf passenger car with a gasoline engine was used, on which the trainees demonstrated simulated failures of the engine's hardware systems during the experiments. To measure the impact on emissions, professional equipment was used to measure the composition of harmful emissions in exhaust gases from the car. After the tests, it was found that seemingly insignificant problems can repeatedly worsen the composition of harmful emissions.

Г8.27. Hristo Kanevski, Slavi Lyubomirov. (2022) "Analysis of sensors affecting harmful emissions from road transport applied in engineering education", ICERI2022 (15th annual International Conference of Education, Research and Innovation), Seville (Spain), Publication year: 2022, ISBN: 978-84-09 -45476-1, ISSN: 2340-1095, Pages: 7136-7145, doi: 10.21125/iceri.2022.1814..

The report presents a comparative analysis of the waveforms of two structurally different air volume sensors. During training with trainees, data was taken from a mechanical air quantity sensor, model BOSCH 1 734 655.9, in which a measuring plate is moved in proportion to the volume of air entering the engine. Additional analysis was done on a ZDTOPA 93BB-12B579-BA Incandescent Air Volume Sensor, where a thermistor measures the intake air temperature. The heating wire has a constant temperature maintained by the electronic control unit (ECU) using the signal from the thermistor. It was found that increasing the intake air flow caused the temperature of the heating wire to drop and the engine control unit immediately compensated for this by feeding more current through the wire. The control scheme that simultaneously senses the supplied current and proportionally converts it to voltage is discussed. In this way, the electronic control unit (ECU) of the engine has the most precise and immediately updated information about the amount of air entering the engine.

Particularly important in the issue under consideration is obtaining results to ensure quality training of interested persons, specialists and students in the field of automotive electronic systems.

Г8.28. Angel Chekichev, Anatoly Parushev, Slavi Lyubomirov. (2022). "A Study Methodology of Filters Implemented Using the LABVIEW Environment", Proceedings of a National Scientific Conference with International Participation on the Theme "Education, Science, Society" November 3-4, 2022, ISBN 978-619-7663-43-3 (online), pp. 1042-1048.

Knowing the basics of filter research methodology is an important point covered in this article. Knowledge of the LabView development environment is important for students' training, because it helps to better and effectively understand the main theoretical concepts involved in their studies in the disciplines "Digital Signal Processing" and "Signals and Systems". Also, an

additional opportunity for teaching is provided through the construction and creation of virtual laboratories, which help to more efficiently and qualitatively perceive the material through remote access.

- Г8.29. Hristo Kanevski, Slavi Lubomirov. (2022). "Investigation of Gas Nozzles Affecting Harmful Emissions", Proceedings of the National Scientific Conference with International Participation on Education, Science, Society November 3-4, 2022, ISBN 978-619-7663-43-3 (online), pp. 1080-1091.

An analysis of electronically controlled valve nozzles is presented in the report. During the training with students, data was taken from nozzles with electronically controlled valves that inject liquefied petroleum gas into the intake manifold of the internal combustion engine.

To carry out the research presented in this report, the equipment of the company "Autoditex" is used.

- Г8.30. Parushev, A. Chekichev, S. Lyubomirov, R. Popov, N. Paunkov. (2023). "Virtual bench for Remote measurement of air flow velocity in a duct through a pitot tube", 17th International Technology, Education and Development Conference, INTED2023 Proceedings, Valencia, Spain, ISBN: 978-84-09-49026-4, ISSN: 2340 -1079, Pages: 5536-5541, doi: 10.21125/inted.2023.1449.

The authors of this article draw attention to the main problems related to the creation of a virtual laboratory designed for remote measurement of the air flow velocity in a duct using a pitot tube. An important point in this is students' understanding of the basics and working principles of this pitot tube. The pitot tube is mainly used to measure the flow rate of gases and liquids, which consists of two concentrically bent tubes whose openings in communication with the liquid are arranged in a specific way.

A tube is opened perpendicular to the fluid flow, so learners can determine and conclude that the pressure in that tube is equal to the ambient pressure or static pressure. Thus, learners conclude that pressure is the total pressure as the sum of static and dynamic pressure. Based on this, it is clear that students' understanding of theoretical conceptual relationships is essential in analyzing the data that can be obtained from a manometer that is placed on a pitot tube.

- Г8.31. Paunkov, N. and Popov, R. and Chekichev, A. and Parushev, A. and Lyubomirov, S. (2023). "Magnetic field measurement with microprocessor platform with intelligent sensor", 17th International Technology, Education and Development Conference, INTED2023 Proceedings, Valencia, Spain, ISBN: 978-84-09-49026-4, ISSN: 2340-1079, Pages: 5282-5289, doi: 10.21125/inted.2023.1367.

A standard methodology for determining power losses in silicon wafers caused by eddy currents is reviewed. We use the Epstein apparatus, by which we set specific values for the magnetic induction, which we keep constant for each of the experiments. The magnetic induction is measured by the smart sensor, but we need to break the magnetic wire to insert the sensor, resulting in an air gap. We measure the magnetic induction in the air gap, for this we need to recalculate the entire magnetic circuit, since there is no air gap intended. We compare the results we get with those measured by the sensor and get an average of about 4-5% error. Which shows that we have done the calculations correctly. As a benchmark, we take the readings of the magnetic sensor.

- Г8.32. Parushev, A. and Chekichev, A. and Paunkov, N. and Popov, R. and Lyubomirov, S. (2023). "Virtual bench for remote measurement of the specific heat capacity of air", 17th International Technology, Education and Development Conference, INTED2023 Proceedings, Valencia, Spain, ISBN: 978-84-09-49026-4, ISSN: 2340-1079, Pages : 5248-5253, doi: 10.21125/inted.2023.1358.

The report focuses on the development of autonomous communication and technological means, ensuring the application of new methods and methodologies for upgrading knowledge in the field of heat exchange processes and specifically in determining the specific heat capacity of air. It is an essential part of the training of students in engineering education and in particular in the field of eco-technology and eco-energy.

The authors of this article direct the main attention to the creation of a virtual laboratory for the remote study of the specific heat capacity of the air, and for this purpose the trainees must follow the sequence of actions indicated in the relevant methodology. Virtualization provides ample opportunities for learners to upgrade their knowledge in this field. And also the creation of individual skills and qualities for synthesizing and analyzing data from the built virtual stand.

Г8.33. Paunkov, N. and Popov, R. and Parushev, A. and Chekichev, A. and Lyubomirov, S. (2023). "Measurement of electrical power and energy with a smart meter", 17th International Technology, Education and Development Conference, INTED2023 Proceedings, Valencia, Spain, ISBN: 978-84-09-49026-4, ISSN: 2340-1079, Pages: 5000 -5008, doi: 10.21125/inted.2023.1300.

A microprocessor smart device has been developed to measure current, voltage, electrical energy, power, power factor and phase angle. The measurement of current and voltage is done using a current and voltage sensor that converts them into analog voltage signals that are fed to an Arduino Nano series microprocessor. The use of this smart device in the training of students in the discipline "Electrical Engineering" and related disciplines in the Faculty of Physics and Technology of PU "Paisiy Hilendarski" and SU "St. Kliment Ohridski", makes learning a complex theory that must be presented interesting and appropriate for students. The training becomes a visual practical demonstration, i.e. how all the digital devices work and how the real-time monitoring results will be processed and analyzed. This results in providing a wider range of tools that students can use to present the resulting measurement data. In this way, opportunities are provided to develop skills and competencies and enrich their knowledge in the field of electrical engineering and understanding of microprocessor and microcontroller technology.

Г8.34. Shotarova, S. and Stoyanova-Petrova, S. and Lyubomirov, S. (2023). "Enhancing engineering learning through the use of an interactive laboratory", 15th International Conference on Education and New Learning Technologies, EDULEARN23 Proceedings, Palma, Spain, 3-5 July, 2023, ISBN: 978-84-09-52151-7, ISSN : 2340-1117, Pages: 1716-1724, doi: 10.21125/edulearn.2023.0523, <https://doi.org/10.21125/edulearn.2023.0523>, publisher = {IATED}.

In this article, the authors analyze the advantages of modern interactive laboratories implemented in various disciplines. Our review and analysis reveal a number of interesting observations, findings, and insights in virtual and remote lab implementations. Virtual and remote labs provide a number of benefits such as remote persistent access, flexibility and freedom to learn at your own pace and reset/re-experiment without wasting resources in a safe environment and provide new learning opportunities. In this context, we describe the various virtual laboratory functions used in educational tasks at the university level and conduct research on the advantages and disadvantages they offer for teaching.

Designing, planning and setting up a virtual lab can be a very difficult process, which can become even more complicated if the lab needs to provide access to real equipment. A problematic step in developing such virtual labs is choosing the right access method. Currently, there are many technologies that allow users to access devices remotely.

Г8.35. Velev E., Lyubomirov Sl., (2023), Methodology for restoring the gerotor pump of automotive hydraulic amplifiers, Mechanics of Machines, book 3, 2023, ISSN 0861-9727 in print.

In the present work, a practical approach for restoring a gerotor pump used in the hydraulic amplifiers of a car is developed and illustrated. The introduction of hydraulic steering is a new era in the automotive industry, because the turning of the steering wheel and, respectively, of the turning wheels is supplemented by a pump, which reduces the required effort. The methodology shown can be used to restore the operability of this vehicle unit.

Г8.36. Stanislav Asenov, Anatoly Parushev, Slavi Lyubomirov, Daniela Shehova, Hristo Kanevski, Emil Veleв. "Creating a three-dimensional virtual hall for engineering education". Journal of Physics and Technology, Volume 1 (2019) Number 1, pp. xx ISSN 2535-0536 (in press).

In the context of rapidly developing technological trends, virtual reality (VR) represents a highly impactful tool for innovation in various sectors, including education. The authors of the article share their experience of creating a virtual classroom with a specialized interactive assembly model with the application of modern technologies in engineering education. Using an integrated approach combining the competencies of tools such as Blender, SolidWorks and Unity, an innovative educational solution has been created that provides deeper learning. The virtual classroom will allow students to be part of an intelligently constructed educational space in which they will be able to not only visualize and manipulate objects, but also assemble them in the virtual space. The essential advantage of this approach is the active involvement of students in the learning process. The virtual environment stimulates interest and imagination by providing the opportunity for real interactions and experiences. The relevance of the article stems from the growing need for innovative educational approaches reflecting modern technological changes and requirements.

Г8.37. Hristo Kanevski, Stanislav Asenov, A. Parushev, S. Lyubomirov, D. Shehova, C. Copilusi, I. Geonea and L. Racila. "3D Printing in the Automotive Industry". Journal of Physics and Technology, Volume 1 (2019) Number 1, pp. xx ISSN 2535-0536 (in press).

The article presents the implementation of 3D printing in the automotive industry. According to a report by automotive research company Smart Tech Publishing, 3D printing is increasingly being used to produce automotive parts.

The authors of the article present the process of designing and making a functional cup holder replacing the existing factory one. The 3D printed cup holder provides car upgrades by providing space for a smartphone, coins and power cable. The realized cup holder is resistant to temperature changes during different seasons and is characterized by stable mechanical parameters.

Г8.38. Hristo Kanevski, Stanislav Asenov, Anatoly Parushev, Slavi Lyubomirov, Daniela Shehova. "Create a Virtual 3D Object of Hotel Building". Journal of Physics and Technology, Volume 1 (2019) Number 1, pp. xx ISSN 2535-0536 (in press).

The article presents a generated 3D object of the hotel building through the Blender software, which is successfully connected with the virtual reality tools - Oculus Quest 2 and can be applied in the following areas and fields: education and research; architecture and project visualization; gaming industry and virtual reality, animation and film industry; advertising and marketing etc. The virtualized 3D object is a floor of an existing Vanilex building. With its powerful tools and capabilities, Blender gives users flexibility and creative freedom to create impressive virtual buildings and architectural projects.

Г8.39. A. Parushev, R. Popov, S. Lyubomirov, D. Shehova, St. Asenov, H. Kanevski, Emil Veleв, S. Shotarova. "Using 3D Modeling to Demonstrate the Device and Operating Principles of an Automotive Clutch". Journal of Physics and Technology, Volume 1 (2019) Number 1, pp. xx ISSN 2535-0536 (in press).

In the report, the authors emphasize modern production technologies, also known as 3D printing or additive manufacturing, which have applications in various areas of human activity.

These methods are characterized by accuracy and economy compared to traditional methods of manufacturing parts, components and elements. These technologies are characterized by: low production costs, the ability to create complex and innovative models, flexibility of the materials used and extremely fast production speed. Technological advances in this field are opening doors for the use of additive technologies in the academic and scientific sectors. In this regard, the emphasis of the publication is placed on the creation of a three-dimensional model for students' understanding of the main functional capabilities of the dry, frictional, single-disc clutch in modern cars. This model can be used to create educational and scientific tools that facilitate learning and expand the scope of scientific research in this area, contributing to the improvement of the quality of scientific and educational activity.

Г8.40. S. Lyubomirov, V. Rupetsov, E. Velev. "Methodology for automated fixture design in CAD environments". "Days of Science 2023" of SUB - Plovdiv November 23-24, 2023. Scientific works of the Union of Scientists in Bulgaria - Plovdiv, series B. Natural and humanities, vol. XXIV, ISSN 1311-9192 (Print), ISSN 2534 -9376 (On-line), 2023. Scientific researches of the Union of Scientists in Bulgaria-Plovdiv, series B. Natural Sciences and the Humanities, Vol. XXIV, ISSN 1311-9192 (Print), ISSN 2534-9376 (On-line), 2023. (in press).

The report presents a methodology for the automated design of devices in the conditions of CAD environments, used in the training of students of mechanical engineering majors. For the creation of prototypes of the models, a 3D printer Creat Bot PEEK - 300, owned by the Faculty of Physics and Technology at the University of Plovdiv, was used. The Mastercam program (Groover, 2013) was used to develop a machining control program. Emphasis is placed on the design features of the product.

Г8.41. S. Lyubomirov, E. Velev, St. Assenov, D. Shekhova, Hr. Kanevski, Sn. Shotarova. "Software platforms for three-dimensional automated design" "Days of Science 2023" of SUB - Plovdiv November 23-24, 2023. Scientific works of the Union of Scientists in Bulgaria - Plovdiv, series B. Natural Sciences and Humanities, vol. XXIV, ISSN 1311 - 9192 (Print), ISSN 2534-9376 (On-line), 2023. Scientific researches of the Union of Scientists in Bulgaria-Plovdiv, series B. Natural Sciences and the Humanities, Vol. XXIV, ISSN 1311-9192 (Print), ISSN 2534-9376 (On-line), 2023. (in press).

The report presents the modern CAD systems that are used for fully automated design, technological preparation, analysis and production of products in mechanical engineering and for electronic management of technical documentation. CAD/CAM systems are a suitable environment for automated structural and technological design during detail processing. The report presents modern software platforms for three-dimensional automated design used in the training of students of mechanical engineering specialties. The requirements for technical professions related to industrial production are already changing, and the tasks of specialists who will work in "smart" factories or conduct scientific research, rethink. Therefore, universities are faced with a responsible task, to provide future engineers, technologists, designers with sufficiently deep knowledge and practical skills in the field of the latest technologies, so that they enter the digital world fully prepared.

- **Manuals**

- **Learning aid**

1. Lyubomirov, S., Chekichev, A., Raidovska, V., Shekhova, D., Nedeva, M. (2017). Computer simulations in electrical and electronics education. Learning aid, Marty-Denny Group 219 p., ISBN 978-619-7207-04-0, [COBISS.BG-ID - 1279852260](#)

The study aid is suitable for practical training of students in the technical disciplines of professional fields 5.2. Electrical engineering, electronics and automation and 5.3. Communication and computer technology.

The developed topics from ch. assistant professor Daniela Shekhova are: Visual simulations of oscillator circuits (RC generator with Vin-Robinson bridge); Computer design and modeling of analog adders; Simulation models of integrated amplifiers; Simulating amplitude pulse shapers (Schmitt trigger) in the Multisim environment; Test circuits for determining parameters of operational amplifiers using analysis media.

▪ **A book**

1. Lyubomirov, S., Shekhova, D. (2018). Programming for Mobile Devices, Book, Marty-Denny Group, 274 p., ISBN 978-619-7207-10-11, [COBISS.BG-ID - 1286839012](#)

The book Programming for mobile devices is intended for students of the educational-qualification degree "bachelor" majoring in "Hardware and software systems" and "Information and computer engineering" at Plovdiv University "Paisiy Hilendarski". The content is aligned with the relevant curricula. It can also be used in the education of students from other Higher Universities and schools.

The content of the book, the volume of individual topics and their structure are discussed by the authors. Topics 3, 5, 7 and 8 were developed by Assoc. Prof. Dr. Eng. Slavi Lyubomirov, topics 1, 2 and 4 from Ch. Assistant Professor Daniela Shekhova, PhD, Chapter 6 was developed jointly by the authors.

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