



## Institutional Sign In

All



[ADVANCED SEARCH](#)

Conferences > 2024 23rd International Sympo...

# Learning Fundamentals of Electrical Engineering by the Aid of Virtual Laboratories

**Publisher:** IEEE

[Cite This](#)

PDF

Vasilija Sarac [All Authors](#) ...



## Alerts

[Manage Content Alerts](#)

[Add to Citation Alerts](#)

### Abstract



Down  
PDF

#### Document Sections

- I. Introduction
- II. Virtual Laboratory for Electrical Circuits
- III. Conclusion

**Abstract:**Digitalization has been playing an important role in the education of electrical engineers during the last decade. Virtual laboratories have become a valuable tool in cur... [View more](#)

#### ► Metadata

##### Abstract:

Digitalization has been playing an important role in the education of electrical engineers during the last decade. Virtual laboratories have become a valuable tool in curriculum of electrical engineering especially when there is no available laboratory equipment or in case of remote learning. The paper presents several examples of virtual laboratory exercises aimed to enhance the curriculum of fundamentals of electrical engineering through testing Kirchhoff's and Ohm's laws, measurement of altering voltage, current and power factor. The students benefit from the virtual laboratories as they gain the necessary skills for handling the measuring instruments and establishing the necessary electrical connection between them. Moreover, the students obtain the knowledge and logic necessary for translating the electrical circuits from paper to the physical world.

**Published in:** 2024 23rd International Symposium INFOTEH-JAHORINA (INFOTEH)

[Authors](#)

[Figures](#)

[References](#)

[Keywords](#)

[More Like This](#)



Date of Conference: 20-22 March 2024

DOI: 10.1109/INFOTEH60418.2024.10496024

Date Added to IEEE Xplore: 22 April 2024

Publisher: IEEE

► ISBN Information:

Conference Location: East Sarajevo, Bosnia and Herzegovina

► ISSN Information:

---

 Contents

---

## I. Introduction

Digitalization has changed the way of working of universities and moreover it has changed the complete concept of teaching and learning. The sustainability of universities is of paramount importance in the highly competitive environment of higher education, and it highly depends on the number of enrolled students [1]. Therefore, the universities are forced to develop their curriculum in accordance with the latest state-of-the-art technologies. Without any doubt, the virtual and remote laboratories are one of them as they enable access from anywhere any time without any limitations of the number of users, providing the users with the comfort of experiencing the real physical experiments from the computer or even phones. However, the distinction should be made between two types of online laboratories: virtual and remote. In a remote laboratory all the hardware components (e.g. the measurement equipment) physically exist somewhere in the institution. By connecting this equipment to the network, the relevant part of the experiment can be controlled and examined by students from a remote location. On the other hand, in a virtual laboratory all the above components are entirely simulated by software and can be accessed remotely by the users [2]. Here another differentiation should be introduced between virtual laboratory and virtual reality. The last term refers to interaction with 3D objects that create an illusion of 3D reality. Examples of 3D virtual reality laboratories aimed for teaching electrical machines and mechatronic can be found in [3]–[4]. Remote laboratories that are using web-server system based on the LabVIEW and integrated into Moodle platform are given in [5] and [6]. An example where assignments are designed to link the theory learning with online practicals is presented in [7]. The physical electrical machines and drives setup, associated software, and ICT platform to implement the assignments are implemented in teaching electrical machines and drives at TU Delft [7]. A complex technical field, mechatronics and more precisely, robotics being a perfect symbiosis of Mechanical and Electrical Engineering has been presented by the Virtual Laboratory for Robotics (VLR) developed by School of Electrical Engineering at University of Belgrade [8]. Other examples of virtual laboratories from the field of electromagnetism and electrical machines can be found in [9]–[15]. There are numerous advantages of the usage of virtual laboratories. They are safe, inexpensive, and often freely available via web links, without any limitations of the number of participants, no damage of equipment and no overcrowded classes, therefore the exercises can be done more effectively. Yet, the two major drawbacks are: lack of contact with real equipment and laboratory conditions that are following the strict procedures of equipment handling, and students' manual skills i.e. dexterity and caution are not improving, otherwise, necessary, when performing the real experiments. This effect to some extent can be reduced by using high fidelity 3D models. The second drawback comes from the fact that virtual environments are like video games. The students tend not to take the experiments seriously, often, more occupied with graphic interface than with the essence of the experiment and its mathematical representation. Following the trends in teaching fundamentals of electrical engineering curriculum, the virtual laboratory developed by University of Ruse as a web-based freely available laboratory, was introduced in teaching fundamentals of electrical engineering at Goce Delcev University [11]. The laboratory for fundamentals of electrical circuits is hosted on Engine for Virtual Electrical Engineering Equipment EVEEE platform at University of Ruse. It is based on the concept that a virtual copy of most of the equipment used in electrical engineering can be created with the use of variables, operations with them, and several virtual components: switches/buttons, potentiometers, text, graphical and state indicators, inputs/outputs (sockets). A detailed description of the concept of the laboratory can be found in [11] and [16]. This paper presents four examples of exercises with electrical circuits. Two are with DC voltage and are aimed for testing Kirchhoff's and Ohm's laws. The other two have AC voltage as power supply and are aimed for testing Ohm's law and active power and power factor

measurement. Students benefit from obtaining the knowledge and skills for handling and reading the universal meter, the laboratory DC and AC voltage source, variable resistor, and energy meter. Furthermore, the theoretical concepts of impedances and power factor calculation are confirmed by measurements. Finally, the electrical circuits from paper are translated into electrical (wire) connection providing the students with knowledge how to make an analogy between electrical drawing and electrical wiring i.e. how to wire various parts of electrical equipment.

---

Authors



---

Figures



---

References



---

Keywords



---

#### More Like This

A Web-based electrical and electronics remote wiring and measurement laboratory (RwmLAB) instrument  
IEEE Transactions on Instrumentation and Measurement  
Published: 2005

---

A Web-based hands-on real-time electrical and electronics remote wiring and measurement laboratory (RwmLAB) instrument  
Proceedings of the 20th IEEE Instrumentation Technology Conference (Cat. No.03CH37412)  
Published: 2003

**Show More**



**IEEE Personal Account**

CHANGE  
USERNAME/PASSWORD

**Purchase Details**

PAYMENT OPTIONS  
VIEW PURCHASED  
DOCUMENTS

**Profile Information**

COMMUNICATIONS  
PREFERENCES  
PROFESSION AND  
EDUCATION  
TECHNICAL INTERESTS

**Need Help?**

US & CANADA: +1 800  
678 4333  
WORLDWIDE: +1 732  
981 0060  
CONTACT & SUPPORT

**Follow**



[About IEEE Xplore](#) | [Contact Us](#) | [Help](#) | [Accessibility](#) | [Terms of Use](#) | [Nondiscrimination Policy](#) | [IEEE Ethics Reporting](#)  | [Sitemap](#) | [IEEE Privacy Policy](#)

A not-for-profit organization, IEEE is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity.

© Copyright 2024 IEEE - All rights reserved.

**IEEE Account**

- » Change Username/Password
- » Update Address

**Purchase Details**

- » Payment Options
- » Order History
- » View Purchased Documents

**Profile Information**

- » Communications Preferences
- » Profession and Education

» [Technical Interests](#)

## Need Help?

» **US & Canada:** +1 800 678 4333

» **Worldwide:** +1 732 981 0060

» [Contact & Support](#)

[About IEEE Xplore](#) | [Contact Us](#) | [Help](#) | [Accessibility](#) | [Terms of Use](#) | [Nondiscrimination Policy](#) | [Sitemap](#) | [Privacy & Opting Out of Cookies](#)

A not-for-profit organization, IEEE is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity.

© Copyright 2024 IEEE - All rights reserved. Use of this web site signifies your agreement to the terms and conditions.