

# وزارة التعليم العالي والبحث العلمي

BADJI MOKHTAR- ANNABA UNIVERSITY  
UNIVERSITE BADJI MOKHTAR ANNABA



جامعة باجي مختار - عنابة

Année : 2019

Faculté: Sciences de l'Ingénierat  
Département: Electronique

## MEMOIRE

Présenté en vue de l'obtention du diplôme de : MASTER

**Intitulé:**  
**Graphical User Interface for Remote-lab Using SVG**

**Domaine : Sciences et Technologie**  
**Filière : Télécommunication**  
**Spécialité : Réseaux et Télécommunication**

**Par :**  
**MIHOUBI Zeyneb**

**DEVANT Le JURY**

**Président : M. Taibi Pr UBM Annaba**

**Directeur de mémoire : M. Fezari Pr UBM Annaba**

**Examineur : S. Toumi Pr UBM Annaba**

**Examineurs : A.Larbi Pr UBM Annaba**

**Abstract:**

There are some learning activities which are difficult to effectively replicate in an online environment. Engineering laboratories are one such activity, where on-campus delivery is still the dominant mechanism, and online delivery is in its preliminary stages. This thesis undertakes a virtual lab design a course in electrical and electronics engineering. Virtual laboratories are described as “essential educational tools which provide students real-simulated experiments that can be conducted at any time, without instructor surveillance or guidance.”.

In our thesis we developed web virtual lab for Operational Amplifier course, the application was developed using HTML, CSS, SVG and JS langages, it has been tested by some students and their feedback were interesting to improve the application

**key words:** Remote lab, virtual lab, op-amplifier, svg, electronic, E-learning, distance learning, GUI

**Résumé :**

Certaines activités d'apprentissage sont difficiles à reproduire efficacement dans un environnement en ligne. Les laboratoires d'ingénierie sont une de ces activités, où la livraison sur le campus est toujours le mécanisme dominant, et la livraison en ligne est à ses débuts. Cette thèse consiste en un laboratoire virtuel à concevoir un cours en génie électrique et électronique. Les laboratoires virtuels sont décrits comme « des outils éducatifs essentiels qui fournissent aux étudiants des expériences simulées de manière réelle et qui peuvent être menées à tout moment, sans surveillance ni encadrement par un instructeur ».

Dans notre thèse, nous avons développé un laboratoire virtuel sur le Web pour le cours d'amplificateur opérationnel. L'application a été développée à l'aide de langages HTML, CSS, SVG et JS. Elle a été testée par certains étudiants et leurs retours ont été intéressants pour améliorer l'application.

**mots clés:** Laboratoire distant, laboratoire virtuel, amplificateur opérationnel, svg, E-learning, formation à distance, Interface graphique.

**التلخيص:**

يصعب محاكاة بعض أنشطة التعليم بفعالية عبر الإنترنت. حيث تعتبر مختبرات الهندسة الكهربائية والإلكترونية و الالكترونك احد تلك الأنشطة، في حين أنه لا يزال التعليم داخل الحرم الجامعي هو الآلية السائدة، فالتوصيل عبر الإنترنت لا يزال في مراحله الأولى.

تتكون هذه الاطروحة من مختبر افتراضي لتصميم عمل مخبري في الهندسة الكهربائية والإلكترونية. يتم وصف المختبرات الافتراضية بأنها "أدوات تعليمية أساسية توفر للطلاب تجارب واقعية محاكيه، يمكن إجراؤها في أي وقت دون إشراف أو توجيه من قبل أستاذ مشرف".

فقد قمنا في أطروحتنا، بتطوير مختبر افتراضي على الانترنت لتطبيق عملي لمكبر التشغيل. حيث تم تطويره

باستخدام لغات البرمجة التالية: JS و SVG و CSS و HTML

بعد ذلك تم اختباره من قبل بعض الطلاب وكانت ملاحظاتهم مثيرة للاهتمام لتحسين التطبيق .

**الكلمات المفتاحية:** مختبر عن بعد، مختبر افتراضي، مكبر عمليات، التعليم الإلكتروني، التعليم عن بعد , واجهة المستخدم الرسومية , svg

## *Dedication*

*With all respect and love I dedicate this modest work*

*To my dearest mother:*

*Affable, honorable, lovely: You represent for me the symbol of kindness with excellence, the source of tenderness and the example of loyalty that has not ceased to encourage me and pray for me. Your prayer and blessing have been of great help to me in completing my studies.*

*No dedication can be eloquent enough to express what you deserve for all the sacrifices you have given me since my birth, during my childhood and even in adulthood.*

*To my dear father:*

*You knew how to instill in me the sense of responsibility, optimism and self-confidence in the face of the difficulties of life. Your advice has always guided my steps towards success. Your endless patience, your understanding and your encouragement are for me the indispensable support that you always knew how to bring me. I owe you what I am today and what I will be tomorrow and I will always do better to stay proud and never disappoint.*

*May God Almighty preserve you, grant your health, happiness, tranquility of the spirit and protect you from all evil.*

*To my dear brother and sisters: Samir, Mounira, Amira and Lilia thank you for your love and your encouragement*

*To my BBF and BFF Hanen and Nasro, thank you for being part of my deep life, you are my antidepressant, love you more than myself.*

*To my sweetie pie Nadoucha*

*To the people who always helped and encouraged me, who were always by my side, and who accompanied me on my way to graduate school*

*My best aunt Nadia, Hanan ,Radja, Sihem ,Houda ,Ahlem, Hamza, Zaki, Imene, Yousra.*

## **Acknowledgement**

I thank God Almighty for giving us the health and the willingness to begin and end this memoir.

I warmly thank my supervisor, Pr Mohamed Fezari, for agreeing to lead this work with many skills:

Thank you for your unfailing availability, your scientific rigor and the trust you gave me during the development of this memoir, thank you for the acuity of your enlightened advice.

I also thank the jury members for accepting to judge this modest work, you do us a great honor. I owe a thank you to all Electronic department teachers for their scientific and teaching skills.

I also thank Mouadh Bekhouche et Ragoua Zakaria to thier help

I want to thank warmly all the people who helped me and supported me,

If I inadvertently forget someone forgive me and be thanked for the support.

## **Acronym List**

**GUI:** Graphical User Interface

**SVG:** Scalable Vector Graphics

**HTML:** HyperText Markup Language

**JS:** JavaScript

**CSS:** Cascading Style Sheets

**Pw :**practical work

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### **General Introduction**

Like Maria Montessori said "only practical work and experience lead the young to maturity " so the practical work is very important for students, especially the College of Science and Technology because it brings them closer to their future work environment but some department are having problems like the lack of devices and the vow of classes.

One of main problems in teaching electronics today is practical work, the number os tudenst registred in licenec is large and the lab classes are limited. So we proved in this work a virtual op-amplifier lab and the procedure to develop the main interface.

Building of virtual electrical and electronic laboratories facilitates students' autonomic learning. Through virtual experiments, students can preview experimental contents, get to know experimental process and observe possible experimental phenomenon. Therefore, students will be easier and more confident at experimental classes and experimental teachers' workload will be reduced.

Virtual electrical and electronic laboratories are mainly used by beginners of electrical specialties in universities. Therefore, application interface and experimental content are simple and easy to operate; there are many experimental instructions.

This is why we have implemented this thesis to discuss a solution to avoid this problem and avoid this obstacle and deliver information to the student with minimal damage This solution is based on the development of a graphical user interface for Virtual Op-amplifier lab using SVG, HTML5, CSS3 and JS.

For educational applications, the teacher may first introduce the principle of Operational Amplifier and then ask students to enter the virtual Op-Amplifier laboratory by using a tablet computer for interactive operation. Students can select a practical work by following the system direction and conduct experiments to observe its response. If they make a mistake during operation, the system will provide a textual reminder to show the right way of doing it. After all tasks have been completed, the students can take the online test to evaluate their learning achievements. This study used the innovative learning technology to enhance students' scientific literacy, research skills and problem-solving ability. Combining virtual

reality with the situated learning theory, the “virtual op-amp laboratory” was designed as an app to achieve the goal of exploring operational amplifier circuit. Students can realize the principle schemes of op-amplifier through interactive operation and instant feedback, and become familiar with the operating procedure via repeated practices. A teaching experiment was conducted in this study to investigate whether the virtual op-amplifier laboratory can enhance students’ learning effectiveness as well as their learning interest and motivation.

Our thesis is divided into four chapters, in the first one, we began to talk about the state of art in virtual laboratory progress for different scientific domains, in the second chapter we got acquainted with the programming languages used to develop the graphical user interface for the application. After that, we have presented in chapter 3 the design of the graphical interface for our virtual -lab based on Operational Amplifiers and their applications in electronic circuits design and signal conditioning. In this virtual lab design, we integrated a link to download the courses and we added a questionnaire concerning the practical work. Finally, we tested the application on a group of students and registered their responses on tables to see how they have responded with it.

### **Problematic:**

One of main problems in teaching electrical engineering and electronics today is practical work to be done by students. The number of registered student in licence level is large and the lab classes are limited. The disponibility of teacher's and assistant in practical work also is limited. So we present in this thesis a solution based on the development of a virtual op-amplifier lab and the procedure to develop the main interface.

Building of virtual electrical and electronic laboratories facilitates students' autonomic learning. Through virtual experiments, students can preview experimental contents, get to know experimental process and observe possible experimental phenomenon. Therefore, students will be easier and more confident at experimental classes and experimental teachers' workload will be reduced.

Virtual electrical and electronic laboratories are mainly used by beginners of electrical specialties in universities. Therefore, application interface and experimental content are simple and easy to operate; there are many experimental instructions.

However, the web lab development requires e-learning techniques and Web development software knowledge such as HTML5, CSS and to make the interface interactive we do need SVG and JavaScript.

## **State of the art in virtual laboratories**

In the last decade a number of fully software based virtual laboratories in different fields have been developed. In most cases they are specific to an educational context and do not offer possibilities for generalization to a platform applicable to a wider class of engineering disciplines. These laboratories have different levels of technical complexity. For the purpose of this paper we have selected examples which are seen to be relevant to the present state of development and are inline with the identified future trends and which cover different STE applications.

### **I.1 General initiatives**

The general initiatives have a wider focus and try to provide a framework for both virtual and remote-access-physical facilities. Exemple:

a) "LiLa" is the acronym for the "Library of Labs", an initiative of eight universities and three enterprises, coordinated by University of Stuttgart (Germany) [2]. The project "LiLa" was co-funded by the European Commission by its eContent plus programme. The goal of the project was to promote the mutual exchange of and access to virtual laboratories (simulation environments), and remote laboratories.

b) The Go-Lab Project (Global Online Science Labs for Inquiry Learning at School) was a European collaborative project co-funded by the European Commission (Seventh Framework Programme) [3][4]. It united nineteen organizations from twelve countries, coordinated by the University of Twente (Netherlands). These online labs can be used by universities, schools, instructors and students, in order to extend regular learning activities with scientific experiments.

### **I.2 Science-physics**

a) Project VccSSe (Virtual Community Collaborating Space for Science Education) was a three year project started in October 2006, as a collaboration between several institutions from UK, Romania, Spain, Greece, Poland, and Finland. The main purpose of the VccSSe was to adapt, develop, test, implement and disseminate training modules, teaching methodologies and pedagogical strategies based on the use of Virtual Instrumentation in different areas of

science (physics, chemistry, biology) in order to benefit students through the availability of virtual instruments in the classroom [5]

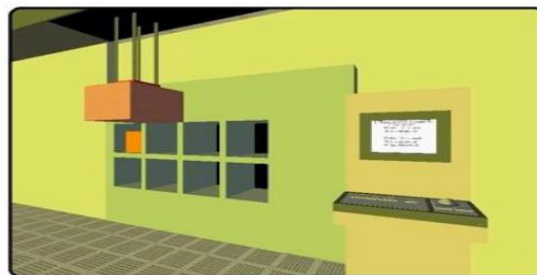
b) The TEALsim, is an open source environment designed for authoring, presenting, and controlling simulations. It was developed by the TEAL (Technology Enabled Active Learning) Project at MIT (Massachusetts Institute of Technology). One of the objectives of TEALsim, is to increase student's conceptual and analytical understanding of the nature and dynamics of electromagnetic phenomena. TEALsim is very useful in electromagnetism, helping students to visualize phenomena. [6]

### **I.3 Process technology**

a) The Virtual Laboratory "Ironmaking" has been developed at the RWTH Aachen University in Germany (Department of Ferrous Metallurgy), aiming to provide a deep understanding of the blast furnace process (Babich & Mavrommatis, 2009). The key innovative component of the Virtual Laboratory is the VSM (Visual Simulation Model) software that processes parameters entered and outputs both operating and learning results. The VSM software is implemented in Java. Teachers and learners can interact with each other using a software interface that allows monitoring of the activity of the learners; the answering of their questions; and analyzing the results.

b) The Department of Chemical Engineering at Oregon State University created the Virtual CVD Learning Platform (Figure 1.). It simulates the process of the chemical vapor deposition (CVD).

The Virtual CVD Learning Platform provides a capstone experience in which students synthesize engineering science and statistics principles [7]. Simulation of the reactor is based on fundamental principles of mass transfer and chemical reaction, obscured by added disturbance ("noise"). The advanced software features include a 3-D graphical user interface, an instructor Web interface with integrated assessment tools, and a database server.



**Figure 1. The Virtual CVD Learning Platform (Koretsky et al., 2008). Figure shows loading of wafers into a CVD furnace within 3D graphical user interface.**

## **I.4 Engineering - non robotic**

a) A virtual laboratory for control systems applied to technological plants was designed at Slovak University of Technology in Bratislava [8] The laboratory provides for virtual simulations of three technological plants (liquid storage tank system, tube heatexchanger, and continuous stirred-tank reactor). For instance, a liquid storage tank system simulates system dynamics, utilizing two general mathematical models of the plant (non-linear and linear). Each of the models consists of several ODEs (Ordinary Differential Equations), depending on the number of tanks in the system.

b) The concept of a multiplatform virtual laboratory for educational purposes was developed by the Universitat Politècnica de Catalunya, Barcelona, Spain (Signal Theory and Communications Department). This virtual laboratory provides control system experiments at University level. The main concepts illustrated by the magnetic-levitator virtual experiment include: PID (Proportional-Integral-Derivative) controllers, root locus controller design, and ITAE (Integral Time Absolute Error) optimal controller design [9] c) The TriLab project was developed at Loughborough University, UK. This novel laboratory model combines the three access modes (Hands-On, Virtual, and Remote) in one unifying software package (the TriLab), by using LabVIEW [10] The focus of our interest is in the virtual mode, which is the Process Control Virtual Laboratory (PCVL). It is used for demonstrating control systems concepts via manipulating a simulated model of a physical process. The PCVL provides a virtual model of an Armfield PCT40 tank filling process, as well as additional control and regulation capacities. Researchers at Firat University (Turkey) described the creation of a Virtual Electric Machine

d) Stevens Institute of Technology (USA) developed an innovative method for teaching mechanical engineering students about machine dynamics. An online virtual laboratory enables students to learn by interacting in a virtual environment (Figure 2.), much like massively multiplayer online games such as Half-life 2, The Sims, WoW (World of Warcraft), and Second Life. The game based laboratory environment was created as part of the course "Mechanisms and Machine Dynamics" which introduces the principles of kinematics and dynamics and applies them to linkages, cam systems, gear trains, belt and train drives, couplings, and vibrations. Users (students, teaching assistants, and professors) design their own avatars and discuss projects through instant messaging, all within a virtual 3-D environment of the laboratory. In this virtual environment, the laws of physics are applied.



Users are able to manipulate equipment and machinery in order to set up their experiments. Once set up, the experiment yields data based on the interactions of the parts. Progress is monitored by the professor and teaching assistants, and learning is assessed with quizzes before and after the laboratory exercise [11]



Figure 2. Virtual laboratory at Stevens Institute of Technology (Aziz et al., 2009; Aziz et al., 2014). Good

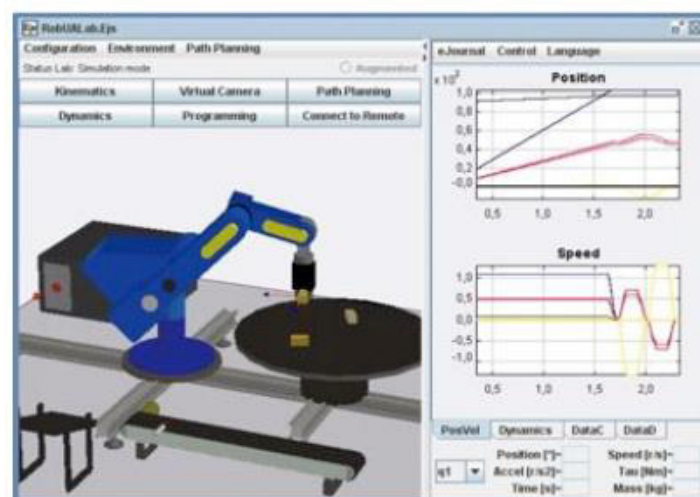
example of the realization of all four criteria defined in Section 3.

### **I.5 Engineering – Robotics**

a) RoboUALab (Figure 3.) is designed as a virtual and remote laboratory to simulate and execute a manipulator robot, and it is developed at the University of Alicante, Spain. RoboUALab is a system that allows students to practice movement commands with a simulated industrial robot.

Also a real robot, located in a laboratory of the University of Alicante, can be handled by vis-  
-cous friction), and programming Java routines for their robot manipulator. In general, the only equipment that the student requires are a computer connected to the Internet, the Java runtime library, and either the VRML software or the Java 3D runtime library, depending on the version of the RoboUALab being used. Advanced RoboUALab features also include a virtual camera enabling users to view a virtual workspace projection of an eye-in-hand virtual camera, and data visualization tools that enable users to view in real-time all the variables means of tele-operation. This system has been developed since 1999, with several versions having been released since then. The latest version of the applications are based on Easy Java

Simulations, an open-source tool for people who do not have advanced programming skills. The user-friendly interface and the graphical simulation are very realistic. With this virtual laboratory, students can learn robotic concepts such as: robot kinematics (using the Denavit-Hartenberg approach), path planning, robot dynamics (affected by link masses, inertias and viscous friction), and programming Java routines for their robot manipulator. In general, the only equipment that the student requires are a computer connected to the Internet, the Java runtime library, and either the VRML software or the Java 3D runtime library, depending on the version of the RoboUALab being used. Advanced RoboUALab features also include a virtual camera enabling users to view a virtual workspace projection of an eye-in-hand virtual camera, and data visualization tools that enable users to view in real-time all the variables concerning the position, transformation, and kinematic and dynamic models of the virtual robot (Torres, Candelas, Puente, Pomares, Gil, & Ortiz, 2006; Jara, Candelas, Puente, & Torres, 2011).

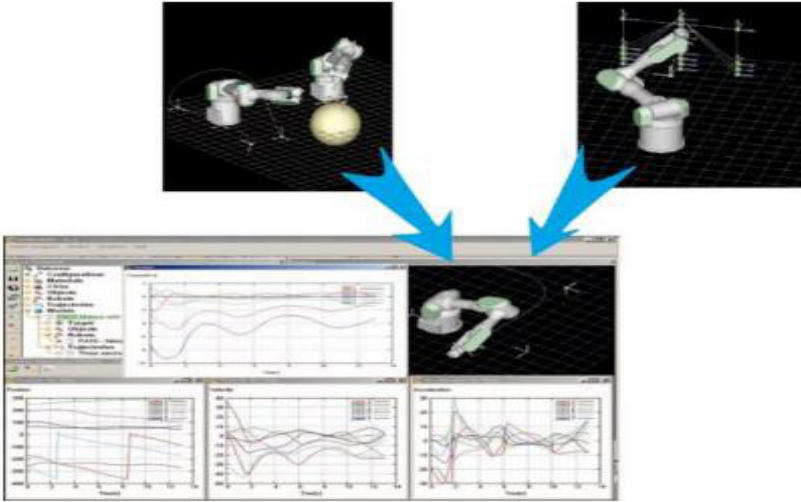


**Figure 3. RoboUALab (Torres et al., 2006; Jara et al., 2011). Besides graphical interface, figure shows**

b) A virtual laboratory for teaching mobile robotics was developed at the Department of Computer Science, Tecnológico de Monterrey (Mexico). The original aim was to develop a novel course for teaching basic robotics at the undergraduate level, with several new didactical and technical contributions (Noguez & Enrique Sucar, 2006)

c) ROBOMOSP (ROBOTics MOdeling and Simulation Platform) was developed by the Robotics and Automation Group (GAR) of the Pontificia Javeriana University, in Cali, Colombia. It is a 3-D multiplatform, and a CAD system implemented with open-source tools. This modeling

and simulation environment for robotic manipulators, adds novel characteristics and functions that are not found in most of the other commercial and noncommercial robotic software packages that are available. It includes a solution to the multibody dynamics problem using an approach based on the automatic calculation of the mass properties of robot multibodies.



**Figure 4. ROBOMOSP (Jaramillo-Botero et al., 2006). Figure shows robotic manipulator executing**

d) The VCIMLAB (Virtual CIM Laboratory) was developed at the Eastern Mediterranean University, Cyprus [12] It is an educational software application for training users on the operating principles of CIM (computer integrated manufacturing) and automated production systems, which make use of industrial robots, CNC machines, and automated assembly equipment. The system provides a 3D interactive, virtual laboratory environment (Figure 5)

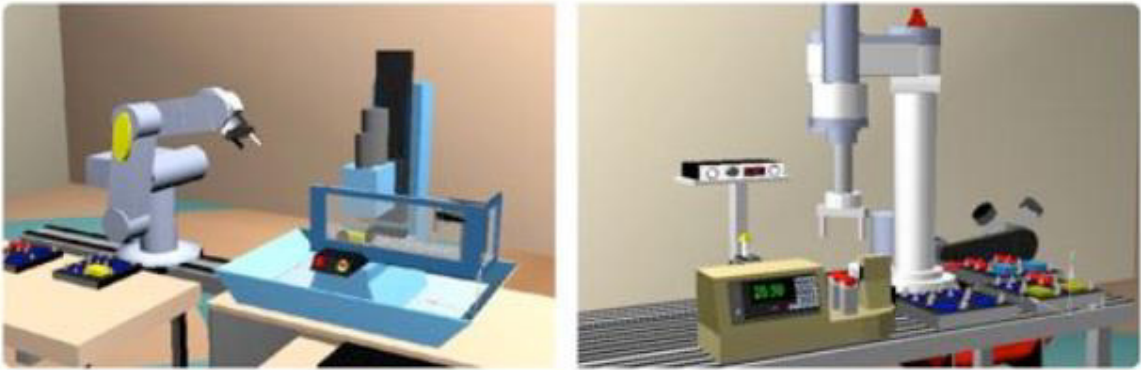
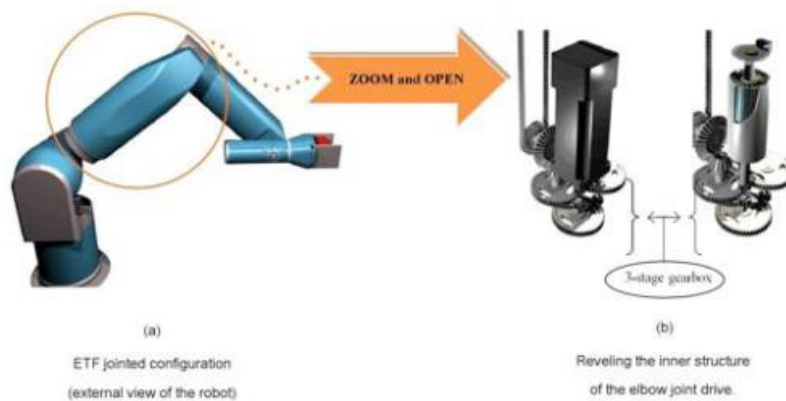


Figure 5. VCIMLAB (Hashemipour et al., 2011). Automated production system presents virtual replica of the real CIM laboratory.

e) The Virtual Laboratory for Robotics (VLR) was developed at ETF [13] The idea behind VLR was to demonstrate the main features of industrial robots, being perfect examples of complex mechatronic systems. State-of-the-art technologies are used in order to realize the VLR concept, through appealing graphical modules, and a modern user interface. The notion of dynamics is of key relevance in the concept.



**Figure 6. VLR at ETF [14] Revealing of the inner structure, shown on the right, can be extremely useful for deeper understanding of mechanism principles.**

f) USARSim is an open source high fidelity multi-robot simulator that can be used both for education and research. Development of the simulator started at Carnegie Mellon University and the University of Pittsburgh. Although it was originally developed for urban search and rescue simulations, it is a general purpose multi-robot simulator. USARSim is platform independent and runs on Windows, MacOS and Linux.

In order to provide a systematic and concise summary of comparison and evaluation of virtual labs, we have organized the evaluation results into the form of Table 1. The table gives the relevant data: institution, funding, and an evaluation note according to the proposed criteria **described above**

**Table 1. List of virtual lab projects with specifications.**

Project	Coordinating Institution	Field	Funding	year
LiLa	University of Stuttgart, GER	General initiative	European Commission	2009
Go-Lab Project	University of Twente, Netherland	General initiative	European Commission	2013
VccSSe	Valahia University of Targoviste, Romania	Physics	European Commission	2006
TEALsim	MIT, USA	Physics	National Science Foundation, Davis Educational Foundation	2010
Ironmaking	RWTH Aachen University, Germany	Process Technology	University research	2009
The Virtual CVD Learning Platform	Oregon State University, USA	Process Technology	University research	2008
Virtual laboratory of process control	Slovak University of Technology, Bratislava	Engineering - non robotic	University research	2011
Multiplatform Virtual Laboratory for educational purposes	Universitat Politècnica Catalunya, Spain	Engineering - non robotic	University research	2012
TriLab	Loughborough University, UK	Engineering - non robotic	University research	2013
Virtual Electric Machine Laboratory	Firat University, Turkey	Engineering - non robotic	University research	2009
Virtual Laboratory Environment	Stevens Institute of Technology, USA	Engineering - non robotic	University research	2009
RoboUALab	University of Alicante, Spain	Robotics	University research	1999

Virtual Laboratory for Mobile Robotics	Department of Computer Science, Tecnológico de Monterrey, Mexico	Robotics	University research	2006
ROBOMOSP	Pontificia Javeriana Univer, Colombia	Robotics	University research	2006
VCIMLAB	Eastern Mediterranean Univ, Cyprus	Robotics	University research	2011
VirtualRobot	Polytechnic University of Valencia, Spain	Robotics	University research	2004
VLR	School of Electrical Engineering, Univ. of Belgrade, Serbia	Robotics	University research	2007
USARSim	University of Pittsburgh, USA	Robotics	National Institute of Standards and Technology, USA	2005
COSIMIR	University of Dortmund, GER	Robotics	commercial	2002
RoboLogix	Logic Design Inc., Canada	Robotics	commercial	1996

To realise a remote lab we need to use a few programming languages to build our project in this chapter we will introduce the web technology we used

## GRAPHIC USER INTERFACE

A graphical user interface (GUI) is an interface through which a user interacts with electronic devices such as computers, hand-held devices and other appliances.

This interface uses icons, menus and other visual indicator (graphics) representations to display information and related user controls, unlike text-based interfaces, where data and commands are in text. GUI representations are manipulated by a pointing device such as a mouse, trackball, stylus, or a finger on a touchscreen.

The need for GUI became apparent because the first human/computer text interface was through keyboard text creation by what is called a prompt (or DOS prompt). Commands were typed on a keyboard at the DOS prompt to initiate responses from a computer.

**Some useful languages to design web interfaces.**

### II.1 SVG [15]

**Scalable Vector Graphics (SVG)** is an XML based vector image format for two-dimensional graphics with support for interactivity and animation. The SVG specifications are an open standard developed by the World Wide Web Consortium (W3C) since 1999.

SVG images and their behaviors are defined in XML text files. This means that they can be searched, indexed, scripted, and compressed. As XML files, SVG images can be created and edited with any text editor, as well as with drawing software.

All major modern web browsers—including Mozilla Firefox, Internet Explorer, Google Chrome, Opera, Safari, and Microsoft Edge—have SVG rendering support.



**Figure 7. the difference between svg quality and the author image form**

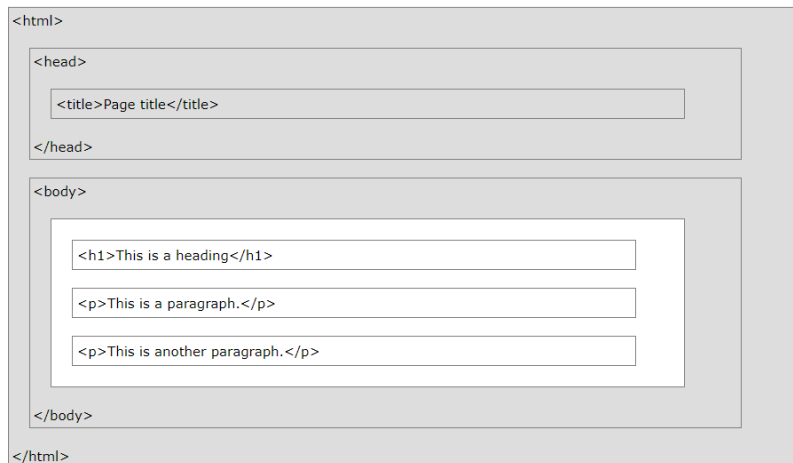
## II .2 HTML5 [16]

**Hyper TextMarkupLanguage (HTML)** is the standard markup language for creating a static Web pages and web application

HTML describes the structure of Web pages using markup

- HTML elements are represented by tags and they are the building blocks of HTML page.
- HTML tags label pieces of content such as "heading", "paragraph", "table", and so on
- Browsers do not display the HTML tags, but use them to render the content of the page

Figure 8. visualisation of a HTML page structure :



- The `<!DOCTYPE html>` declaration defines this document to be HTML5
- The `<html>` element is the root element of an HTML page
- The `<head>` element contains meta information about the document
- The `<title>` element specifies a title for the document
- The `<body>` element contains the visible page content
- The `<h1>` element defines a large heading
- The `<p>` element defines a paragraph



## HTML Tags

HTML tags are element names surrounded by angle brackets:

```
<Tag Name>content goes here...</tag Name>
```

- HTML tags normally come **in pairs** like `<p>` and `</p>`
- The first tag in a pair is the **start tag**, the second tag is the **end tag**
- The end tag is written like the start tag, but with a **forward slash** inserted before the tag name

### a) Web Browsers

- Web browsers (Chrome, IE, Firefox, Safari..) receive HTML documents from a web server or from local storage and render the documents into multimedia web pages. HTML describes the structure of a web page semantically and originally included cues for the appearance of the document. The browser does not display the HTML tags, but uses them to determine how to display the document.
- Only the content inside the `<body>` section (the white area above) is displayed in a browser
- Most recent HTML is HTML 5

### b) CSS [17]

CSS stands for **Cascading Style Sheets**, describes **how HTML elements are to be displayed on screen, paper, or in other media** it saves a lot of work. It can control the layout of multiple web pages all at once

- External style sheets are stored in **CSS files**

CSS is used to define styles for the web pages, including the design, layout and variations in display for different devices and screen sizes.

HTML was NEVER intended to contain tags for formatting a web page!

It was created to **describe the content** of a web page, like:

```
<h1>This is a heading</h1>
```

```
<p>This is a paragraph. </p>
```

When tags like <font>, and color attributes were added to the HTML 3.2 specification, it started a nightmare for web developers. Development of large websites, where fonts and color information were added to every single page, became a long and expensive process.

### **II .3 JavaScript[18]**

JavaScript is a dynamic computer programming language. It is lightweight and most commonly used as a part of web pages, whose implementations allow client-side script to interact with the user and make dynamic pages. It is an interpreted programming language with object-oriented capabilities.

JavaScript was first known as Live Script, but Netscape changed its name to JavaScript, possibly because of the excitement being generated by Java. JavaScript made its first appearance in Netscape 2.0 in 1995 with the name LiveScript. The general-purpose core of the language has been embedded in Netscape, Internet Explorer, and other web browsers.

The ECMA-262 Specification defined a standard version of the core JavaScript language:

- JavaScript is a lightweight, interpreted programming language.
- Designed for creating network-centric applications.
- Complementary to and integrated with Java.
- Complementary to and integrated with HTML.
- Open and cross-Platform

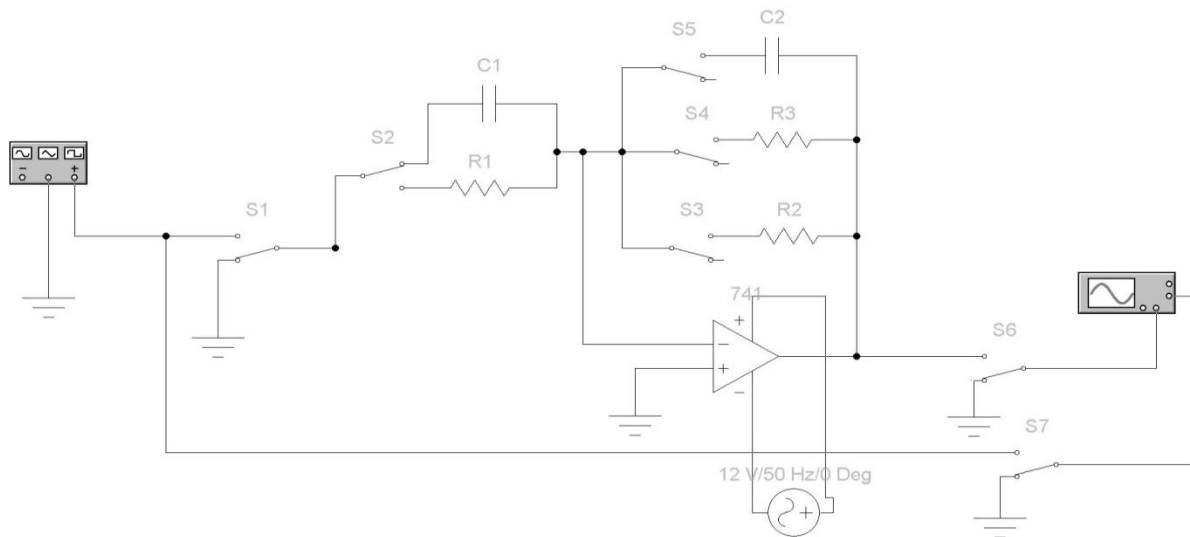
### III.1 Presentation of selected Practical work

The designed virtual lab is for 3<sup>rd</sup> year Licence students in electronic department, the course is Operational Amplifier and its applications.

The main applications proposed for student s are: Inverter, Non-inverter, Integrator and derivator circuits.

The student can get more details on the circuits by getting the course in PDF file, he can download it from main page.

Once the student selects a practical work “PW” to do, we present the figure 4 with all switches and then he should select the appropriate switches to design the selected PW.



Switch matrix relay for 4 PW is presented in table III.2

Switch\state	S1	S2	S3	S4	S5	S6	S7
<b>Inverter</b>	1	1	1	1	0	1	1
<b>Non-inver</b>	0	1	1	1	0	1	1
<b>integrator</b>	1	1	0	0	1	1	1
<b>derivator</b>	1	0	1	1	0	1	1

**Table III. 2**Switch matrix relay for 4 Pw

If the students select the wrong Switch then he will get a warning message “You can damage the device”, so he will get another chance to change the switch status.

The proposed Practical work in our Virtual lab are:

**III.1.1 Inverter:** With two resistors we can construct the fundamental feedback network of a negative feedback amplifier. Depending on the terminal at which the signal is applied, the fundamental negative feedback configuration can be in the **inverting amplifier arrangement**, where the input signal,  $V_{in}$ , is applied to the inverting terminal, Figure, or in the **non-inverting amplifier arrangement**, where the input signal,  $V_{in}$ , is applied to the non-inverting terminal, Figure 7(b).

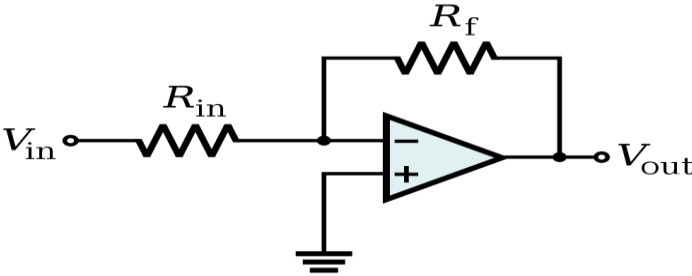


Figure 9. Inverter amplifier

$$V_{out} = -R_f/R_{in} * V_{in}$$

Results of Simulation of the circuit

And the  $V_{in}$  and  $V_{out}$  signal are presented in figure 10

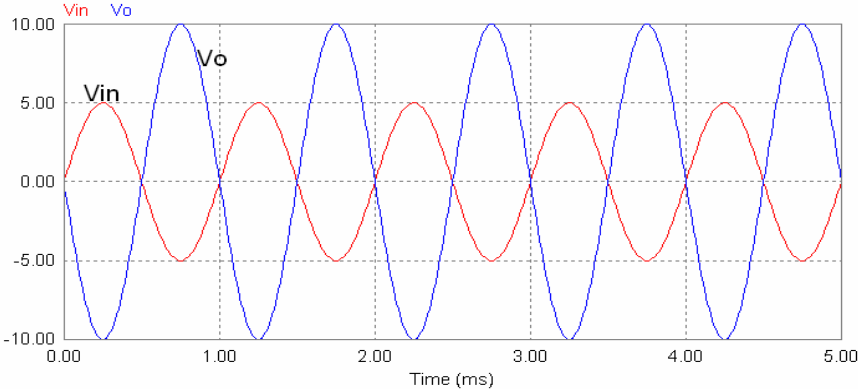


Figure 10. diagrams of input and ourput signals

### III.1.2 Non-inverter

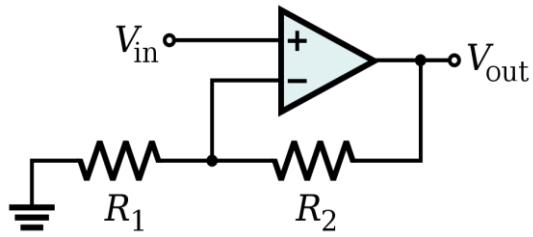


Figure 11. Non-inverter amplifier

$$V_{out} = \frac{R_1 + R_2}{R_1} * V_{in}$$

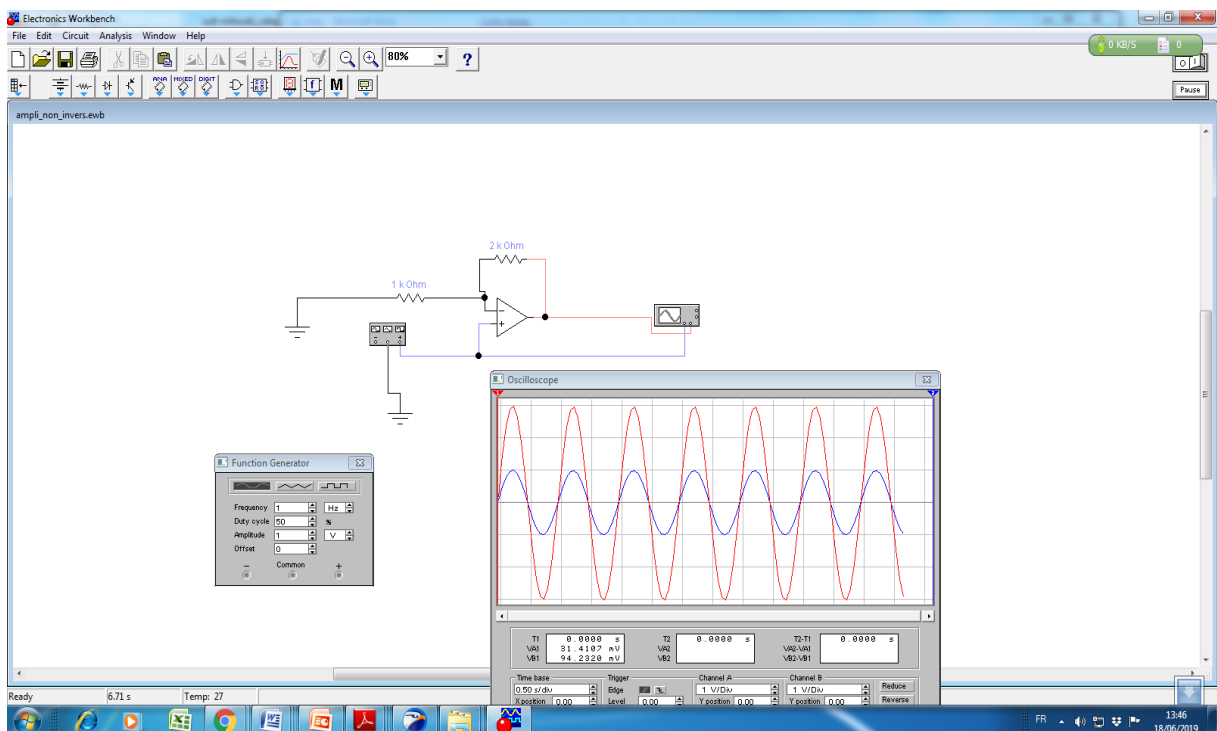


Figure 12. Results of Simulation of Non-inverter circuit

### III.1.3 Integrator

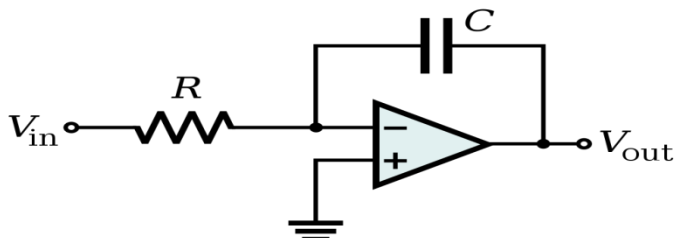


Figure 13. Integrator amplifier

$$V_{out} = - \int_0^t \frac{V_{in}}{RC} dt + V_{initial}$$

III.1.4 Diferentiator

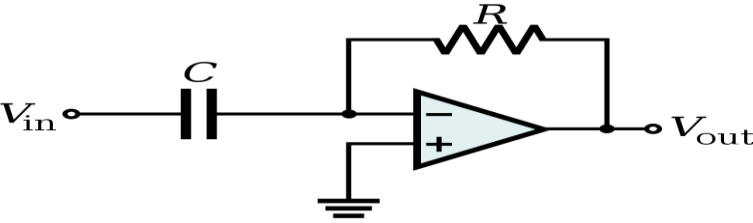


Figure 14. Diferentiator amplifier

$$V_{out} = -RC \frac{dV_{in}}{dt}$$

Results of Simulation of the circuit

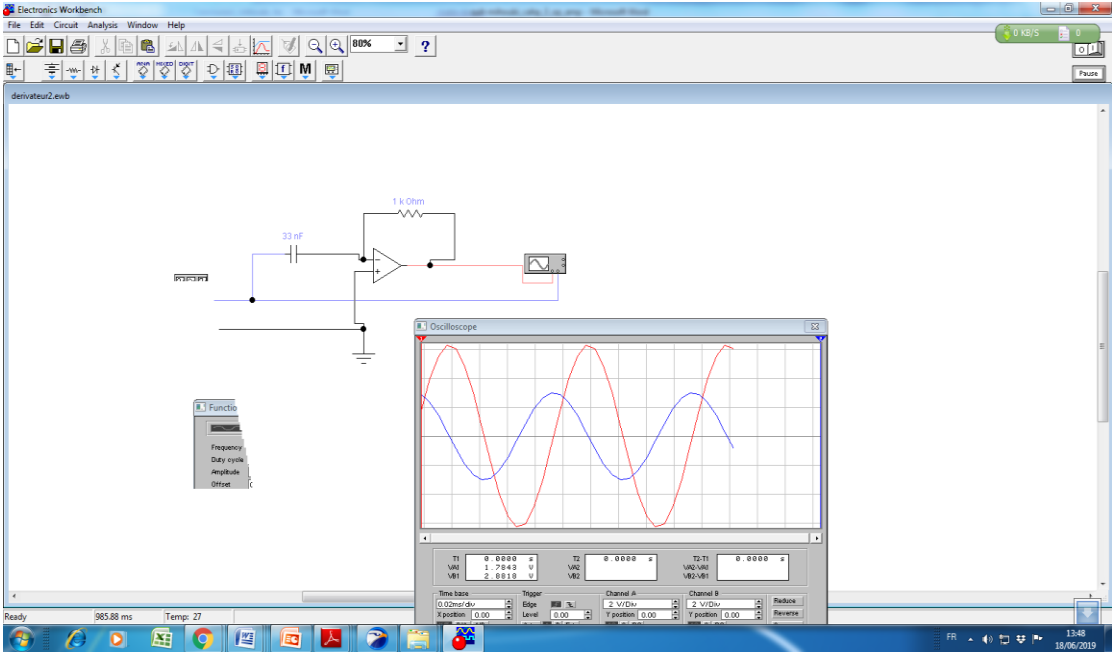


Figure 15. Results of Simulation of Diferentiator circuit

### III.2 Virtual OP- amplifier lab design details

there are a lot of programming language to create graphical interface but we chose html Even it has an advantage and inconvenient but it is derived from the same programming language as svg, this language is XML

#### III.2.1 Synoptic

The overall synoptic of our virtual lab design is presented in this flowchart.

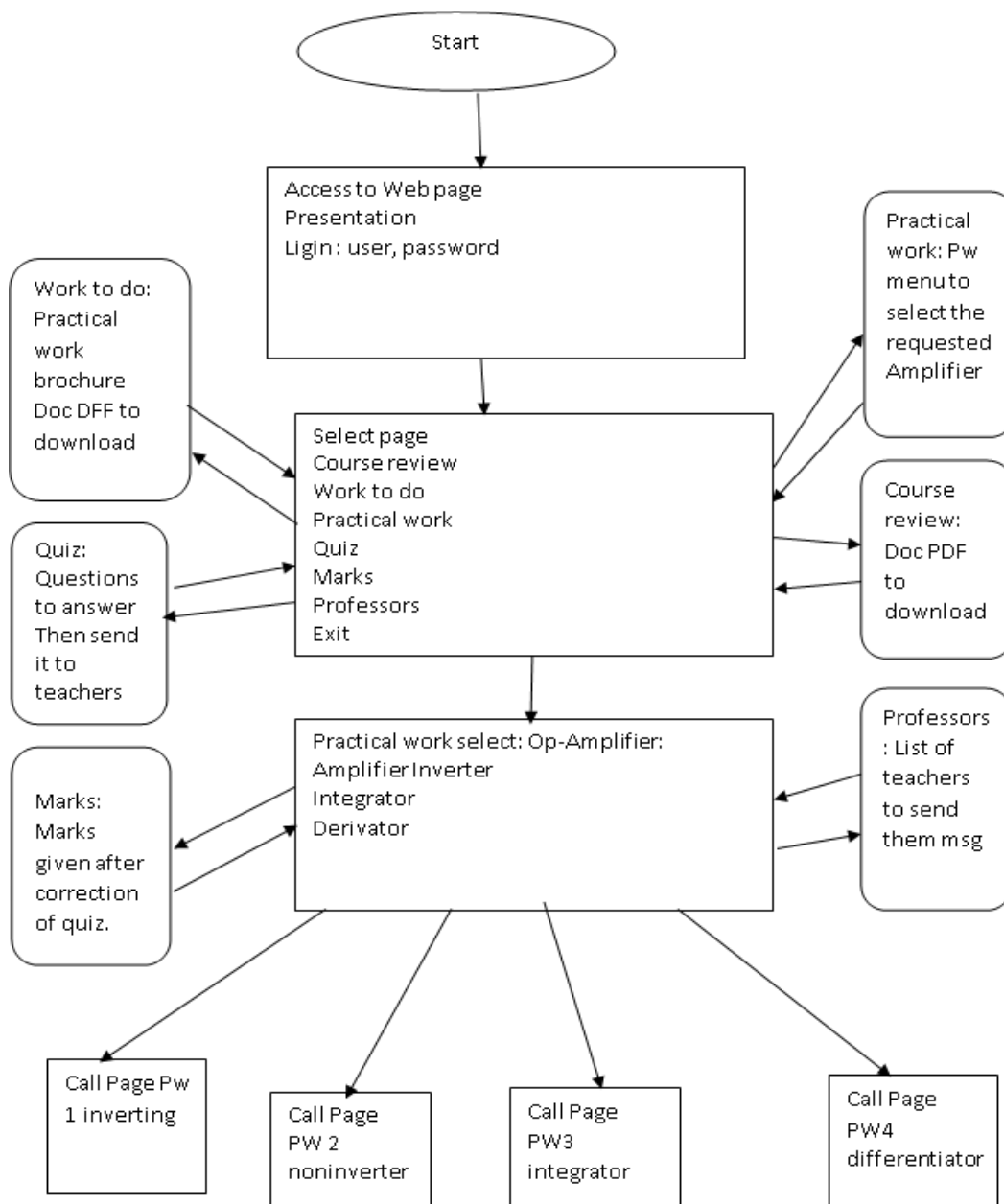
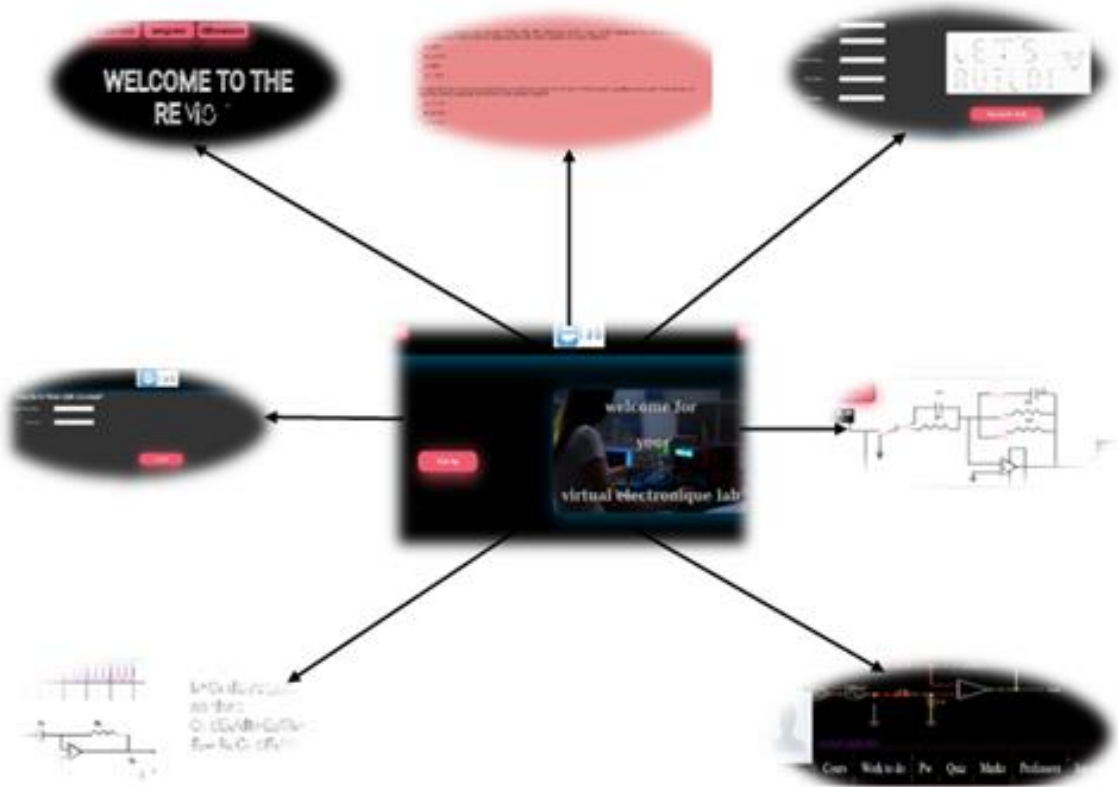


Figure 16. flowchart of synoptic of the virtual lab design

**III.2.2 Introduction**

For this work we used Windows 8.1 Internet, Text Editor and, figma and svg editor to draw and extract the codes svg.

We explain here the work we have done through screenshot and diagrams step by step.



**Figure 17.the different pages of the interface**



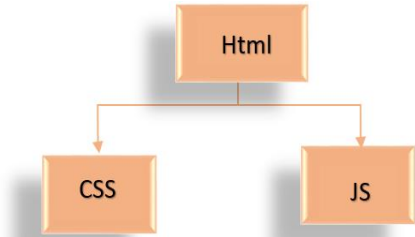
**III.2.3 home page design**

When the student launches the remote-lab website a home page opens consist a black background and bleu light shadow and also a slide of pictures and three button (login, sing in, gest log )



**Figure18. home page of remote-lab**

To do all of this work we followed the following diagram



**Figure 19. diagram used for creation of home page**

**The explanation of figure 19**

using html we created a web page continent three button (sing in, sing up,gest log) then with css we add the color of (background, light shadow, buttonscolor)and finely we used JavaScriptfunctions to create a slide of pictures and the click on the button)

After clicking on the login button, it will open a window with a black background, white area for writing and a pink button, so when the student enters his personal data and click on the sing up for lab button, an account will be created in the remote-lab.

### III.2.4 login interface and sing up button design

on click on the login button and it will open a window as follows



Figure20.login interface



Figure 21. sign up interface

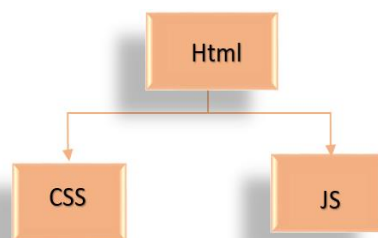


Figure22. diagram used for creation login and sign up interface

#### The explanation of figure 22

We used the same diagram of home page to create the login and sign in window we use html to create the registration Form and css to give color to background button and writing zone and we use the function of JavaScript to Click button and open window in the same page.

### III.2.5 remote-lab account design

After we login to the account, we find a page like a Facebook profile contains an animated image and a profile picture, and an eight-button each one leads us to a different link.

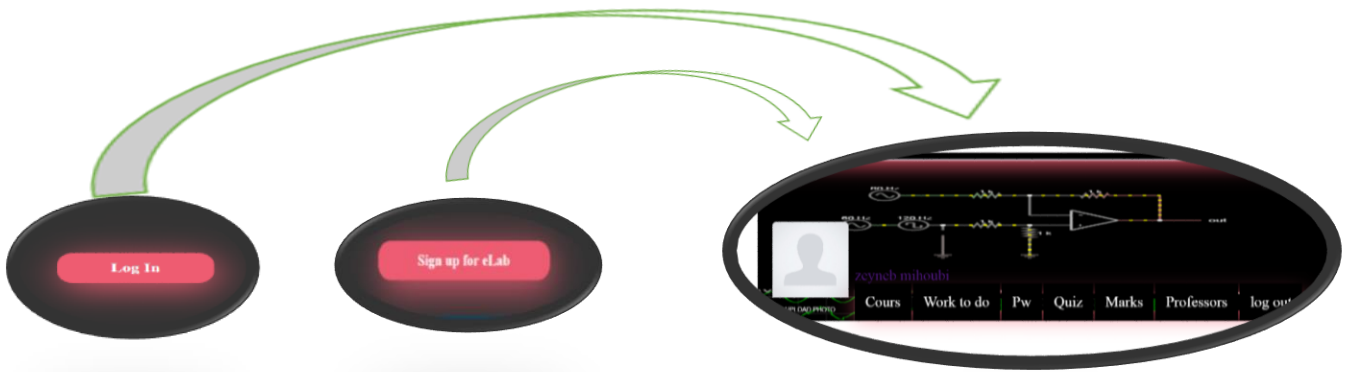


Figure23.remotelab account interface

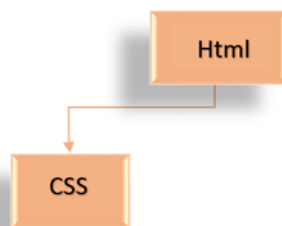


Figure 24. diagram used for creation of remote lab account

#### The explanation of figure 24

we used the html5 to create the links in the form of button and we used the css3 to give the color and the position of the buttons and the images in the page

#### III.2.5 explanation of the account button

**Cours** :link lead us to the cours (pdf file ).

**Work to do** :brochurs are set by teachers to download by students

**Marks** :quiz marks given by proffesores

**Log out**:lead us to home page

**Upload photo** :by clicking on the button( upload photo) we will be able to put a personal picture.

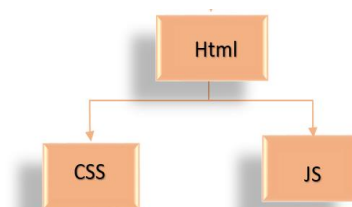
**Profesors** :When we hover this button a list of professors will open containing the curriculum vitae of themand the student can communicate with them.

### III.2.6 professors and upload photo button design



**Figure 25.the function of Professors button**

**Figure 26.the function of upload photo button**



**Figure 27. diagram used for creation of professors and upload photo button**

#### The explanation of figure 27

**For the profesors button** : we using html to creat the link and css to do the hover and the vertical liste.

**And for upload photo button:** we using html to load the base photo and using css to creat the hover button and using javascript to upload range photo and to creat the button of accepte or reject picter .

III.2.7 practical work page design

When we click on the button of pw it will lead us to an interface.

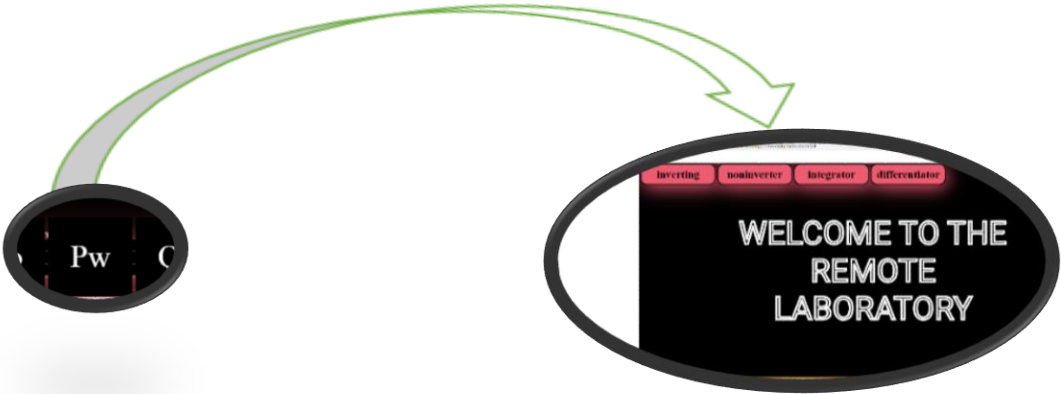


Figure28.practical work menu

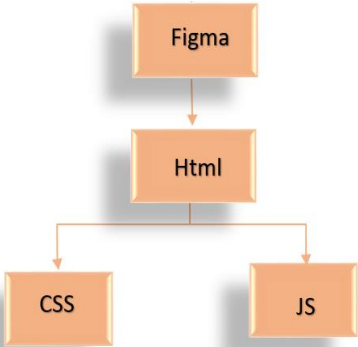


Figure 29. diagram used for creation of practical work menu

The explanation of figure 29

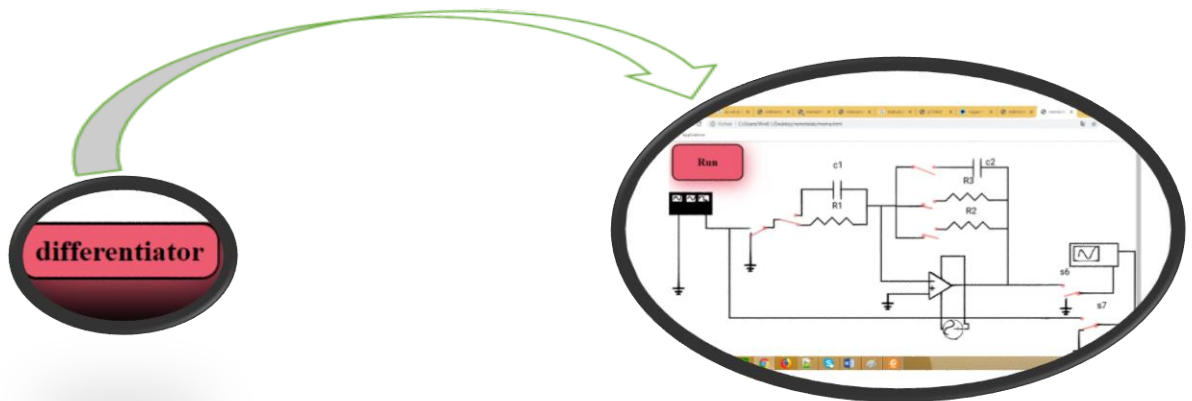
With Figma: We wrote the welcome text and gave it the white color with Figma ,which allows us to convert the text into a svg code Then we put it in a html language to Read it

By CSS language we moved the welcome text and gave the background black color as we arranged the list horizontally and give it a pink color with the addition of shadow

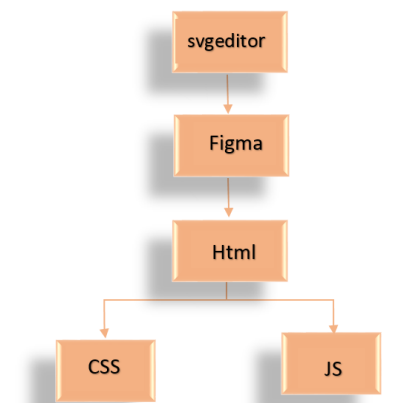
### III.2.8 schema of op-amplifier design

**Note:** Each title from the list is linked to a link that opens another page.

we take as an example differentiator it will open an interface that contains a white background and w pink run button and a schema of amplifier drawn by svg format.



**Figure 30.**the function of differentiator button



**Figure 31.** practical work simulator

#### The explanation of figure 31

using the svg editor, we drew the schema in svg format then we opened it with figma for removed each part of the drew to a separate code then we put the separate draw and each cutter in a separate html file next with css we placed every cutter in her position in the schema, using JavaScript we created a function that can be replaced an image by another one

### III.2.9 Notification design

when we click on it to close the cutouts, and finally we created a run button and we gave it the fill and color with css

**note:** We made with JavaScript a notification in the case clicking on the wrong cutter.

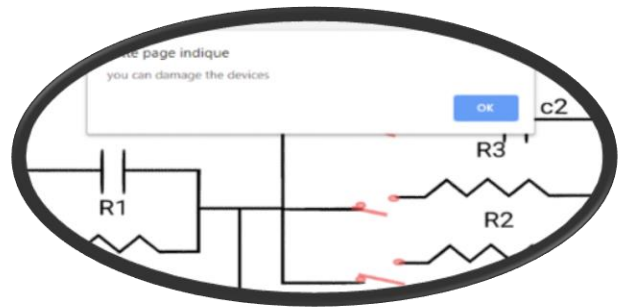


Figure 32. warning notification

### III.2.3 execution page design

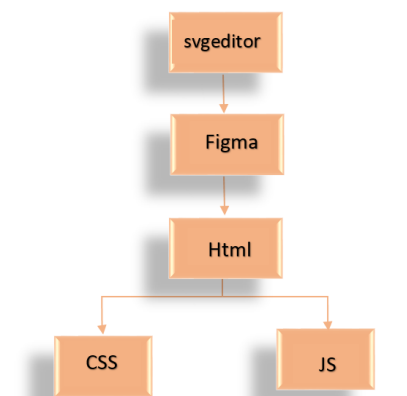


Figure 33. diagram used for creation of execution page.

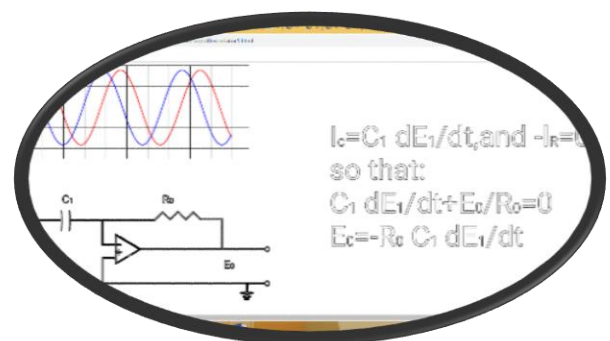


Figure 34. execution page

#### The explanation of figure 33

using the svgeditor, we drew the schema in svgformat then we wrote the amplifier formula and gave it the white color with Figma, which allows us to convert the text into a svgcode, nextwith html we wrote a grid code in svgformat and created a function with JavaScript to draw a signal and finely usingcss we gave the color to the signal and we animate it and we animate the amplifier formula too.

### III.2.10 Quiz page design

when we press quiz button it will open to us a pink interface contains a many question and black button to send the answers to the professor.



Figure35.Quizinterface

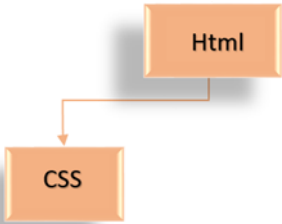


Figure 36. diagram used for creation of the quiz page

The explanation of figure 36 using html, we wrote the quiz and the send button and with css we gave it the color and the form.



## IV Test and Result

### IV.1 Test and feedback of students on the Designed Virtual Operational Amplifier lab

The designed virtual lab is for 3<sup>rd</sup> year Licence students in electronic department, the course is Operational Amplifier and its applications.

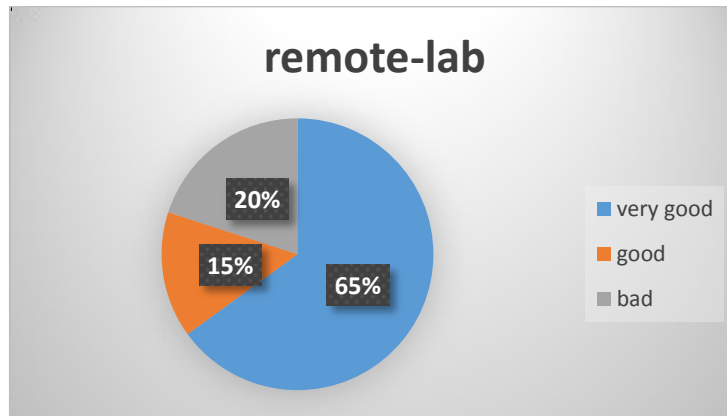
A group of students have tested it on PC and here is their feed back concerning the questionnaire presented in table 4.1 where 10 questions are exposed to get feed back of students concerning the virtual op-amplifier lab : presentation, ease of use, design , circuit schema comprehension.

**Table IV.1: The questionnaire as a satisfaction survey of the virtual op-amplifier Laboratory**

Evaluation Item	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I understand most of the textual descriptions in the virtual Op-Amp lab	30%	35	20	10	5
The images in the virtual Op-Amp lab are clear.	15	32	30	15	8
I understand the steps of operating procedure after using the virtual Op-Amp lab	25	30	15	20	20
The contents of the virtual Op-Amp lab show me the principle of Operational Amplifier	45	40	5	5	5
I actively completed the tasks and took the online test.	20	30	40	10	0
I downloaded the course resume from virtual lab	40	45	5	0	0
Using the virtual Op-Amp lab helps me understand the principle Op-Amplifier	25	30	20	10	5
I have problem to select switches for specific PW	10	15	10	40	
I like to use the virtual Op-Amp lab as an interactive teaching material.	40	30	0	15	15
The visual design of the virtual Op-Amp lab is delightful and consistent.	05	10	30	40	15

## IV.2 Discuss results and suggest solutions

The second scenario to test the application is as follows: after we finished the application we gave it to 20 students from the electronic department in the license level to try it and then we took their opinion on it and the result was as follows:



**Figure 37: Illustration of students' opinion concerning the interface**

**65 %** said that it was very good as a new initiative to provide the practical work in the form of a graphic user interface, also they said that it had a beautiful form and graphics are so clear and easy to use as well as an excellent way to save time through which they can create the required work at any time and place.

It also provides additional information they cannot get in the real class because the time given to the real lab is not enough to provide and discuss all the information, but in this interface can be put an endless number of questions to various professors of the department.

**15 %** They said it was generally good: on the form level, the GUI is beautiful and clear and at the professional level, it is a good initiative to develop and facilitate laboratory work. They also said that it is easy for them to use it. It also saves them time, so they can use laboratory time in other works. It is also a good way to communicate with teachers, especially students who are ashamed to ask questions from their colleagues however It has some disadvantages such as inability to control electronic devices.

20% they said that it's bad because they prefer the real laboratory work because it gives them the opportunity to work in a group that enables them to acquire more information and to discuss the results and lessons between them. This is what they can't do in the graphical interface. The idea of communicating with a professor is not good because he cannot respond to messages instantaneously because they are not chatting, and the things they criticized a lot are not to be able to see the performance of the reel devices and not touch and manipulate them. Also, they will not be able to create the schema themselves, however they can do all this thing in The real laboratory

In the end they concluded that virtual laboratory work is merely a theoretical study with an applied flavor. And real lab work cannot be replaced by any remote laboratory, no matter how much it develops.

We have designed the graphical user interface in the SVG model to keep the graphics clear no matter how we zoom on it, also to make it is so easy and clear for any student or professor to work regardless of the type of device used (Mobile phone, tablet, Data Show or Personal Computer)

We have done this virtual op-amplifier-lab for the following reasons:

To improve the scientific level by replacing the real working session with virtual laboratories sessions. Thus, the professor can offer a lot of additional work and lessons.

It does not remain limited to the number of sessions scheduled in the semester or the extent of the availability of practical work class such as the availability of electricity and sections and it also saves time for the professor or teacher instead of re-explaining the lessons and work required for each group enough to put them in the user interface for all sections and any student facing a problem can send question for the professor responsible of the lesson.

The student also have a quiz question to answer, and the responses are sent directly to the teacher.

Finally, it is a good way to reduce the level of cheating among students because the work is individual.

Students have always complained about the hours they spend studying and how tired they are. This interface is the practical solution to reduce the hours imposed on them, so they can take advantage of the time of practical work session in other jobs and also allow them the opportunity to work in any place and time.

Also, they can ask an endless number of questions on the professors by messaging, and they can also do more than a laboratory work because in the virtual world time has not a limit.

Also, individual work also teaches them self-reliance and not relying on others to search for information. It helps to develop the capacity of the mind absorptive.

## Conclusion

In this work, We have designed a graphical user interface based on HTML and SVG languages, this will make it easy and clear for any student or professor to work regardless of the type of device used (Mobile phone,tablete or PC)

We have done this remote-lab for the following reasons:

To allow students do their PW anywhere, No need for more laboratory spaces, teachers can access the developed work at any time.

In our work we used many programming languages beside HTML to develop the interface.:

SVG was used to simplify graphic representation of electronic components such as Op-Amplifier and Signal generator. We used CSS language to implement component color background and placing cutters. In this project we were inspired by web design techniques to develop our virtual lab.

We selected Op-amplifier as application because with this electronic component we develop many Practical works : inverter, non-inverted, active filters, integrator and others.

We concluded that Virtual labs may help students do their practical work at any time and anywhere . The developed system were tested on a group of students and their feedback were interesting, the student can reply to quiz questions to see their level of understanding , they can ask a line number of questions to the professors by messaging, and they can also do more than a laboratory work because in the virtual world time has no limit.

Also, individual work also teaches them self-reliance and not relying on others to search for information. It helps to develop the capacity of the mind absorptive.

## **Further Work**

IF we continue works in direction of developing Virtual Laboratories, we can cover the other electronic subjects, provide much more experiments and increase the flexibility of other applications: i.e. logic circuits, transistors , and RLC circuits,. The modifications of the systems are planned to implement in following directions:

- a) increasing the interactivity in virtual environments;
- b) user interface improvement; graphically;
- c) creation of new services to support connection between laboratories and practicing classes;
- d) feedback system developing: answering questions of students ;
- e) make the gui in 3d format to make it so close to the real lab
- f) add a video of courses to gui
- g) add a window of chatting between students and proffesors

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- [16] [https://www.w3schools.com/html/html\\_intro.asp](https://www.w3schools.com/html/html_intro.asp)
- [17] [https://www.w3schools.com/css/css\\_intro.asp](https://www.w3schools.com/css/css_intro.asp)
- [18] [https://www.tutorialspoint.com/javascript/javascript\\_overview.html](https://www.tutorialspoint.com/javascript/javascript_overview.html)



this is some examples of the code used to create the GUI

```
4 <meta charset="utf-8" />
5 <link href="css5.css" media="all" rel="stylesheet" type="text/css" />
6 <link href="css6.css" media="all" rel="stylesheet" type="text/css" />
7 <script src="js3.js"></script>
8 </head>
9 <body>
10 <div id="menu-outer">
11 <div class="table">
12 <ul>
13 <li><a id="1" href="memc.html" ><h1>inverting</h1></a></li>
14 <li><a id="2" href="memd.html" ><h1>noninverter</h1></a></li>
15 <li><a id="3" href="memb.html" ><h1>integrator</h1></a></li>
16 <li><a id="4" href="mema.html" ><h1>differentiator</h1></a></li>
17 </ul>
18 </div>
19 </div>
20 </div>
21 <svg
22 id="logo"
23 width="786" height="295" viewBox="0 0 786 295" fill="none" xmlns="http://www.w3.org/2000/svg">
24
25 <path id="M23.2266 49.5249L24.5023 58.3083L26.3702 50.3941L39.4917 3.91494H46.8725L59.675 50.3941L61.4974 58.4455L62.9098 49.4791L73.2065 3.91494
26 <path id="M129.713 39.735H100.964V63.3405H134.36V70.5228H92.2162V3.91494H133.904V11.143H100.964V32.5527H129.713V39.735Z" stroke="white" stroke-
27 <path id="M154.508 63.3405H185.945V70.5228H145.715V3.91494H154.508V63.3405Z" stroke="white" stroke-width="6" mask="url(#path-1-outside-1)"/>
28 <path id="M242.178 49.3876C241.358 56.4327 238.761 61.8766 234.387 65.7193C230.044 69.5316 224.257 71.4377 217.028 71.4377C209.192 71.4377 202.
29 <path id="M305.655 39.369C305.655 45.8956 304.561 51.5987 302.374 56.4784C300.187 61.3276 297.089 65.0331 293.08 67.595C289.071 70.1568 284.39
30 <path id="M330.542 3.91494L352.228 58.2626L373.915 3.91494H385.26V70.5228H376.512V44.5842L377.332 16.5869L355.554 70.5228H348.857L327.125 16.7
31 <path id="M438.668 39.735H409.919V63.3405H443.315V70.5228H401.171V3.91494H442.859V11.143H409.919V32.5527H438.668V39.735Z" stroke="white" stroke
32 <path id="M522.293 11.143H500.971V70.5228H492.269V11.143H470.992V3.91494H522.293V11.143Z" stroke="white" stroke-width="6" mask="url(#path-1-out
33 <path id="M582.353 39.369C582.353 45.8956 581.26 51.5987 579.073 56.4784C576.886 61.3276 573.788 65.0331 569.778 67.595C565.769 70.1568 561.09
34 <path id="M663.564 11.143H642.242V70.5228H633.539V11.143H612.263V3.91494H663.564V11.143Z" stroke="white" stroke-width="6" mask="url(#path-1-out
35 <path id="M724.854 70.5228H716.061V39.735H682.619V70.5228H673.872V3.91494H682.619V32.5527H716.061V39.735H724.854V70.5228Z" stroke="white" stroke-wi
36 <path id="M778.353 39.735H749.604V63.3405H783V70.5228H740.856V3.91494H782.544V11.143H749.604V32.5527H778.353V39.735Z" stroke="white" stroke-wi
```

html code of Practical work page

```
1 {
2   padding:0;
3   margin:0;
4   box-sizing: border-box;
5 }
6 body{
7   width:100%;
8   height:100vh;
9   background-color:rgb(0,0,0);
10 }
11 #logo{
12   position:absolute;
13   top:50%;
14   left:50%;
15   transform:translate(-50%,-50%);
16 }
17 #logo path:nth-child(1){
18   stroke-dasharray:572px;
19   stroke-dashoffset:572px;
20   animation:line-anim 3s ease forwards 0.3s;
21 }
22 #logo path:nth-child(2){
23   stroke-dasharray:572px;
24   stroke-dashoffset:572px;
25   animation:line-anim 3s ease forwards 0.6s;
26 }
27 #logo path:nth-child(3){
28   stroke-dasharray:572px;
29   stroke-dashoffset:572px;
30   animation:line-anim 3s ease forwards 0.9s;
31 }
32 #logo path:nth-child(4){
33   stroke-dasharray:572px;
34   stroke-dashoffset:572px;
35 }
```

the css programs for animate the svg text

```
C:\Users\Win8.1\Desktop\remotelab\css6.css - Notepad++
Fichier Edition Recherche Affichage Encodage Langage Paramètres Outils Macro Exécution Compléments Documents ?
css6.css | css5.css | mmd.css | mma.css | mmb.css | mmc.css | n1a.svg | n2a.svg | n3a.svg | n3d.svg | quiz.html | quiz.css | svg2.html | memoire.html | mema.html | differentiator1.html
1 ul {
2   padding:0;
3   margin:0;
4   list-style-type:none;
5 }
6 li {
7   margin-left:4px;
8   float:left; /*pour IE*/
9 }
10 #ul{
11   position:absolute;
12   top:50%;
13   left:50%;
14   transform:translate(-50%,-50%);
15 }
16 ul li a {
17   display:block;
18   float:left;
19   width:220px;
20   background-color:#ee5c71;
21   color:black;
22   text-decoration:none;
23   text-align:center;
24   padding:10px;
25   border:3px solid;
26   box-shadow: 5px 10px 50px 0 #ee5c71;
27   border-radius: 20px;
28 }
29 ul li a:hover {
30   background-color:#ff0b55;
31   box-shadow: 1px 2px 20px 0 #ff0b55;
32 }
```

Css code to do design of practical work page (color menu ...)

```
css6.css | css5.css | mmd.css | mma.css | mmb.css | mmc.css | n1a.svg | n2a.svg | n3a.svg | n3d.svg | quiz.html | quiz.css | svg2.html | memoire.html | mema.html | differentiator1.html
1
2 .clsSecondImg
3 {
4   width:4%;
5   position:absolute;
6   top:247px;
7   left:727px;
8 }
9
10 .clsFirstImg
11 {
12   width:100%;
13   position:absolute;
14   top:45px;
15   left:0px
16 }
17
18 .clsSImg
19 {
20   width:5%;
21   position:absolute;
22   top:111px;
23   left:690px;
24 }
25
26
27
28 .a
29 {
30   width:4%;
31   position:absolute;
32   top:240px;
33   left:230px;
34 }
```

Cascade Style Sheets File | length: 1466 lines: 151 | Ln: 1 Col: 1 Sel: 010 | Windows (CR LF) UTF-8 | INS

Css code to range the cuters is their position on schema

```

119 top:170px;
120 left:760px;
121 }
122 }
123 .n
124 {
125 width:1%;
126 position:absolute;
127 top:511px;
128 left:1185px;
129 }
130 }
131 #o
132 {
133 {
134 display:block;
135 float:left;
136 width:180px;
137 background-color:#ee5c71;
138 color:black;
139 text-decoration:none;
140 text-align:center;
141 padding:10px;
142 border:3px solid;
143 box-shadow: 5px 10px 50px 0 #ee5c71;
144 border-radius: 20px;
145 }
146 }
147 #o:hover {
148 background-color:#ff0b55;
149 box-shadow: 1px 2px 20px 0 #ff0b55;
150 }
151 }

```

Cascade Style Sheets File length: 1466 lines: 151 Ln: 1 Col: 1 Sel: 0 | 0 Windows (CR LF) UTF-8 INS

### Css code to make run button design

```

1 <svg width="35" height="28" viewBox="0 0 27 28" fill="none" xmlns="http://www.w3.org/2000/svg">
2 <g opacity="0.62">
3 <path d="M25.088 16.9105L1.83496 10.8434L25.088 16.9105Z" fill="#E98A8A"/>
4 <path d="M25.088 16.9105L1.83496 10.8434" stroke="#E84141" stroke-width="3" stroke-linejoin="round"/>
5 </g>
6 </svg>
7

```

### Svg cutter code

```

1 <svg width="55" height="30" viewBox="0 0 41 40" fill="none" xmlns="http://www.w3.org/2000/svg">
2 <g opacity="0.62">
3
4 <path d="M5 22L80 0" stroke="#E84141" stroke-width="6" stroke-linejoin="round"/>
5 </g>
6 </svg>
7
8

```

### Svg cutter code

```

1 <svg width="25" height="28" viewBox="0 0 27 28" fill="none" xmlns="http://www.w3.org/2000/svg">
2 <g opacity="0.62">
3 <path d="M25.088 16.9105L1.83496 10.8434L25.088 16.9105Z" fill="#E98A8A"/>
4 <path d="M25.088 16.9105L1.83496 10.8434" stroke="#E84141" stroke-width="2" stroke-linejoin="round"/>
5 </g>
6 </svg>
7

```

### Svg cutter code

```

1 <svg width="25" height="28" viewBox="0 0 27 28" fill="none" xmlns="http://www.w3.org/2000/svg">
2 <g opacity="0.62">
3 <path d="M25.088 16.9105L1.83496 10.8434L25.088 16.9105Z" fill="#E98A8A"/>
4 <path d="M25.088 16.9105L1.83496 10.8434" stroke="#E84141" stroke-width="2" stroke-linejoin="round"/>
5 </g>
6 </svg>
7

```

### svg cutter code

```

4 <link rel="stylesheet" href="quiz.css">
5 <link rel="stylesheet" href="https://font.googleapis.com/css?family=Lato" >
6
7
8 <!--<script src="quiz.js"></script-->
9 </head>
10 <body>
11 <form id="quiz" name="quiz">
12 <p>Question1.Explain What Are The Applications Of An Inverting Amplifier?</p>
13 <input id="textbox" type="text" name="question1">
14 <p>Question2.Explain What Are The Applications Of Integrator?</p>
15 <input id="textbox" type="text" name="question2">
16 <p>Question3.Op-amp Is Used Mostly As An Integrator Than A Differentiation. Explain Why?</p>
17 <input id="textbox" type="text" name="question3">
18 <p>Question4.What Is Characteristic Of Ideal Op Amp?</p>
19 <input id="textbox" type="text" name="question4">
20 <p>Question5.What Is The Formula For Non Inverting Amplifier?</p>
21 <input id="textbox" type="text" name="question5">
22
23 <p>Question6. In an Inverting Amplifier circuit, the output voltage
24 vo is expressed as a function of </p>
25 <input type="radio" id="mc" name="question6"=" Input current">a) Input current <br>
26 <input type="radio" id="mc" name="question6"="Output current">b) Output current<br>
27 <input type="radio" id="mc" name="question6"="Source voltage ">c) Source voltage <br>
28 <input type="radio" id="mc" name="question6"="Source current">d) Source current <br>
29
30 <p>Question7. The gain is also known as scaling factor and
31 it is the ratio of Rf/Rs in case of an Inverting amplifying circuit, If Vs= 12V and ve=1mV, then Rf/Rs is </p>
32 <input type="radio" id="mc" name="question7"="12000">a)12000<br>
33 <input type="radio" id="mc" name="question7"="1200">b)12000<br>
34 <input type="radio" id="mc" name="question7"="12000">c)12000 <br>
35 <input type="radio" id="mc" name="question7"="1">d)1<br>
36
37 <p>Question8 for opamp non inverter. If Rs= 50, Rf= 250 and -2.5V < vr < 2.5V

```

## Html code of Quiz

```

1 body {
2   font-family: 'Lato', sans-serif;
3 }
4 #quiz {
5   margin-left:10px;
6   background:#E9E8A8A;
7   padding:10px 20px 10px 20px;
8   width:800px;
9   border-radius:20px;
10  float:left;
11 }
12 input {
13   margin-bottom:20px;
14   display:black;
15 }
16
17 #textbox {
18   height:150px;
19   width:600px;
20   font-size:16px;
21   border-radius:5px;
22   border :none;
23   padding-left:2px;
24 }
25 #button{
26   background:#000000;
27   border :none;
28   border-radius:5px;
29   padding:10px 20px 10px 20px;
30   color:white;
31   font-size:16px;
32   transition-duration: .5s;
33   margin-top:15px;
34 }

```

## Css code of Quiz

```
1 <!DOCTYPE html>
2 <html lang="en">
3 <head>
4 <link href="nma.css" media="all" rel="stylesheet" type="text/css" />
5 </head>
6 <body>
7
8 <form id="form1" runat="server">
9 <div>
10 
11
12 
13 </div>
14
15 <script>
16 function changeImage () {
17     var ima = document.getElementById('myImage');
18     if (ima.src.match("n3a")){
19         ima.src = "1a.svg" ;
20     } else{
21         ima.src="n3a.svg";
22     }
23 }
24 </script>
25
26 <!------->
27 <form id="form1" runat="server">
28 <div>
29 
30 </div>
31 <script>
32 function a () {
33     var a11 = document.getElementById('a1');
34     if (a11.src.match("413b")){
```

### Html schema code

```
19 <div>
20 <svg class="clsFirstImg" width="100%" height="100%" xmlns="http://www.w3.org/2000/svg">
21 <defs>
22
23 <pattern id="grid" width="50" height="50" patternUnits="userSpaceOnUse">
24 <rect width="100" height="100" fill="url(#smallGrid)"/>
25 <path d="M 100 0 L 0 0 0 100" fill="none" stroke="gray" stroke-width="1"/>
26 </pattern>
27 </defs>
28 <rect width="50%" height="75%" fill="url(#grid)" />
29 </svg>
30
31
32 <svg id="logo" class="clsSecondImg" width="400" height="400" viewBox="0 0 1294 632" fill="none" xmlns="http://www.w3.org/2000/svg">
33
34 <path d="M24.3672 112H10.8672V9.625H24.3672V112Z" stroke="black" stroke-width="8" mask="url(#path-1-outside-1)"/>
35 <path d="M57.4141 107.395C59.7344 107.395 61.7617 106.691 63.4961 105.285C65.2305 103.879 66.1914 102.121 66.3789 100.012H72.5312C72.41
36 <path d="M144.25 54.7656H85.6094V43.4453H144.25V54.7656ZM144.25 83.9453H85.6094V72.6953H144.25V83.9453Z" stroke="black" stroke-width="8"
37 <path d="M241.141 79.5156C239.875 90.3438 235.867 98.7109 229.117 104.617C222.414 110.477 213.484 113.406 202.328 113.406C190.234 113.4
38 <path d="M273.379 112H266.84V68.6523L253.727 73.4688V67.5625L272.359 60.5664H273.379V112Z" stroke="black" stroke-width="8" mask="url(#p
39 <path d="M330.578 73.3281C330.578 61.6562 333.344 52.2812 338.875 45.2031C344.406 38.0781 351.648 34.5156 360.602 34.5156C369.508 34.51
40 <path d="M474.93 64.6797H430.562V100.961H482.102V112H417.062V9.625H481.398V20.7344H430.562V53.6406H474.93V64.6797Z" stroke="black" strc
41 <path d="M512.652 112H506.113V68.6523L493.73 4688V67.5625L511.633 60.5664H512.652V112Z" stroke="black" stroke-width="8" mask="url(#path
42 <path d="M539.898 120.789H528.719L571.469 9.625H582.578L539.898 120.789Z" stroke="black" stroke-width="8" mask="url(#path-1-outside-1)
43 <path d="M593.477 73.3281C593.477 61.6562 596.242 52.2812 601.773 45.2031C607.305 38.0781 614.547 34.5156 623.534 34.5156C632.406 34.515
44 <path d="M695.57 17.5V35.9219H709.773V45.9766H695.57V93.1562C695.57 96.2031 696.203 98.5 697.469 100.047C698.734 101.547 700.891 102.25
45 <path d="M724.609 132.391L717.227 127.328C721.633 121.188 723.93 114.859 724.117 108.344V96.6016H736.844V106.797C736.844 111.531 735.67
46 <path d="M800.266 112C799.516 110.5 798.906 107.828 798.438 103.984C792.391 110.266 785.172 113.406 776.781 113.406C769.281 113.406 766
47 <path d="M843.93 35.9219L844.352 45.4844C850.164 38.1719 857.758 34.5156 867.133 34.5156C883.211 34.5156 891.32 43.5859 891.461 61.7266
48 <path d="M907.914 73.3281C907.914 61.6562 910.68 52.2812 916.211 45.2031C921.742 38.0781 928.984 34.5156 937.938 34.5156C946.844 34.515
84 <path d="M491.172 586.516C489.906 597.344 485.898 605.711 479.148 611.617C472.445 617.477 463.516 620.406 452.359 620.406C440.266 620.40
85 <path d="M523.41 619H516.871V575.652L503.758 580.469V574.562L522.391 567.566H523.41V619Z" stroke="black" stroke-width="8" mask="url(#pa
86 <path d="M580.609 580.328C580.609 568.656 583.375 559.281 588.906 552.203C594.438 545.078 601.68 541.516 610.633 541.516C619.539 541.51
87 <path d="M724.961 571.68H680.594V607.961H732.133V619H667.094V516.625H731.43V527.734H680.594V560.641H724.961V571.68Z" stroke="black" str
88 <path d="M762.684 619H756.145V575.652L743.031 580.469V574.562L761.664 567.566H762.684V619Z" stroke="black" stroke-width="8" mask="url(#
89 <path d="M789.93 627.789H778.75L821.5 516.625H832.609L789.93 627.789Z" stroke="black" stroke-width="8" mask="url(#path-1-outside-1)"/>
90 <path d="M843.508 580.328C843.508 568.656 846.273 559.281 851.805 552.203C857.336 545.078 864.578 541.516 873.531 541.516C882.438 541.51
91 <path d="M945.602 524.5V542.922H959.805V552.977H945.602V600.156C945.602 603.203 946.234 605.5 947.5 607.047C948.766 608.547 950.922 609
92 </svg>
93 </div>
94 <form id="logo" width="808" height="392" viewBox="0 0 808 392" fill="black" xmlns="http://www.w3.org/2000/svg">
95 <path stroke="black" d="M126.37 81.5613V96.1032H79.0129H31.7839L28.4651 92.3097C24.6357 87.7574 20.551 87.5045 16.8493 91.4245C13.2752
96 <path stroke="black" fill-rule="evenodd" clip-rule="evenodd" d="M30.6956 97.8968L26.947 93.612L26.9346 93.5971C25.205 91.541 23.6805 90
97 <path stroke="black" fill-rule="evenodd" clip-rule="evenodd" d="M151.899 99.8968C151.899 128.222 152.154 132.774 153.814 132.774C155.473 132.774 155.728 130.119 155.728 116.3
98 <path stroke="black" fill-rule="evenodd" clip-rule="evenodd" d="M451.866 70.1821L425.7 96.1032H155.728V81.5613C155.728 69.4219 155.345
99 <path stroke="black" d="M463.357 32.6465H457.346V43H453.953V17.4062H462.426C465.309 17.4062 467.523 18.0625 469.07 19.375C470.629 20.0
100 <path stroke="black" d="M485.301 35.7227C485.301 38.2617 484.867 40.1484 484 41.3828C483.133 42.6172 481.777 43.2344 479.934 43.2344C47
101 <path stroke="black" d="M151.797 34.8789C151.48 37.5859 150.479 39.6777 148.791 41.1543C147.115 42.6191 144.883 43.3516 142.094 43.3516
102 <path stroke="black" d="M161.992 43H159.812V28.5508L155.44 30.1562V28.1875L161.652 25.8555H161.992V43Z" fill="black"/>
103 <path stroke="black" d="M44.4375 181.17H33.3457V190.24H46.2305V193H29.9707V167.406H46.0547V170.184H33.3457V178.41H44.4375V181.17Z" fill
104 <path stroke="black" d="M56.0039 193H53.8242V178.551L49.4531 180.156V178.188L55.6641 175.855H56.0039V193Z" fill="black"/>
105 <path stroke="black" d="M664.438 243.17H653.346V252.24H666.23V255H649.971V229.406H666.055V232.184H653.346V240.41H664.438V243.17Z" fill=
106 <path stroke="black" d="M679.578 247.723C679.578 250.262 679.145 252.148 678.277 253.383C677.41 254.617 676.055 255.234 674.211 255.234
107 </svg>
108 </body>
109 </html>
```

### Html code of execution pw



```
1 *{
2   padding:0;
3   margin:0;
4   box-sizing: border-box;
5 }
6 body{
7   width:100%;
8   height:100vh;
9   background-color:FFF8Bf;
10 }
11
12 #logo path:nth-child(1){
13   stroke-dasharray:572px;
14   stroke-dashoffset:572px;
15   animation:line-anim 3s ease forwards 0.3s;
16 }
17 #logo path:nth-child(2){
18   stroke-dasharray:572px;
19   stroke-dashoffset:572px;
20   animation:line-anim 3s ease forwards 0.6s;
21 }
22 #logo path:nth-child(3){
23   stroke-dasharray:800px;
24   stroke-dashoffset:600px;
25   animation:line-anim 3s ease forwards 0.9s;
26 }
27
28 #logo path:nth-child(5){
29   stroke-dasharray:572px;
30   stroke-dashoffset:572px;
31   animation:line-anim 3s ease forwards 1.5s;

```

Page 7 of 8 Cascade Style Sheets File length : 7 336 lines : 297 Ln: 1 Col: 1 Sel: 0 | 0 Windows (CR LF) UTF-8 INS

Css code of execution pw