



Training Action

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Introduction

This guide is part of a Technical Action (TA) integrated in the European project VISIR+. It provides a brief overview of the required actions to prepare and conduct electrical and electronic experiments using the remote lab named VISIR. Some examples of the required steps to prepare and conduct experiments are presented and, at the end, it is suggested to participants the conduction of some experiments traditionally provided in every electrical engineering course curricula.

The guide is divided in 3 sections.

- Section 1: Introduces the VISIR system presenting some of the most important panel interfaces and procedures required to prepare, setup and conduct experiments.
- Section 2: Presents two examples of experiment able to conduct using the VISIR system. It is explained to participants the way students can setup a circuit, and measure/observe electrical signals.
- Section 3: Suggests some other experiments that should be conducted individually by each participant (with tutor guidance).

Introduction of the VISIR

The VISIR is a real laboratory that enables students to remotely conduct electrical/electronic experiments using real equipment, like in traditional hands-on laboratories. Currently implemented in Austria, Georgia, India, Portugal, Spain, and Sweden, the VISIR enables students to generate, measure and observe electrical signals on different nodes of a circuit able to setup in a virtual breadboard.

To access the VISIR users should have a PC connected to the Internet running a compatible web browser (ideally with a recent Flash plugin installed). There are no access restrictions, since all the commands are sent using the HTTP protocol. As the VISIR runs asynchronously according to FIFO command requests, it is possible run several experiments simultaneously. The only limitation is imposed by the underline hardware infrastructure.

To use the VISIR users should access a set of webpages. They can use it as a teachers, technicians or students. Teachers and technicians are responsible of preparing courses and the associated experiments, while students will use the VISIR system to remotely conduct those experiments. Figure 1 illustrates some of the webpages provided to access, and to manage courses and experiments.

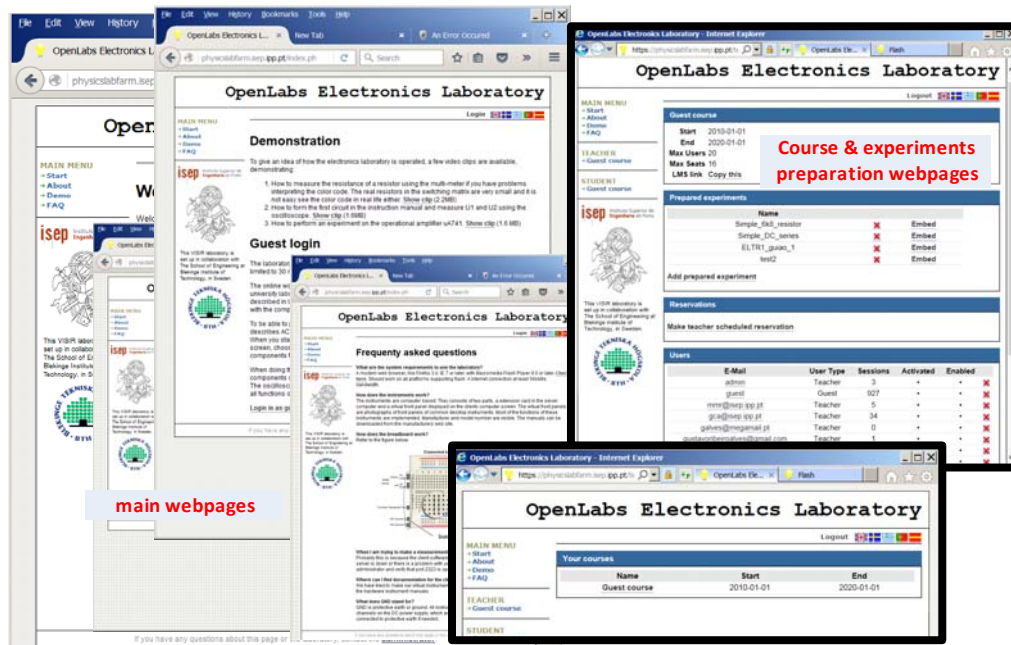


Figure 1: Some webpages provided by the VISIR.

With the VISIR students may use a set of measurement instruments (Oscilloscope, Digital MultiMeter –DMM–, DC power supply, Function Generator or others) able to connect to different nodes of electrical/electronic circuits comprising several components, such as resistors, capacitors, specific electronic integrated circuits (e.g. AmpOp), etc. Both the components and the measurement instruments should be connected to one or more *Switching Matrixes* integrated in the underlying hardware infrastructure and listed in a text file named *ComponentList*. It is according to the available connections listed in this file that teachers/technicians should specify each available circuit by defining a set of rules in another type of text files named *MaxLists*.

The underlying VISIR infrastructure may integrate several switching matrixes interconnected in columns. As represented in figure 2 a), the 1st one, the bottom matrix, may connect up to 3 DC power supplies and a function generator, the 2nd one up to two DMMs, and the 3th one a two channel oscilloscope. The remaining ones are adopted to connect the components used in electrical/electronic circuits. Each of these matrixes provides 10 nodes (A to I and a ground - 0 node -) to connect components and/or to establish shortcuts, which are used to enable the measurement of currents using a DMM. Figure 2 b) illustrates an example of connections established between the components and a switching matrix, plus an example of some rules defined in a *MaxList* file.

Therefore, to use the VISIR it is mandatory a previous preparation of each experiment (the main steps of this process are described in annex A). This can be made by a teacher and/or technician by doing two basic actions: i) physically connect the measurement instruments and the electronic components to a one or more switching matrixes and; ii) define a set of rules in the *MaxList* text file. Once the experiments were prepared, they must be included, together with students and teachers, in a particular course that should be created (the main steps of this process are described in annex B). A set of web interfaces, similar to the ones represented in figure 3, are used to setup the circuits in a

virtual breadboard, and to control the selected instruments to generate, measure and/or observe electrical signals. Students can pick up the available components and setup the suggested circuit in the virtual breadboard. They can also connect the available instruments in different nodes of the circuit using the same panel interfaces usually available in a common hands-on laboratory. Note that all circuits must be described in one or more *MaxList* files, which indicates the nodes where a particular component or instrument may be connected. If the circuit wasn't setup according to the description present in the *MaxList* file, an error will be generated.

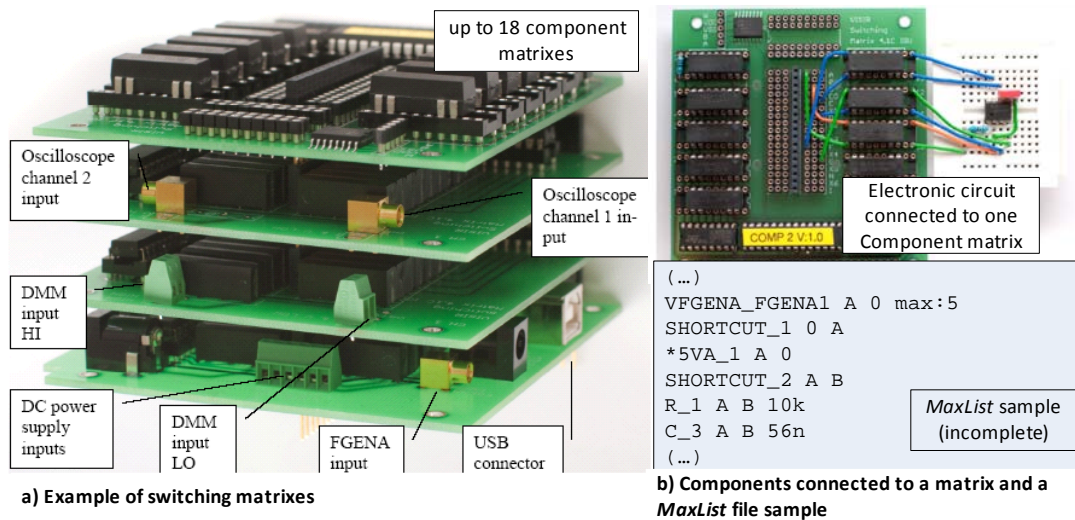


Figure 2: Picture of four Switching Matrixes, an electronic circuit connected to the one matrix and an example of some rules defined in a *MaxList* file.

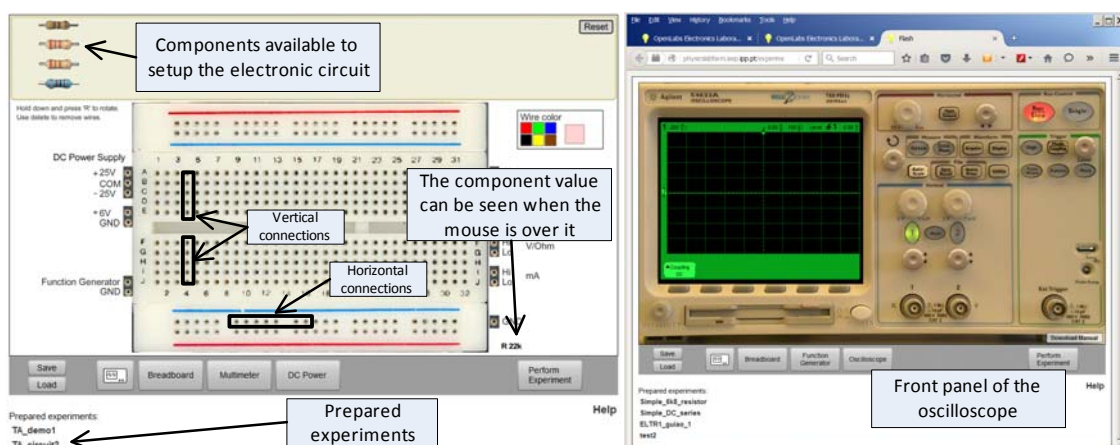


Figure 3: Example of some panel interfaces used to conduct experiments using the VISIR system.

Demo Circuits

To exemplify the operation of the VISIR system, the schematic and the *MaxList* files of two circuits are presented: i) a serial resistor circuit (figure 4) and ii) a RC circuit (figure 5). The *MaxList* files and the associated nodes of each circuit are presented so participants may understand their relevance for setting up and measuring values in a circuit. Annex C provides a list of these *MaxList* files plus the *ComponentList* file listing the components available in the VISIR system.

Participants will access the main panel of the experiments comprising the virtual breadboard and a set of instruments. They will setup each circuit and connect the instruments on different nodes to generate, measure and observe the electrical signals according to a set of steps.

Circuit 1

Website: <https://physicslabfarm.isep.ipp.pt/> (Course: TA_VISIR Experiment: TA_demo1)

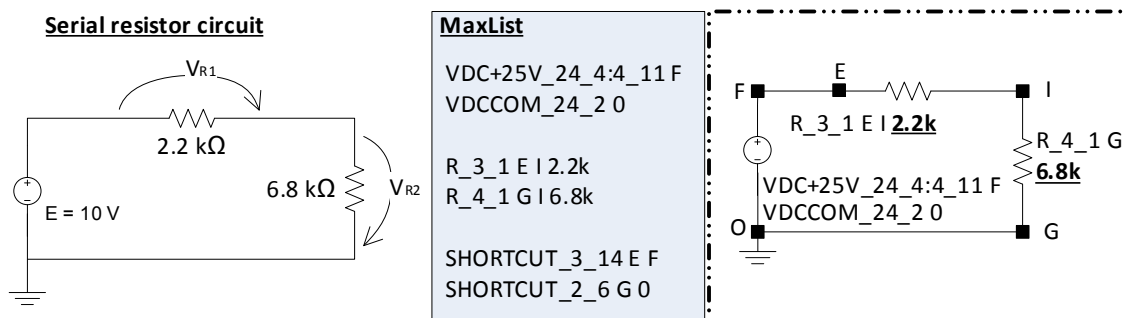


Figure 4: Serial circuit and the *MaxList* file with the nodes used in the experiment preparation.

1. Observe the value of each resistor using the interface and confirm it with the DMM;
2. Selecting the +25 V DC power, setup the circuit in the virtual breadboard and connect the outputs +25V and COM to the circuit (connect the COM to the GND).
3. Connect the DMM and measure the voltage in each resistor;
4. Connect the DMM to measure the current in the circuit;
 - a. Place the DMM between the voltage source and the resistor;
 - b. Place the DMM between both resistors and observe that there is an error (verify the rules defined in the *MaxList* file that is also available in Annex C);
5. Swap the resistors and observe that there is an error (verify the rules defined in the *MaxList* file that is also available in Annex C).

Take your notes here:

Circuit 2

Website: <https://physicslabfarm.isep.ipp.pt/> (Course: TA_VISIR Experiment: TA_demo2)

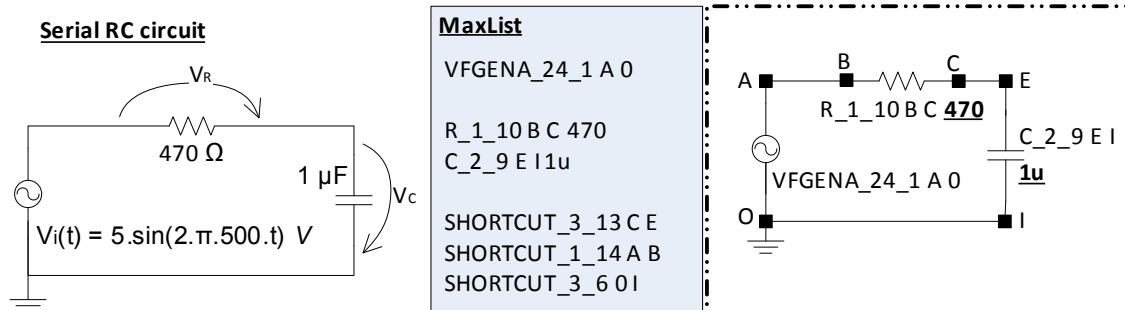


Figure 5: Serial RC circuit and the MaxList file with the nodes used in the experiment preparation.

1. Observe the value of each component using the interface and confirm the value of the resistor with the DMM;
2. Setup the circuit in the virtual breadboard and adjust the voltage and the frequency levels of the Function Generator as indicated;
3. Confirm the adjusted voltage and frequency levels using the Oscilloscope.
4. Connect the terminals of the Oscilloscope to observe simultaneously the signal generated by the function generator, $v_i(t)$, and the signal in the capacitor, $v_c(t)$ (test the different buttons available in the oscilloscope);
5. Adjust the Oscilloscope as you traditionally do in a hands-on laboratory to calculate the gap between both signals;
6. Do not connect the instruments' grounds and observe if there is any error;
7. Verify the restrictions imposed by the VISIR to observe simultaneously the signals in the resistor, $v_r(t)$, and in the capacitor $v_c(t)$;
8. Swap the positions of R and C components and observe the generated error (verify the rules in the MaxList file that is also available in Annex C);
9. Using the DMM, measure the voltages and the currents in the circuit.

Take your notes here:

Suggested circuits

In this section participants are invited to conduct by their own some electrical/electronic experiments using the VISIR system available at ISEP. Choose the most appropriated experiment(s) to your course and execute the suggested steps. Note that the experiments were previously prepared according to the rules defined in *MaxList* files available in Annex C.

Circuit 1: DC serial and parallel circuits

Website: <https://physicslabfarm.isep.ipp.pt/> (Course: TA_VISIR Experiment: TA_circuit1)

In this circuit you should select one of the available resistors of the table. You must select one R1 and you can select R2, R3, and open or shortcut the branches. This means you can setup up several circuits and you are able to read currents and voltages in every resistor.

Available resistors			
R1 [Ω]	1k0	470	22k
R2 [Ω]	2k2	open	
R3 [Ω]	82k	open	

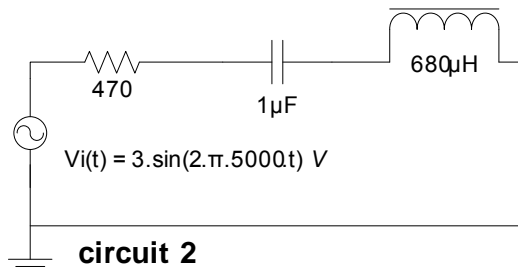
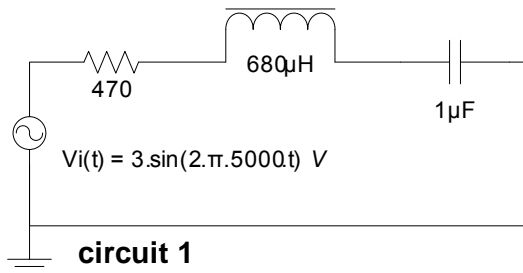
1. Setup one circuit in the breadboard according to the available resistors in the table;
2. Selecting the DC power, connect the outputs +6V and GND to the circuit.
3. Adjust the voltage source to E=6 V and confirm the value using the DMM;
4. Using the DMM measure the currents in the different branches of the circuit
(note: if you try to measure the currents between the indicated points a-b, c-d, e-f or g-h an error will be generated - see the *MaxList* file in the Annex C -);
5. Using the DMM measure the voltage in each component;
6. Repeat this analysis to the other circuits able to setup according to the possibilities indicated in the table.

Notes:

Circuit 2: Serial RLC circuit

Website: <https://physicslabfarm.isep.ipp.pt/> (Course: TA_VISIR Experiment: TA_circuit2)

In these circuits you can evaluate the gap between the voltage source and the voltage in the inductance and in the capacitor.



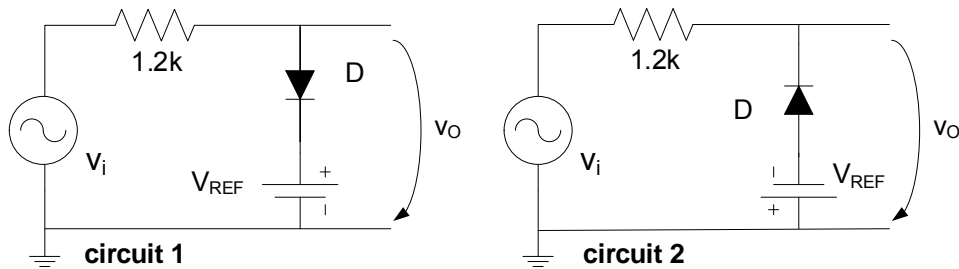
1. Setup circuit 1 and adjust $V_i(t)$ to the indicated values;
2. Using both channels of the oscilloscope confirm and visualize $V_i(t)$ and $V_c(t)$;
3. Using the DMM measure the RMS current in the different branches;
4. Using the DMM measure the RMS voltage in each component;
5. Setup circuit 2 and adjust the $V_i(t)$ to the indicated values;
6. Using both channels of the oscilloscope confirm and visualize $V_i(t)$ and $V_L(t)$;
7. Using the DMM measure the RMS current in the different branches;
8. Using the DMM measure the RMS voltage in each component.

Notes:

Circuit 3: Limiting circuits with diodes

Website: <https://physicslabfarm.isep.ipp.pt/> (Course: TA_VISIR Experiment: TA_circuit3)

In these circuits you can evaluate the diode commutation according to a reference voltage.



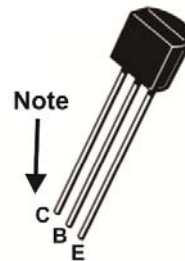
1. Setup circuit 1 and adjust the Function Generator to $V_i = 5 \sin(2\pi \cdot 5000 \cdot t)$ V and confirm that value using the Oscilloscope;
2. Selecting the DC power, connect the outputs +25V and COM to the circuit (connect the COM to the GND), and adjust $V_{REF} = 2$ V. Confirm that value using the DMM;
3. Visualize V_i and V_o simultaneously using the Oscilloscope;
4. Change V_{REF} and verify that the commutation point of the diode changes;
5. Setup circuit 2 and repeat steps 2, 3 and 4.

Notes:

Circuit 4: Circuit with BJT – DC operating point

Website: <https://physicslabfarm.isep.ipp.pt/> (Course: TA_VISIR Experiment: TA_circuit4)

In this circuit you can evaluate the TBJ (BC547) state according to the operating point (V_{ce} , I_c).



1. Setup the circuit, connect the DC power outputs +6V and COM (connect the COM to the GND), and adjust to $E=6\text{ V}$. Confirm that value using the DMM;
2. Using the DMM, fill-in the following table and evaluate the current state of the BJT (active, saturation or cut-off); (note: you can only measure currents between points a-b, c-d and e-f. Observe the *MaxList* file in Annex C.)

R1	R2	E	I_C	I_E	I_B	V_{CE}	V_{BE}	V_{BC}	state
6k8	22k	6 V							

Notes:

Circuit 5: Amp-op Inverter Circuit

Website: <https://physicslabfarm.isep.ipp.pt/> (Course: TA_VISIR Experiment: TA_circuit5)

In this circuit you can evaluate an inverter amplifier using an AMP-OP.

$R1 = 100\text{ k}$
 $R2 = 100\text{ k or } 220\text{ k}$
 $R_L = 2.2\text{ k}$
 $E = 6 \cdot \sin(2 \cdot \pi \cdot 5000 \cdot t)\text{ V}$

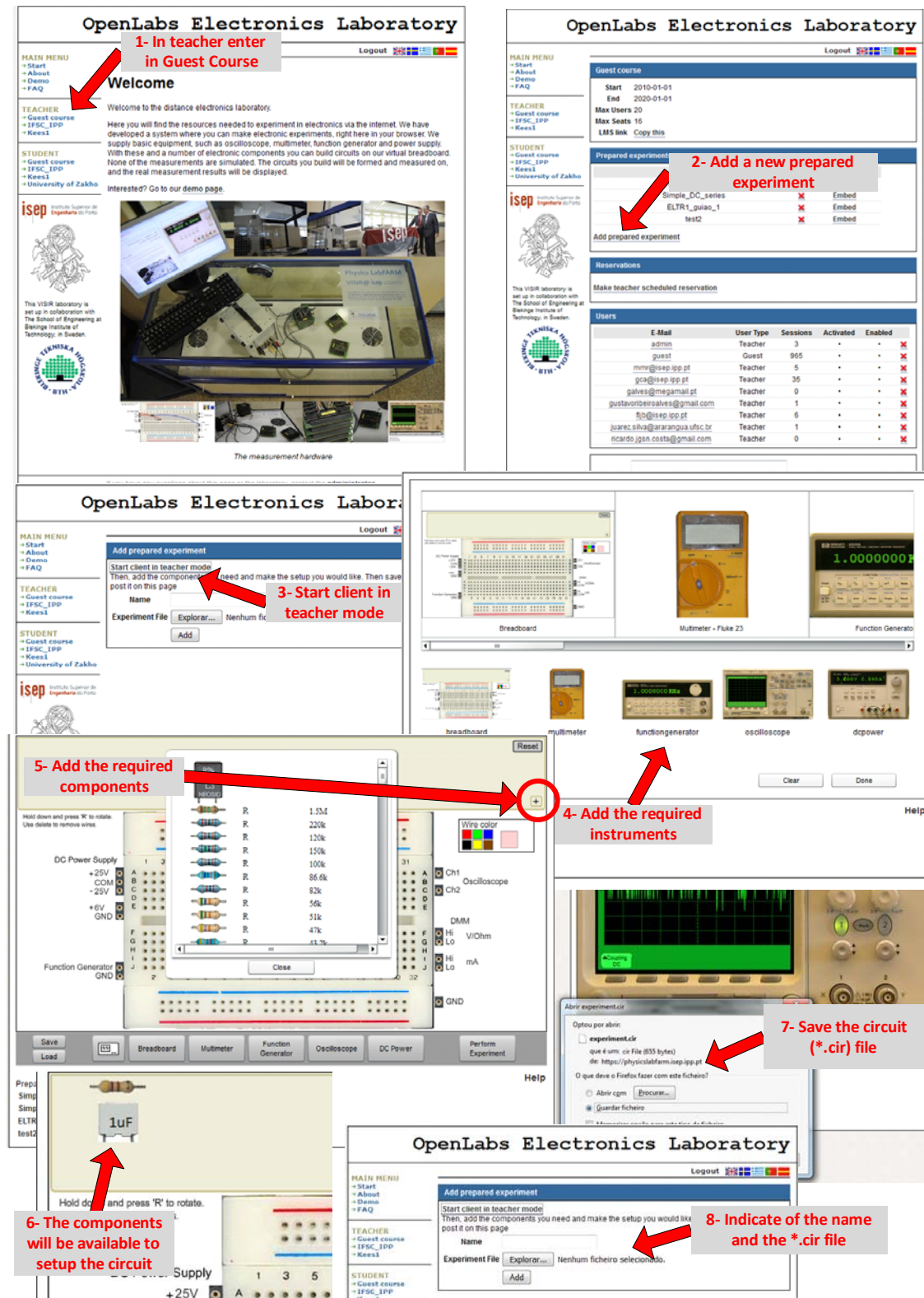
1. Setup the circuit in the virtual breadboard changing $R2$ according to the values indicated in the table;
2. Using the Function Generator adjust the V_i voltage according to the indicated in the figure and, using the Oscilloscope, verify the amplitude and the frequency;
3. Using the Oscilloscope observe V_i and V_o of the circuit;
4. Using the DMM measure the RMS:
 - voltage in the different components;
 - current in the load.

Notes:



Annex A – Experiment preparation

This section provides some screenshots with the steps required to prepare an experiment after the definition of a *MaxList* and a new *ComponentList* by the technician (if new components are required to the new experiment).



1- In teacher enter in Guest Course

2- Add a new prepared experiment

3- Start client in teacher mode

4- Add the required instruments

5- Add the required components

6- The components will be available to setup the circuit

7- Save the circuit (*.cir) file

8- Indicate of the name and the *.cir file

Figure 6: Steps required to prepare an experiment after the definition of a MaxList.

Annex B – Creating a course with prepared experiments

Once an experiment is prepared (annex A) the administration should create the courses with one or more prepared experiments. They should also associate teachers and these the students able to attend the course and the associated experiments, as illustrated in the sequence of figure 7.

1- Admin Courses

2- Add course

3- Define course

4- Add teachers or instructors (in admin mode)

5- Add prepared experiment (in teacher mode)

6- Add prepared experiment

7- Add students (in teacher mode)

The figure illustrates the main steps required to create a course integrating prepared experiments in the OpenLabs Electronics Laboratory system. The steps are numbered 1 through 7, corresponding to the screenshots shown:

- 1- Admin Courses:** The 'Admin' menu is selected, leading to the 'Admin Courses' page.
- 2- Add course:** The 'Add course' button is clicked, leading to the 'Add course' form.
- 3- Define course:** The 'Define course' form is filled out, including course name, start/end dates, and max users.
- 4- Add teachers or instructors (in admin mode):** The 'Add teachers or instructors' form is filled out, including email and user type.
- 5- Add prepared experiment (in teacher mode):** The 'Add prepared experiment' form is filled out, including experiment name and file.
- 6- Add prepared experiment:** The 'Add prepared experiment' form is filled out, including experiment name and file.
- 7- Add students (in teacher mode):** The 'Add students' form is filled out, including student email and user type.

Figure 7: Main steps required to create a course integrating prepared experiments.

Annex C – MaxLists

ComponentList File (components.list)
VFGENA_24_1 A 0 VDCCOM_24_2 0 VDC+6V_24_3:4_5 A VDC+25V_24_4:4_11 F VDC-25V_24_5:4_12 B R_1_1 A C 1.2k R_1_3 B C 1k R_1_10 B C 470 R_2_3 A B 1k R_2_8 G H 100k R_3_1 E I 2.2k R_3_3 A G 100k R_3_8 G H 220k R_4_1 G I 6.8k R_4_2 C D 6.8k R_4_3 B C 22k R_4_8 H I 82k R_4_9 H B 22k CE_2_9 E I 1u C_3_2 C I 4.7u C_3_9 C E 0.22u C_3_10 H A 0.1u D_1_2 H E 1N4148 D_2_2 E H 1N4148 L_1_8 G F 680u Q_2_12:2_13:2_14 C H G bc547b OP_4_7:4_13:4_14:4_4:4_6 NC1 G C B NC2 H F NC3 uA741 SHORTCUT_1_4 B I SHORTCUT_1_5 F 0 SHORTCUT_1_6 I G SHORTCUT_1_7 E B SHORTCUT_1_9 A D SHORTCUT_1_11 0 C SHORTCUT_1_12 H 0 SHORTCUT_1_13 A G SHORTCUT_1_14 A B SHORTCUT_2_1 G H SHORTCUT_2_4 A I

SHORTCUT_2_5 H D SHORTCUT_2_6 G 0 SHORTCUT_2_7 F G SHORTCUT_2_10 D C SHORTCUT_2_11 A C SHORTCUT_3_4 D E SHORTCUT_3_5 B C SHORTCUT_3_6 0 I SHORTCUT_3_7 D F SHORTCUT_3_11 E I SHORTCUT_3_12 C G SHORTCUT_3_13 C E SHORTCUT_3_14 E F SHORTCUT_4_10 D B
TA_demo1.MAX
VDC+25V_24_4:4_11 F VDCCOM_24_2 0 R_3_1 E I 2.2k R_4_1 G I 6.8k SHORTCUT_2_6 G 0 SHORTCUT_3_14 E F
TA_demo2.MAX
VFGENA_24_1 A 0 VDCCOM_24_2 0 R_1_10 B C 470 CE_2_9 E I 1u SHORTCUT_1_14 A B SHORTCUT_3_6 0 I SHORTCUT_3_13 C E
TA_circuit_1.MAX
VDCCOM_1 0 VDC+6V_1 A R_R_1_3 B C 1k R_R_1_10 B C 470 R_R_3_1 E I 2.2k R_R_4_3 B C 22k R_R_4_8 H I 82k SHORTCUT_1_4 B I

SHORTCUT_1_5 F 0 SHORTCUT_2_1 G H SHORTCUT_2_6 G 0 SHORTCUT_2_11 A C SHORTCUT_3_6 0 I SHORTCUT_3_14 E F
TA_circuit_2_RLC.MAX
VFGENA_24_1 A 0 VDCCOM_24_2 0 R_1_10 B C 470 CE_2_9 E I 1u L_1_8 G F 680u SHORTCUT_1_14 A B SHORTCUT_3_6 0 I SHORTCUT_3_12 C G SHORTCUT_3_14 E F
TA_circuit_2_RCL.MAX
VFGENA_24_1 A 0 VDCCOM_24_2 0 R_1_10 B C 470 CE_2_9 E I 1u L_1_8 G F 680u SHORTCUT_1_5 F 0 SHORTCUT_1_6 I G SHORTCUT_1_14 A B SHORTCUT_3_13 C E
TA_circuit_3_a.MAX
VFGENA_24_1 A 0 VDCCOM_24_2 0 VDC+25V_24_4:4_11 F R_1_1 A C 1.2k D_2_2 E H 1N4148 SHORTCUT_2_1 G H SHORTCUT_2_7 F G SHORTCUT_3_13 C E
TA_circuit_3_b.MAX
VFGENA_24_1 A 0 VDCCOM_24_2 0 VDC-25V_24_5:4_12 B

R_1_1 A C 1.2k
D_1_2 H E 1N4148
SHORTCUT_1_4 B I
SHORTCUT_1_6 I G
SHORTCUT_2_1 G H
SHORTCUT_3_13 C E
TA_circuit_4.MAX
VDCCOM_1 0
VDC+6V_1 A
R_R_4_2 C D 6.8k
R_R_4_9 H B 22k
Q_Q1 C H G bc547b
SHORTCUT_S_1_5 F 0
SHORTCUT_1_9 A D
SHORTCUT_S_1_14 A B
SHORTCUT_S_2_7 F G
TA_circuit_5.MAX
VDCCOM_1 0
VFGENA_24_1 A 0
VDC+25V_24_4:4_11 F
VDC-25V_24_5:4_12 B
R_R_2_8 G H 100k
R_R_3_1 E I 2.2k
R_R_3_3 A G 100k
R_R_3_8 G H 220k
OP_1 NC1 G C B NC2 H F NC3 uA741
SHORTCUT_S_1_11 0 C
SHORTCUT_S_2_5 H D
SHORTCUT_S_3_4 D E
SHORTCUT_S_3_6 0 I