DATE	COURSE/YEAR/GROUP	NAME

UNIVERSITY OF PLYMOUTH

Department of Communication and Electronic Engineering

COMPUTER SIMULATION USING "ELECTRONICS WORKBENCH"

SIMPLE RESISTOR NETWORKS

Learning Objectives

This labsheet is intended to be the student's first introduction to **Electronics Workbench.**

The labsheet covers:

- The series resistor combination: $R_T = R_1 + R_2$
- The parallel resistor combination: $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
- The voltage divider equation: $V_2 = V_s \frac{R_2}{R_1 + R_2}$

First Use of "Electronics WorkBench"

Copies of labsheets are available in the grey metal drawers in room 201.

Prior to starting this exercise, it is advisable to ask your tutor to show you the main features of the simulation, or to work through the tutorial section of the Electronics Workbench manual.

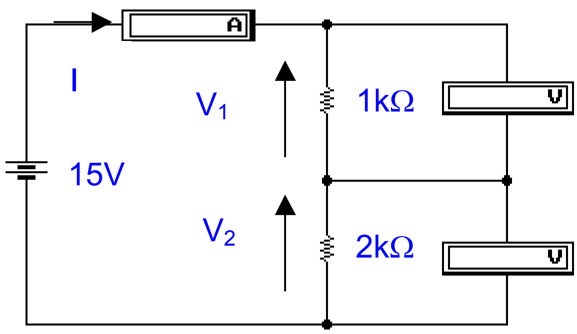
Student copies of the software are available (to bona fide students) for long-term loan for use on home computers throughout the first year. The software packs can be booked out from the Project Stores area within room 6 on the ground floor of Smeaton.

PART 1. Series Circuits

Work through the problems below and complete the tables of results. It is important that the theoretical solutions be undertaken alongside the simulations. Complete all parts of this section prior to moving on to Part 2.

Two resistors are connected in series to a battery. Calculate the circuit current and the voltage across each resistor, and compare the values with those from a computer simulation.

In the calculation, remember than the resistances must be converted from kΩ to Ω before doing the calculation. V_s is the source voltage, i.e. battery voltage.



Calculations: I, V_1, V_2

I = V_s /Total Resistance

=

V_1 =

V_2 =

NB Do the calculations now, before turning over to page 3, to find further instructions on using the software.

Results:

Simulation	Calculation
I =	I =
V_1 =	V_1 =
V_2 =	V_2 =

Alternatively, the values for V_1 and V_2 can be calculated straight off using the voltage divider formula.

$$V_1 = V_s \frac{R_1}{R_1 + R_2} =$$

$$V_2 =$$

This time, can you "get away with" not changing kΩ to Ω?

Explain why. (NB If you are unsure, always convert to base units, ie volts, amps, and ohms)

Running the Simulation

Along the top of the screen (underneath the instrument icons), you will see a series of icons representing libraries of components.

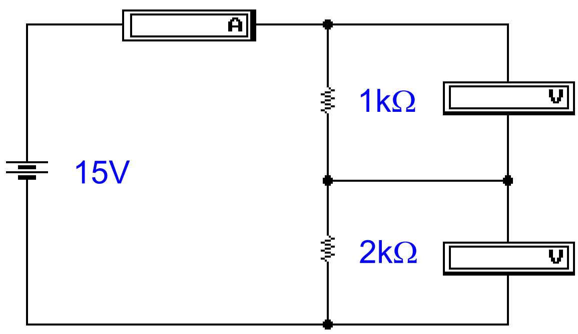
The battery and ground are found by highlighting the resistor 'library'(it becomes yellow). Down the left-hand side of the screen appear the components you can use. Drag the component you require on to the drawing area. To change the value of the component e.g., the battery voltage, double click left on it, (after placing it on the drawing area).

The resistors are also in the 'resistor library' . After placing the symbol, optionally click on it to highlight it, and select Circuit & Rotate (or short cut: Control R) to rotate it by 90 degrees clockwise"

To find a meter, click on the 'Lamp library' (5 icons right of the 'resistor library'). NB you can drag as many voltmeter and ammeter 'components' on to the drawing area as needed. There is another option. You can choose ONE multimeter instrument, from the instrument shelf above the libraries. After placing it on the drawing area, double click to expand it.

To wire, left click at the end of a component (its end 'gains a black blob') and holding the left button down, move the cursor to the end of another component. Release the mouse button when its end 'gains a black blob'.

To run the simulation, press the "toggle switch" (top right hand courner), or select Circuit & Activate". Normally, you have to switch off the simulation before other operations such as saving the file.



Use Help & Help Index or the manual to find out more. It is also worth remembering some of the short cut keys i.e., Control + 'a letter', found to the right of the commands in the top drop down tool bars.

PART 1. (continued)

Change the 2 kΩ resistor to 4 kΩ. I have chosen the value 4kΩ because, using round numbers, the pattern of voltage division is clearer. However, this resistor value is not available in real-life (except as an expensive precision resistor). So, highlight the resistor, and type in its value. Repeat the calculation and simulation.

Calculation	Simulation
I =	I =
V_1 =	V_1 =
V_2 =	V_2 =

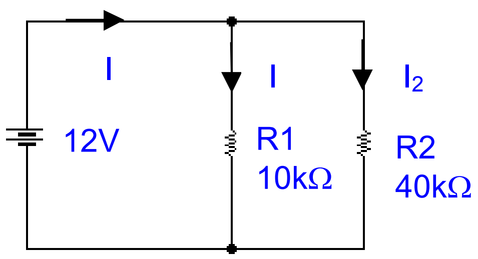
Why is the current reduced?

Why have the values V_1 and V_2 changed?

Do V_1 and V_2 still add up to 15 V?

PART 2. Parallel Circuits

Repeat the procedure for the parallel circuit shown below.



$I_1 = V_s/R_1 =$

$I_2 =$

$I = I_1 + I_2 =$

You will need to place ammeters in the above circuit before simulation.

Tip: If you select a meter, Control & Rotate give you have the option of 90 degree rotation if selected once or 180 degrees if selected twice, to get a tidy screen layout (NB use before wiring up). If you are getting negative readings, reconnect the wires to the + and – negative terminals. Conventional current, flowing out of the + of the battery should flow into the + of the meter.

Results:

Calculation	Simulation
I =	I =
I_1 =	I_1 =
I_2 =	I_2 =

Alternatively, we can calculate I by calculating first the equivalent resistance R_T of the circuit

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} =$$

So R_T =

$$I = \frac{V_s}{R_T} =$$

Which method do you prefer?

Replace R_2 by another 10 kΩ resistor, leaving R_1 at 10 kΩ, and repeat the calculation and simulation

Calculation	Simulation
I =	I =
I_1 =	I_1 =
I_2 =	I_2 =

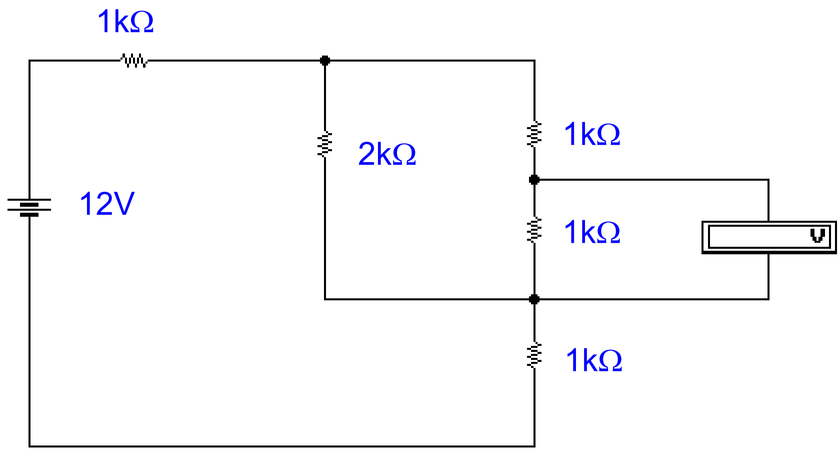
Comment on the value of the equivalent resistor R_T

Why are I_1 and I_2 equal?

Why has I increased?

PART 3. Simplifying Circuits

Many circuits appear quite complex, but using the series resistor and parallel resistor equations (see first page), a circuit with many resistors can be simplified to one equivalent resistor R_T. This is useful as we can find the total current drawn from a battery. Simplify the following circuit on paper, then check by simulation. When the total current is found, then the voltages across and currents through all the resistors can be calculated.



Calculations:
NB Sketch the circuit as you simplify it by stages (Hint: ignore the meter and start by simplifying two of the resistors to one)

R_T = **I_T =** **V $_{\text{on meter above}}$ =**

Printouts in EWB

To complete your notes on the simulation, it is well worth taking a few minutes extra to get some printouts of the current circuit.

Choose File & Print

You can select the things you want printed. Try "Schematic". If you use an instrument, then you can also select the instrument display to be printed.