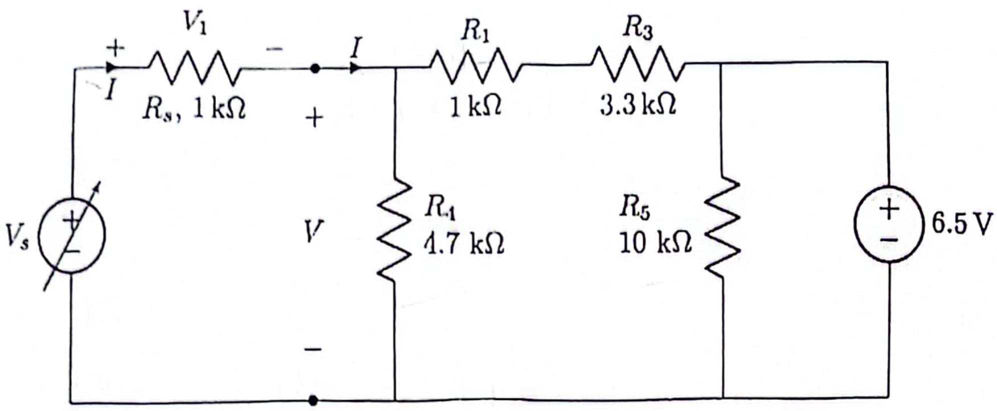


Circuit 3

- For each of these circuits, apply the specified supply voltages (from the first column of their respective data tables) using the DC power supply.
- Measure the voltage, V_1 across the 1 kΩ resistor using the multimeter and use Ohm's law to calculate the current I through the two terminals (denoted by • in the circuits).
- Measure the voltage, V across the two terminals (denoted by • in the circuits) using the multimeter, and fill up the data tables.

Data Tables

Signature of Lab Faculty: [signature] **Date:** 17.02.24

** *For all the data tables, take data up to three decimal places, round to two, then enter into the table.*

Table 1: Resistance Data

For all your future calculations, please use the observed values only (**even for theoretical** calculations).

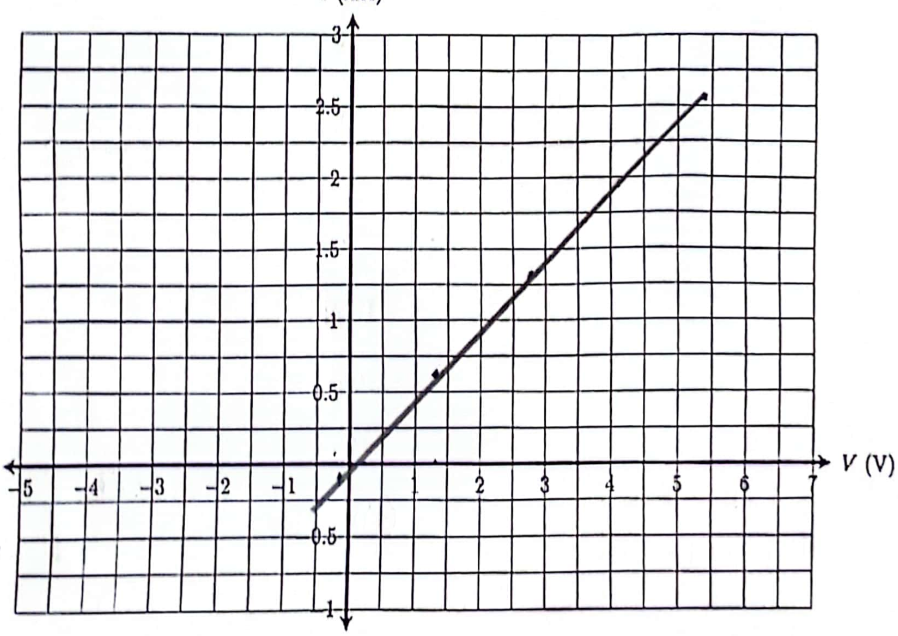
Notation	Expected Resistance	Observed Resistance (kΩ)	Notation	Expected Resistance	Observed Resistance (kΩ)
R_s	1 kΩ	1.011 kΩ	R_3	3.3 kΩ	3.273 kΩ
R_1	1 kΩ	~~3.273 kΩ~~ 1.011 kΩ	R_4	4.7 kΩ	4.62 kΩ
R_2	2.2 kΩ	2.16 kΩ	R_5	10 kΩ	9.89 kΩ

CS CamScanner

Table 2: Data from Circuit 1

V_s (V)			V_1 (V)		V (V)		$I = \frac{V_1}{R_1}$ (mA)	
Expected Voltage	From DC power supply	Using multi-meter	Experi-mental	Theo-retical	Experi-mental	Theo-retical	Experi-mental	Theo-retical
0.0	0	-3.5×10^{-3}	-10^{-3}	0	-2×10^{-3}	0	-10^{-3}	0
2.0	2	1.988	0.625	0.625	1.36	1.38	0.625	0.625
4.0	4	4.00	1.26	1.25	2.74	2.75	1.26	1.25
6.0	6	6.04	1.90	1.88	4.13	4.13	1.90	1.88
8.0	8	8.00	2.52	2.51	5.48	5.47	2.52	2.51

Plot the values of I and V from the above table.



$m = \frac{y_2 - y_1}{x_2 - x_1}$

$m = \frac{I_2 - I_1}{V_2 - V_1}$

$= \frac{1.26 - 0.625}{2.74 - 1.36}$

$= 0.43$

Draw the best-fitting straight line through all the data points.

Slope of the straight line, m = 0.43 $k\Omega^{-1}$

Resistance from the plot, $R_T = \frac{1}{m}$ = 2.33 $k\Omega$

Percentage of Error $= \left|\frac{R_2 - R_T}{R_2}\right| \times 100\%$ = 5.91 %

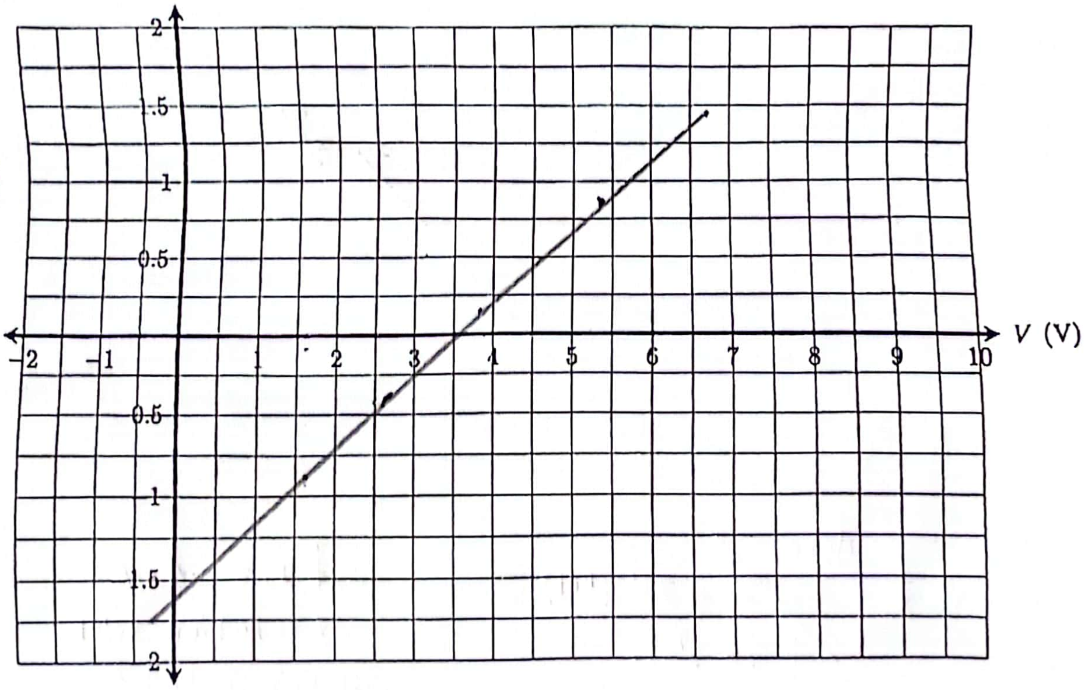
Table 3: Data from Circuit 2

V_s (V)			V_1 (V)		V (V)		$I = \frac{V_1}{R_1}$ (mA)	
Expected Voltage	From DC power supply	Using multi-meter	Experi-mental	Theo-retical	Experi-mental	Theo-retical	Experi-mental	Theo-retical
0.0	0.8	0.8	-0.8	-0.81	1.62	1.61	-0.8	-0.81
2.0	2.0	2.08	-0.4	-0.44	2.5	2.43	-0.4	-0.44
4.0	4.0	4.04	0.18	0.19	3.8	3.81	0.18	0.19
6.0	6.0	6.02	0.8	0.81	5.2	5.18	0.8	0.81
8.0	8.0	8.1	1.45	1.43	6.65	6.56	1.45	1.43

Plot the values of I and V from the above table.

$m = \frac{0.8-0.18}{5.2-3.8}$

$= 0.44$



Draw the best-fitting straight line through all the data points.

Slope of the straight line, m = 0.44 $k\Omega^{-1}$

Resistance from the plot, $R_T = \frac{1}{m}$ = 2.23 $k\Omega$

The straight line intersects x-axis at, V_T = 3.5 V

CS CamScanner

Table 4: Data from Circuit 3

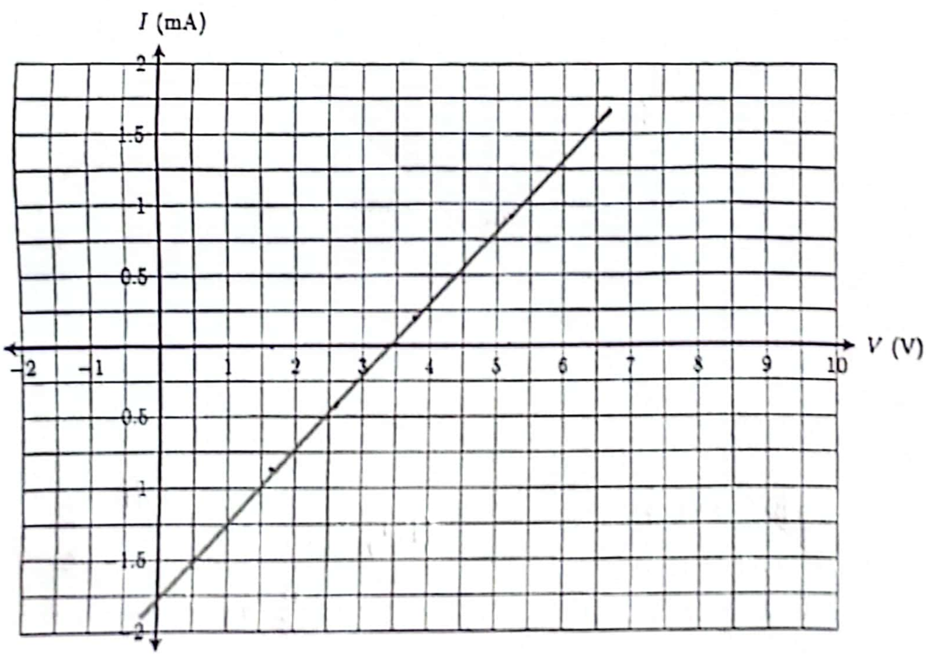
V_S (V)			V_1 (V)		V (V)		$I = \frac{V_1}{R_1}$ (mA)	
Expected Voltage	From DC power supply	Using multi-meter	Experi-mental	Theo-retical	Experi-mental	Theo-retical	Experi-mental	Theo-retical
0.0	0·8	0·78	-0·8	-0·8	1·6	1·6	-0·8	-0·8
2.0	2·0	2·06	-0·4	-0·4	2·48	2·48	-0·4	-0·4
4.0	4·0	4·02	0·18	0·17	3·8	3·9	0·18	0·17
6.0	6·0	6·02	0·8	0·8	5·22	5·23	0·8	0·8
8.0	8·0	8·09	1·4	1·4	6·65	6·65	1·4	1·4

$m = \frac{1.9 - 0.8}{6.66 - 5.22}$

Plot the values of I and V from the above table.

$m = \frac{0.8 - 0.18}{5.22 - 3.8}$

$= 0.43$



Draw the best-fitting straight line through all the data points.

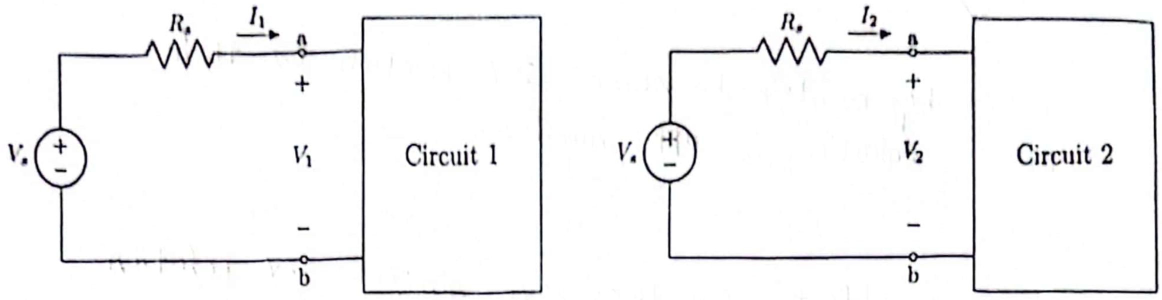
Slope of the straight line, m = 0·43 $k\Omega^{-1}$

Resistance from the plot, $R_T = \frac{1}{m}$ = 2.29 $k\Omega$

The straight line intersects x-axis at, V_T = 3·5 V

Questions

1. What conditions must exist for the following two circuits to be equivalent to each other with respect to terminals $a - b$?



The $I_1 - V_1$ relation and $I_2 - V_2$ relation must be same.

2.

(a) For the **Circuit 2** you constructed in the laboratory, derive a relation between I and V.

As from the graph we ~~Ae~~ can find a line which is intersecting y-axis(-ve) at 1.7 (app.) and x-axis at 3.5 (app.). we can follow [$y = mx + c$] equation and say,

$I = mV + c$

$I = 0.4V + (-1.28)$

$I = 0.4V - 1.28$

$c = I - mV$

$= 0.8 - (5.2 \times 0.4)$

$= -1.28$

(b) For the **Circuit 3** you constructed in the laboratory, derive a relation between I and V.

As from the graph we can find a line which is intersecting y-axis (-ve) at 1.8 (app.) and x-axis at 3.5 (app.). We can follow [$y = mx + c$] equation and say,

$I = mV + c$

$I = 0.4V + (-1.26)$

$I = 0.4V - 1.26$.

$C = I - mV$

$C = 1.4 - (6.65 \times 0.4)$

$= -1.26$

(c) Did you notice any similarity between the $I - V$ relationships in (a) and (b)?

☑ Yes ☐ No

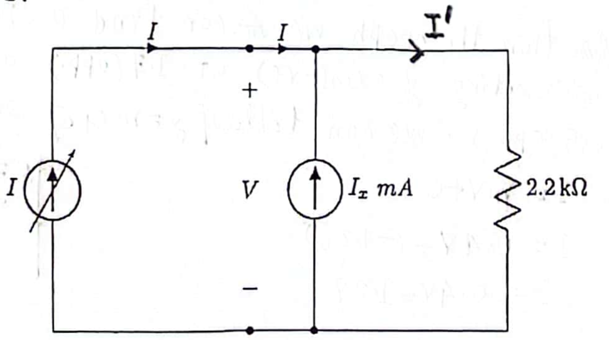
If yes, what are they?

They maintain the same I-V relation as their equation is (app.) similar.

(d) Will it have any effect if one of these two circuits is replaced with the other? Why?

No effect. As they have similar I-V relation-ship, they're equivalent to each other.

(e) Now, for the following circuit, determine the value of I_x so that the $I - V$ relation matches with those you derived in (a) and (b). Is this circuit also equivalent to **Circuit 2 and Circuit 3**?



Here,

$I + I_x = I'$ [KCL]

$\Rightarrow I = I' - I_x$

$\Rightarrow I = \frac{V}{2.2} - I_x$ [Ohm's]

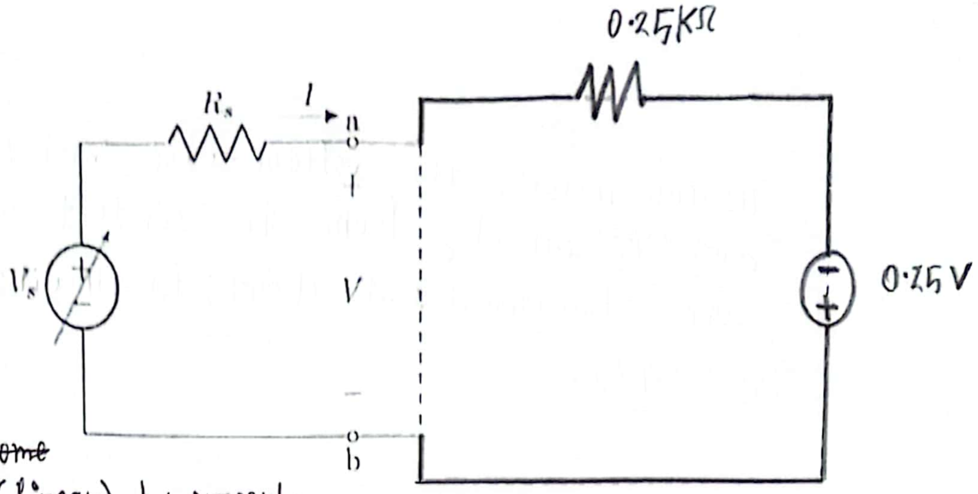
$\Rightarrow I = 0.4V - I_x$

Equation from circuit 2 and 3 : $I = 0.4V - 1.3$

$\therefore$ if $I_x = 1.4$ mA

I-V relation with circuit 2 and 3 matches and then they become equivalent.

CamScanner



Draw inside the dashed box

Discussion:

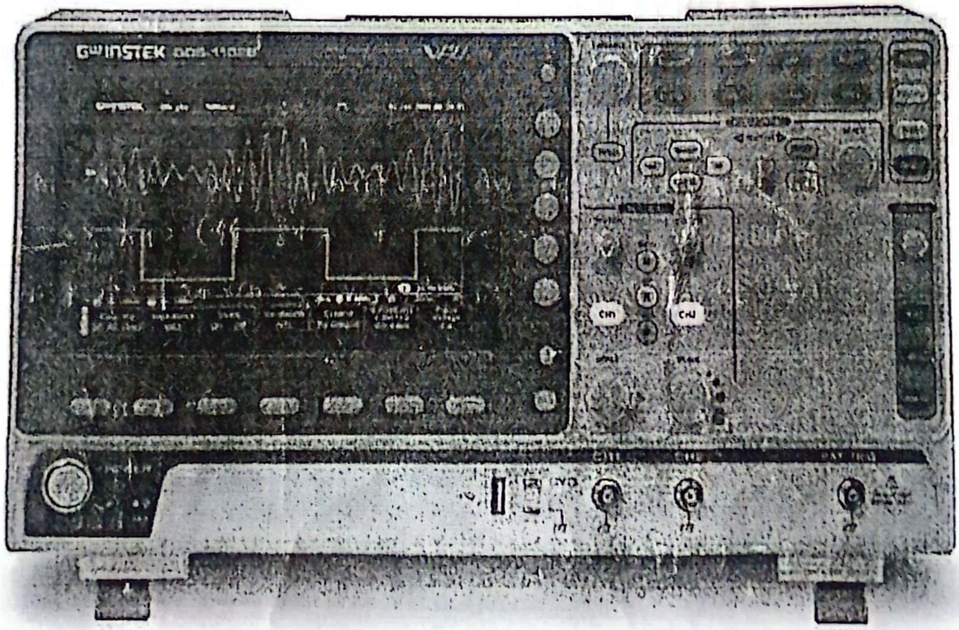
We found I-V relationships of ~~some~~ total 03 circuits(linear) by properly measuring V, I of a specific terminal and constaructing a graphical representation.

Part 2: By Using Oscilloscope

Theory

Oscilloscope

Oscilloscope is a device that can measure a sequence of voltages over time and can display that information by plotting them on a screen. In fact, oscilloscopes available at our labs are dual channel (`CH1` and `CH2`), meaning, they can simultaneously show voltage vs time graph across two separate set of nodes.



An oscilloscope

CS CamScanner