University College

21S ITT2 Electronics

OLA21 - First Attempt

Author

Dainty Lyka Bihay Olsen
dlbo28887@edu.ucl.dk

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1 Introduction

This hand-in is the Electronics OLA 21 ITT2, first attempt.

2 Audience

This OLA is meant for teachers, and handed in on WISEflow. Ilias Esmati is the supervisor for this assignment.

3 Inventory

Hardware:

- Breadboard
- Power Supply
- Resistors: 2x 68 Ω, 470 Ω, 1K Ω
- Cables/Wires
- Multimeter or Oscilloscope

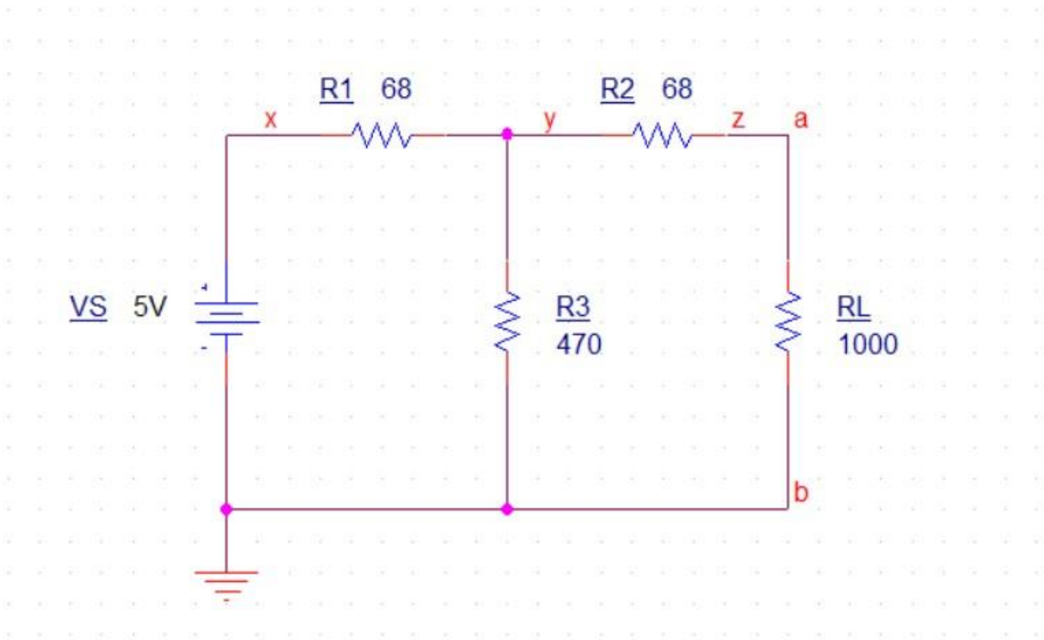
Software:

- Orcad

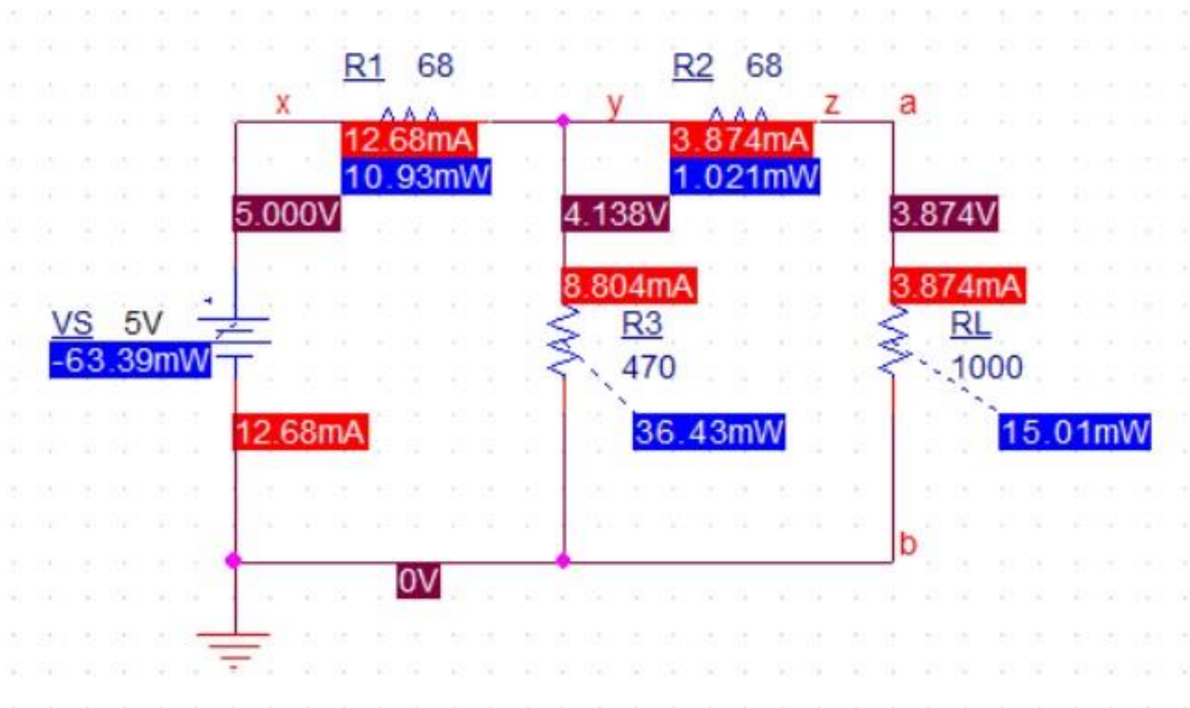
4 Deliverables

- **Part 1 (Orcad)**

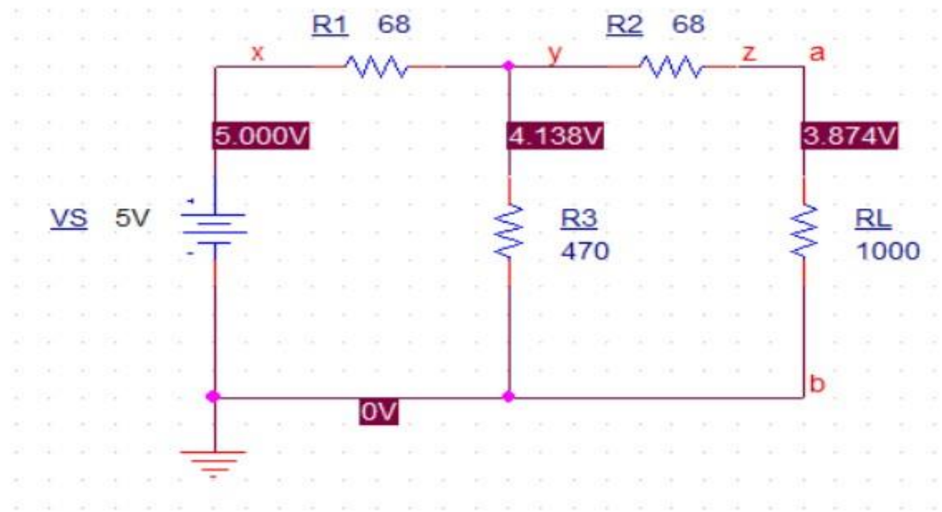
1. Draw the Circuit using Orcad with the given parameters.



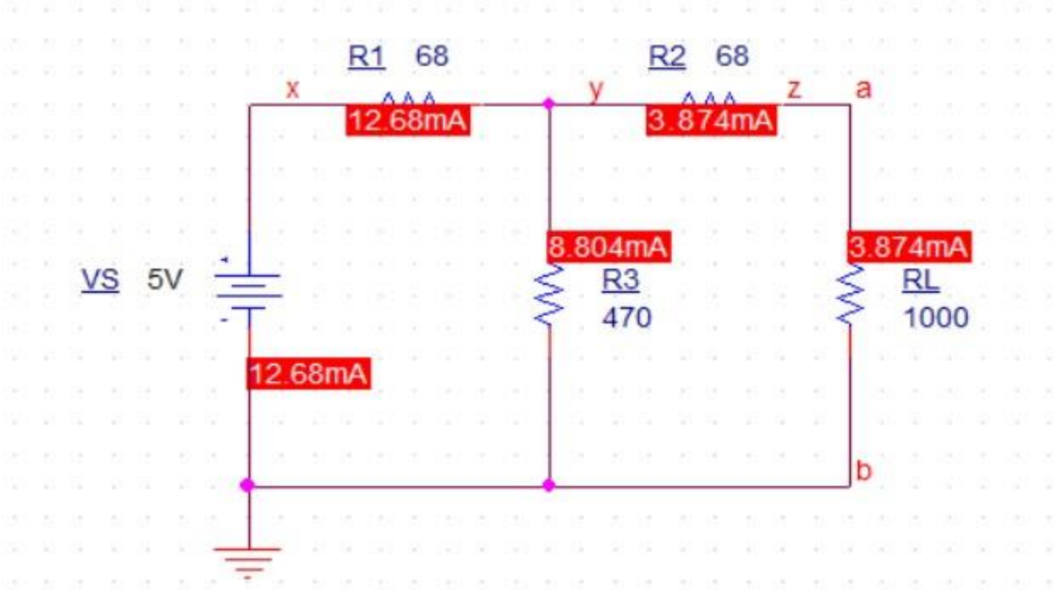
2. Run a bias point simulation and show (Current, voltage and power)



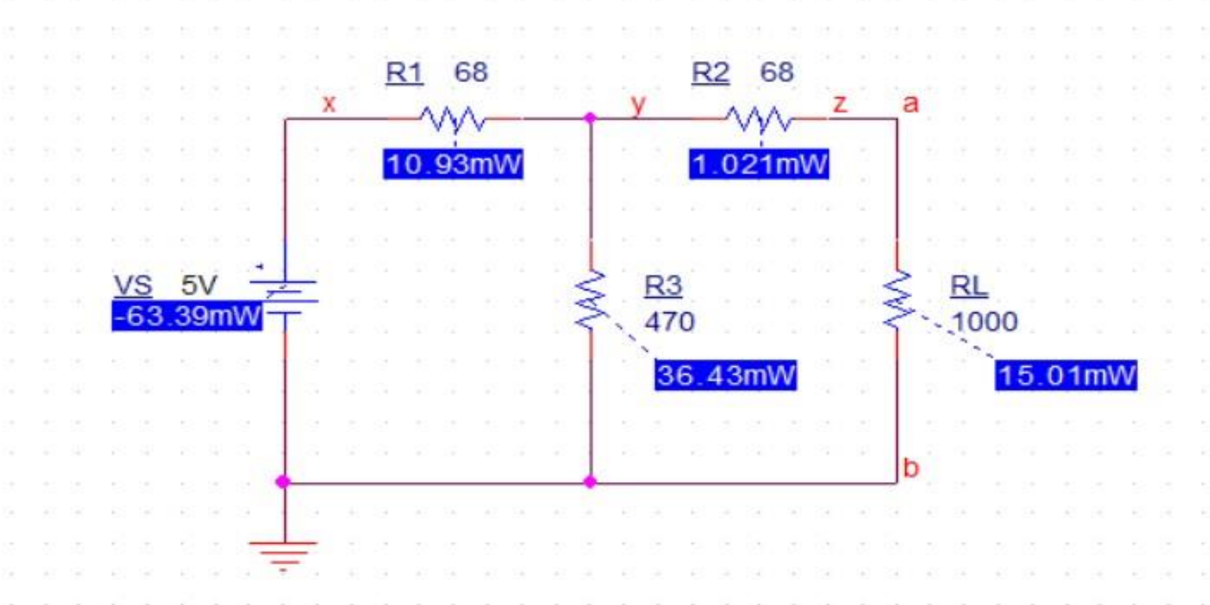
3. What is the Voltage at point x, y and z?



4. What is Current through R1, R2 and RL?

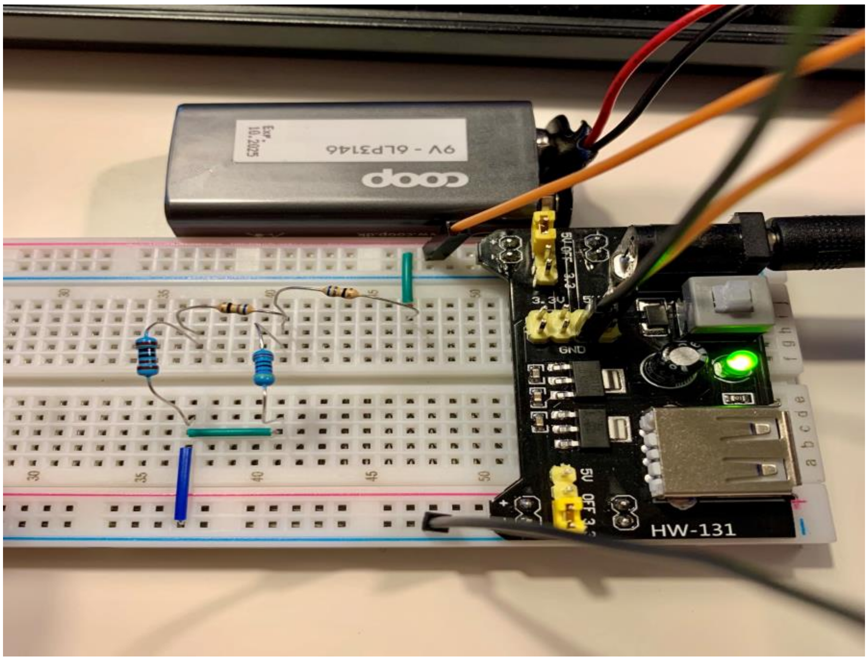


5. What is the power consumed by R1, R2, R3 and RL ?



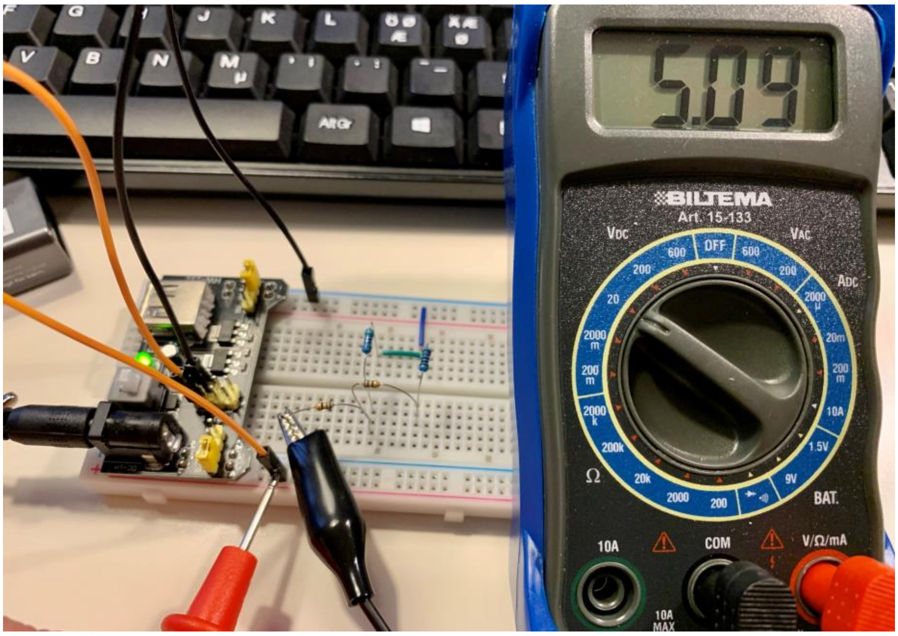
- **Part 2 (Physical Circuit Measurement)**

1. Build the circuit with the given parameters on a breadboard

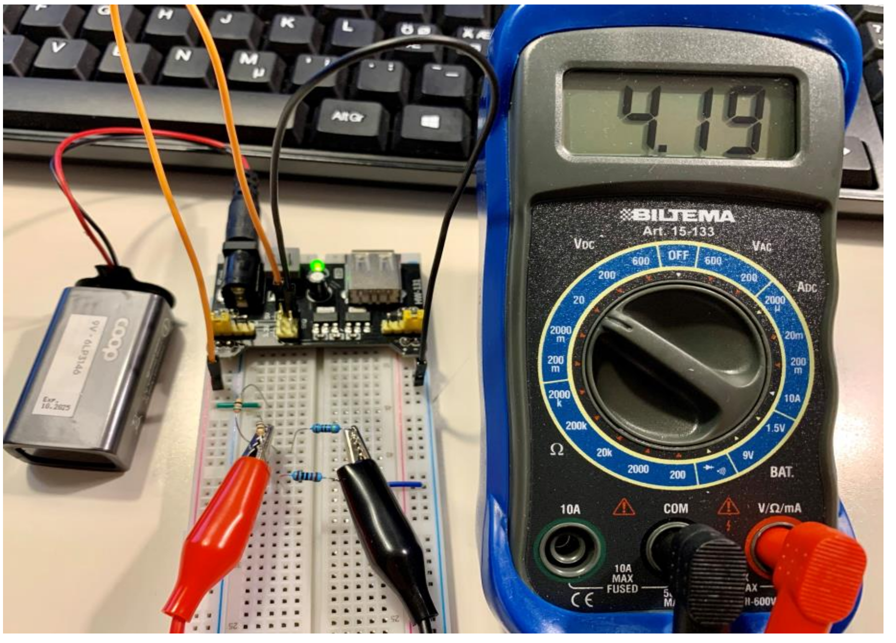


2. Measure the voltage at point x, y and z

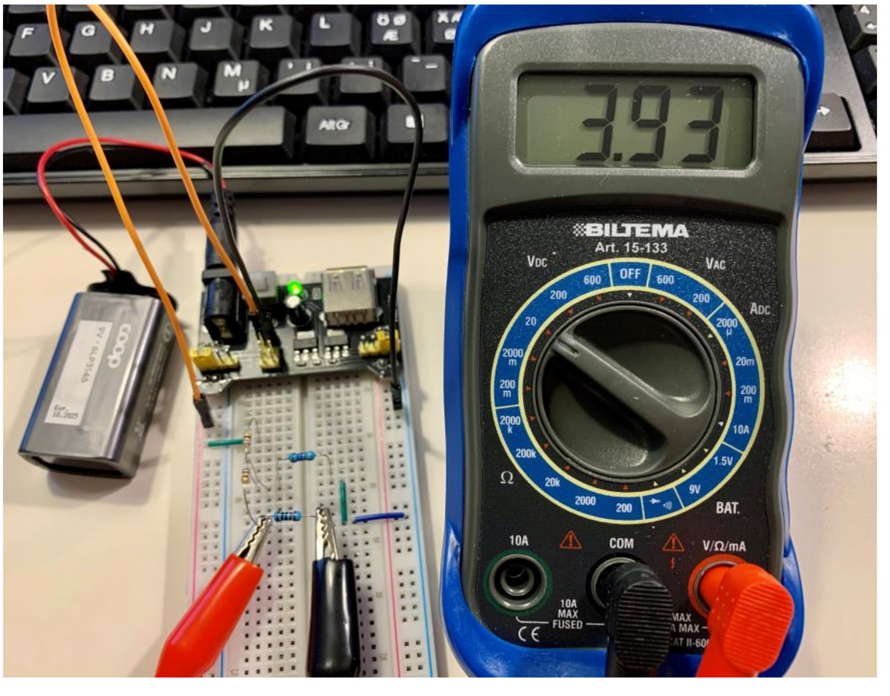
At point x:



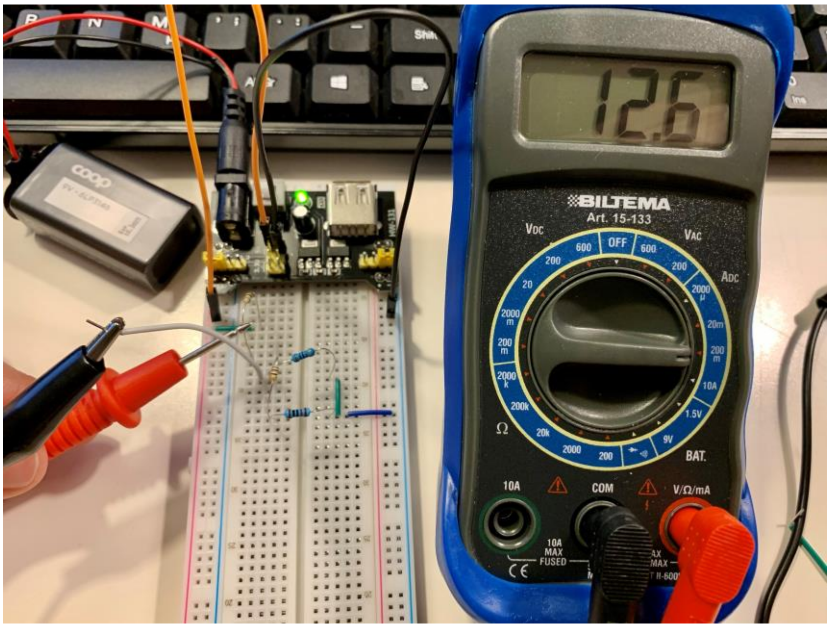
At point y:

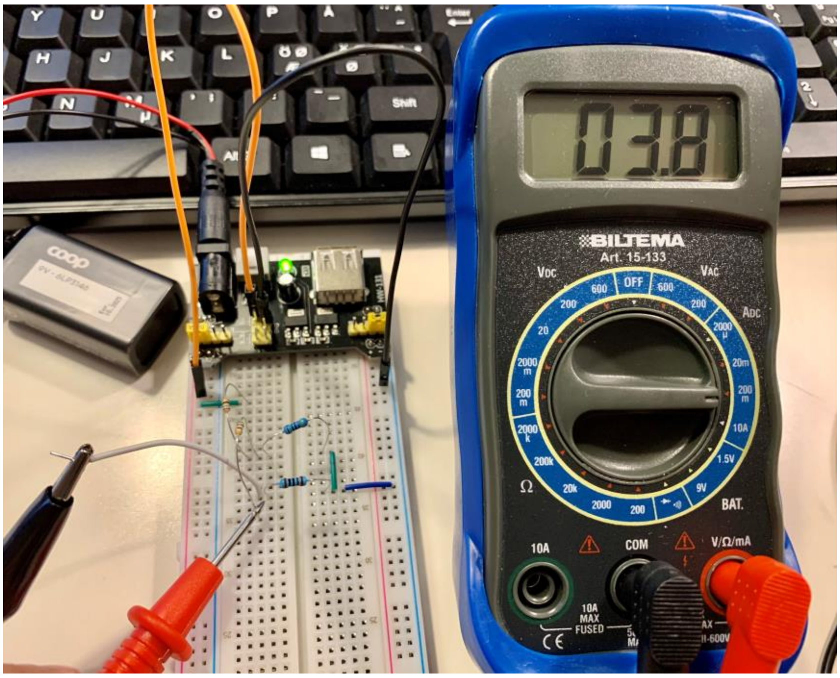


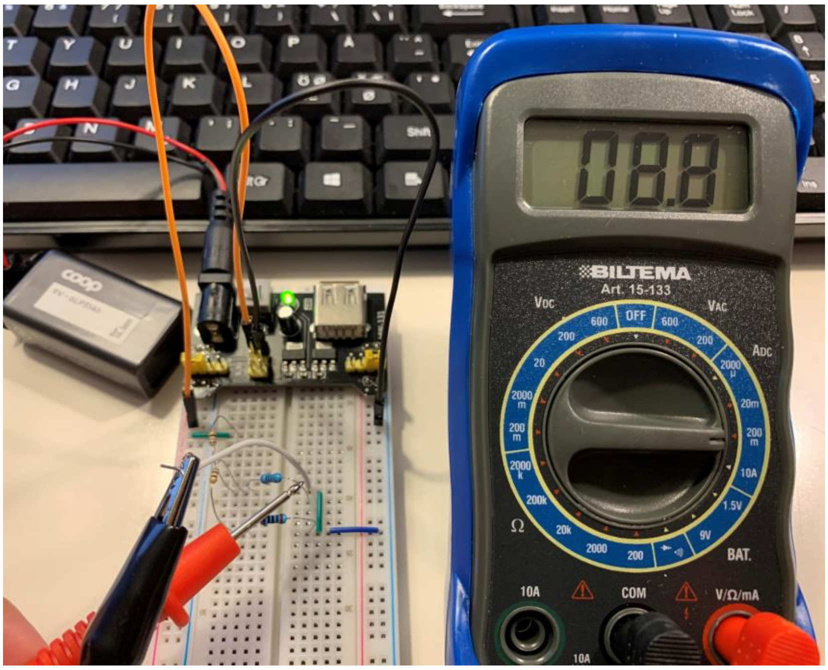
At point z:

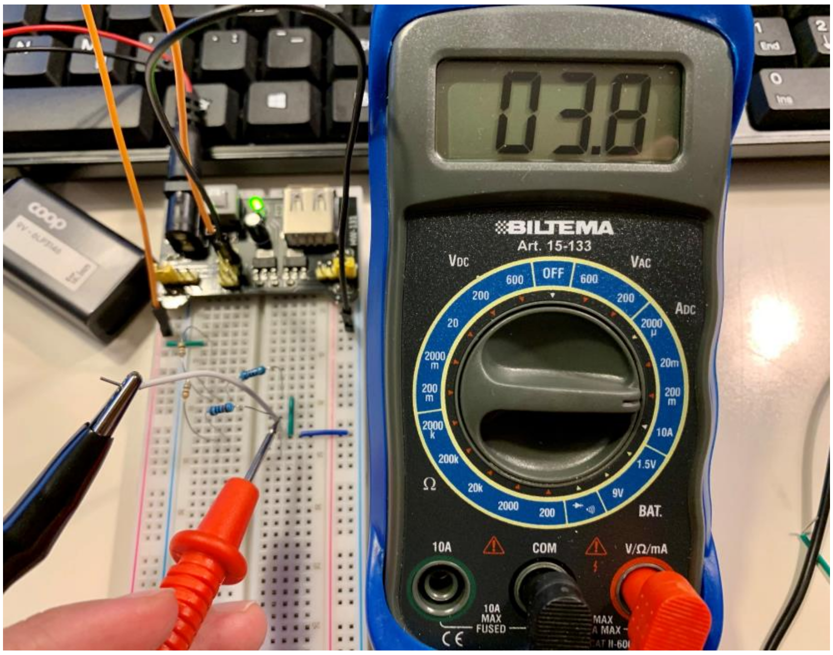


3. Measure the current through R1, R2, R3 and RL









4. Use your measurement data to calculate the power dissipated by R1, R2, R3 and RL

   P = $I^2 R$

   Power at R1 : P = $(12.6\text{mA})^2(68\Omega)$ = 10.76mW

   Power at R2 : P = $(3.8\text{mA})^2(68\Omega)$ = 0.981mW

   Power at R3 : P = $(8.8\text{mA})^2(470\Omega)$ = 36.396mW

   Power at RL: P = $(3.8\text{mA})^2(1000\Omega)$ = 14.440mW

- **Part 3 (Percentage Error)**

1. Calculate the percentage error for voltage, current and power for each circuit element.

$$percent\ error = \frac{measured - real}{real} \cdot 100\%$$

Percentage error for voltage at point x y z

X = $\frac{5.09V - 5V}{5V} \cdot 100\%$= 1.8% , Y = $\frac{4.19V - 4.138V}{4.138V} \cdot 100\%$= 1.26%, Z = $\frac{3.93V - 3.874V}{3.874V} \cdot 100\%$= 1.45%

Percentage error for current at R1, R2, R3, RL

R1 = $\frac{12.6mA - 12.68mA}{12.68mA} \cdot 100\%$= -0.63% , R2 = $\frac{3.8mA - 3.874mA}{3.874mA} \cdot 100\%$= -1.91%

R3 = $\frac{8.8mA - 8.804mA}{8.804mA} \cdot 100\%$= -0-045% , RL = $\frac{3.8mA - 3.874mA}{3.874mA} \cdot 100\%$= -1.91%

Percentage error for calculated Power

P1 = $\frac{10.76mW - 10.93mW}{10.93mW} \cdot 100\%$= -1.56% , P2 = $\frac{0.981mW - 1.021mW}{1.021mW} \cdot 100\%$= -3.92%

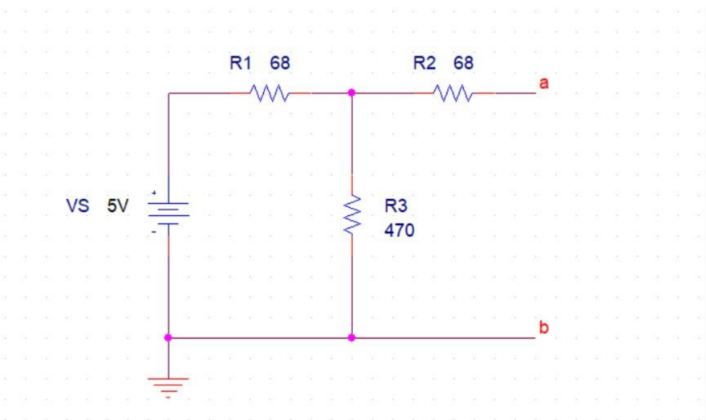
P3 = $\frac{36.396mW - 36.43mW}{36.43mW} \cdot 100\%$= 1.46% , PL = $\frac{14.440mW - 15.01mW}{15.01mW} \cdot 100\%$= -3.80%

- **Part 4 (Thevenin calculation)**

1. Calculate the open circuit voltage (Thevenin Voltage)
2. Calculate the open circuit resistance (Thevenin Resistance)
3. Calculate the load (RL) current
4. Calculate the voltage across the load (RL)
5. Find the maximum power transfer to the load

Solutions as follow :

(Step 1) Open the 1kΩ load resistor

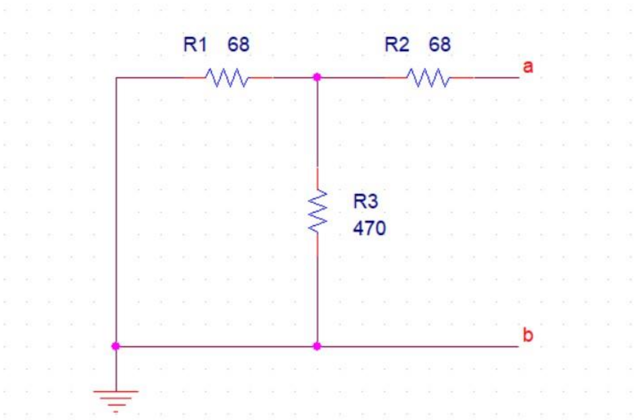


Since this is an open circuit, current is not flowing through R2, calculate the current flowing from series resistors R1 and R2 using ohms law,

I = V/R = 5V / (68Ω +470Ω) = 5V/ 538Ω = 9.29mA , and V3 = (9.29mA)(470Ω) = 4.367V

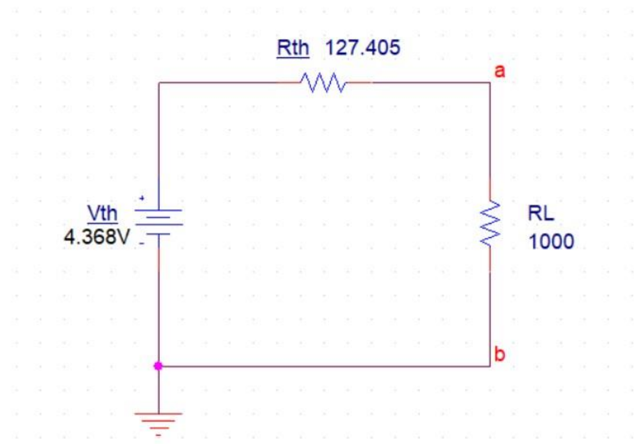
But R2 || R3, so V3 is the same across voltage terminals AB. Therefore, Vth = 4.368V

(Step 2) Open current sources and short voltage sources as shown.



We can calculate for open circuit resistance Rth, since R1 is series with parallel R2 and R3, therefore
*Rth = 68Ω + (470Ω || 68Ω) = 68Ω + [(470Ω*68Ω) /(470Ω + 68Ω)]*
Rth = 127.405Ω

(Step 3) The Thevenin equivalent circuit as shown.



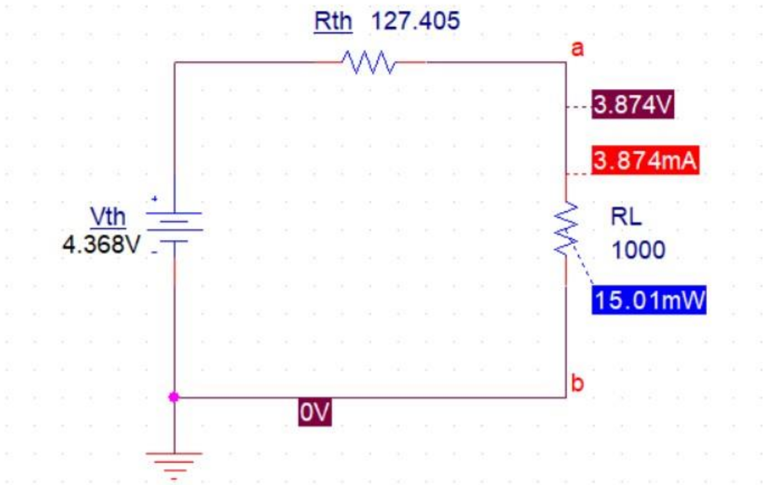
Using ohms law, calculate the total load current and load voltage

$I_L = V_{TH} / (R_{TH} + R_L) = 4.368V / (127.405\Omega + 1k\Omega) = 3.874mA,$

$V_L = I_L \times R_L = (3.874mA)(1k\Omega) = 3.874V$

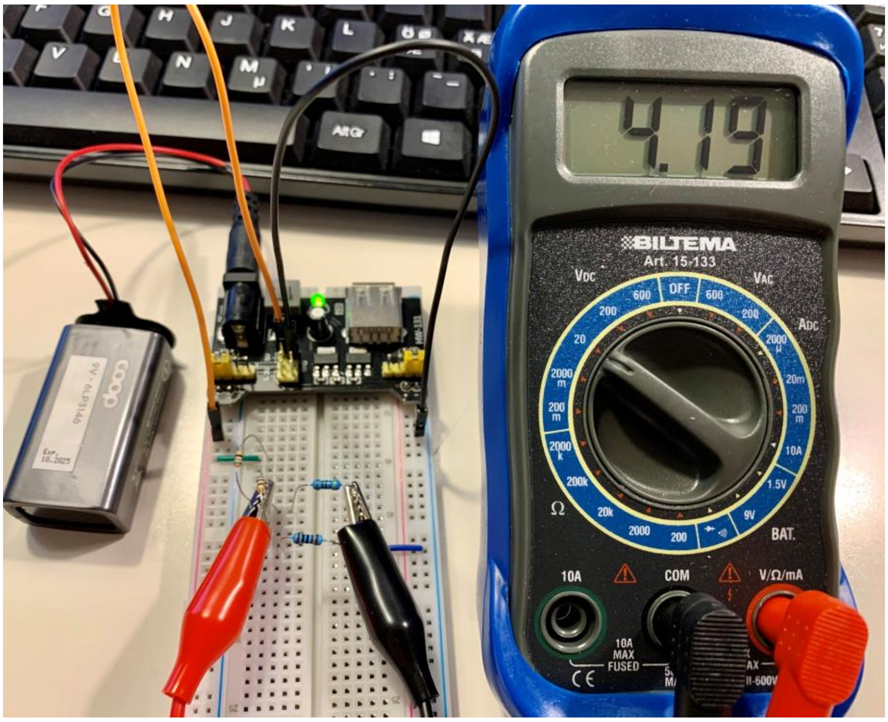
(Step 4) To calculate for maximum power transfer to the load use P = $I^2 R$,
therefore $PL = I^2 RL = (3.874mA)^2(1k\Omega) = 15.01mW$

Simulating in Orcad gives the same results

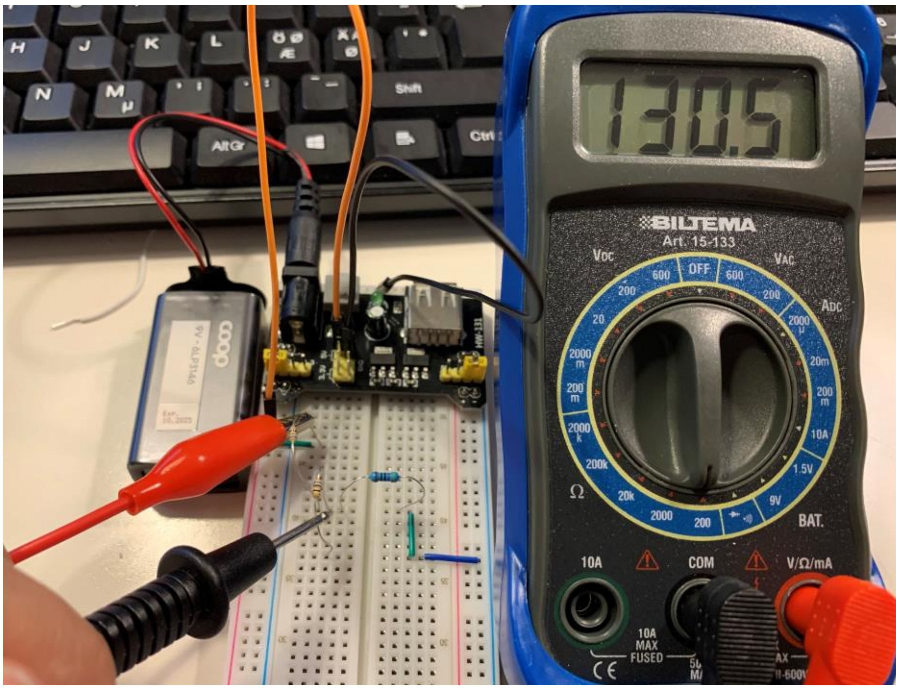


- **Part 5 (Thevenin measurement)**

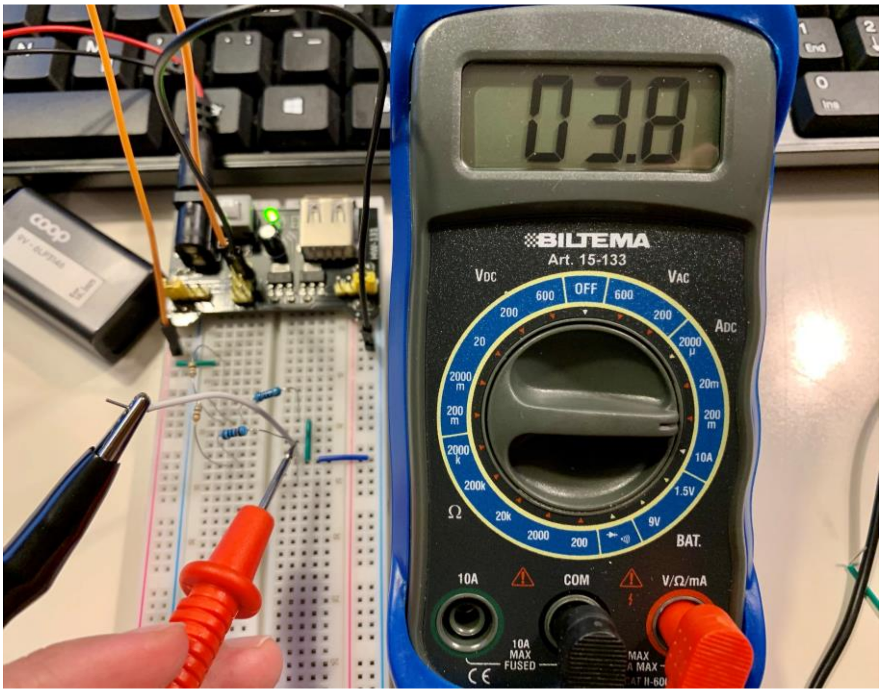
1. Measure the open circuit voltage (Thevenin Voltage)



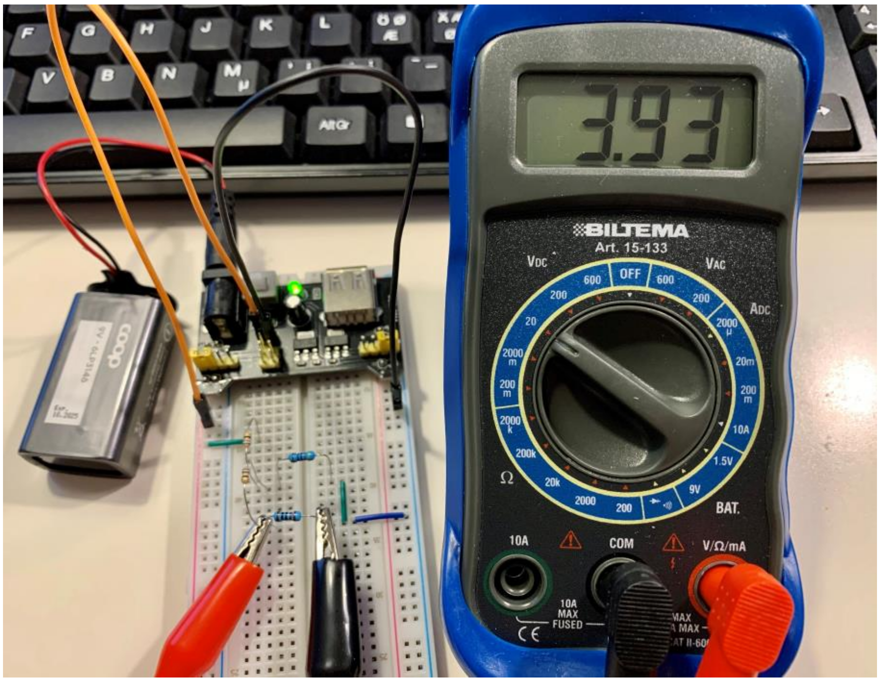
2. Measure the open circuit resistance (Thevenin Resistance)



3. Measure the load (RL) current



4. Measure the voltage across the load (RL)



- **Part 6 (Percentage Error)**

1. Calculate the percentage error for calculated and measured Thevenin

$$percent\ error = \frac{measured - real}{real} \cdot 100\%$$

Percentage error for Thevenin voltage

Vth = $\frac{4.19V - 4.368V}{4.368V} \cdot 100\%$= -4.08%

Percentage error for Thevenin resistance

Rth = $\frac{130.5\Omega - 127.405\Omega}{127.405\Omega} \cdot 100\%$= 2.43%