Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.200 – Circuits & Electronics
Spring 2026

Quiz #1

11 March 2026

Name: Solutions

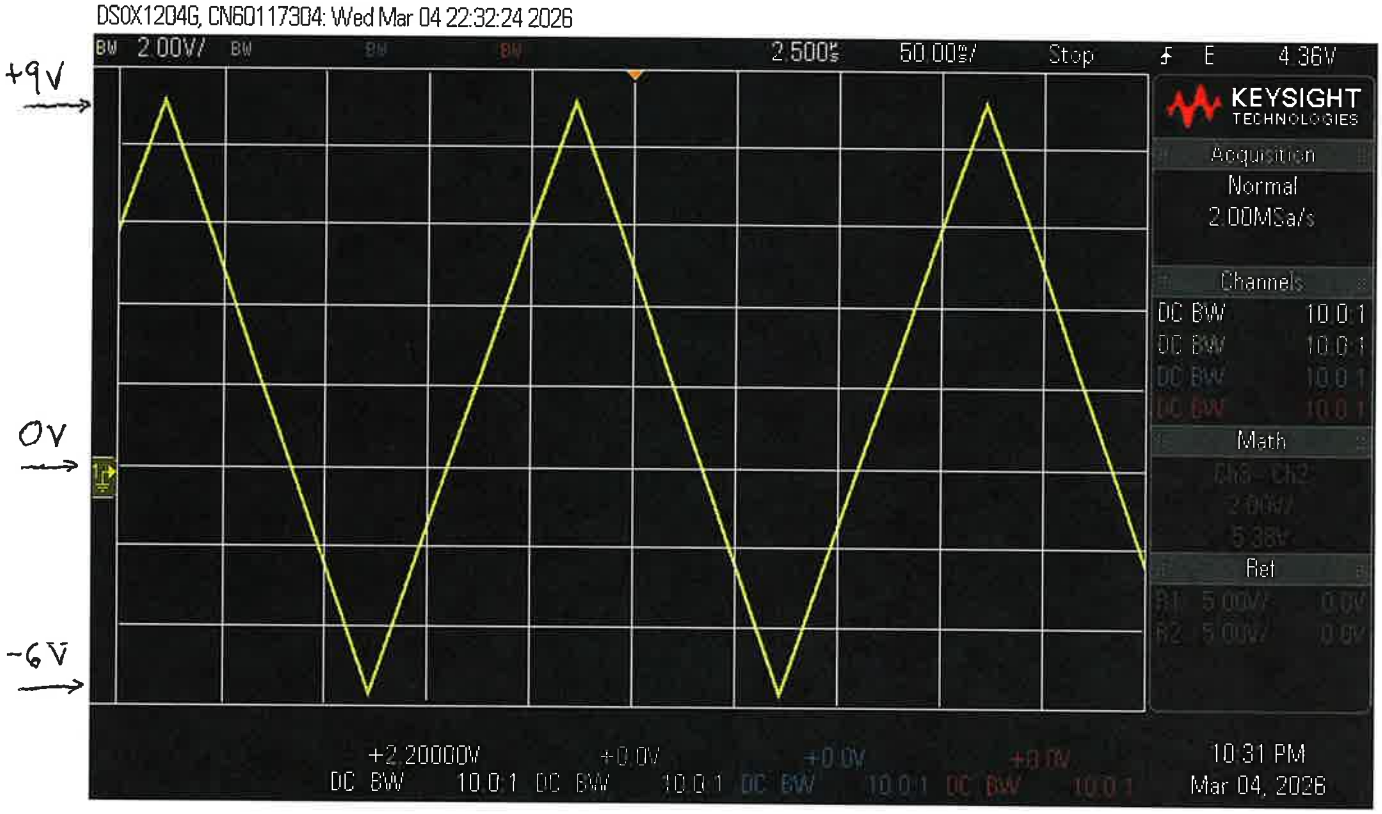
MIT Kerberos ID: ______________________

Recitation Time: 12 1 2

- There are 13 pages in this quiz, including this cover page.
- Please put your name and Kerberos ID in the spaces provided above, and circle the time of your recitation.
- Please do not remove any pages from this quiz.
- Do your work for each question within the boundaries of that question, or on the back of the preceding page. *When finished with each part, clearly write your answer for that part into the corresponding answer box or graph.*
- *All numerical answers require proper units.*
- *In order to guarantee receipt of full credit, all answers should be justified by supporting math and/or explanations.*
- This is a closed-book closed-electronics quiz but a single two-sided page of notes is allowed.
- Good luck!

Problem 1: Oscilloscope Reading - 4%

Shown below is a voltage waveform measured with the 6.200 oscilloscope. Determine the maximum and minimum voltages, and the period and frequency of the waveform.



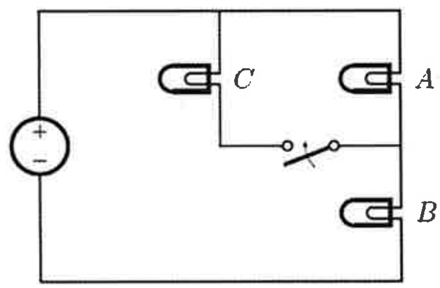
Maximum V: +9 Volts	Minimum V: − 6 Volts
Period: 200 ms	Frequency: 5 Hz

Period = 4 Divisions * 50 $\frac{\text{ms}}{\text{Division}}$ = 200 ms

Problem 2: Lights & Power - 4%

Consider the circuit shown below comprising a constant voltage source, three identical light bulbs, and a switch. Initially the switch is open, and then it closes so that Bulb C turns on. Assume that the light bulbs are resistive in nature with a temperature-independent resistance, and that their brightness increases with their power dissipation.

Note that correct answers will receive positive credit, incorrect answer will receive negative credit, and empty answers will receive zero credit.



(2A) After the switch closes, does Bulb A become brighter or darker, or is its brightness unchanged? Does Bulb B become brighter or darker, or is its brightness unchanged? Circle the appropriate answers.

Bulb A:	Brighter	**Darker**	Unchanged
Bulb B:	**Brighter**	Darker	Unchanged

(2B) Now let the source in the light bulb circuit be a constant current source. After the switch closes, does Bulb A become brighter or darker, or is its brightness unchanged? Does Bulb B become brighter or darker, or is its brightness unchanged? Circle the appropriate answers.

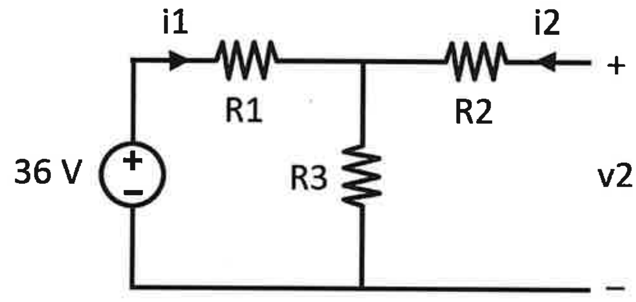
Bulb A:	Brighter	**Darker**	Unchanged
Bulb B:	Brighter	Darker	**Unchanged**

(2A) Closing the switch reduces the voltage across bulb (A) and increases the voltage across bulb (B).

(2B) Closing the switch diverts current from bulb (A) while the current throgh bulb (B) remains the same.

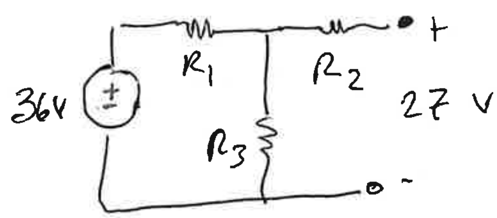
Problem 3: Mystery Circuit – 16%

The circuit shown below contains a known voltage source and three resistors with unknown resistances. When $i_2 = 0$ (open circuit), v_2 is observed to be 27 V. When $v_2 = 0$ (short circuit), i_1 is observed to be 9 mA and i_2 is observed to be -6 mA. With this information, determine the three unknown resistances R_1, R_2 and R_3.



$R_1 =$ 2 kΩ	$R_2 =$ 3 kΩ	$R_3 =$ 6 kΩ

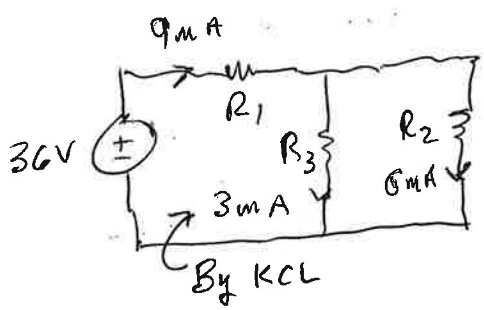
Experiment #1



$\Rightarrow$ $R_1 = A$
$R_3 = 3A$

$A = 2B$

Experiment #2



$\Rightarrow$ $R_2 = 3B$
$R_3 = 6B$

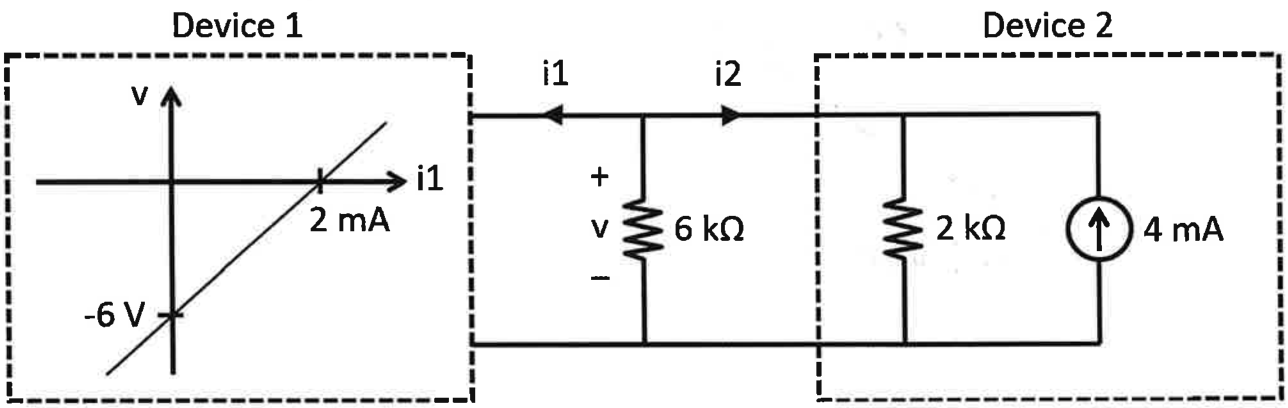
So $R_1 = 2B$, $R_2 = 3B$, $R_3 = 6B$

Experiment #2 $\Rightarrow$ $\frac{36\,V}{9\,mA} = R_1 + R_2 \| R_3 = 2B + 2B = 4\,k\Omega$

$\Rightarrow$ $B = 1\,k\Omega$

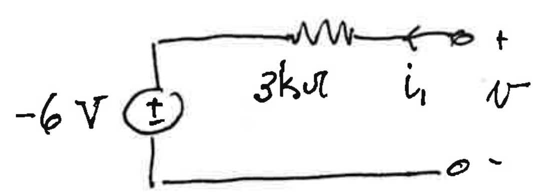
Problem 4: Graphs & Equivalences – 16%

Two devices, Device 1 and Device 2, are both connected in parallel with a 2-kΩ resistor as shown below. The relation between the terminal voltage v and current i_1 of Device 1 is described graphically. The relation between the terminal voltage v and current i_2 of Device 2 is described by a Norton equivalent.



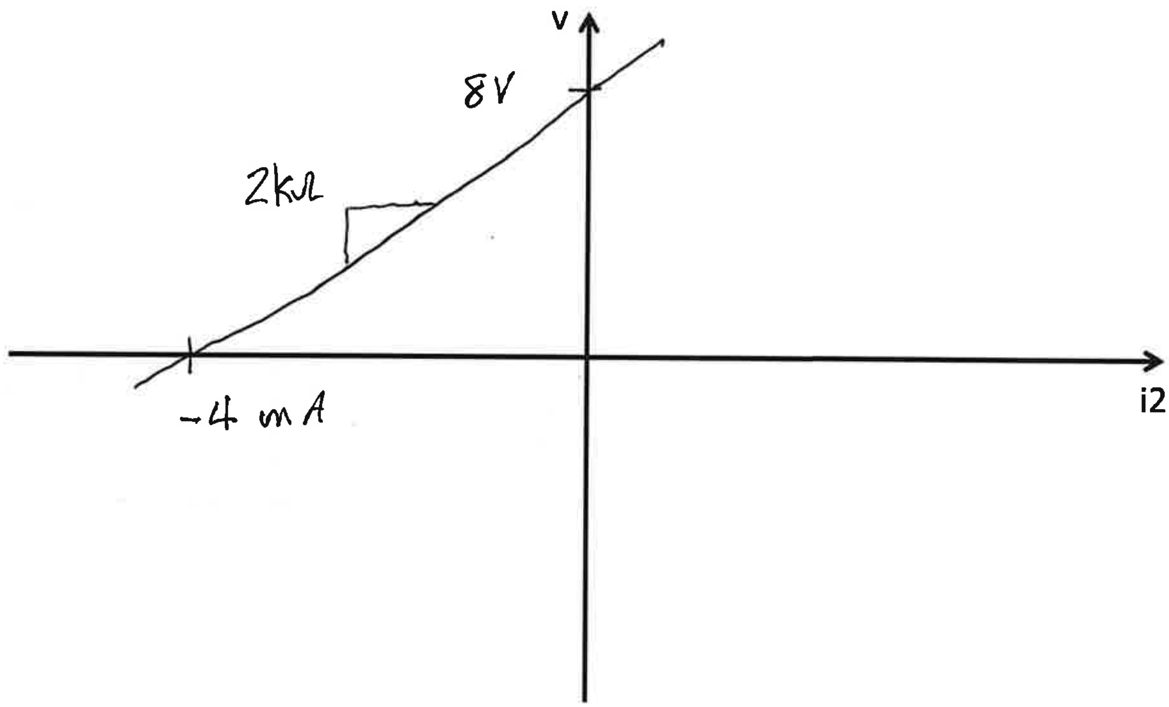
(4A) Draw the Thevenin equivalent of Device 1 in the answer box provided below. Make sure to provide values for all components and label the terminal variables i_1 and v.

Thevenin Equivalent:



$$\frac{6V}{2mA} = 3k\Omega$$

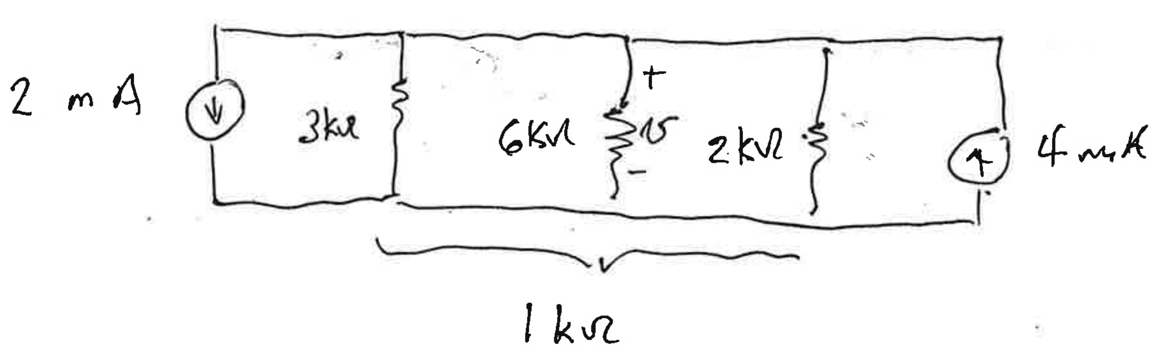
(4B) Graphically sketch the relation between i_2 and v for Device 2 on the axes provided below. Make sure to label all intercepts and slopes.



(4C) Determine v.

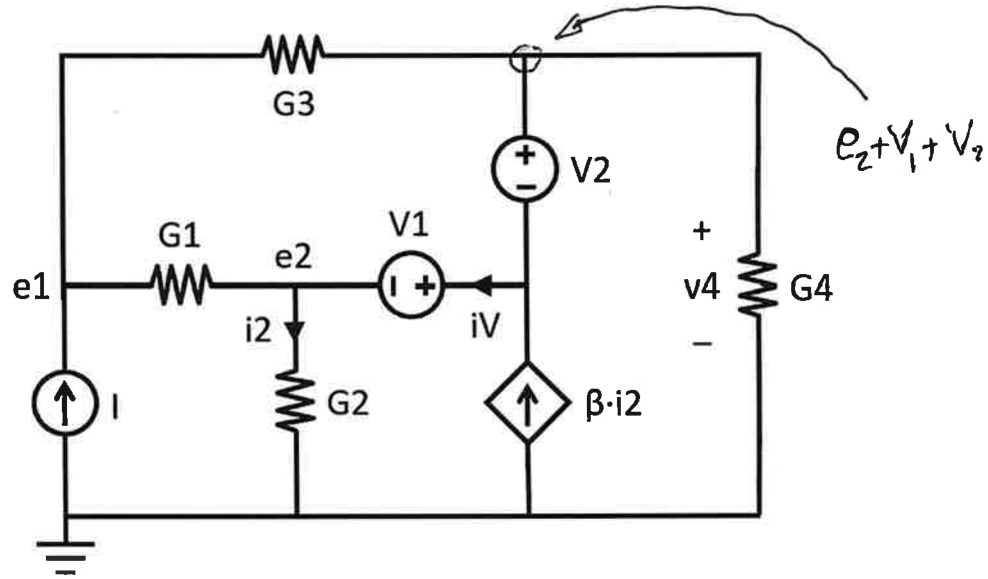
$v =$ 2 V

Use Norton equivalences



Problem 5: Node Analysis – 12%

Consider the circuit shown below in which all resistors are labeled with their conductances. The first objective of this problem is to establish a node analysis that can be used to determine the unknown node voltages e_1 and e_2. The second objective of this problem is to use the results of the node analysis to determine several select branch variables.



(5A) Provide two node equations that can be solved for the unknown node voltages e_1 and e_2. The equations should be written in terms of e_1, e_2 and the circuit parameters.

Equation 1: $G_1(e_2-e_1) + G_3(e_2+V_1+V_2-e_1) + I = 0$

Equation 2: $G_1(e_1-e_2) + G_2(0-e_2) + \beta e_2 G_2$
$+ G_4(0-e_2-V_1-V_2) + G_3(e_1-e_2-V_1-V_2) = 0$

(5B) Assume that e_1 and e_2 are known from the node-voltage analysis. Express v_4 in terms of the known e_1 and e_2, and the circuit parameters.

$v_4 =$ $e_2 + V_1 + V_2$

(5C) Assume that e_1 and e_2 are known from the node-voltage analysis. Express i_V in terms of the known e_1 and e_2, and the circuit parameters.

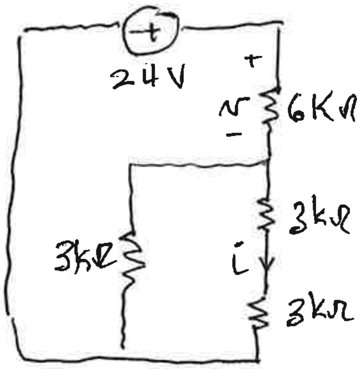
$i_V =$ $G_1(e_2 - e_1) + G_2 e_2$

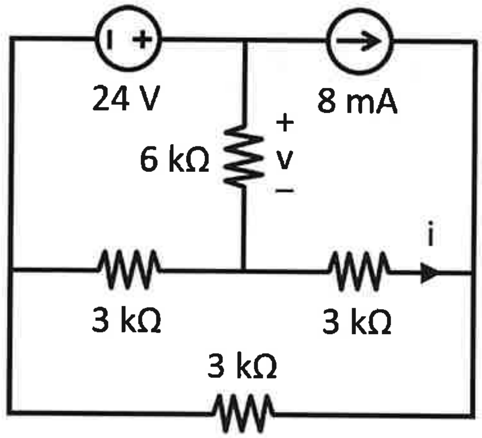
Problem 6: Miscellany – 12% Each Part

Use Superposition

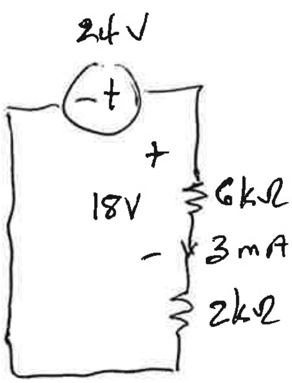
All parts of this problem are independent of the others.

(6A) Determine i and v in the following circuit.





$i =$ −2 mA	$v =$ 12 V



⇓

$i = 1\text{ mA}$

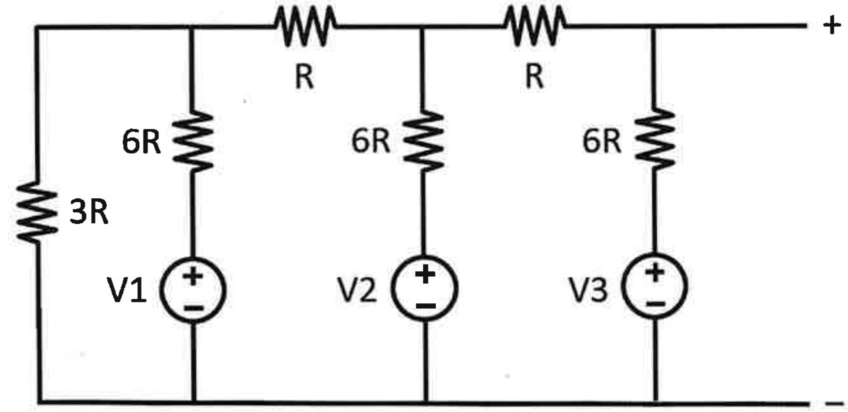
$i = -3\text{ mA}$

$v = -6\text{ V}$

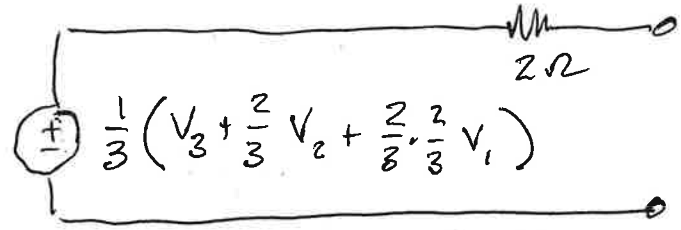
$v = 18\text{ V} - 6\text{ V} = 12\text{ V}$

$i = 1\text{ mA} - 3\text{ mA} = -2\text{ mA}$

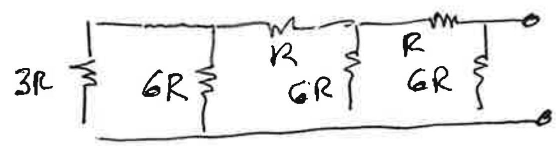
(6B) Draw the Thevenin equivalent of the following circuit in the answer box provided below. Make sure to provide values for all components and label the terminal polarity.



Thevenin Equivalent:



$\frac{1}{3}\left(V_3 + \frac{2}{3}V_2 + \frac{2}{3}\cdot\frac{2}{3}V_1\right)$



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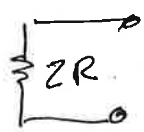
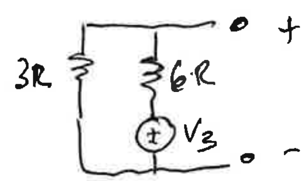


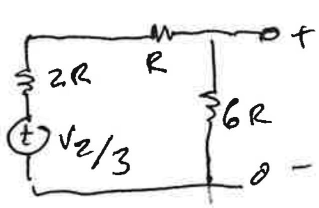
$= R_{TH}$

V_3 alone ⇒



$\frac{1}{3}V_3$

V_2 alone ⇒

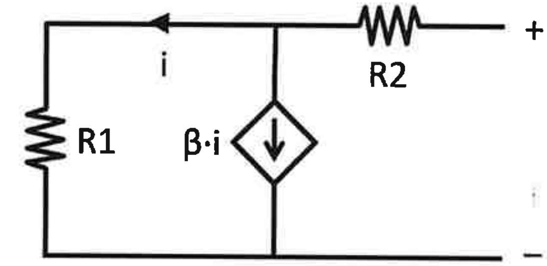


$\frac{2}{3}\frac{V_2}{3}$

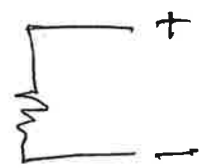
V_1 alone ⇒ $\frac{2}{3}\cdot\frac{2}{3}\cdot\frac{V_2}{3}$

Use Superposition

(6C) Draw the Norton equivalent of the following circuit in the answer box provided below. Make sure to provide values for all components and label the terminal polarity.

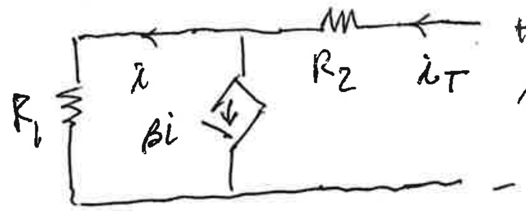


Norton Equivalent: $R_2 + R_1/(\beta+1)$



No Source

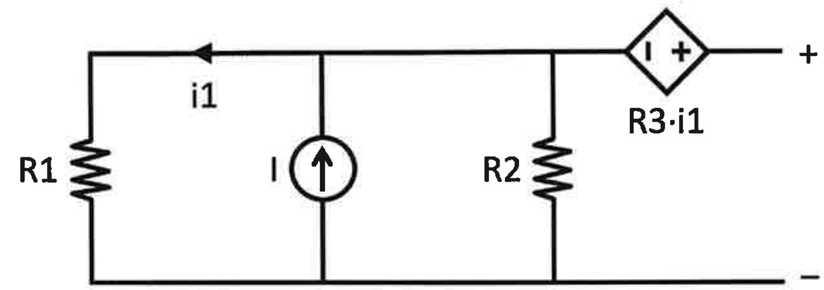
$(\beta+1)i = i_T$



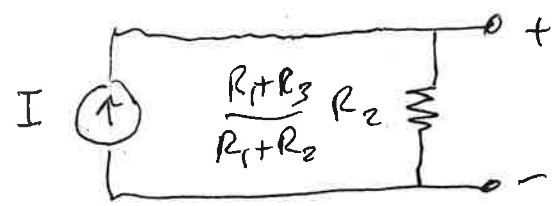
$v_T = R_1 i + R_2(\beta+1)i = (R_1 + R_2(\beta+1))\, i$

$$R_N = \frac{v_T}{i_T} = R_2 + \frac{R_1}{\beta+1}$$

(6D) Draw the Norton equivalent of the following circuit in the answer box provided below. Make sure to provide values for all components and label the terminal polarity.



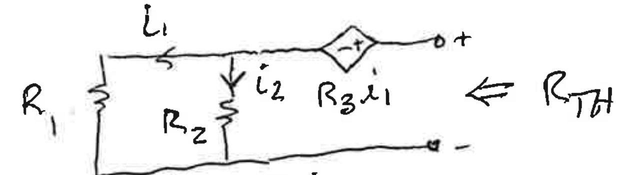
Norton Equivalent:



$$v_{TH} = I\left(\frac{R_1 R_2}{R_1+R_2}\right) + R_3\underbrace{\left(\frac{R_2}{R_1+R_2}\right)I}_{i_1} = I\,\frac{R_1+R_3}{R_1+R_2}R_2$$

i_1 ← For open terminals

Zero source ⇒



$$i_2 = \frac{R_1 i_1}{R_2}$$

Terminal current $= i_1 + i_2 = \left(1+\frac{R_1}{R_2}\right) i_1$

Terminal voltage $= i_1 R_1 + R_3 i_1$

$$R_{TH} = \frac{\text{Terminal Voltage}}{\text{Terminal Current}} = \frac{R_1+R_3}{\left(1+\frac{R_1}{R_2}\right)} = \frac{(R_1+R_3)R_2}{R_2+R_1}$$

$$I_N = \frac{V_{TH}}{R_{TH}} = I$$