Name: _____ (please print)

Signature: _____

ECE 2202 – Quiz 1
September 1, 2022

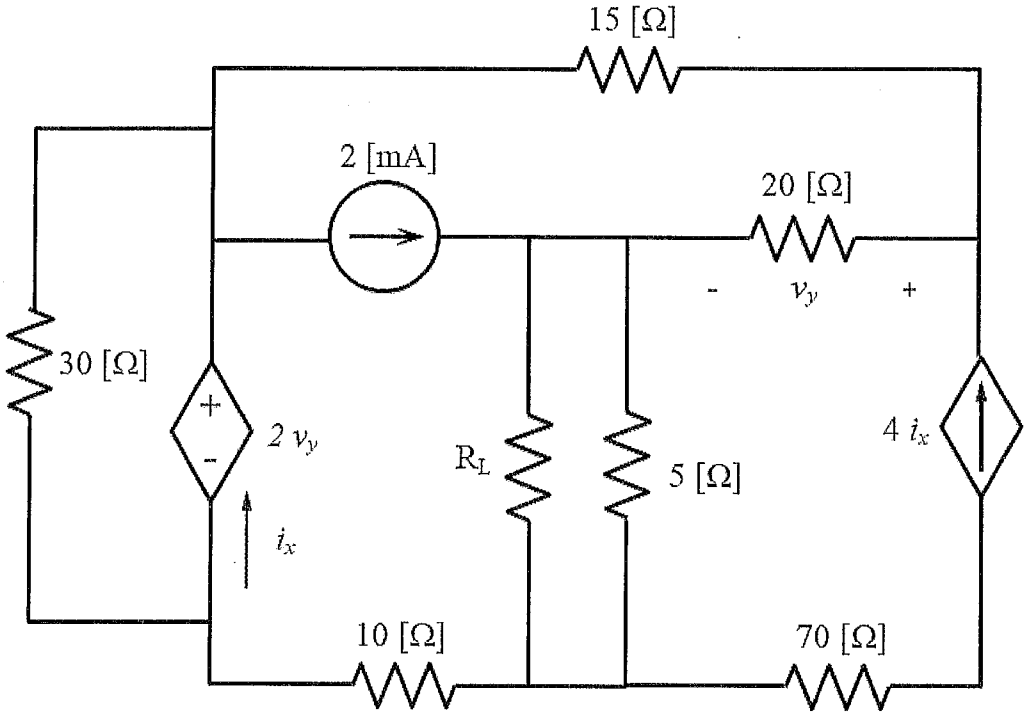
1. This quiz is closed book, closed notes. You may have one 8.5 x 11" crib sheet.
2. Show all work necessary to complete the problem. A solution without the appropriate work shown will receive no credit. A solution which is not given in a reasonable order will lose credit.
3. Show all units in solutions, intermediate results, and figures. Units in the quiz will be included between square brackets.
4. If the grader has difficulty following your work because it is messy or disorganized, you will lose credit.
5. Do not use red ink. Do not use red pencil.
6. You will have 30 minutes to work on this quiz.

_____/20

Room for extra work

In the circuit below, the load resistor R_L has been adjusted so that maximum power is delivered to R_L.

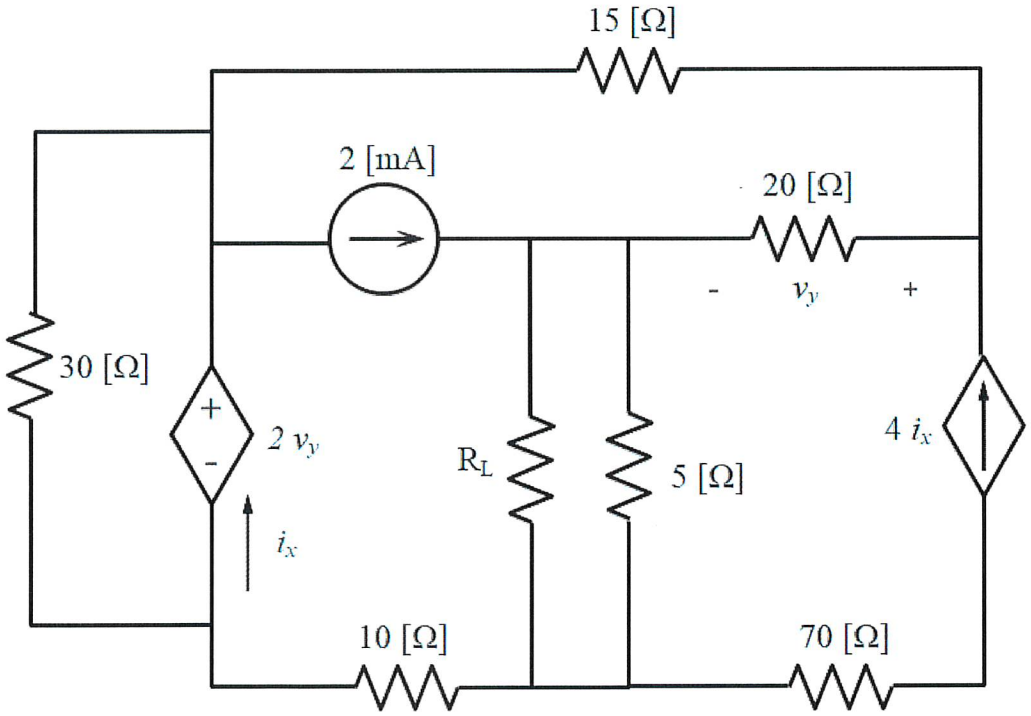
a) What value does R_L have?
b) What power is delivered to R_L?



Room for extra work

In the circuit below, the load resistor R_L has been adjusted so that maximum power is delivered to R_L.

a) What value does R_L have?
b) What power is delivered to R_L?

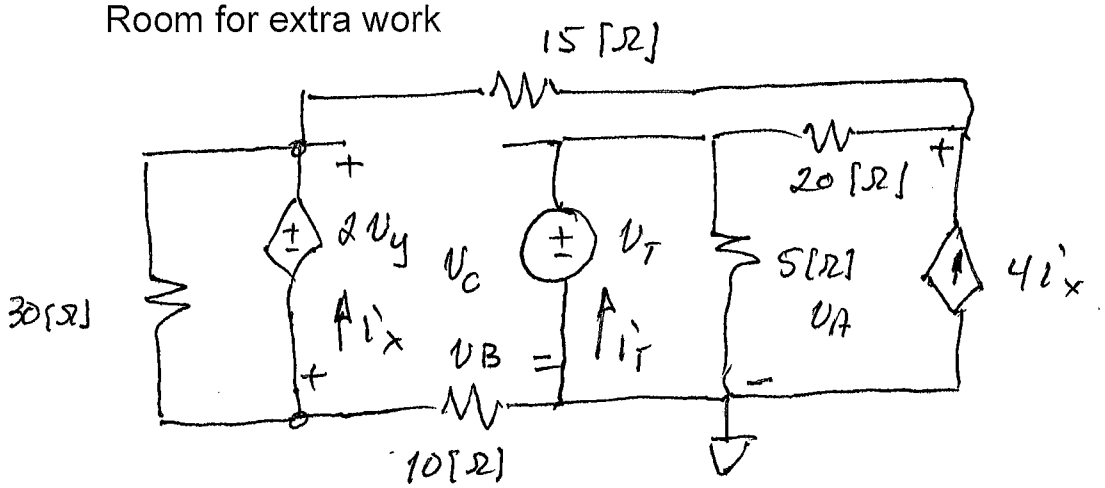


We need the Thevenin equivalent seen by R_L. Part a) requires only R_{TH}, but part b) requires V_{TH} as well.

Simplification: 70 Ω is in series with a current source, so we can ignore it.

Re-draw with a test source:

Room for extra work



$v_T \equiv 1$ [V]

$$\frac{v_A - 1}{20} - 4i_x + \frac{v_A - v_C}{15} = 0$$

$$\frac{v_B}{10} + \frac{v_C - v_A}{15} = 0$$

$$v_B - v_C = -2v_y$$

$$v_y + 1 - v_A = 0$$

$$i_x = -\frac{v_B}{10} - \frac{v_B - v_C}{30}$$

$v_A = 1.48$ [V]

$v_B = 0.288$ [V]

$v_C = 1.168$ [V]

$v_y = 0.480$ [V]

$i_x = -11.2$ [mA]

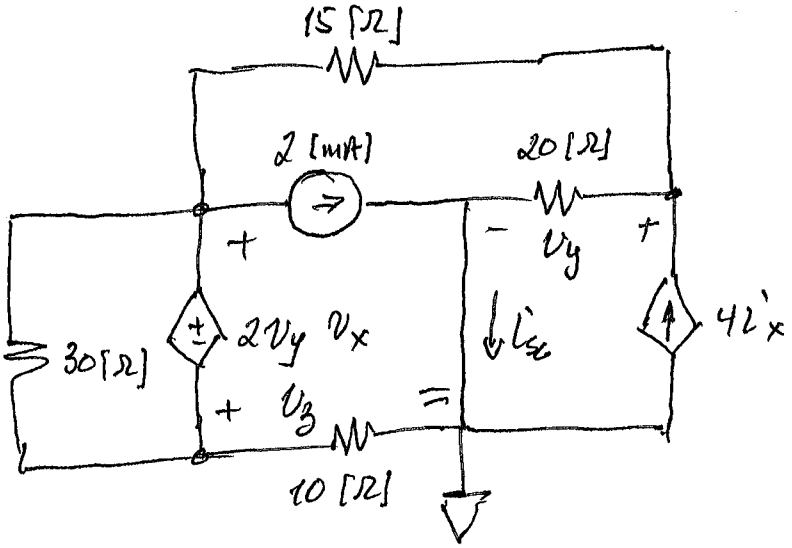
$$i_T = \frac{1}{5} - \frac{v_y}{20} = 0.176 \text{ [A]} \Rightarrow \boxed{R_{TH} = 5.6818 \text{ [Ω]}}$$

So $R_L = R_{TH} = 5.682$ [Ω] will provide max power.

pg. 2

Room for extra work

We need either i_{sc} or v_{oc} to find v_{TH}. We will use both methods as a check.



We can use v_y as a node voltage.

Define $v_x \neq v_3$.

$$\frac{v_y}{20} - 4i'_x + \frac{v_y - v_x}{15} = 0$$

$$\frac{v_x - v_y}{15} + 0.002 + \frac{v_3}{10} = 0$$

$$v_x - v_3 = 2v_y$$

$$i'_x + \frac{v_3}{10} + \frac{v_3 - v_x}{30} = 0$$

$$v_x = -27.36 \text{ [mV]}$$
$$v_y = -9.6 \text{ [mV]}$$
$$v_3 = -8.16 \text{ [mV]}$$
$$i'_x = 0.176 \text{ [mA]}$$

$$i'_{sc} = \frac{v_y}{20} + 0.002 = 1.52 \text{ [mA]}$$

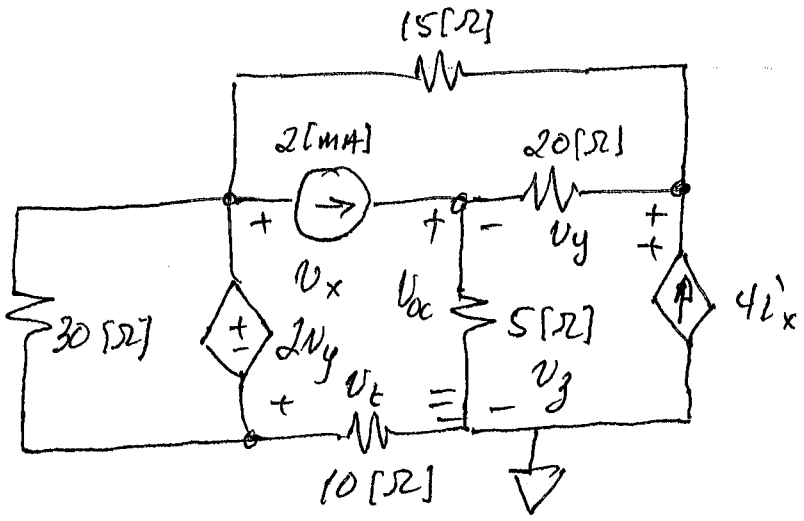
$$\therefore \quad v_{TH} = i'_{sc} \cdot R_{TH} = 8.636 \text{ [mV]}$$

So max power delivered to R_L is $P_{max\ to\ R_L} = \frac{v_{TH}^2}{4R_{TH}}$

$$= 3.281 \text{ [mW]}$$

pg. 2a

We're done, but let's find V_{oc} as a check.



$$\frac{V_3 - V_{oc}}{20} - 4i'_x + \frac{V_3 - V_x}{15} = 0$$

$$\frac{V_{oc}}{5} + \frac{V_{oc} - V_3}{20} - 0.002 = 0$$

$$\frac{V_x - V_3}{15} + 0.002 + \frac{V_t}{10} = 0$$

$$V_x - V_t = 2V_y$$

$$V_y + V_{oc} - V_3 = 0$$

$$i'_x + \frac{V_t}{10} + \frac{V_t - V_x}{30} = 0$$

$V_x = -17.27$ [mV]

$V_y = -5.454$ [mV]

$V_t = -6.364$ [mV]

$V_3 = 3.182$ [mV]

$\boxed{V_{oc} = 8.636 \text{ [mV]}}$

$i'_x = 0.2727$ [mA]

So we have $V_{oc} = V_{TH} = 8.636$ [mV], which checks!