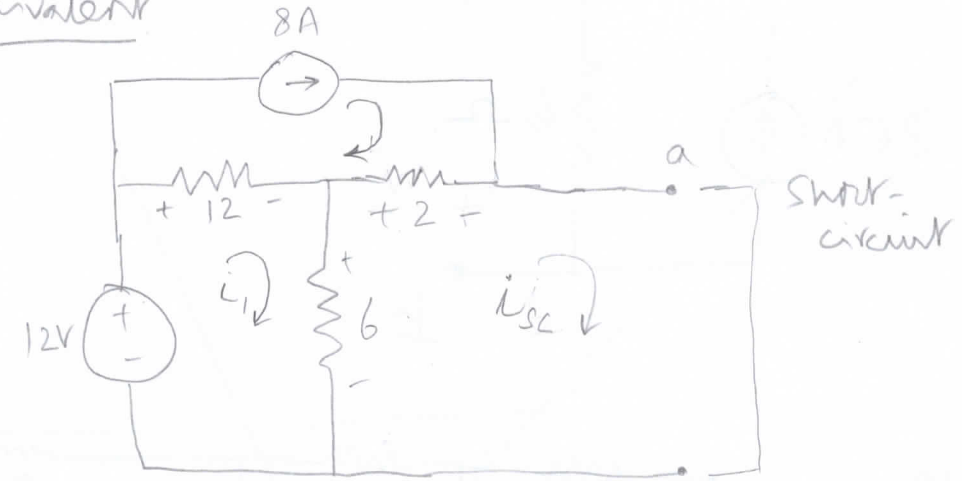
Pr 4.66

Find Norton Equivalent



We know $I_N = I_{sc}$

and $R_N = R_{in}$ with all sources set to zero.

to find I_{sc}:

Writing mesh equations:

$i_{12\Omega} = i_1 - 8$
$i_{6\Omega} = i_1 - i_{sc}$
$i_{2\Omega} = i_{sc} - 8$

$$-12 + 12(i_1 - 8) + 6(i_1 - i_{sc}) = 0$$
(or) $18i_1 - 6i_{sc} = +108 \rightarrow (1)$

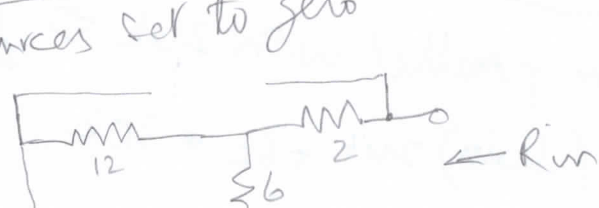
$$-6(i_1 - i_{sc}) + 2(i_{sc} - 8) = 0$$
(or) $-6i_1 + 8i_{sc} = +16 \rightarrow (2)$

Solving (1) & (2)

$$I_N = i_{sc} = 156/18$$
$$= 8.67 \text{ Amps}$$

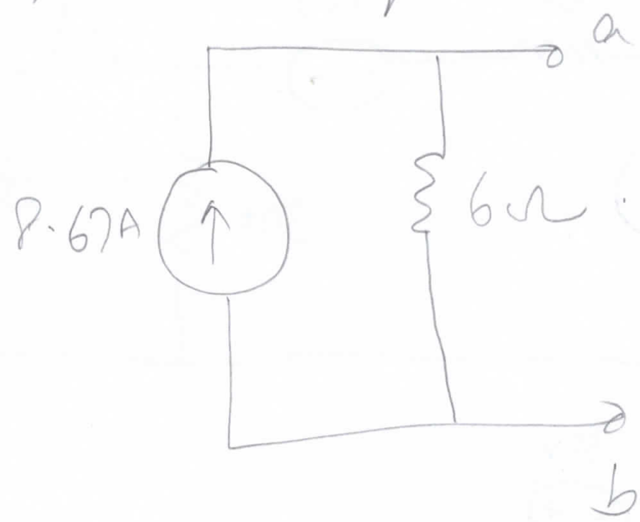
to find R_N

With sources set to zero



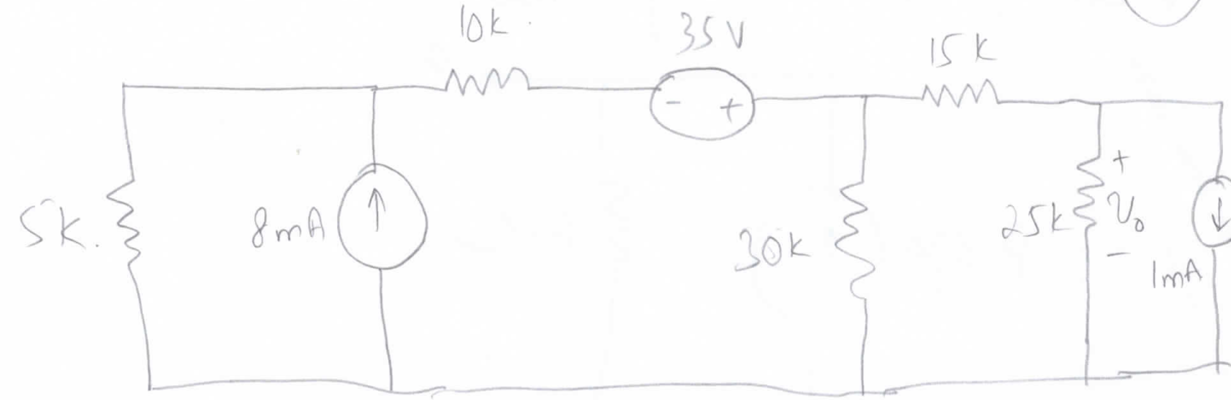
$R_N = 2$ in series with $12 \| 6$
$= 2 + 4$
$= 6\ \Omega$

Hence, Norton eq. is

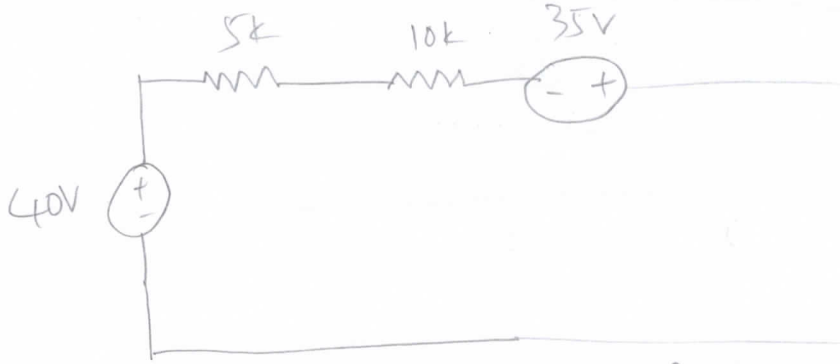


Pr 4.61

a).

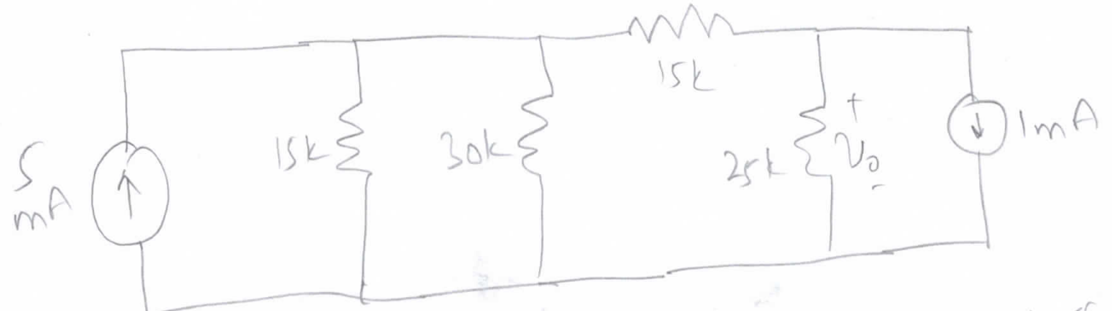


First step



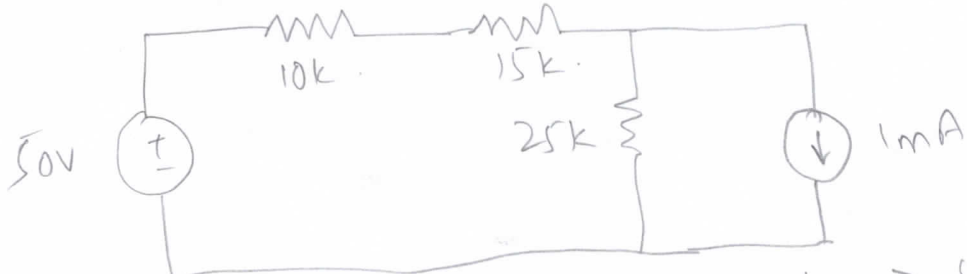
5k in parallel with 8mA ⇒ 40V in series with 5k.

Second step



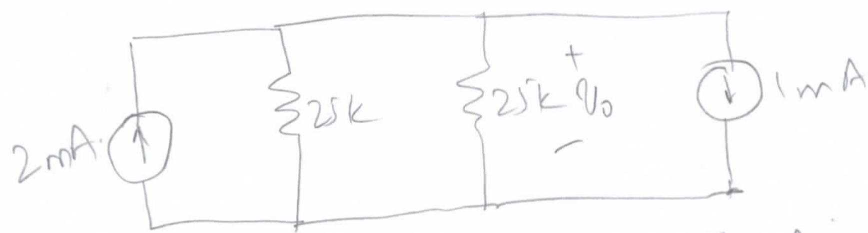
Add 40V + 35V. 75V in Series with 15k ⇒ 5mA in || 15k.

Third step



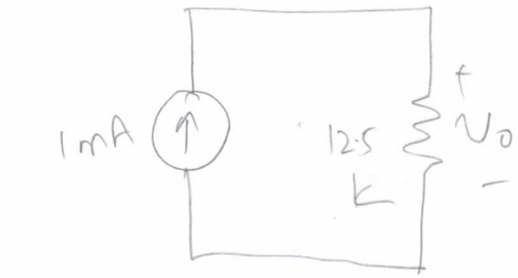
15k || 30k = 10k. 5mA || with 10k ⇒ 50V in series 10k.

Fourth step



(4)

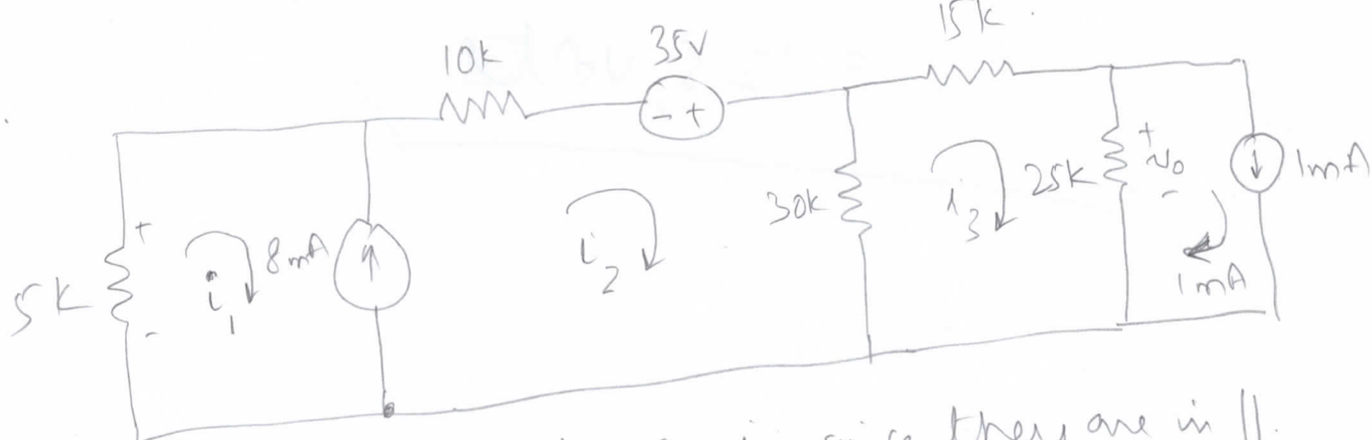
Final Step



$v_o = 12.5k * 1mA$

$= 12.5$ volts.

b).



Voltage across 8mA source is $5000 i_1$, since they are in ||.

Loop 1: $i_2 - i_1 = 8\times10^{-3} \rightarrow (1)$

Loop 2: $5000 i_1 + 10000 i_2 - 35 + 30000(i_2 - i_3) = 0$

or $5000 i_1 + 40000 i_2 - 30000 i_3 = 35 \rightarrow (2)$

Loop 3: $-30000(i_2 - i_3) + 15000 i_3 + 25000(i_3 - 1\times10^{-3}) = 0$

$-30000 i_2 + 70000 i_3 = 25 \rightarrow (3)$

Put (1) in (2) $5000(i_2 - 8\times10^{-3}) + 40000 i_2 - 30000 i_3 = 35 \rightarrow (2)$

or $45000 i_2 - 30,000 i_3 = 75 \rightarrow (2)$

$i_3 = 1.5\, mA$

$i_2 = 2.667\, mA$

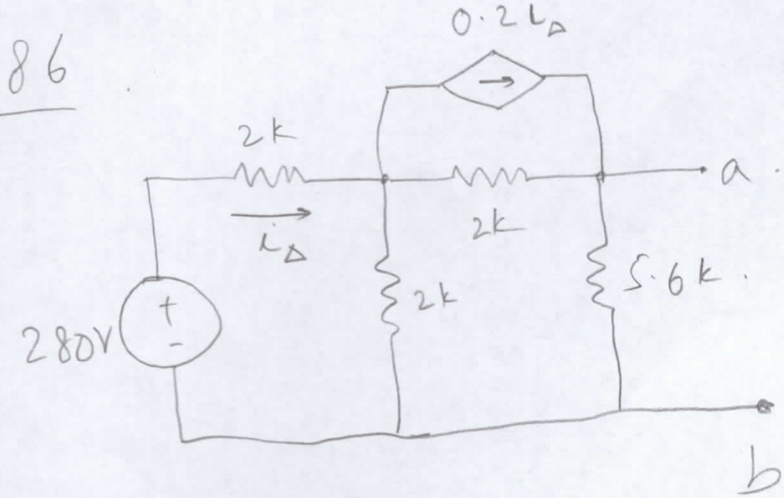
$i_1 = -5.33\, mA$

Hence: $v_o = 25k * (i_3 - 1mA)$

$= 25000 * (1.5 - 1) * 10^{-3}$

$= 12.5$ volts

Pr 4.86



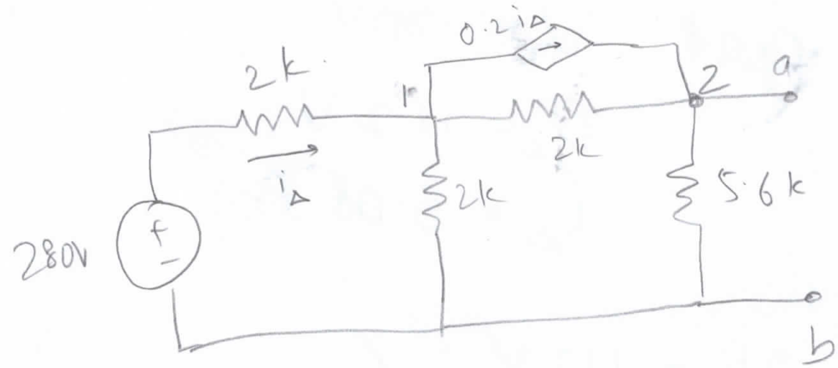
a) find R_o for max power
b) find max Power
c) % of total Power to R_o.

ⓐ. We must first create the Thevenin Equivalent of the above circuit.

i.e. we must find V_{Th} & R_{Th}. Then $R_o = R_{Th}$.

first, to find V_{Th}

Assume an open-circuit at terminals a and b, then find V_{ab}



Name the two nodes 1 & 2.

KCL at Node 1

$$\frac{v_1 - 280}{2000} + \frac{v_1}{2000} + \frac{v_1 - v_2}{2000} + 0.2 i_\Delta = 0$$

$$\frac{3v_1}{2000} - \frac{v_2}{2000} + 0.2 i_\Delta = \frac{280}{2000} \quad \text{— (1)}$$

KCL at Node 2

$$\frac{V_2 - V_1}{2000} + \frac{V_2}{5600} - 0.2 i_\Delta = 0$$

$$\text{or} \quad -\frac{V_1}{2000} + \frac{19 V_2}{28000} - 0.2 i_\Delta = 0 \longrightarrow (2)$$

Also: $-280V + 2k i_\Delta + V_1 = 0$

$$\text{or} \quad i_\Delta = \frac{280 - V_1}{2000}$$

$$\frac{V_1}{2000} + i_\Delta = \frac{280}{2000} \longrightarrow (3)$$

Solving (1), (2) & (3),

we get $V_1 = 120V$

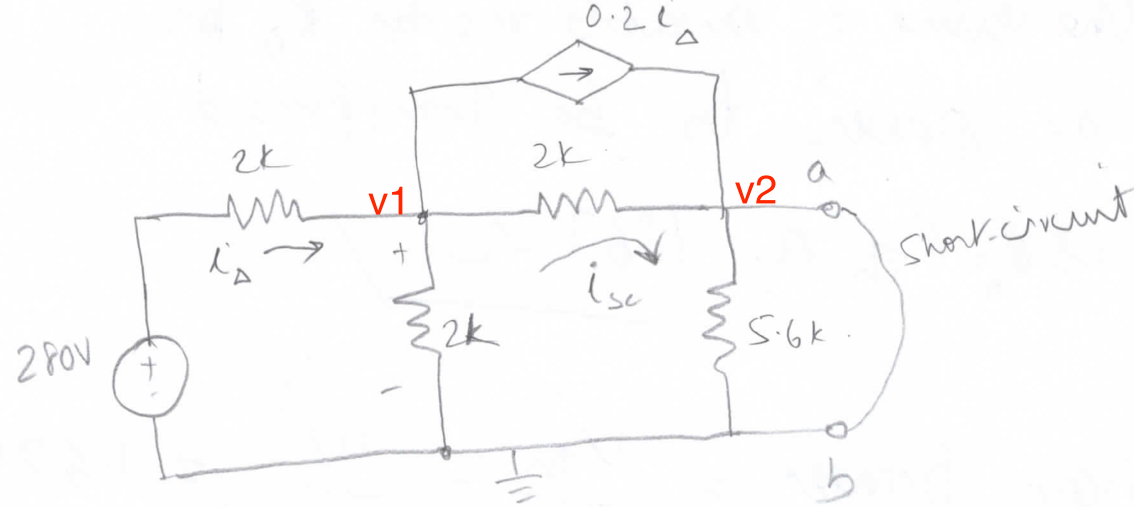
$V_2 = 112V$

$i_\Delta = 0.08\ A.$

$$V_{Th} = V_2 = 112V.$$

Next, to find R_{Th}

$$R_{Th} = \frac{V_{Th}}{i_{sc}}$$



The two mesh-current equations are:

$$-280 + 2000 i_\Delta + 2000(i_\Delta - i_{sc}) = 0$$

$$-2000(i_\Delta - i_{sc}) + 2000(i_{sc} - 0.2 i_\Delta) = 0$$

$$4000 i_\Delta - 2000 i_{sc} = 280 \rightarrow (1)$$

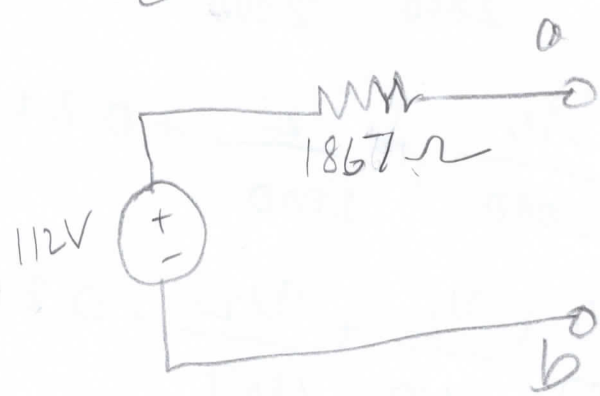
$$-2400 i_\Delta + 4000 i_{sc} = 0 \rightarrow (2)$$

solving: $i_\Delta = 0.1$ A

$i_{sc} = 0.06$ A

So, $R_{Th} = \frac{V_{Th}}{i_{sc}} = \frac{112}{0.06} = 1866.67\ \Omega$

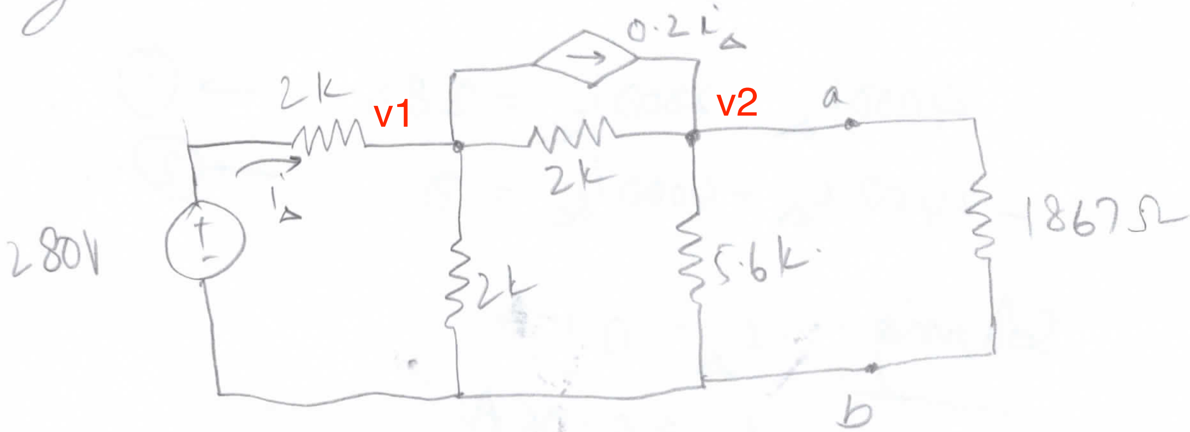
Thevenin Equivalent is



So, the value of variable resistor R_0 for max power to be Transferred is $R_0 = R_{Th}$ or $\underline{1867\ \Omega}$.

(b) Max power $= \dfrac{V_{Th}^2}{4R_L} = \dfrac{112^2}{4 \times 1867} = \underline{\underline{1.679\ \text{Watts}}}$

(c) We have to first find total power generated in the circuit.



→ We have to find i_Δ, and voltage across Dep source.

KVL Mesh 1

$$\frac{v_1 - 280}{2000} + \frac{v_1}{2000} + \frac{v_1 - v_2}{2000} + 0.2 i_\Delta = 0$$

$$\frac{3v_1}{2000} - \frac{v_2}{2000} + 0.2 i_\Delta = \frac{280}{2000} \rightarrow (1)$$

KVL

$$\frac{v_2 - v_1}{2000} + \frac{v_2}{5600} + \frac{v_2}{1867} - 0.2 i_\Delta = 0$$

5

or $-\frac{v_1}{2000} + \frac{34 v_2}{28000} - 0.2 i_\Delta = 0 \rightarrow$ 2

Also, $-280 + 2000 i_\Delta + v_1 = 0$ $\left(i_\Delta = \frac{280 - v_1}{2k} \right)$

or

$$\frac{v_1}{2000} + i_\Delta = \frac{280}{2000}$$

or $v_1 + 2000 i_\Delta = 280 \rightarrow$ 3

Solving 1, 2 & 3 gives

$v_1 = 100V$, $v_2 = 56V$, $i_\Delta = 90 \times 10^{-3}$ Amps.

$p_{280} = -(280)(0.09) = -25.2\,W$.

$p_{DS} = (v_1 - v_2) \times 0.2 i_\Delta = 0.792\,W$.

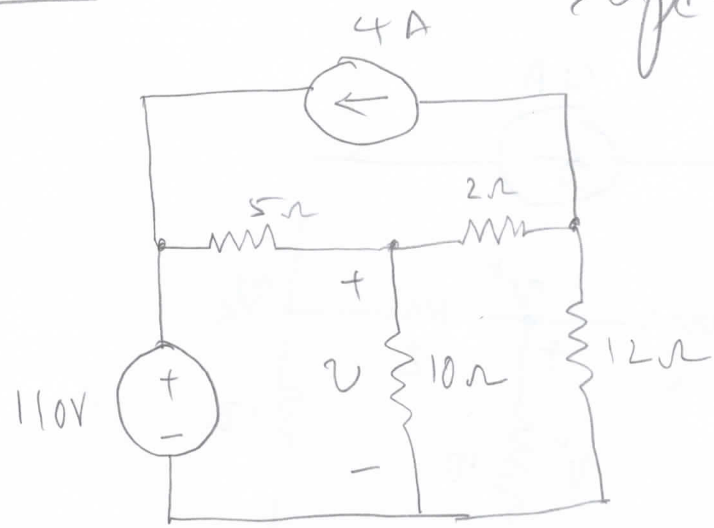
So, only p_{280} is providing power of 25.2 Watts.

Hence % of power going to R_o is

$$\frac{1.68}{25.2} \times 100 = 6.67\%$$

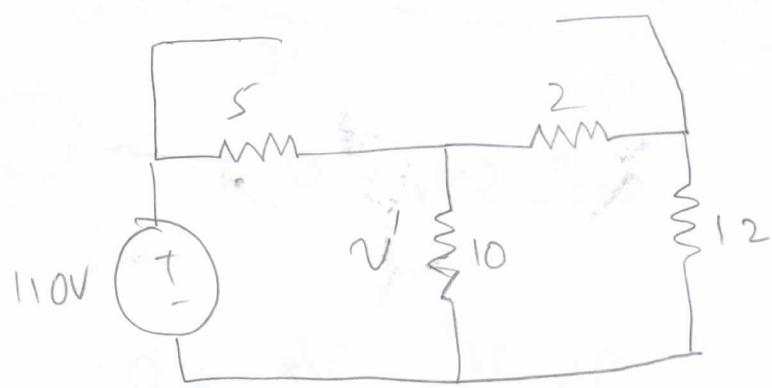
Problem 4.92

Superposition



a) find v. ($v = v' + v''$)

To use Superposition, we first disable the 4A source, and calculate v'



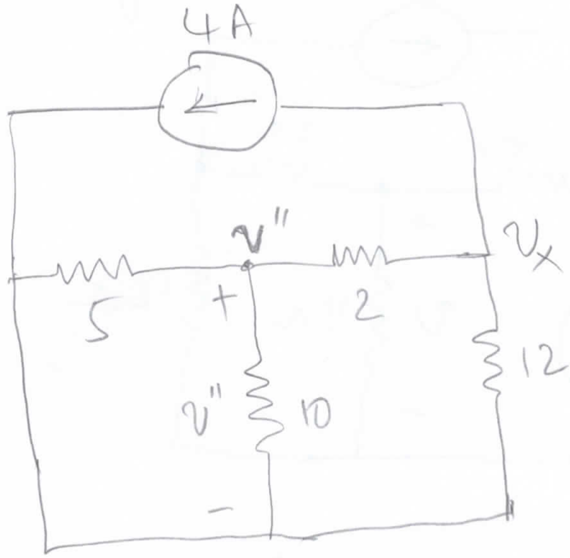
the 5Ω is in series with $10 \| (2+12)$, or

5 in series with $35/6$ Ω (5.83 Ω)

Using voltage divider formula:

$$v' = \left(\frac{5.83}{5+5.83}\right) \times 110 = 59.21 \text{ Volts}$$

Next, we disable 110V source and find v''. (7)



Using Node-Voltage method

KCL at v'': $\frac{v''}{10} + \frac{v''}{5} + \frac{v''-v_x}{2} = 0$

$$\frac{v''+2v''+5v''}{10} - \frac{5v_x}{10} = 0$$

$$8v'' - 5v_x = 0 \longrightarrow (1)$$

KCL at v_x: $4 + \frac{v_x - v''}{2} + \frac{v_x}{12} = 0$

$$\frac{6v_x - 6v'' + v_x}{12} = -4$$

$$-6v'' + 7v_x = -48 \longrightarrow (2)$$

Solving (1) & (2), gives $v'' = -9.2307$ Volts

Hence: $v = v' + v''$

$= 59.21 - 9.23$

≈ 50 volts

b Power in the $10\,\Omega$ resistor

$= v^2/R$

$= \dfrac{50^2}{10}$

$= 250$ watts