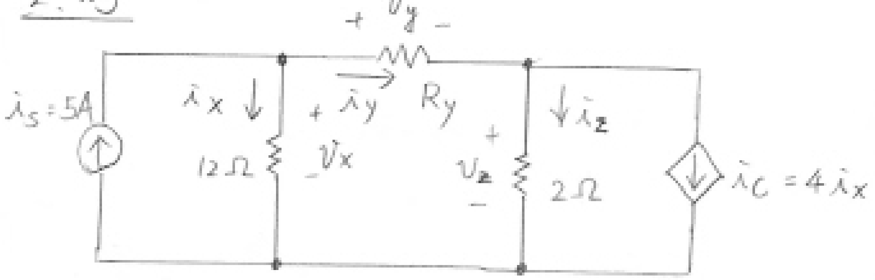
2.23



$i_y = 5 - i_x$

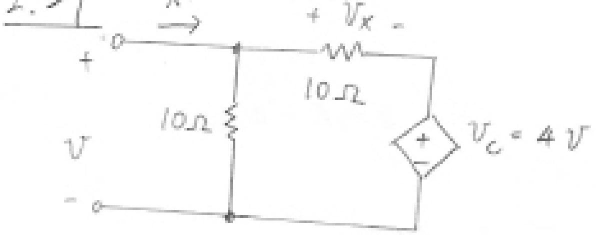
$i_z = i_y - i_c = 5 - 5i_x$

KVL:

$12 i_x - 3(5 - i_x) - 2(5 - 5i_x) = 0$

$\Rightarrow i_x = 1\ A$

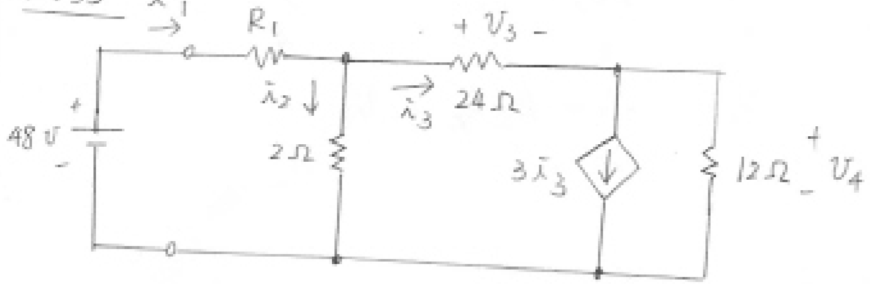
2.29



$v_x = v - v_c = -3v$

$i = \frac{v}{10} + \frac{v_x}{10} = -\frac{v}{5} \Rightarrow Req = \frac{v}{i} = -5\Omega$

2.35



(a) $i_3 = v_3/24 = 1.5\ A$

$v_4 = 12(i_3 - 3i_3) = -36v$

$i_2 = (v_3 + v_4)/2 = 0$

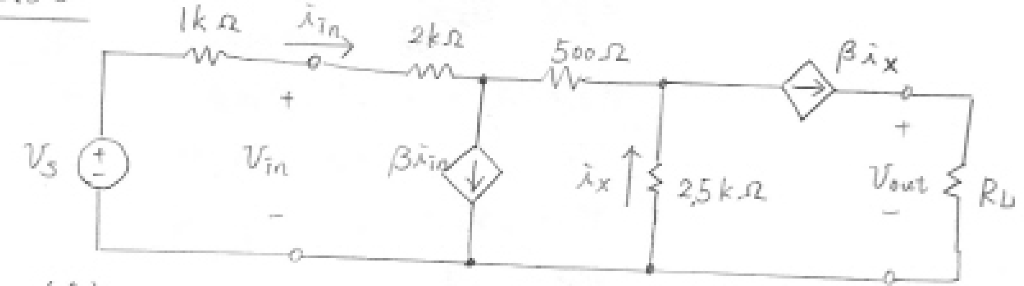
$i_1 = i_2 + i_3 = 1.5\ A$

(b) $R_1 = (48 - v_3 - v_4)/i_1 = 32\Omega$, $Req = 48/i_1 = 32\Omega$

(c) $Ps = 48 \cdot i_1 + v_4(-3i_3) = 234\ w$

$Pd = R_1 \cdot i_1^2 + 2i_2^2 + 24i_3^2 + v_4^2/12 = 234\ w = P_s$

2.36



(a) KCL at bottom node: $-i_{in} + \beta i_{in} - i_x + \beta i_x = 0 \Rightarrow i_x = -i_{in}$

(b) $v_{in} = 2i_{in} + 0.5(i_{in} - \beta i_{in}) + 2.5(-i_x) = (5 - 0.5\beta)\, i_{in}$

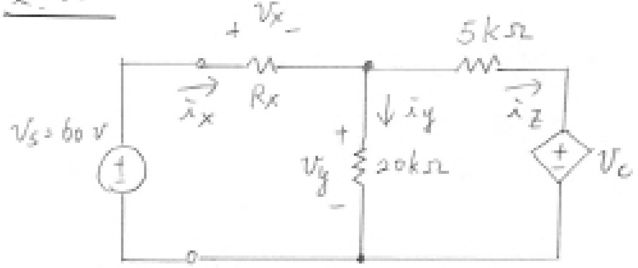
$R_{in} = v_{in}/i_{in} = (5 - 0.5\beta)\ k\Omega$

(c) $i_{in} = 2/(1 + R_{in})$, $V_{out} = R_L \cdot (\beta i_x) = -5\beta i_{in}$

β	R_{in} (kΩ)	i_{in} (mA)	V_{out} (v)
8	1	1	−40
10	0	2	−100
12	−1	∞	−∞
14	−2	−2	140

The model is invalid for $\beta = 12$, which requires infinite current from all three sources.

2.40



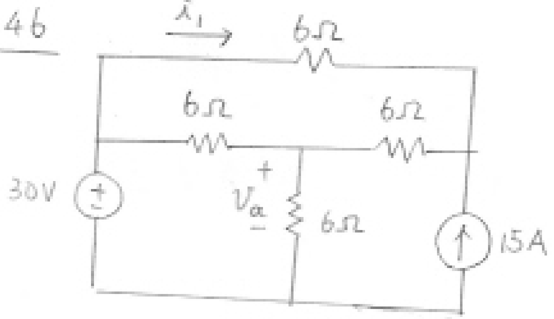
$\hat{v}_y = \hat{i}_y \cdot 20k = 20$ V, $\hat{i}_z = (\hat{v}_y - \hat{v}_c)/5 = 1$ mA

$\hat{i}_x = \hat{i}_y + \hat{i}_z = 2$ mA, $\hat{v}_x = R_x \cdot \hat{i}_x = 10$ V

$\hat{v}_s = \hat{v}_x + \hat{v}_y = 30$ V, $k = 30/v_s = 0.5$

$v_x = \hat{v}_x / k = 20$ V. $v_y = \hat{v}_y / k = 40$ V, $v_c = \dfrac{15k \cdot \hat{i}_y}{k} = 30$ V

2.46



with 30-V source active:

$R_{eq} = [6 \parallel (6+6)] + 6 = 10$

$v_{a\text{-}1} = 6 \cdot 30/R_{eq} = 18$ V

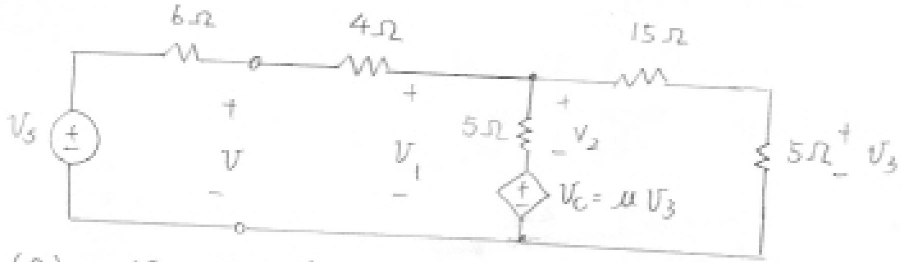
with 15-A source active:

$R_{eq} = 6 \parallel (6 + 6 \parallel 6) = 3.6$

$v_{a\text{-}2} = 6\parallel6 \times R_{eq} \times 15/(6 + 6\parallel6) = 18$

$v_a = v_{a\text{-}1} + v_{a\text{-}2} = 36$ V

2.55



(a) $v_3 = 5v_1/(15+5) = v_1/4$, $v_2 = v_1 - \mu v_3 = (4-\mu)\, v_1/4$

(b) $v_2 = (4-\mu) \cdot 20/4 = 20 - 5\mu$, $i = v_2/5 + v_1/(15+5) = 5 - \mu$

$v = 4i + v_1 = 40 - 4\mu$, $R_{eq} = v/i = (40-4\mu)/(5-\mu)$

(c) $\mu = 0 \Rightarrow R_{eq} = 8\,\Omega$

$v_c = 0 \Rightarrow R_{eq} = 4 + 5 \parallel (15+5) = 8\,\Omega$

(d)

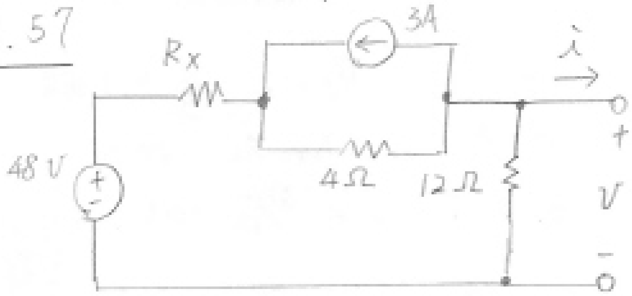
$i = 60/(6+R_{eq})$, $v = R_{eq} \cdot i = 60R_{eq}/(6+R_{eq})$

$P = v \cdot i = 3600 R_{eq}/(6+R_{eq})^2$

μ	R_{eq} (Ω)	i (A)	v (V)	P (W)
1	9	4	36	144
5	∞	0	60	0
6	-16	-6	96	-576
7	-6	∞	-∞	-∞
9	-1	12	-12	-144
10	0	10	0	0

This model is invalid for $\mu = 7$, which requires infinite current from both sources.

2.57



with $i = 0$:

$V_{oc-1} = 12 \times 48/(4+12) = 36\ V$

$V_{oc-2} = (4 \| 12)(-3) = -9\ V$

$V_{oc} = 36 - 9 = 27\ V.$

with $V = 0$:

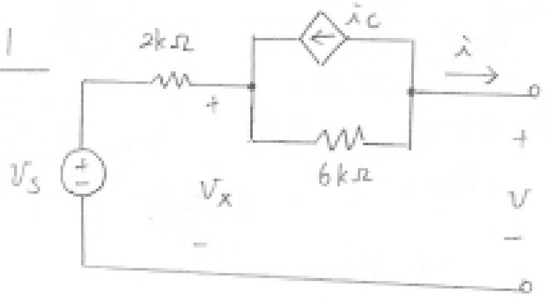
$i_{sc-1} = 48/4 = 12\ A,$

$i_{sc-2} = -3\ A, \quad i_{sc} = 12 - 3 = 9\ A$

$R_t = 27/9 = 3\ \Omega$

for dead network: $R_t = 4 \| 12 = 3\ \Omega$

2.61



with $V_s = 0$:

$i = -i_t, \quad i_c = -4 i_t$

$V_t = 2k \cdot i_t + 6k(i_t - i_c) = 32k \cdot i_t$

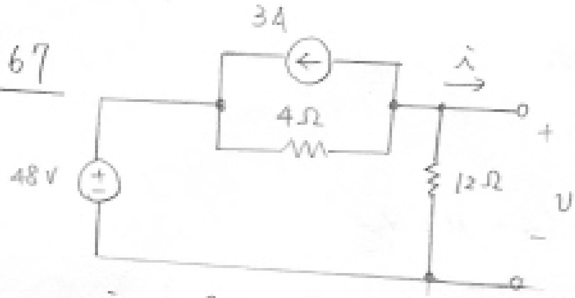
$R_t = V_t / i_t = 32\ k\Omega$

with $i = 0$:

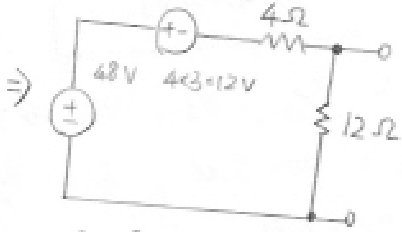
$i_c = 0 \Rightarrow V_{oc} = V_s$

$i_{sc} = V_{oc}/R_t = V_s / 32\ k\Omega$

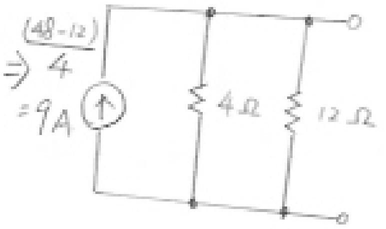
2.67



⇒

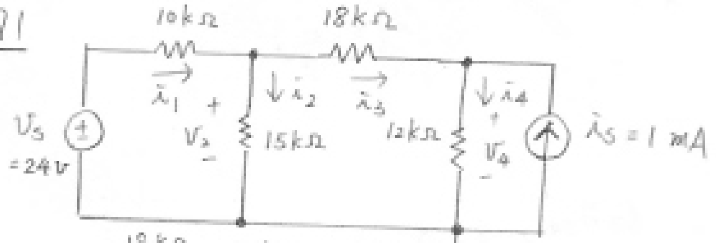


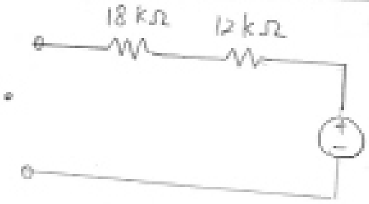
⇒



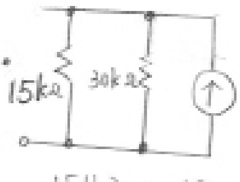
$i_{sc} = 9\ A, \quad R_t = 4 \| 12 = 3\ \Omega, \quad V_{oc} = 3 \times 9 = 27\ V.$

2.71

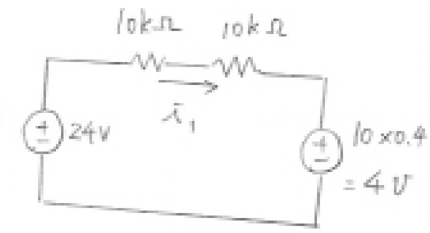




⇒ ...

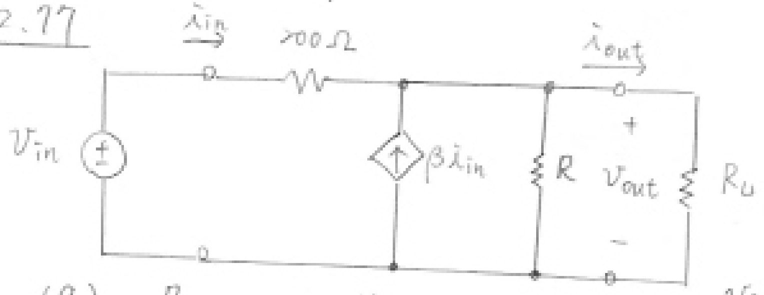


⇒



$i_1 = (24 - 4)/(10k + 10k) = 1\ mA$

2.17



(a) $R_L = 0$: $v_{out} = 0$, $i_{in} = v_{in}/200$, $i_{out} = i_{in} + 49 i_{in} = 50(v_{in}/200)$

$\Rightarrow i_{out}/v_{in} = 0.25$

$R_L = \infty$: $i_{out} = 0$, $v_{out} = 36(i_{in} + 49 i_{in}) = 1800\, i_{in}$

$i_{in} = (v_{in} - v_{out})/200$, $v_{out} = 1800(v_{in} - v_{out})/200 = 9(v_{in} - v_{out})$

$\Rightarrow v_{out}/v_{in} = 0.9$

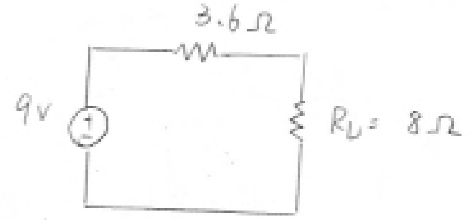
(b) $i_{out\text{-}sc} = 0.25\, v_{in}$, $v_{out\text{-}oc} = 0.9\, v_{in}$, $R_t = v_{out\text{-}oc}/i_{out\text{-}sc} = 3.6\ \Omega$

with $v_{in} = 0$, $v_{out} = v_t$, $i_{out} = -i_t \Rightarrow i_{in} = -v_t/200$

$i_t = v_t/36 - 49 i_{in} - i_{in} = v_t/36 - 50(-v_t/200) = 5v_t/18$

$R_t = v_t/i_t = 3.6\ \Omega$

(c) $v_{out\text{-}oc} = 0.9\, v_{in} = 9\ V$, $R_t = 3.6\ \Omega$



$v_{out} = R_L \cdot v_{out\text{-}oc}/(R_t + R_L) = 6.21\ V$

$P_{out} = v_{out}^2/R_L = 4.82\ W$

$i_{in} = (v_{in} - v_{out})/200 = 0.019\ A$, $P_{in} = v_{in} i_{in} = 0.19\ W$

$P_{out}/P_{in} = 25.4$