HW 5 #3

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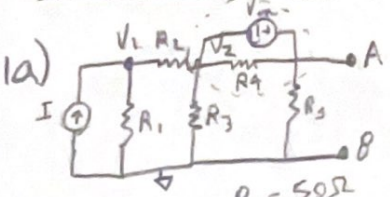
1a)



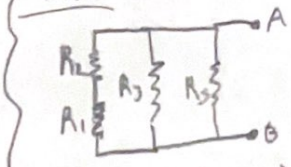
$I = 2A$ $\quad R_3 = 50\Omega$

$R_1 = 200\Omega$ $\quad R_4 = 50\Omega$

$R_2 = 100\Omega$ $\quad R_5 = 100\Omega$

$V_{in} = -10V$

R_{TH}



$$R_{TH} = \left(\frac{1}{R_1+R_2} + \frac{1}{R_3} + \frac{1}{R_5}\right)^{-1}$$

$$= \left(\frac{1}{300} + \frac{1}{50} + \frac{1}{100}\right)^{-1} = \boxed{30\Omega}$$

V_{oc}

KCL

$$\Rightarrow I + \frac{0-V_1}{R_1} - \frac{V_1 - V_2}{R_2} = 0$$

$$\hookrightarrow 2 - \frac{V_1}{200} - \frac{V_1}{100} + \frac{V_2}{100} = 0$$

$$\hookrightarrow 40 - V_1 - 2V_1 + 2V_2 = 0$$

$$\hookrightarrow \underline{40 = 3V_1 - 2V_2} \quad (1)$$

SN in V_2:

$$\frac{V_1 - V_2}{R_2} + \frac{0 - V_2}{R_3} - \frac{(V_2 + V_{in}) - 0}{R_5} = 0 \Rightarrow \frac{V_1}{100} - \frac{V_2}{100} - \frac{V_2}{50} - \frac{V_2}{100} + \frac{10}{100} = 0$$

$$\Rightarrow V_1 - V_2 - 2V_2 - V_2 + 10 = 0 \Rightarrow \underline{10 = 4V_2 - V_1} \quad (2)$$

$$(1) + 3 \times (2)$$

$$\hookrightarrow 40 = 3V_1 - 2V_2$$

$$+ \quad 30 = -3V_1 + 12V_2$$

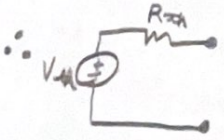
$$70 = 10V_2 \Rightarrow V_2 = 7V$$

$$\hookrightarrow 10 = 4(7) - V_1 \Rightarrow -18 = -V_1 \Rightarrow V_1 = 18$$

w/ $V_2 = 7V$, V_1 we know V_5 (voltage across R_5) is as follows

$\Rightarrow V_2 + V_{in} = V_5 = V_{oc}$ and $V_5 \parallel V_{oc} \Rightarrow V_{oc} = 7 - 10 = 3V$

(a)



w/ $V_{oc} = 3V$

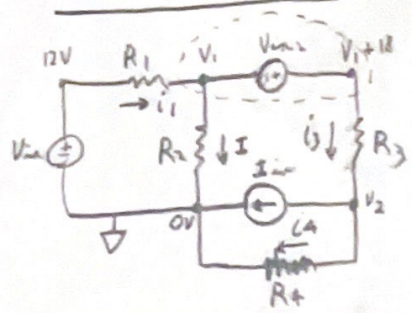
$R_{oc} = 30\Omega$

(b) Know P_{max} when $R_{load} = R_{oc}$ ∴

$$\boxed{R_{load} = 30\Omega}$$

WS#3 - cont'd

2)



$R_1 = 100\,\Omega$
$R_2 = 25\,\Omega$
$R_3 = 75\,\Omega$
$R_4 = 20\,\Omega$
$V_{in1} = 12\,V$
$V_{in2} = 18\,V$
$I_{in} = 2\,mA$

SN) $i_1 - i - i_3 = 0$

(Ohm's Law)

$i_1 = \frac{12 - V_1}{R_1}$, $i = \frac{V_1 - 0}{R_2}$

$i_3 = \frac{(V_1 + 18) - V_2}{R_3}$, $i_4 = \frac{V_2 - 0}{R_4}$

sub i's into SN eq $\Rightarrow \frac{12 - V_1}{100\,\Omega} - \frac{V_1}{25\,\Omega} - \frac{(V_1 + 18 - V_2)}{75\,\Omega} \Rightarrow 36 - 3V_1 - 12V_1 - 4V_1 - 72 + 4V_2 = 0$

$\Rightarrow 36 = -19V_1 + 4V_2$

now KCL @ V_2 node

$\frac{V_1 + 18 - V_2}{R_3} - i_{in} - \frac{V_2 - 0}{R_4} = 0 \Rightarrow \frac{V_1 + 18 - V_2}{75\,\Omega} - 2\,mA - \frac{V_2}{20\,\Omega} \Rightarrow 4V_1 + 72 - 4V_2 - 600 - 15V_2 = 0$

$\Rightarrow 528 = 4V_1 - 19V_2$ w/ numpy $\Rightarrow$ $V_1 = -8.1043\,V$, $V_2 = -29.496\,V$

$\therefore i = \frac{V_1}{25} = \frac{-8.1043}{25} = \boxed{-0.3242\,mA = i}$