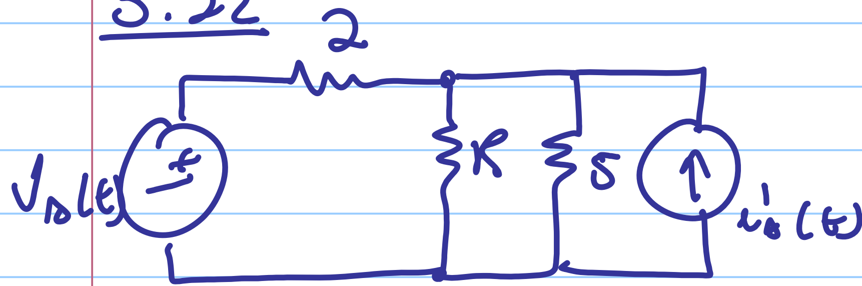
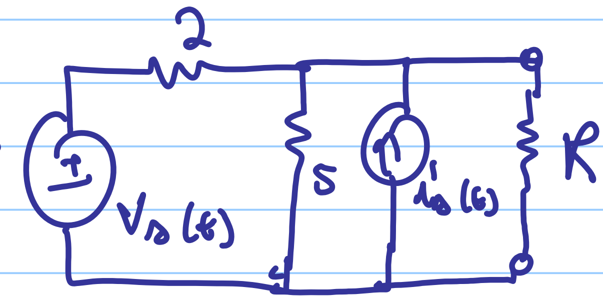
3.22



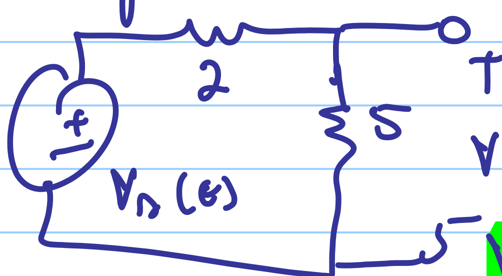
$\Leftrightarrow$



$\Rightarrow$

Using superposition method:

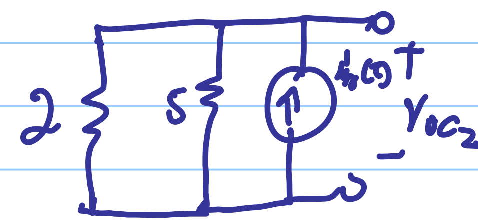
① open circuit current source $\Rightarrow$



$V_{oc_1} = V_s(t)\left(\dfrac{5}{2+5}\right)$

$V_{oc_1} = \dfrac{5}{7}\, V_s(t)$

② Short out the voltage source



current across 5 Ω 2 i_s'

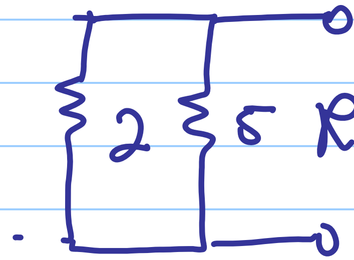
$I_2 = i_s'(t) \times \dfrac{2}{5+2}$

$\dfrac{2}{7}\, i_s'(t)$

$\Rightarrow V_{oc_2} = 5\left(\dfrac{2}{7}\right) i_s'(t) =$ [illegible]

$\therefore\ V_{oc} = V_{oc_1} + V_{oc_2} =$ [illegible]

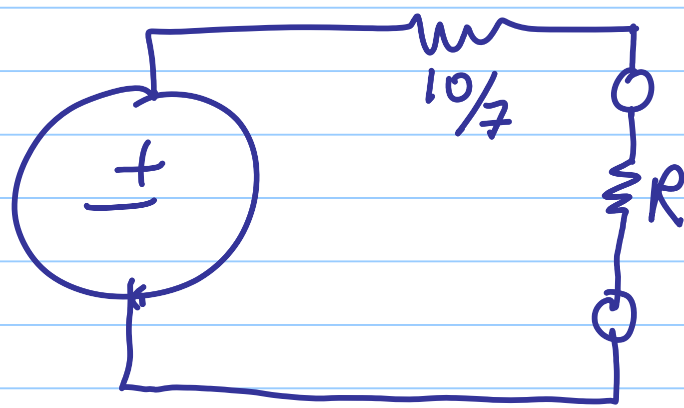
R_{th} ⇒ short out voltage & open circuit current



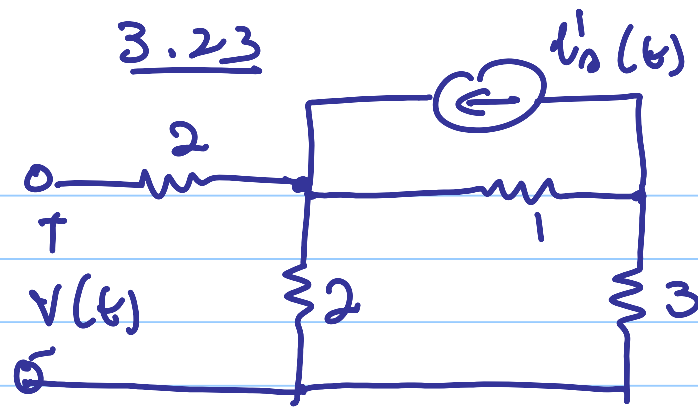
$R_{th} = \frac{5 \times 2}{5+2} = \frac{10}{7}\,\Omega$ ⇒

Thevenin's equivalent is

$\frac{5}{7} V_s(t) + \frac{10}{7} i_s(t)$

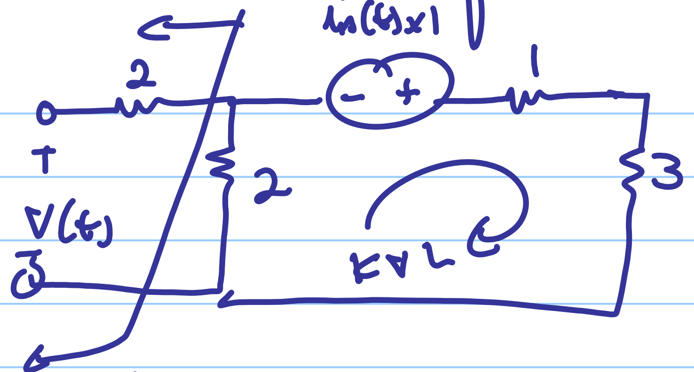


3.23



Use Source transformation ⟹

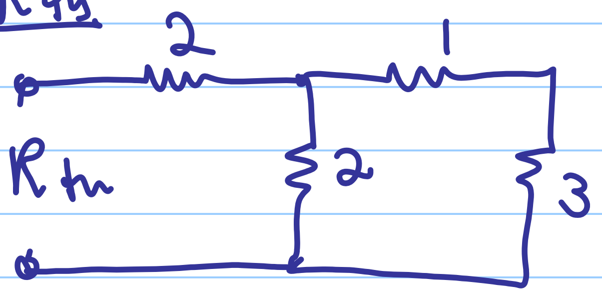
⟹



KVL: $2I - i_s(t) + 3I + I = 0 \Rightarrow$

$6I = i_s'(t) \Rightarrow I = \frac{i_s'(t)}{6}$.

R_{th}

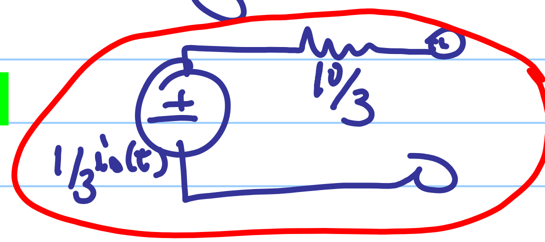


$R_{th} = \frac{4 \times 2}{4+2} + 2 = \frac{8}{6} + 2 \Rightarrow$

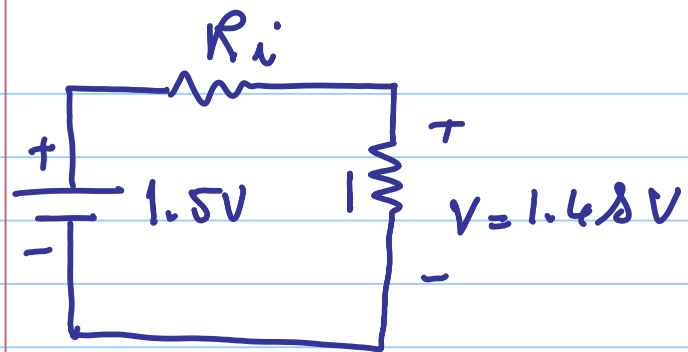
$= \frac{8+12}{6} = \frac{20}{6} =$

⟹ the voltage across the 2Ω Resistor is $V_{oc} = 2I = 2\left(\frac{1}{6} i_s'(t)\right) = \frac{1}{3} i_s'(t)$

Horizontal 2Ω (open circuit).



3.24



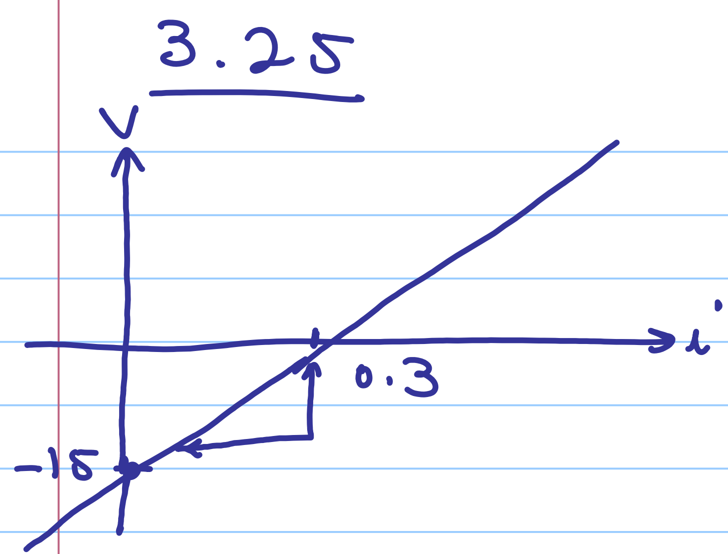
Using voltage divider ⇒

$V = 1.5\left(\frac{1}{1+R_i}\right)$ where $V = 1.48\,V$

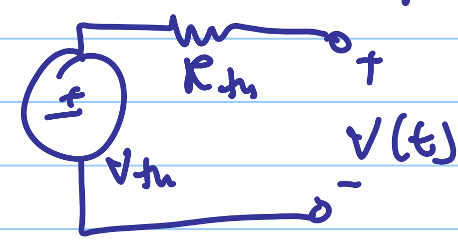
$\Rightarrow 1.48 = \frac{1.5}{1+R_i} \Rightarrow (1+R_i)(1.48) = 1.5V$

$\Rightarrow$ [redacted]

3.25



the thévenin equivalent theorem is



where KVL

$-V_{th} + R_{th}\,i + V(t) = 0$

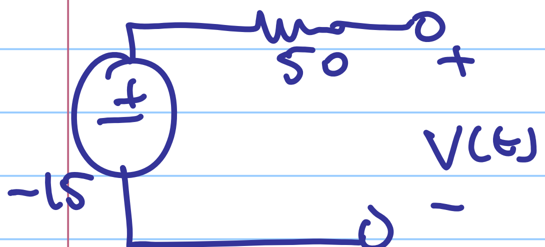
$\Rightarrow V_{th} = R_{th}\,i + V(t)$

$\Rightarrow$ @ $i = 0 \Rightarrow$

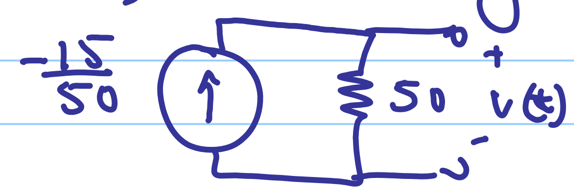
& R_{th} is the slope of the line

$\Rightarrow R_{th} = \dfrac{0-(-15)}{0.3-0} = \dfrac{15}{0.3} = 50\Omega = R_{th}$

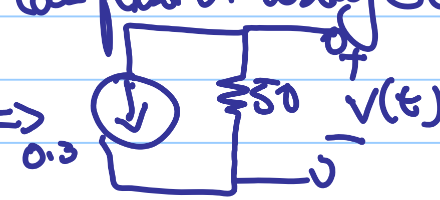
∴ the thevenin:



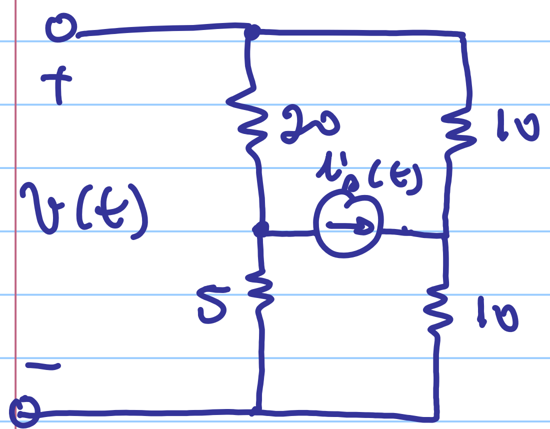
b) Norton, you can find it using source transformation



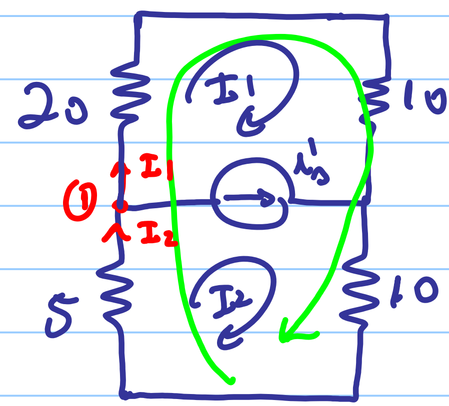
$\Rightarrow$



3.26



we will go ahead & find V_{oc} & then find I_{sc}..



@ node 1: $\boxed{I_2 = I_1 + I_s}$

Superloop:

$20I_1 + 10I_1 + 10I_2 + 5I_2 = 0$

$30I_1 + 15(I_1 + I_s) = 0$

$45I_1 = -15I_s \Rightarrow$

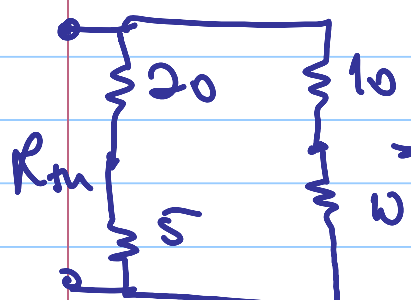
$I_1 = \frac{-15I_s}{45} = -\frac{1}{3}I_s$

& $I_2 = I_1 + I_s = -\frac{1}{3}I_s + I_s = \frac{2}{3}I_s$

$\therefore V_{oc} = 20I_1 + 5I_2 = 20\left(-\frac{1}{3}I_s\right) + 5\left(\frac{2}{3}I_s\right) \Rightarrow$

$V_{oc} = \frac{-20}{3}I_s + \frac{10}{3}I_s = \frac{-10}{3}I_s$

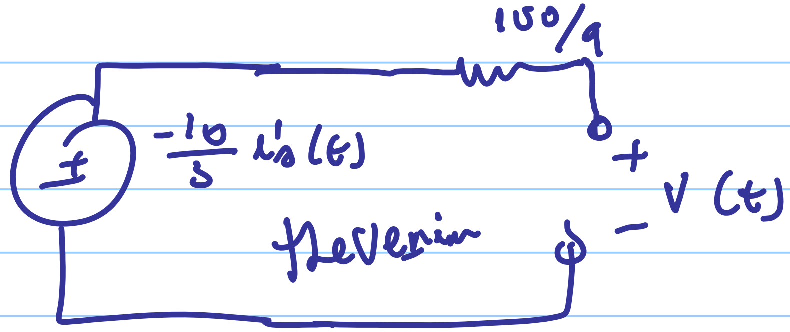
calculate R_{th}:



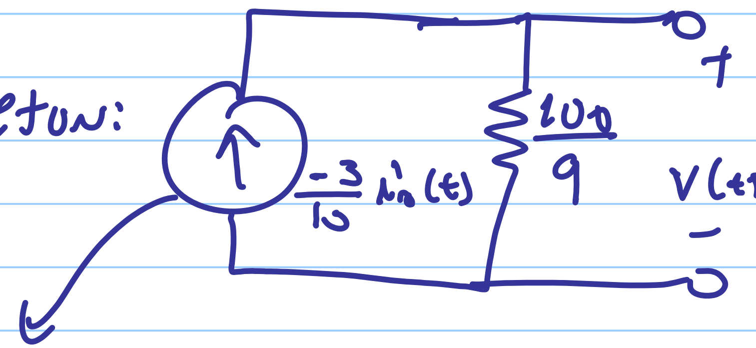
$\Rightarrow R_{th} = \frac{25 \times 20}{25 + 20}$

=

3.26 Continue



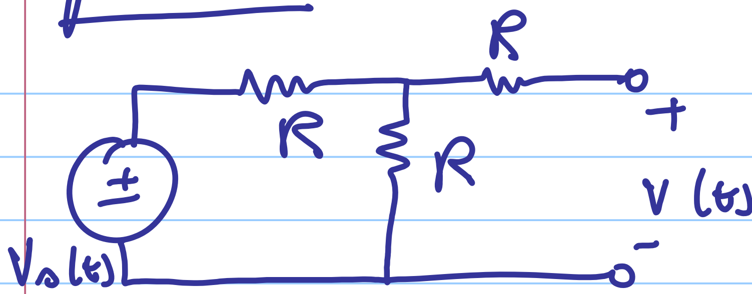
$\Longleftrightarrow$ Norton:



$$i_s'(t) = \frac{V_{oc}}{R_{th}} = \frac{\frac{-10}{3}}{\frac{100}{9}} = \frac{-1\cancel{0}}{3} \times \frac{9}{10\cancel{0}} =$$

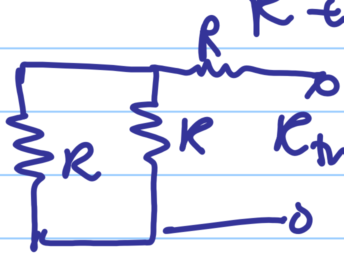
Note: the Book answer is $\frac{3}{10} i_s'(t)$

P 3.28



a) $V_{oc} = V_s(t)\dfrac{R}{R+R} = \dfrac{1}{2}V_s(t)$

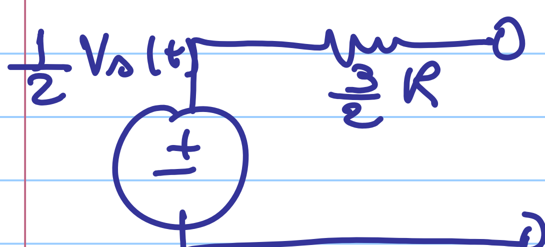
<u>R_{th}</u>



$R_{th} = \dfrac{R \times R}{R+R} + R = \dfrac{R^2}{2R} + R$

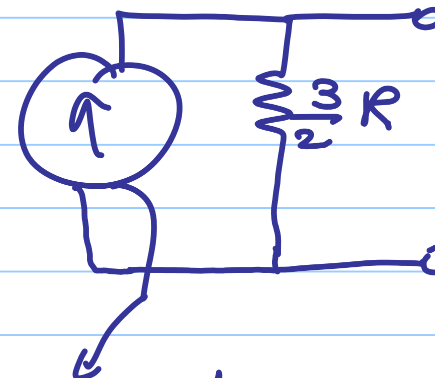
$= \dfrac{R}{2} + R = \dfrac{3}{2}R$

∴



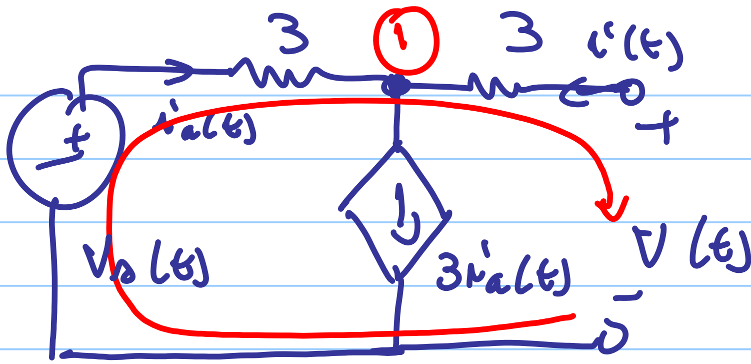
b) Using source transf...

⇒ Norton:



$\dfrac{V_{oc}}{R_{th}} = \dfrac{\frac{1}{2}V_s}{\frac{3}{2}R} = \dfrac{1}{2}V_s \times \dfrac{2}{3R}$

3 - 41



@ node 1 KCL:

$$i'(t) = 3i'_a(t) - i'_a(t) = 2i'_a(t)$$

$$\Rightarrow i'_a(t) = \frac{1}{2} i'(t)$$

super loop ⇒

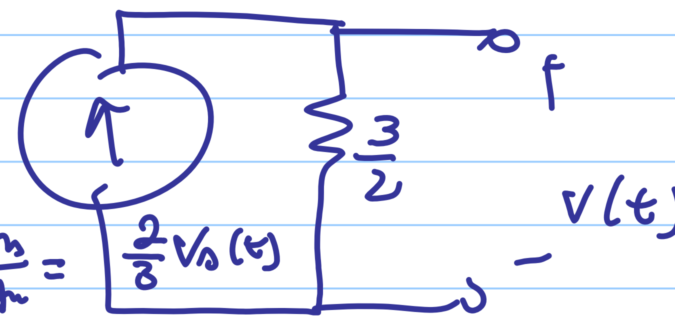
$$-V_s(t) + 3i'_a(t) - 3i'(t) + V(t) = 0$$

$$\Rightarrow V(t) = V_s(t) - 3\left(\frac{1}{2}i'(t)\right) + 3i'(t)$$

$$V(t) = V_s(t) + \frac{3}{2}i'(t)$$

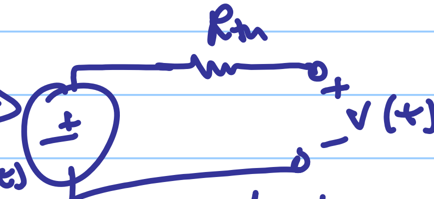
V-i Relation

b) NORTON



$$\frac{V_{th}}{R_{th}} = \frac{2}{3}V_s(t)$$

$$\frac{V_s(t)}{\frac{3}{2}} =$$



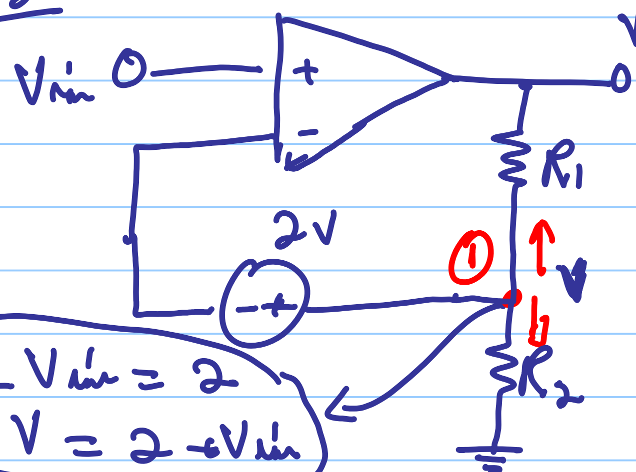
$V_{th} = V_s(t)$

according to the equation ⇒

$\Rightarrow V_s(t) = V_{th}$ &

$R_{th} = \frac{3}{2}$

4.2



$V - V_{in} = 2$
$\Rightarrow V = 2 + V_{in}$

Ideal op amp $\Rightarrow$

$V^- = V^+ = V_{in}$
$i^- = i^+ = 0$

KCL @ node 1:

$$\frac{V - V_{OUT}}{R_1} + \frac{V}{R_2} = 0 \Rightarrow$$

$$\frac{2 + V_{in} - V_{OUT}}{R_1} + \frac{V_{in} + 2}{R_2} = 0$$

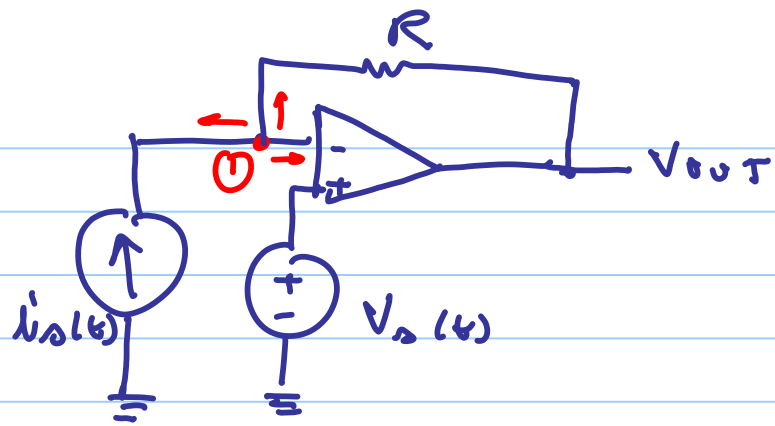
Solve f $V_{OUT} \Rightarrow$

$$\frac{V_{OUT}}{R_1} = \frac{V_{in}+2}{R_2} + \frac{V_{in}+2}{R_1} \Rightarrow$$

$$\frac{V_{out}}{R_1} = \frac{R_1(V_{in}+2) + R_2(V_{in}+2)}{R_1 R_2} \Rightarrow$$

$$V_{out} = \frac{R_1^2(V_{in}+2)}{R_1 R_2} + \frac{\cancel{R_1 R_2}(V_{in}+2)}{\cancel{R_1 R_2}} \Rightarrow$$

4.4



$$\frac{V_{OUT}}{R} = \frac{V_s(t)}{R} + i_s(t) \Rightarrow$$

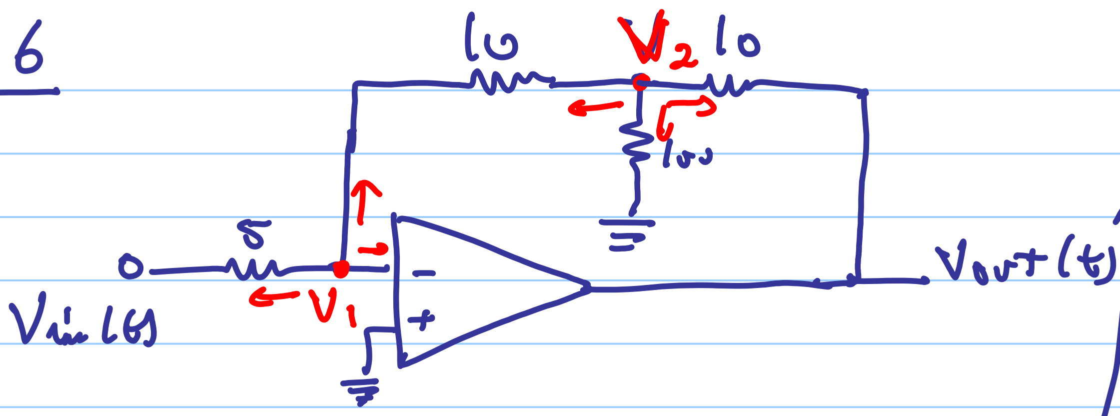
Ideal op amp $\Rightarrow i^- = i^+ = 0$

$V^- = V^+ = V_s(t)$

KCL @ node 1 $\Rightarrow$

$$-i_s(t) + \frac{V_s(t) - V_{OUT}}{R} + \cancel{i^-}^{\,0} = 0 \Rightarrow$$

4.6



Ideal op amp: $i^- = i^+ = 0$
$V^- = V^+ = 0$

we need 2 KCL

@ V_1: $\frac{V_1 - V_{in}}{5} + \frac{V_1 - V_2}{10} + \cancel{i^-}^{\,0} = 0$

we know $V_1 = V^- = V^+ = 0V \Rightarrow$

$\frac{-V_{in}}{5} - \frac{V_2}{10} = 0 \Rightarrow$

$\boxed{-2V_{in} = V_2}$

@ V_2:

$\frac{V_2 - V_1}{10} + \frac{V_2}{10} + \frac{V_2 - V_{OUT}}{10} = 0$

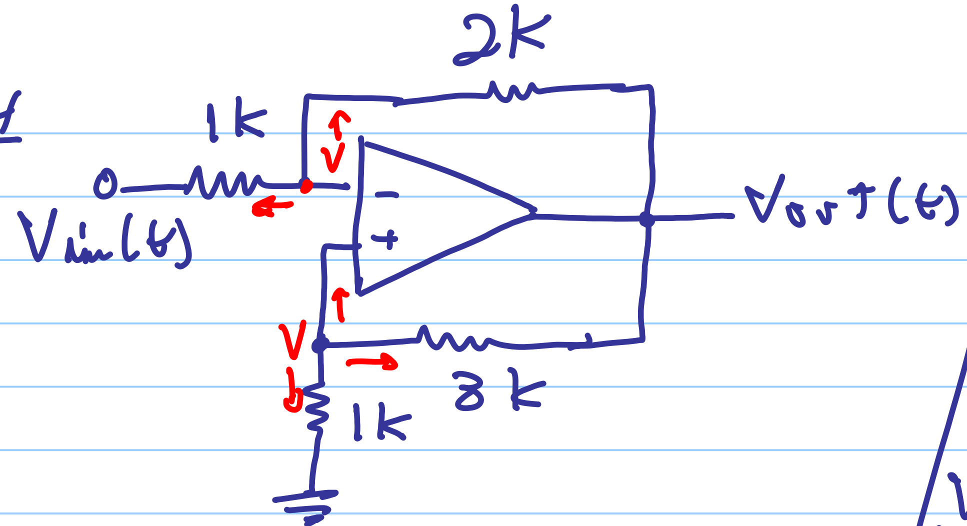
$V_2\left(\frac{1}{10} + \frac{1}{10} + \frac{1}{10}\right) = \frac{V_{OUT}}{10} \Rightarrow$

$V_2\left(\frac{3}{10}\right) = \frac{V_{OUT}}{10} \Rightarrow$

$V_2\left(\frac{3}{10}\right) = \frac{V_{OUT}}{10} \Rightarrow$

$V_{OUT} = 3V_2 \Rightarrow$

4.14



Ideal op amp $\Rightarrow i^- = i^+ = 0$

$V^- = V^+$

KCL @ node $V^- \Rightarrow$

$$\frac{V - V_{in}(t)}{1} + \frac{V - V_{out}}{2} + \overset{\nearrow 0}{i^-} = 0$$

$$V \underbrace{\left(1 + \frac{1}{2}\right)}_{3/2} - \frac{1}{2} V_{out} = V_{in} \Rightarrow$$

$$3V - V_{out} = 2V_{in} \Rightarrow$$

$$\Rightarrow V = \frac{2V_{in} + V_{out}}{3} \quad (1)$$

KCL @ $V^+ \Rightarrow$

$$\frac{V - V_{out}}{3k} + \frac{V}{1k} = 0 \Rightarrow$$

$$V\left(\frac{1}{3} + 1\right) = \frac{V_{out}}{3} \Rightarrow \quad (2)$$

$$\frac{4}{3} V = \frac{V_{out}}{3} \Rightarrow V = \frac{V_{out}}{4}$$

equate equations 1 & 2 $\Rightarrow$

$$\frac{V_{out}}{4} = \frac{2V_{in} + V_{out}}{3} \Rightarrow$$

$$3V_{out} - 4V_{out} = 8V_{in} \Rightarrow$$

$$\Rightarrow V_{out} = -8V_{in}$$