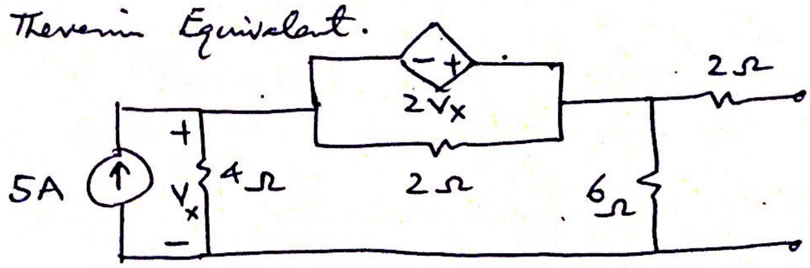
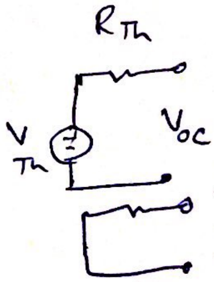
(Pdf)

Example 4.9 Thevenin Equivalent

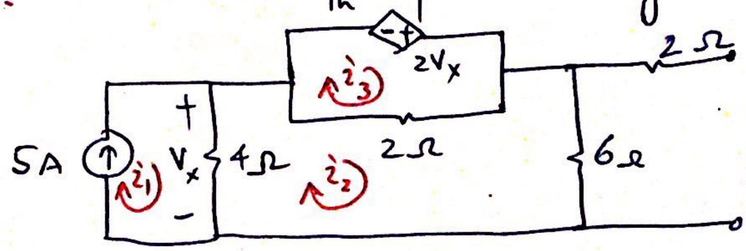
(pp 142 5th Ed Sadiku)

Find Thevenin Equivalent.





Solution: We determine V_{Th} by mesh analysis



— By inspection $i_1 = 5$ A

— KVL mesh 2 $\quad 4(i_2 - i_1) + 2(i_2 - i_3) + 6i_2 = 0$

putting $i_1 = 5$ and simplifying

$$4(i_2 - 5) + 2(i_2 - i_3) + 6i_2 = 0.$$

becomes $\quad 12i_2 - 2i_3 = 20 \quad$ —— (A)

— Now KVL mesh 3

$$-2V_x + 2(i_3 - i_2) = 0$$

By inspection $\quad V_x = 4(i_1 - i_2)$

So we get $\quad -8i_1 + 8i_2 + 2i_3 - 2i_2 = 0 \quad (i_1 = 5)$

becomes $\quad 6i_2 + 2i_3 = 40 \quad$ —— (B)

—— cont'd

— Contd (142)

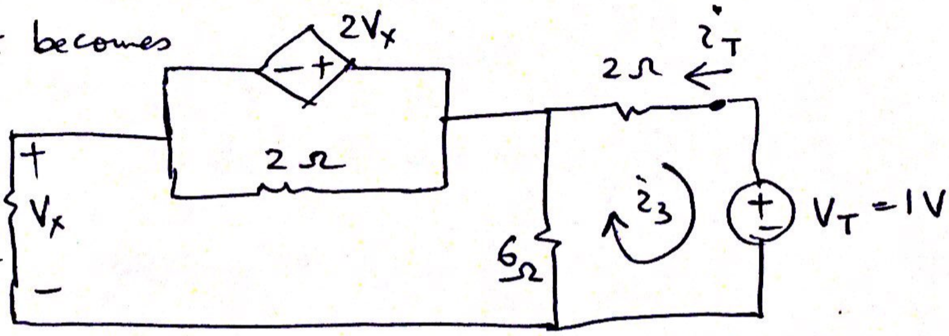
Solving (A) and (B)

$$i_2 = \frac{60}{18} \text{ A}$$

and $V_{Th} = 6 i_2 = 6 \times \frac{60}{18} = 20 \text{ V}$

— To determine R_{Th}, the independent current source is made zero and either a test voltage source or a test current source is applied across terminals where R_{Th} is to be determined.

— The circuit becomes



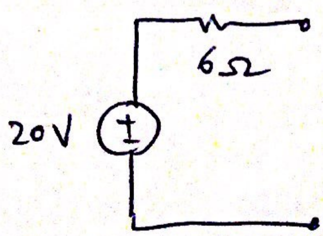
— Again using mesh analysis: (not done here)

$$i_3 = -\frac{1}{6} \text{ A}$$

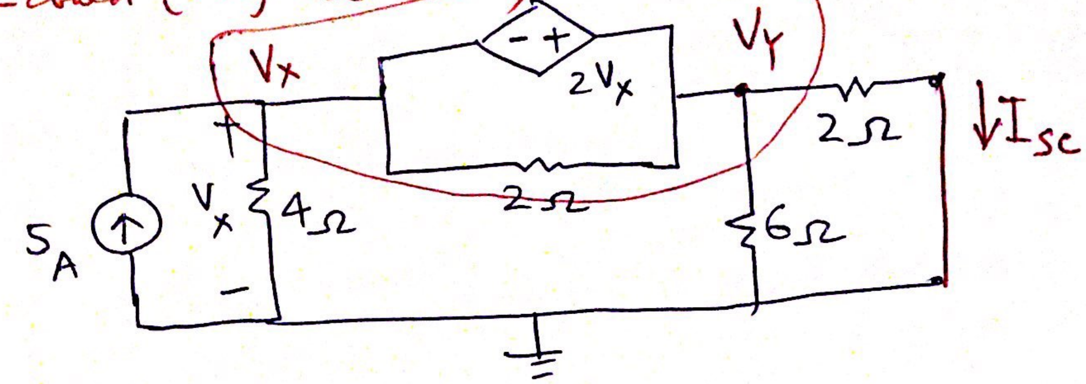
So $i_T = \frac{1}{6}$ A

and $R_{Th} = \frac{V_T}{i_T} = 6 \, \Omega$

— Thevenin equivalent circuit is:



— Contd (Using I_{sc} method)



Using nodal analysis:

Applying KCL to supernode V_x-V_y:

$$\frac{V_x}{4} - 5 + \frac{V_y}{2} + \frac{V_y}{6} = 0 \quad \times 12$$

$$3V_x - 60 + 6V_y + 2V_y = 0$$

$$3V_x + 8V_y = 60 \quad \text{— (A)}$$

Constraint equation

$$V_x - V_y = -2V_x$$

$$3V_x = V_y$$

$$V_x = \frac{V_y}{3} \quad \text{— (B)}$$

So (A) becomes

$$\cancel{3} \times \frac{V_y}{\cancel{3}} + 8V_y = 60$$

$$9V_y = 60 \quad \text{or} \quad V_y = \frac{60}{9}$$

So $I_{sc} = \frac{60}{9} \times \frac{1}{2} = \frac{60}{18}$

We already have $V_{oc} = 20$

So $R_{Th} = \frac{V_{oc}}{I_{sc}} = \frac{20}{60} \times 18 = 6$

$R_{Th} = 6\ \Omega$