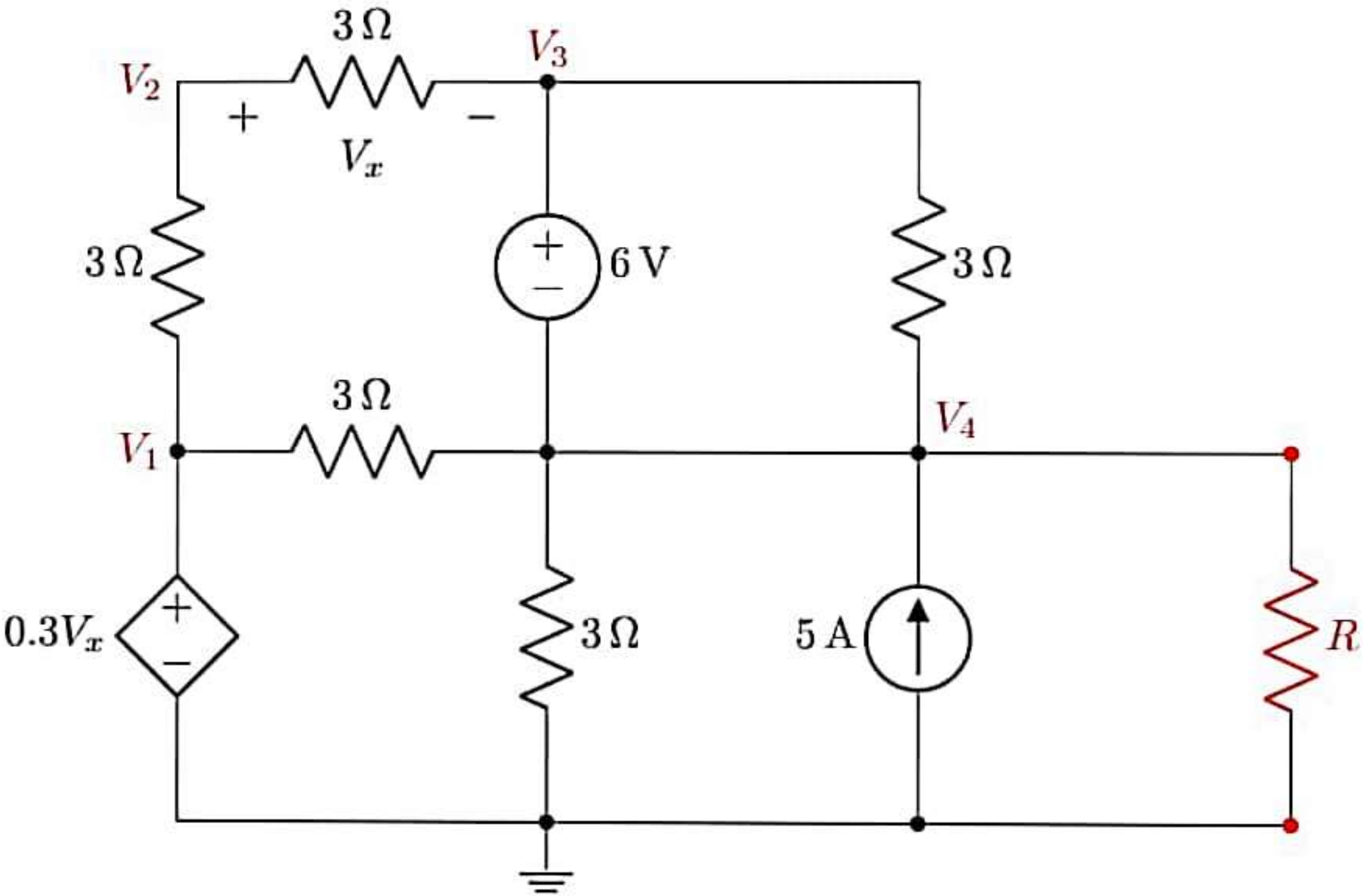
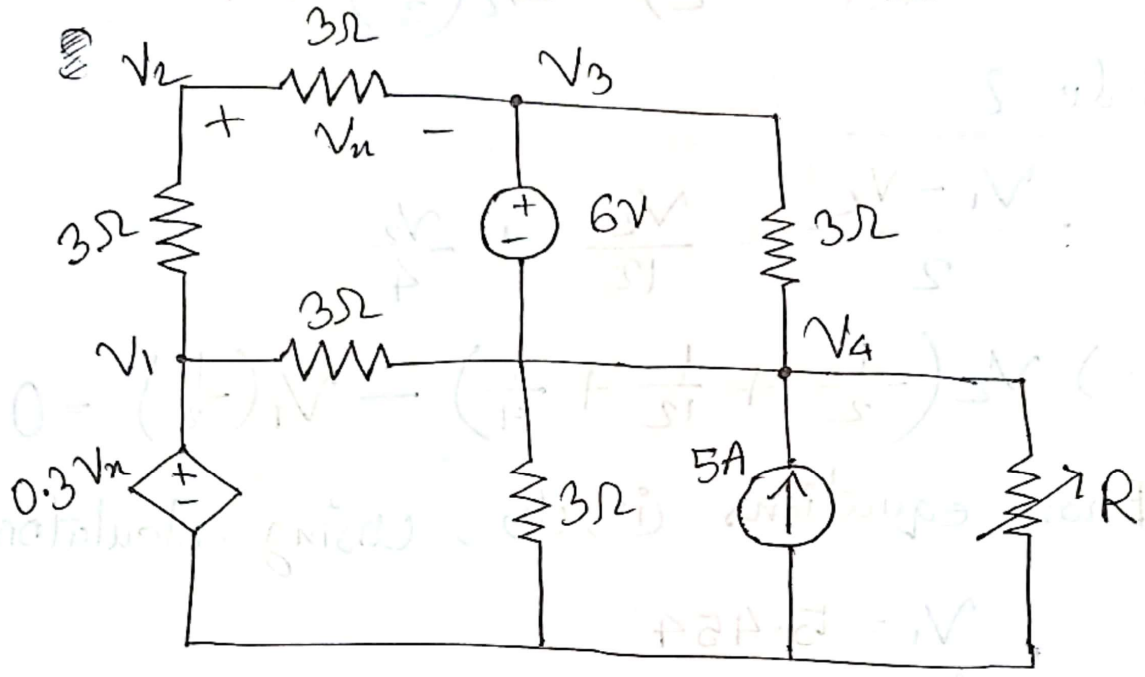
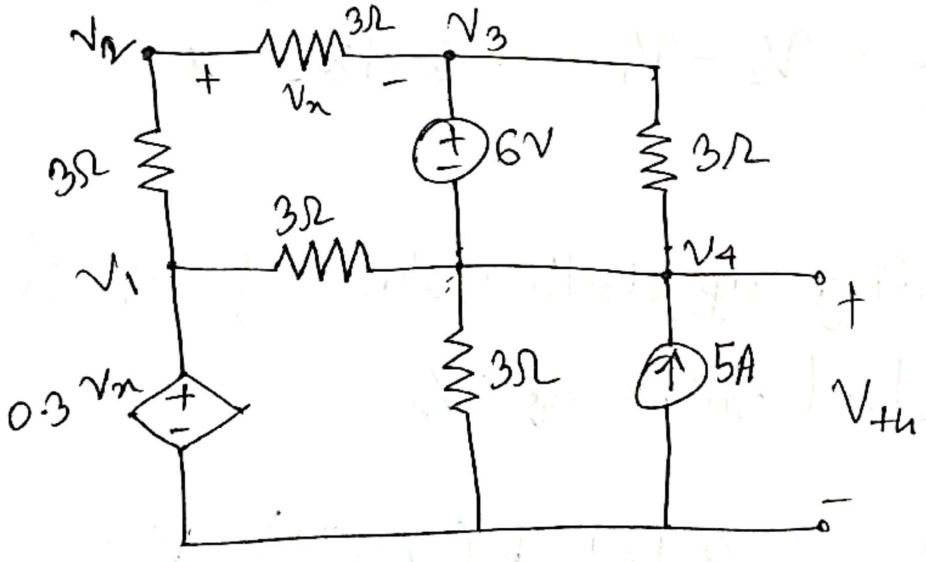

3 Ω
$V_3$
$V_2$
+
$V_x$
−
3 Ω
6 V
3 Ω
3 Ω
$V_4$
$V_1$
$0.3V_x$
3 Ω
5 A
$R$

## [1] Thevenin (Using Nodal Analysis)




### Step - 1

$V_{th}$ Calculation:




### Node - 1

$$V_1 = 0.3\,V_n$$

$$\therefore V_1 = 0.3(V_2 - V_3) \quad \text{---(1)} \quad \because V_n = V_2 - V_3$$

## Node -2

$$\frac{V_1 - V_2}{3} = \frac{V_2 - V_3}{3}$$

$$\Rightarrow V_2\left(\frac{1}{3} + \frac{1}{3}\right) - \frac{V_1}{3} - \frac{V_3}{3} = 0 \quad \text{---(ii)}$$

## Supernode

$$V_3 - V_4 = 6 \quad \text{---(iii)}$$ Across Voltage Source

$$\frac{V_3 - V_4}{3} + \frac{V_3 - V_2}{3} + I = 0 \quad \text{---(1)}$$

$$\frac{V_4 - V_1}{3} + \frac{V_4}{3} + \frac{V_4 - V_3}{3} - 5 - I = 0 \quad \text{---(2)}$$

Adding (1) & (2),

$$\frac{V_3 - V_2}{3} + \frac{V_4 - V_1}{3} + \frac{V_4}{3} - 5 = 0$$

$$\Rightarrow V_3\left(\frac{1}{3}\right) + V_4\left(\frac{1}{3} + \frac{1}{3}\right) - V_2\left(\frac{1}{3}\right) - V_1\left(\frac{1}{3}\right) = 5 \quad \text{---(iv)}$$

Putting $V_4 = V_3 - 6$ from (iii),

$$V_3\left(\frac{1}{3} + \frac{2}{3}\right) - V_2\left(\frac{1}{3}\right) - V_1\left(\frac{1}{3}\right) - 5 + 6\left(\frac{2}{3}\right)$$

$$\Rightarrow V_3 - \frac{V_2}{3} - \frac{V_1}{3} = 9 \quad \text{---(iv)}$$

∴ From (i), (ii), (iv), using calculator,

$$V_1 = -1.7234 \text{ V}$$

$$V_2 = 4.0212 \text{ V}$$

$$V_3 = 9.7659 \text{ V}$$

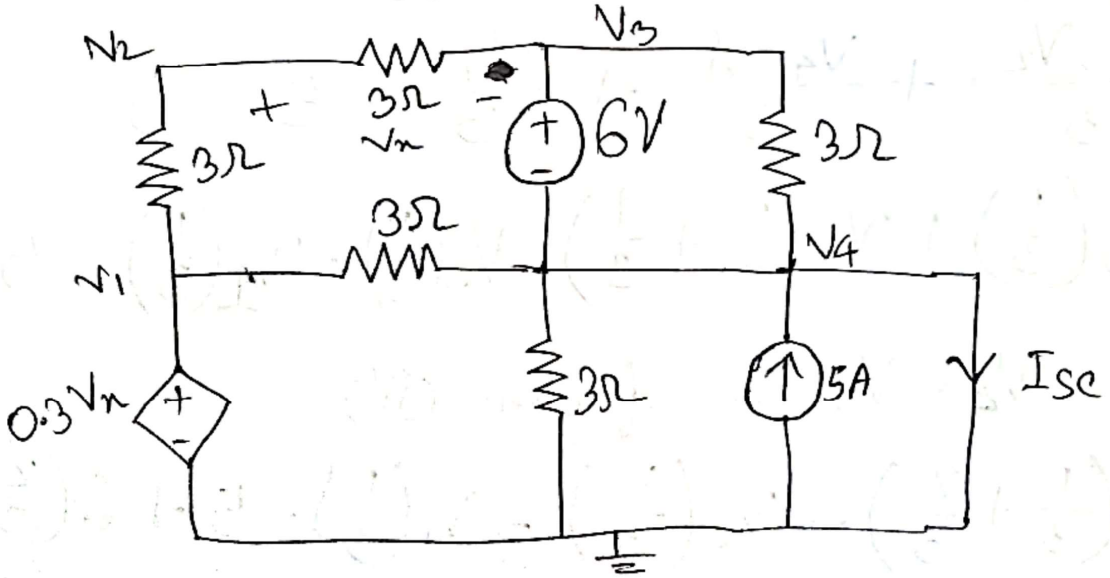
$$\therefore V_4 = V_{th} = V_3 - 6$$

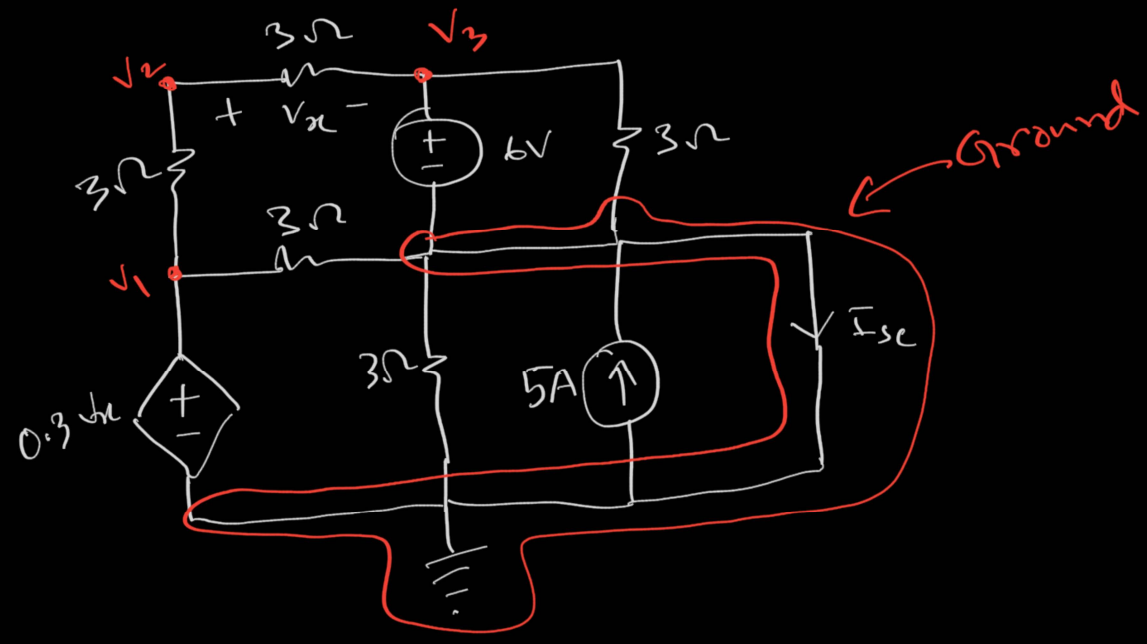
$$= \boxed{3.7659 \text{ V}}$$

(Ans.)

Step - 2

Isc Calculation:






$$V_x = V_2 - V_3$$

**Node 1:** $V_1 = 0.3 V_x$

$$\Rightarrow V_1 = 0.3(V_2 - V_3)$$

**Node 2:** $V_2\left(\frac{1}{3}+\frac{1}{3}\right) - \frac{V_1}{3} - \frac{V_3}{3} = 0$

**Node 3:** $V_3 - 0 = 6$

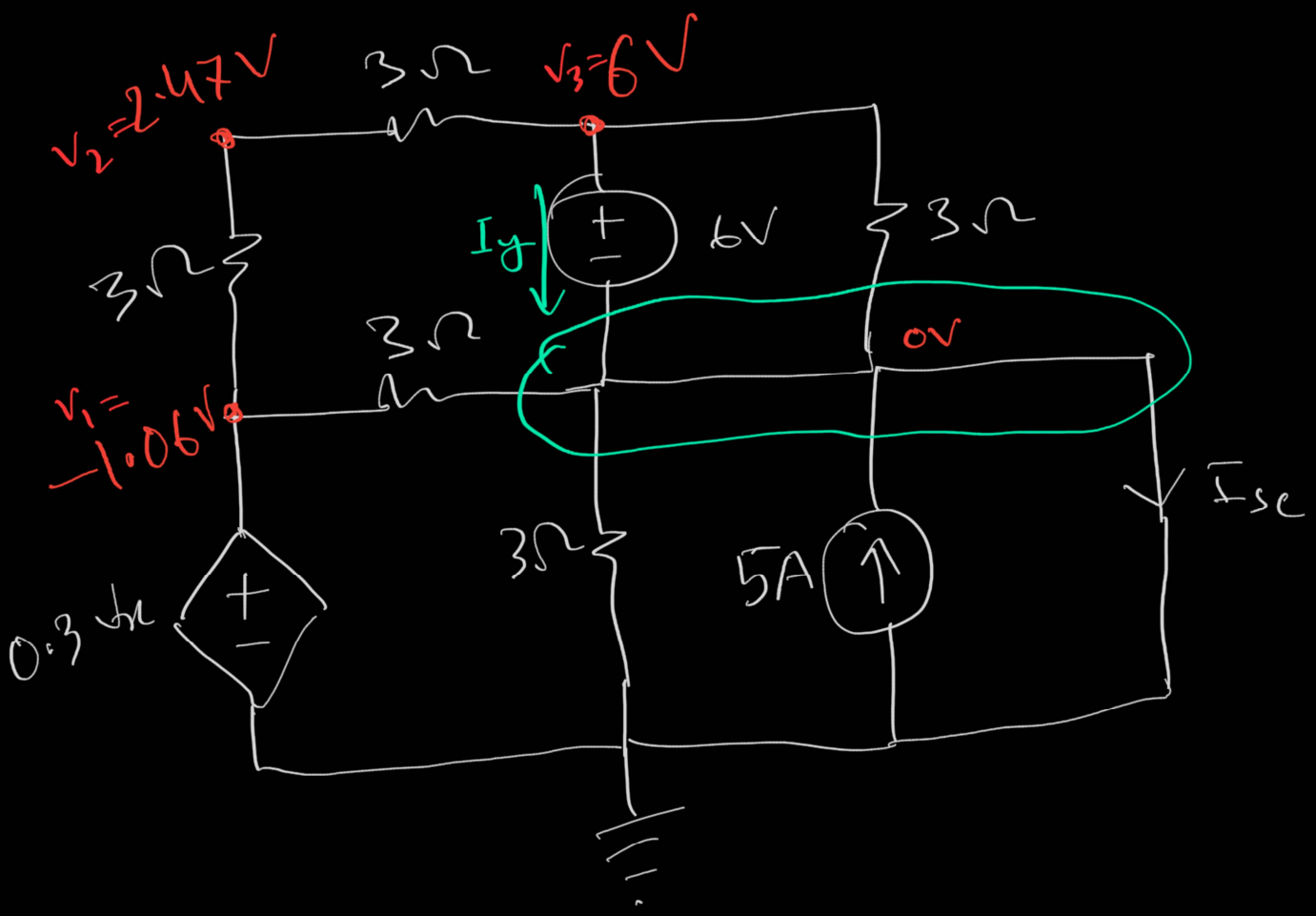
$$\Rightarrow V_3 = 6$$

[Because of the 6V voltage source]

$V_1 = -1.06\,V$,

$V_2 = 2.47\,V$,

$V_3 = 6\,V$




## KCL at node 3:

$$V_3\left(\frac{1}{3}+\frac{1}{3}\right) - \frac{V_2}{3} + I_y = 0$$

$$\Rightarrow I_y = -3.167\,A$$

## KCL at circled area:

$$-I_y + \frac{0-V_1}{3} + \frac{0-0}{3} - 5 + \frac{0-V_3}{3} + I_{sc} = 0$$

$$\Rightarrow 3.167 + 0.3533 + 0 - 5 - 2 + I_{sc} = 0$$

$$\therefore I_{sc} = 3.4797\,A$$

$$V_{oc} = 3.7659\ V$$

$$I_{sc} = 3.4797\ A$$

$$\therefore R_{th} = \frac{V_{oc}}{I_{sc}} = \frac{3.7659}{3.4797}\ \Omega$$

$$= 1.08\ \Omega$$