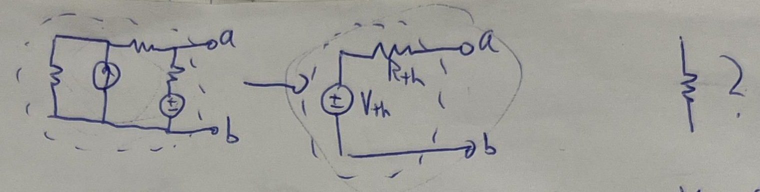
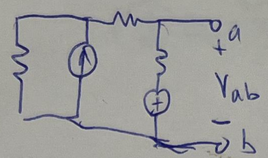
Thevenin

Goal:

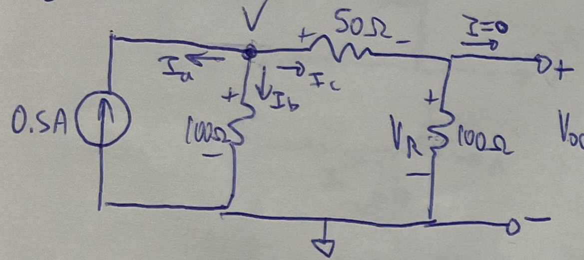


Process:



- Find V_{th} → Calculate V_{ab} (nodal, KVL, divider, etc.)
  → $V_{th} = I_{sc} \cdot R_{th}$
- Find R_{th} → Calculate equivalent resistance
  → $R_{th} = \frac{V_{th}}{I_{sc}}$

① nodal



recognize
- $V_{oc} = V_R = V_{th}$
- $I = 0A$

$\sum I_{enter} = \sum I_{leave}$

$0 = I_a + I_b + I_c$

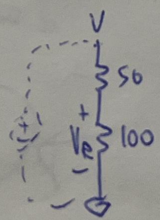
$0 = -0.5 + \frac{V-0}{100} + \frac{V-0}{50+100}$

...

$V = 30V$ → $I_c = 0.2A$

$V_R = I_c \cdot 100\Omega$

$\boxed{V_R = 20V = V_{oc} = V_{th}}$

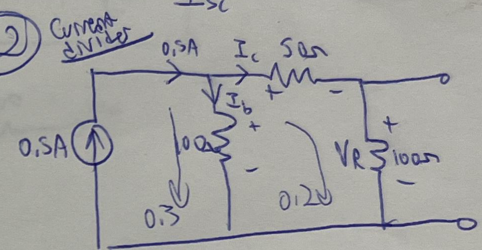


OR

$V_R = V \cdot \frac{100}{100+50} = \boxed{20V}$

Vth

② current divider



$V_R = I_c \cdot 100$

$I_c = 0.5 \frac{100}{100+150} = 0.2A$

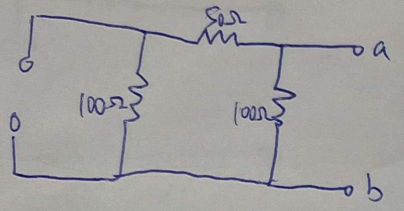
~~$V_R = 0.2 * 100 = 20V$~~

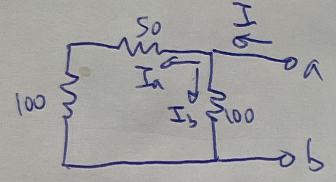
~~$V_R = 0.3 \cdot 100 = ...$~~

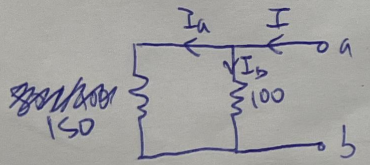
$V_R = 0.2 \cdot 100 = \boxed{20V}$

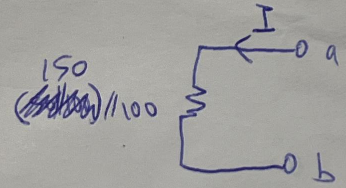
$\boxed{R_{th}}$

① equiv. resistance

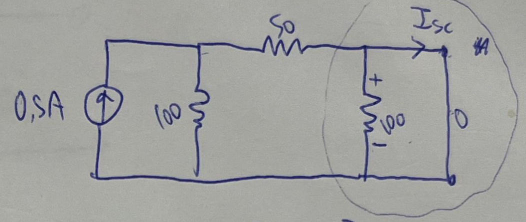




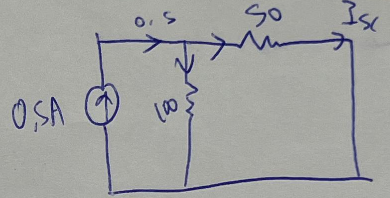




② $R_{th} = \frac{V_{th}}{I_{sc}}$



$R_{eq} = \frac{100 \cdot 0}{100+0} = 0$



$I_{sc} = 0.5 \frac{100}{50+100} = 0.\bar{3}\,A$

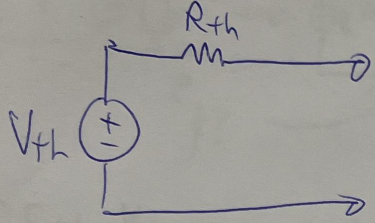
$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{20V}{0.\bar{3}A} = \boxed{60\Omega}$

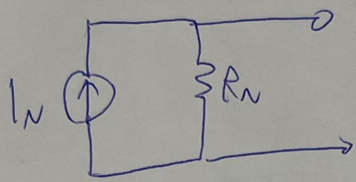
Rth

$\boxed{R_{th} = 60\,\Omega}$

Norton

thevenin eq. Norton eq.



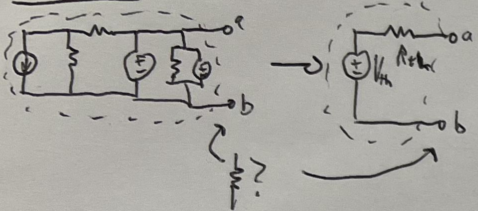


$R_{th} = R_N$

$V_{th} = I_N \cdot R_N$ $I_N = \frac{V_{th}}{R_{th}}$

Thevenin

Goal



① Find V_{th} $\qquad V^+ - V^-$

→ Calculate $V_{ab} = V_{th} = V_a - V_b$

→ $V_{th} = I_{sc} \cdot R_{th}$

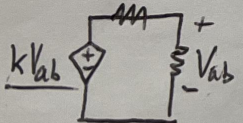
② Find R_{th}

→ equivalent R

"looking into circuit"

→ $R_{th} = \frac{V_{th}}{I_{sc}}$

Dependent Sources



K=Constant

① Normal analysis. (KVL, KCL, nodal, dividers)

② substitution equation

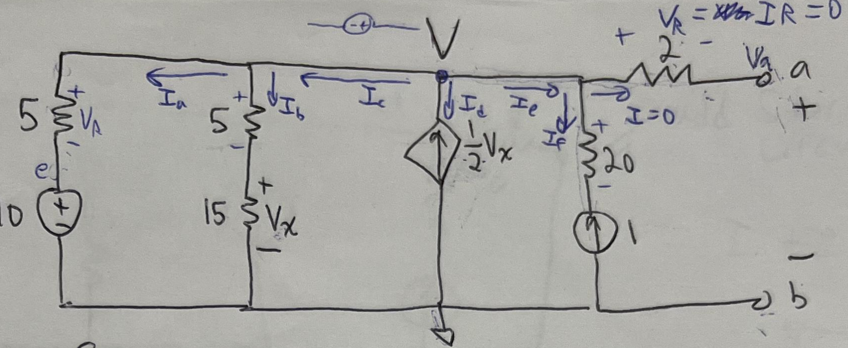
~~...~~ rewrite dependent value

$\frac{V_R}{5} = \frac{V-e}{5}$

$10 = e - 0$

kV_x

$\frac{A}{V}$ $V = A$



$V_R = 0$

$V_R = V - a$

$0 = V - a$

$a = V$

$V_{th} = V_a$

$V_a = V$

Goal: Find V_{th}, R_{th} ⟶ $V_{th} = V_{ab} = V_a - V_b = V$

$V_b = 0V$

★ only true when a-b is open circuit

$I_c + I_d + I_e = 0$

$\underbrace{I_a + I_b}$ $- \frac{1}{2}V_x + I_f = 0$

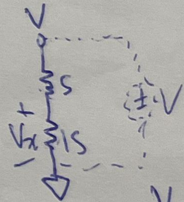
$\frac{V-10}{5} + \frac{V-0}{5+15} - \frac{1}{2}V_x - 1 = 0$ 1eq., 2unk. because of dependent source

$\frac{V-10}{5} + \frac{V}{20} - \frac{1}{2}\left(V \cdot \frac{3}{4}\right) - 1 = 0$ 1eq., 1unk

$V\left(\frac{1}{5} + \frac{1}{20} - \frac{3}{8}\right) = \frac{10}{5} + 1$

$\underline{V = -24V} = V_{th}$

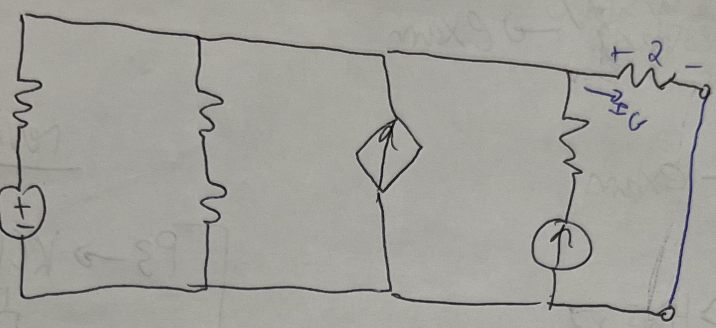
Write V_x in terms of V



$V_x = V \cdot \frac{15}{5+15}$

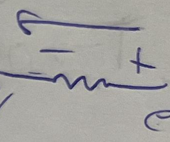
$V_x = V \cdot \frac{3}{4}$

$R_{th} \rightarrow = \frac{V_{Th}}{I_{sc}}$



add Short circuit

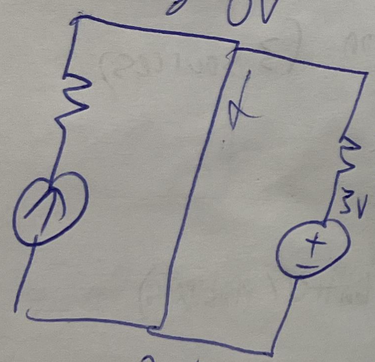
$I + I$



Goal: I_{sc}

$I_G = \frac{V-0}{2} = \underline{4A = I_{sc}}$

$\underline{V=8V}$



$\Rightarrow R_{th} = \frac{V_{th}}{I_{sc}} = \frac{-24}{4} = \underline{-6\Omega}$