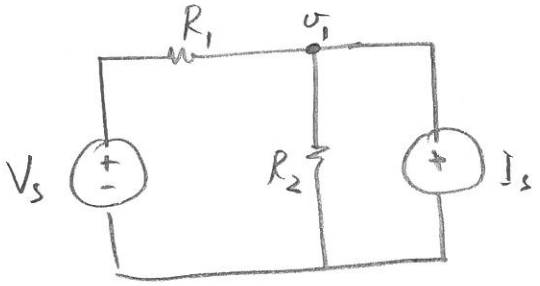
EXAMPLE

WE WILL ANALYZE THE SAME CIRCUIT USING THE FOLLOWING METHODS:

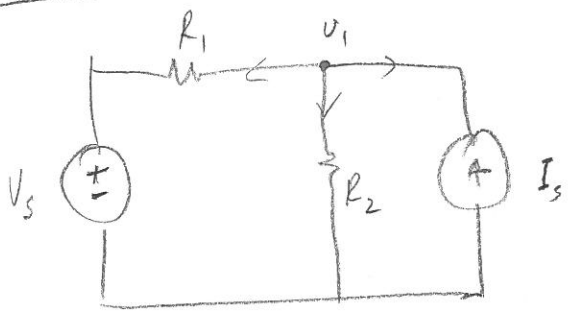
1) NODAL ANALYSIS
2) MESH ANALYSIS
3) SOURCE TRANSFORMATION — THEVENIZING
4) SOURCE TRANSFORMATION — NORTONIZING
5) SUPERPOSITION

CONSIDER THE FOLLOWING CIRCUIT



WE WILL SOLVE FOR VOLTAGE v_1 USING ALL THE ABOVE METHODS

NODAL ANALYSIS

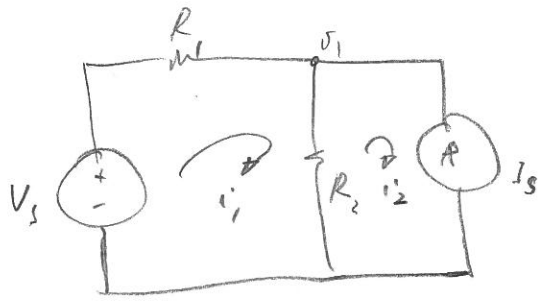


AT THE NODE: $\dfrac{v_1 - V_s}{R_1} + \dfrac{v_1}{R_2} - I_s = 0$

$$\Rightarrow \quad v_1 \left(\frac{1}{R_1} + \frac{1}{R_2} \right) = I_s + \frac{V_s}{R_1}$$

$$\Rightarrow \quad v_1 = \left(\frac{R_1 R_2}{R_1 + R_2} \right) \left(I_s + \frac{V_s}{R_1} \right)$$

Loop Analysis



$$i_2 = -I_s$$

Loop : $$-V_s + R_1 i_1 + R_2 (i_1 - i_2) = 0.$$

$$\Rightarrow i_1 (R_1 + R_2) = V_s + R_2 i_2$$

$$\Rightarrow i_1 = \frac{1}{R_1 + R_2} (V_s + R_2 i_2)$$

$$i_1 = \frac{1}{R_1 + R_2} (V_s - R_2 I_s)$$

$$v_1 = V_s - R_1 i_1$$

$$\Rightarrow v_1 = V_s - \frac{R_1}{R_1 + R_2} (V_s - R_2 I_s)$$

$$= V_s \left(1 - \frac{R_1}{R_1 + R_2}\right) + \frac{R_1 R_2}{R_1 + R_2} I_s.$$

$$= \frac{R_2}{R_1 + R_2} V_s + \frac{R_1 R_2}{R_1 + R_2} I_s$$

$$= \frac{R_1 R_2}{R_1 + R_2} \left(I_s + \frac{V_s}{R_1}\right)$$

or $$v_1 = R_2 (i_1 - i_2)$$

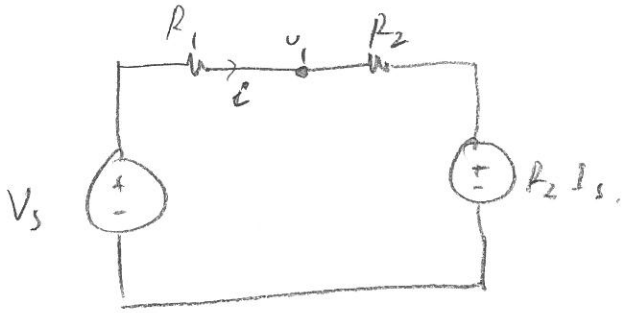
$$= R_2 i_1 + R_2 I_s.$$

$$= \frac{R_2}{R_1 + R_2} (V_s - R_2 I_s) + R_2 I_s.$$

$$= \frac{R_1 R_2}{R_1 + R_2} \left(\frac{V_s}{R_1} - \frac{R_2 I_s}{R_1} + \frac{(R_1 + R_2)}{R_1} I_s\right)$$

$$= \frac{R_1 R_2}{R_1 + R_2} \left(\frac{V_s}{R_1} + I_s\right)$$

THEVENIZE



$$-V_s + (R_1 + R_2)\, i + R_2 I_s = 0.$$

$$\Rightarrow \quad i = \frac{(V_s - R_2 I_s)}{R_1 + R_2}.$$

$$\Rightarrow \quad v_1 = V_s - R_1 i$$

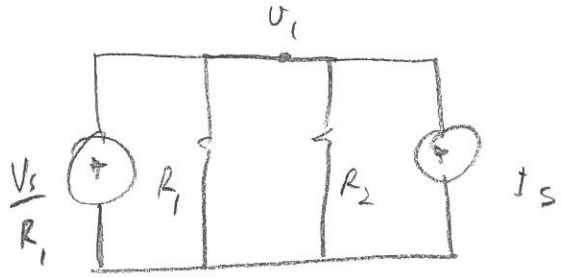
$$= V_s - \frac{R_1}{R_1+R_2}(V_s - R_2 I_s)$$

$$= V_s\left(1 - \frac{R_1}{R_1+R_2}\right) + \frac{R_1 R_2}{R_1+R_2} I_s.$$

$$= \frac{R_2}{R_1+R_2} V_s + \frac{R_1 R_2}{R_1+R_2} I_s.$$

$$v_1 = \frac{R_1 R_2}{R_1+R_2}\left(I_s + \frac{V_s}{R_1}\right)$$

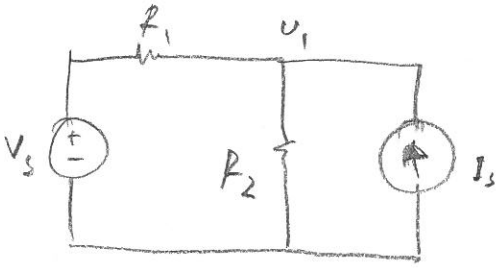
NORTON 12 E



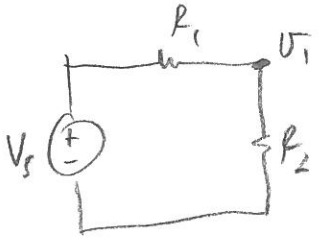
$$V_1 = \left(\frac{V_s}{R_1} + I_s\right)\left(R_1 \| R_2\right)$$

$$= \left(\frac{V_s}{R_1} + I_s\right)\left(\frac{R_1 R_2}{R_1 + R_2}\right)$$

SUPERPOSITION

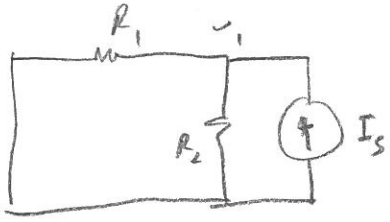


v_1, V_s (v_1 due to V_s alone)



$$v_1 = \frac{R_2}{R_1 + R_2} V_s$$

v_1, I_s (v_1 due to I_s alone)

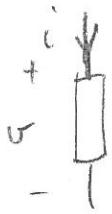


$$v_1 = (R_1 \| R_2) I_s$$

$$\Rightarrow \quad v_1 = v_{1,V_s} + v_{1,I_s} = \frac{R_2}{R_1 + R_2} V_s + \frac{R_1 R_2}{R_1 + R_2} I_s$$

$$= \frac{R_1 R_2}{R_1 + R_2} \left(\frac{V_s}{R_1} + I_s \right)$$

POWER



$p = +vi$

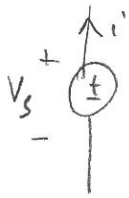
$p = -vi$

RESISTOR

$p = +vi$

POWER IS ABSORBED

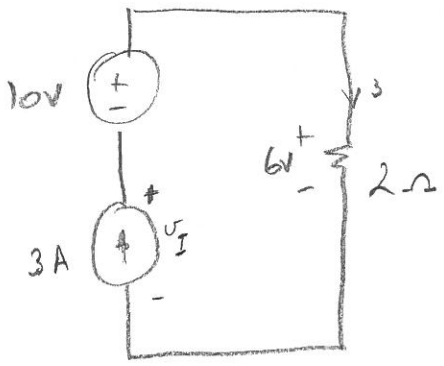
V_{source}



$p = -vi$

POWER IS DELIVERED

EXAMPLE



$$-V_I - 10 + 6 = 0$$

$$V_I = -4$$

$$\therefore \quad p = -vi$$

$$= -(-4)\,3$$

$$= +12\ W$$

+ve $\Rightarrow$ Power is ABSORBED