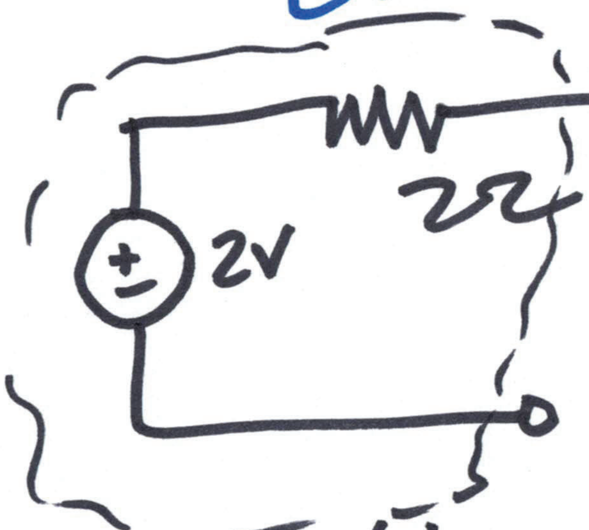
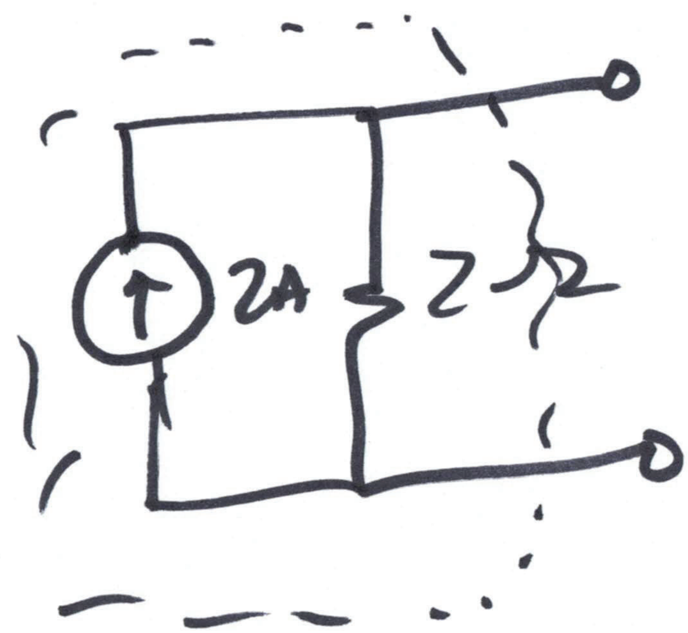
EE 220 Circuits 1

Sept. 27, 2021

Lecture 10



Thevenin



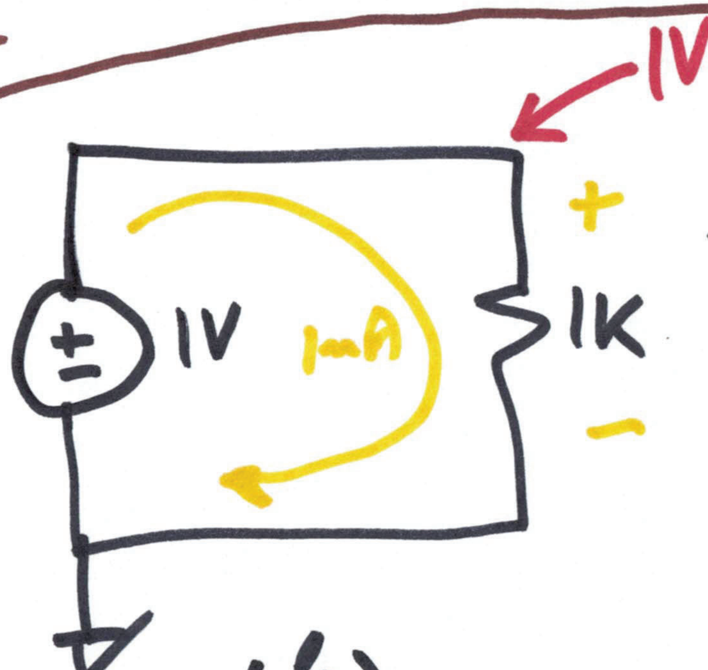
Norton

DC Power

$V = IR$

$I = \frac{V}{R}$

$$\boxed{\frac{V_{DC}^2}{R} = P_{DC} = I_{DC} \cdot V_{DC} = I_{DC}^2 \cdot R}$$



$-1mW$

$+1mW$

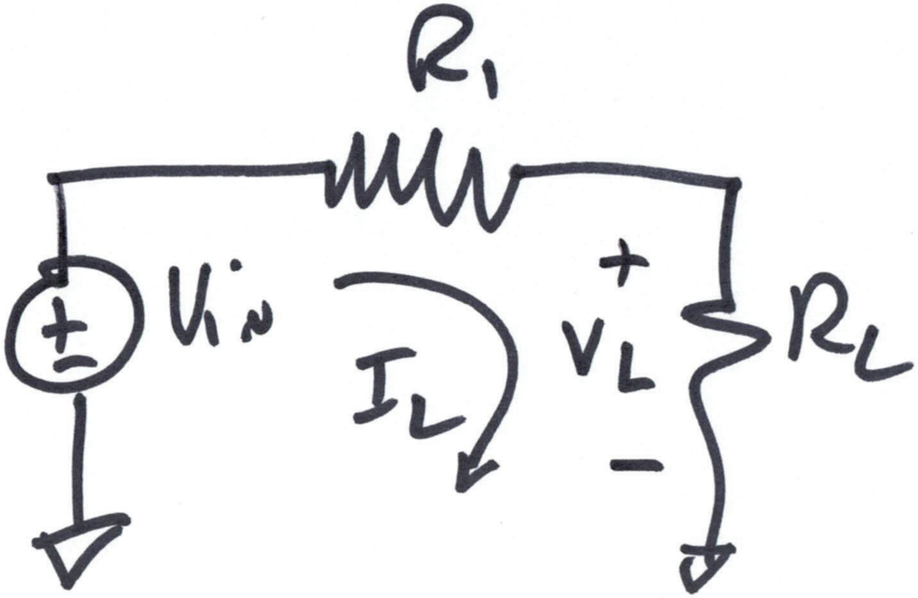
$P = 1mA \cdot 1V = 1mW$

$P = (10^{-3})^2 \cdot 1K = 1mW$

$P = \frac{(1)^2}{1K} = 1mW$

Neg Resistance → source of power

Maximum power transfer



$R_L = ?$

for maximum power transfer

$$P_L = V_L \cdot I_L = \frac{V_{IN} \cdot R_L}{R_L + R_1} \cdot \frac{V_{IN}}{R_1 + R_L}$$

$$P_L = V_{IN}^2 \cdot R_L \left(R_L + R_1\right)^{-2}$$

MAX power transfer

$$0=\frac{d}{da}a\cdot(a+b)\qquad \frac{dP_L}{dR_L}=0=\frac{d}{\cancel{V_s^2 R_L}\,dR_L}\left(\frac{\cancel{V_s^2}\cdot R_L(R_L+R_1)^{-2}}{\cancel{V_s^2}\cdot\cancel{R_L}}\right)$$

$$\frac{d}{dR_L}(R_L+R_1)^{-2}R_L=0$$

$$(R_L+R_1)^2$$

$$0=\left[(R_L+R_1)^{-2}+R_L(-2)(R_L+R_1)^{-3}\cancelto{1}{\frac{d(R_L+R_1)}{dR_L}}\right]$$

$$0=1+(-2)R_L(R_L+R_1)^{-1}$$

$$\frac{2R_L}{R_L+R_1} = 1$$

$$2R_L = R_L + R_1$$

$$\boxed{R_L = R_1}$$

Power = Watts

$$\text{WATTS} = \frac{\text{Joules}}{\text{s}}$$

Isrc

t=0

Energy = Joules

$$\mathcal{E} = \int_0^t P_{DC} \cdot dt$$

$$\mathcal{E} = \int_0^1 1\,\text{mW} \cdot dt = 1\,\text{mW} \cdot (\overset{1}{\cancel{t_1}} - \overset{0}{\cancel{t_0}}) = \boxed{1\,\text{mJ}}$$

NV Energy

$$\text{¢}15/\text{kW}\cdot\text{hr} \rightarrow \underbrace{1{,}000\,\text{W}\cdot 3{,}600\,\text{s}}_{\text{[illegible] Joules}}$$

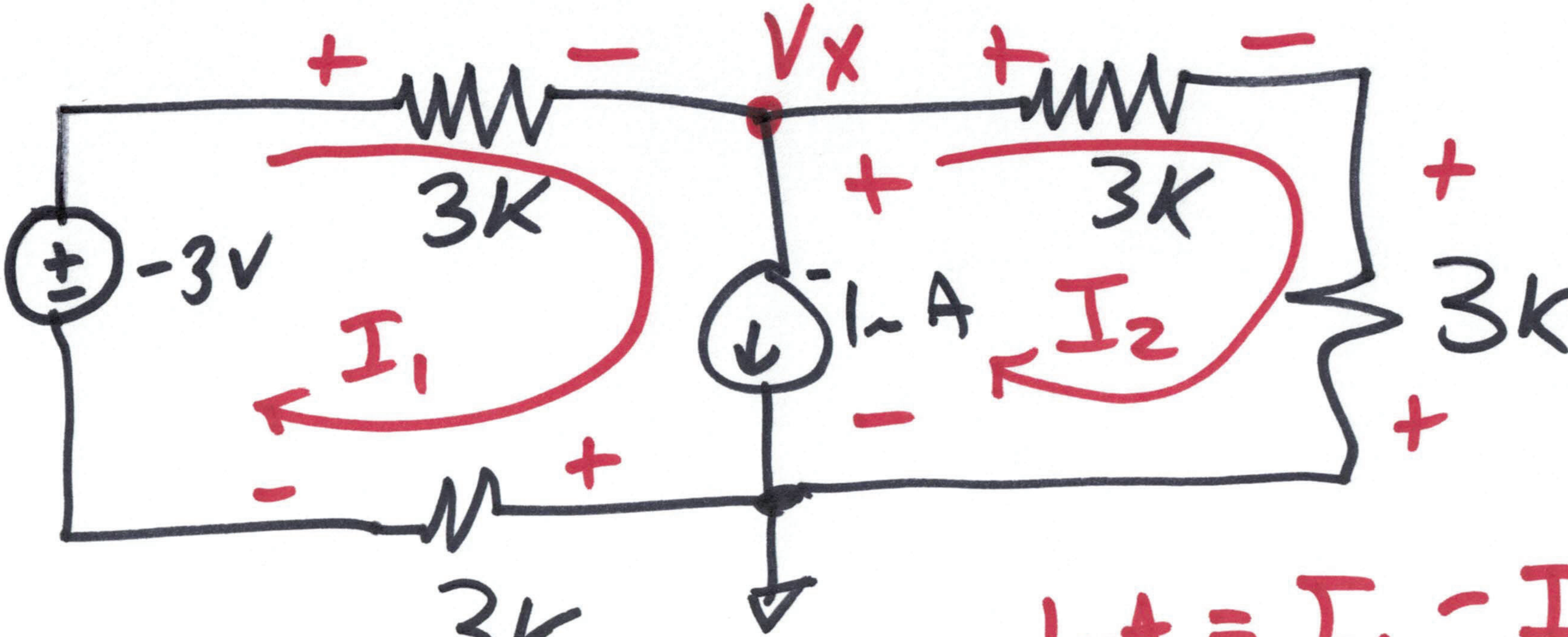
60 W incandesent bulb

2,000 hrs

$$\frac{\text{¢}15}{\text{kW}\cdot\text{hr}}\cdot 60\,\text{W}\cdot 2{,}000\,\text{hrs} = \boxed{= \$18.00}$$

\$2.50

7 W



$$-1mA = I_1 - I_2$$

$$-3k I_1 + (-3V) - 3k I_1 - V_x = 0$$

$$\frac{V_x}{6k} = I_2$$

$$I_1 = \frac{V_x}{6k} - 1mA$$

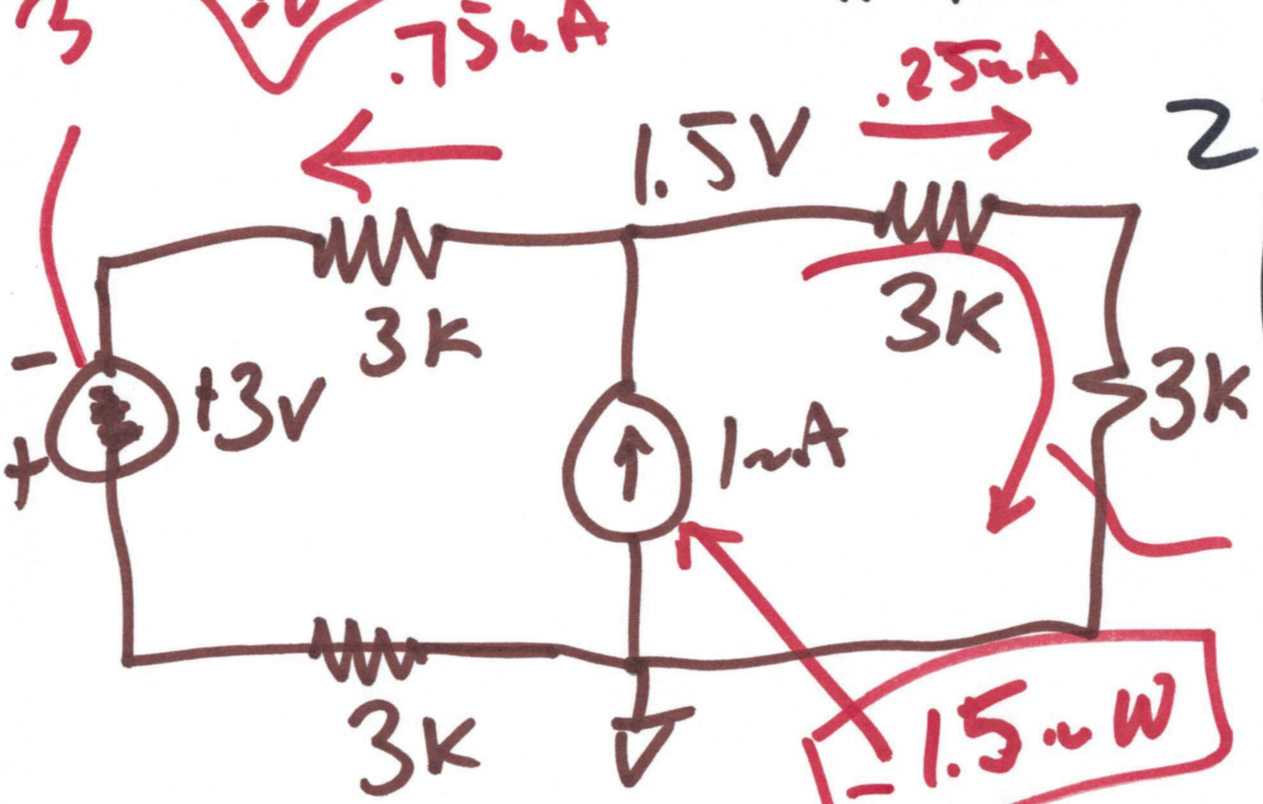
$$-6k\left(\frac{V_x}{6k} - 1mA\right) - 3 - V_x = 0$$

$$-V_x + 6V - 3 - V_x = 0$$

$$2V_x = 3V$$

$$\boxed{V_x = 1.5V}$$

$3 \cdot .75 = \boxed{-2.25mW}$



$$\frac{1.5 - 0}{6K} = 250\mu A$$

$$P_T = 2.25 + 1.5 = 3.75\,mW$$

$$3k\left(\frac{3}{4}mA\right)^2 + 3k\left(\frac{3}{4}mA\right)^2 + 3k\left(\frac{1}{4}mA\right)^2$$

$$+3k\left(\frac{1}{4}mA\right)^2$$

$$3k\left(\frac{9}{16} + \frac{9}{16} + \frac{1}{16} + \frac{1}{16}\right)$$

$$3k\left(\frac{20}{16}\right) = \frac{60}{16}\,mW$$

$$= \underline{\underline{3.75\,mW}}$$