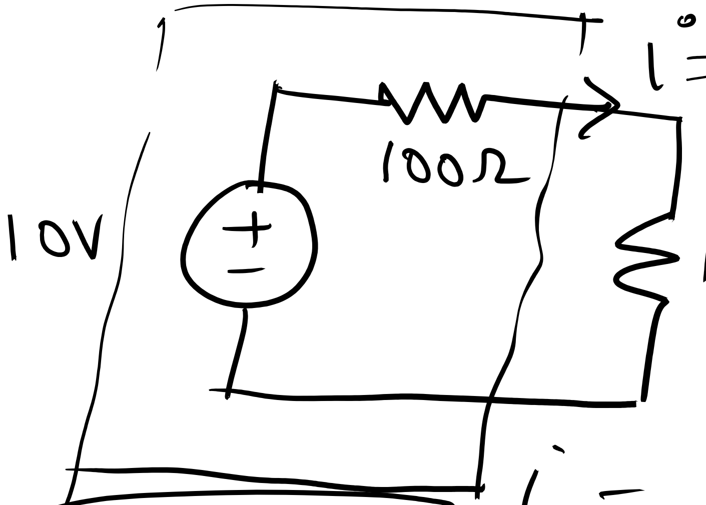
* Ideal Vs Practical Sources

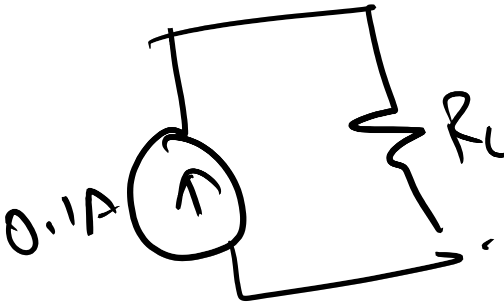


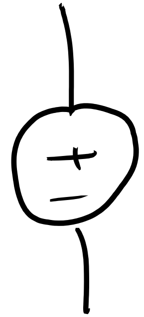
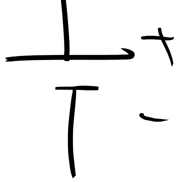
$i = 0.1A \left(\frac{10}{100 + R_L} \right)$

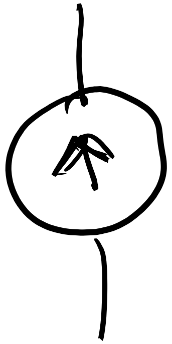
$R_L <<< 100\,\Omega$

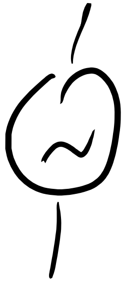
$i_1 = \frac{10}{100+1} = \frac{10}{101} \simeq 0.1$

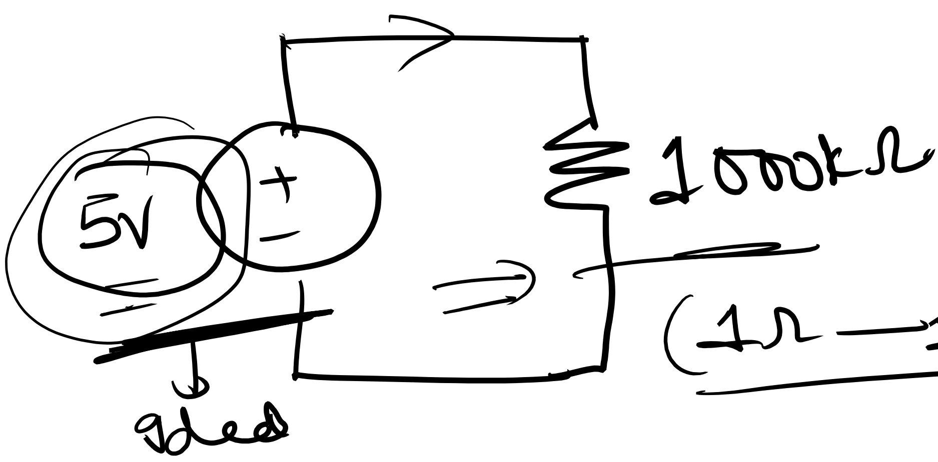
$V_2 = \frac{10}{100+2} = \frac{10}{102} \simeq \underline{0.1}$



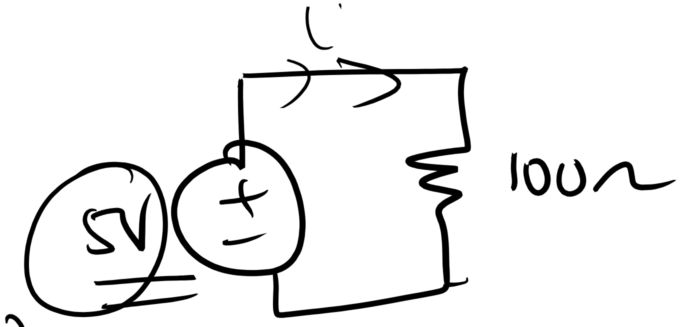
V  ⟹ Battery 

I  ⟹ Desired

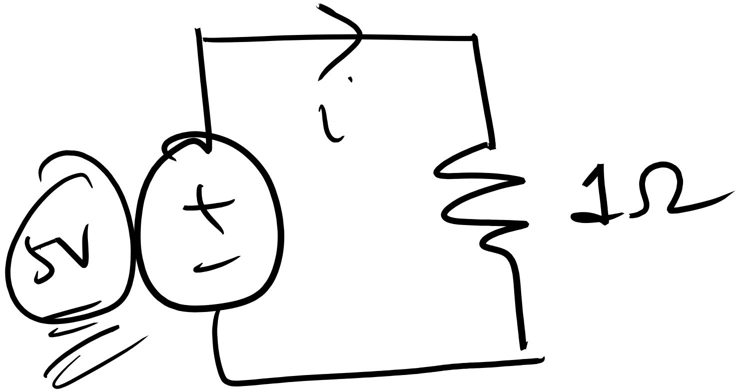
 $V = \underline{220\,V}$



(1Ω — 1MΩ)

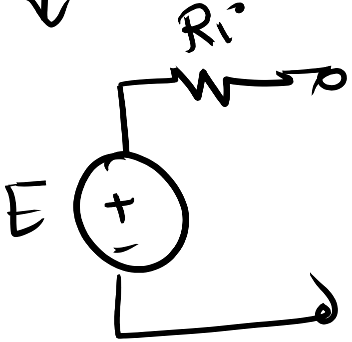


⇒ Cars ignition

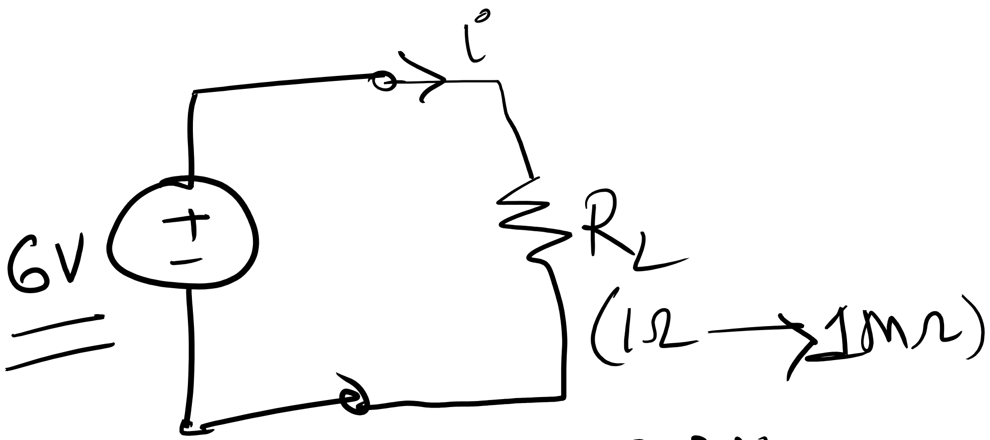


Practical dip in voltage level

↓



* Ideal & Practical Power Sources

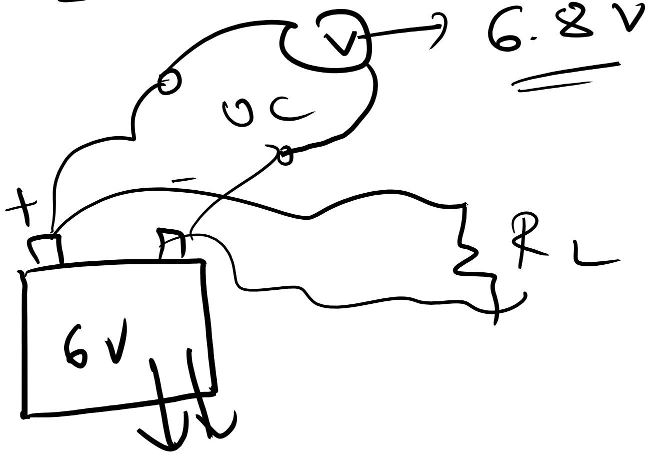


(i) 12V → No Load 0A → 12V

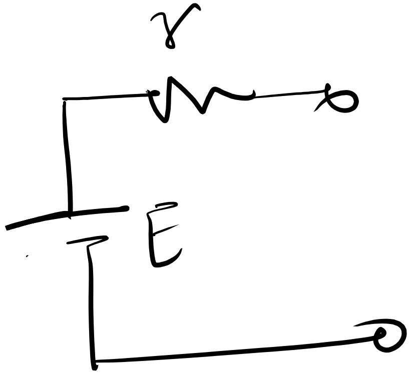
→ 100A → 11V

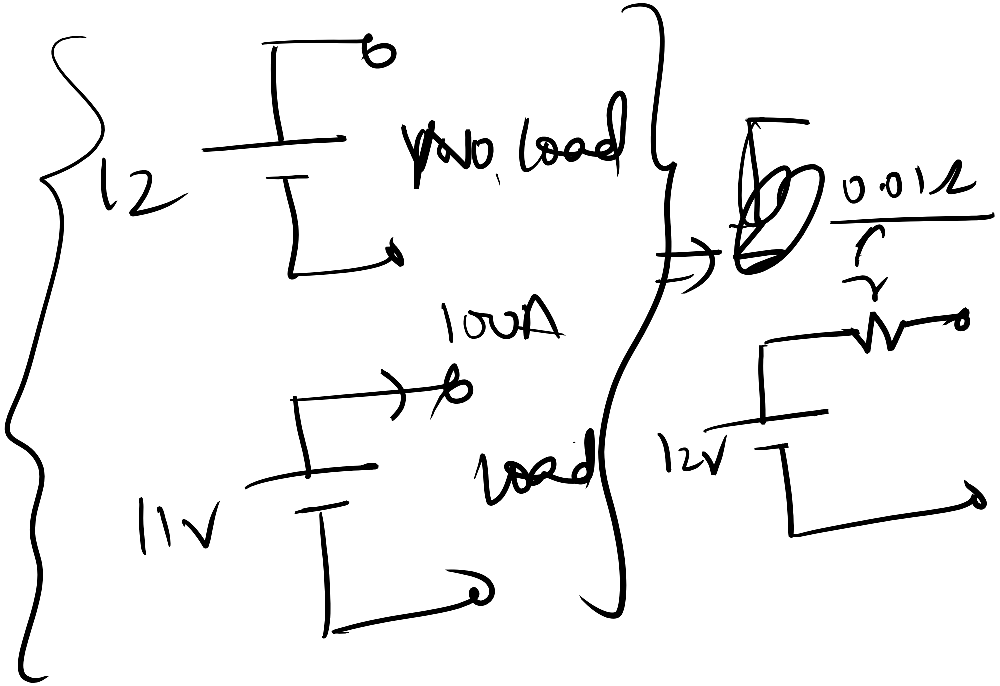
1V

$r = V/R = \frac{1}{100}$



⇒



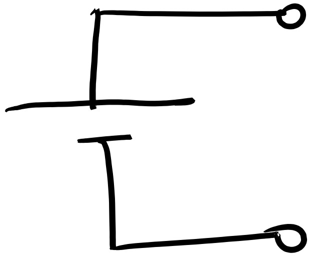


* 

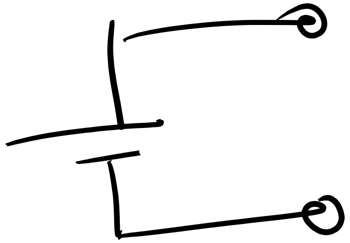
12V → When No current flows ⇒ V = 12V

→ When 100A flows ⇒ V = 11V

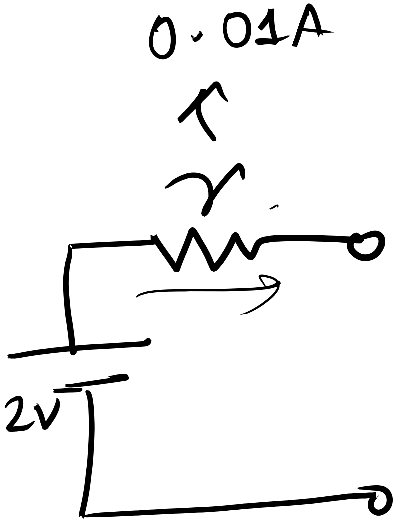
Represent



; No current flows



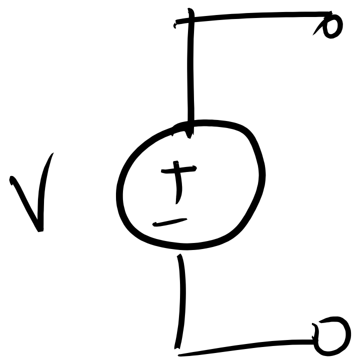
; When 100A current flows

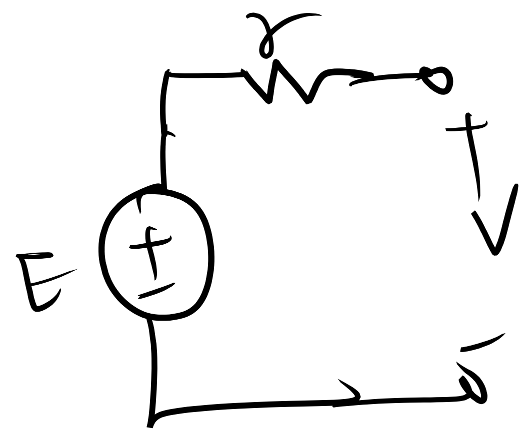


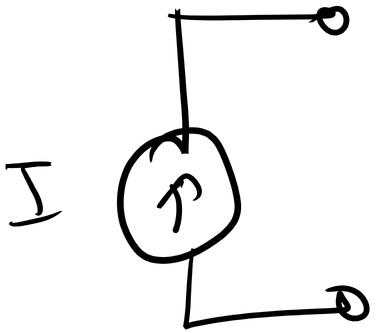
No → 12V

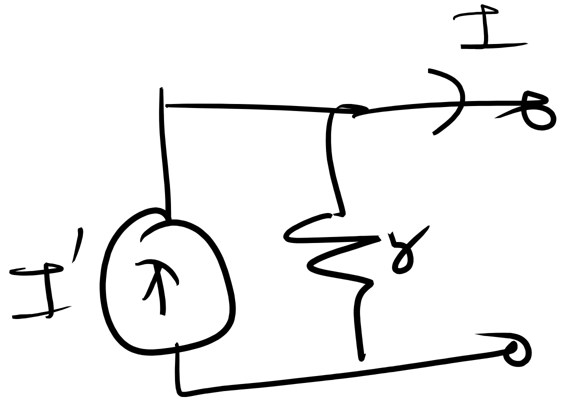
100A → 11V

1V


V
+
−

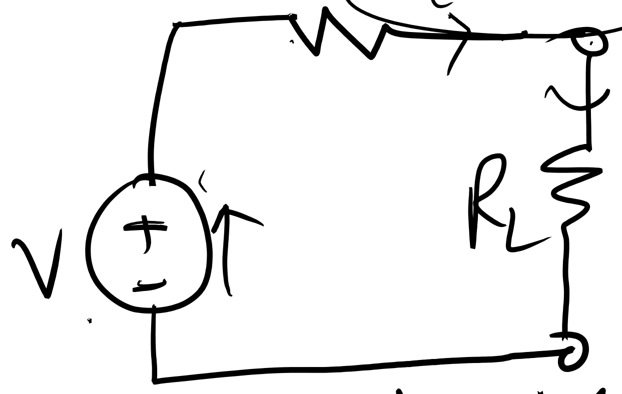

r
E
+
V
−


I

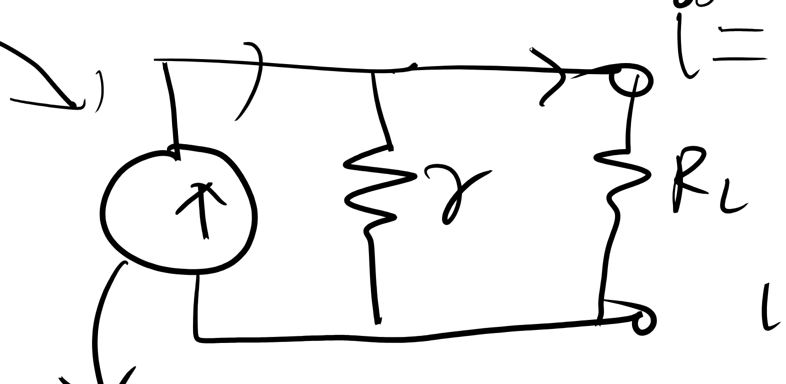

I
I'
r

* Source Transformation

$i = V/R$



$\Rightarrow$



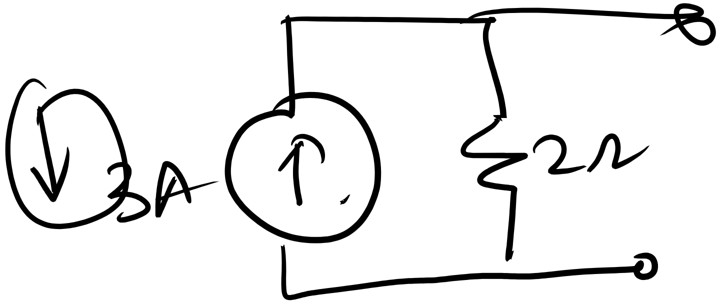
$$i = \frac{V}{(r + R_L)}$$

$I = V/r$

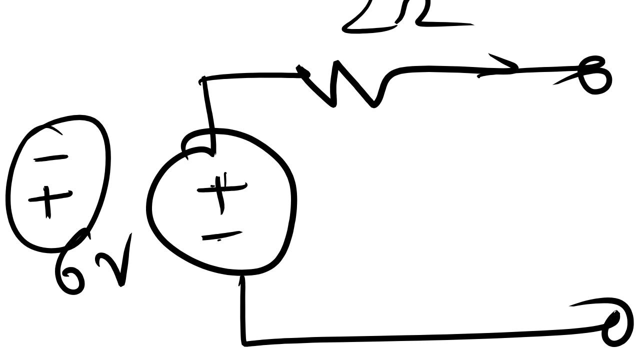
$$i = I * \frac{r}{(R_L + r)}$$

$$i = \frac{V}{\cancel{r}} \frac{\cancel{r}}{(R_L + r)}$$

$$= \frac{V}{(R_L + r)}$$

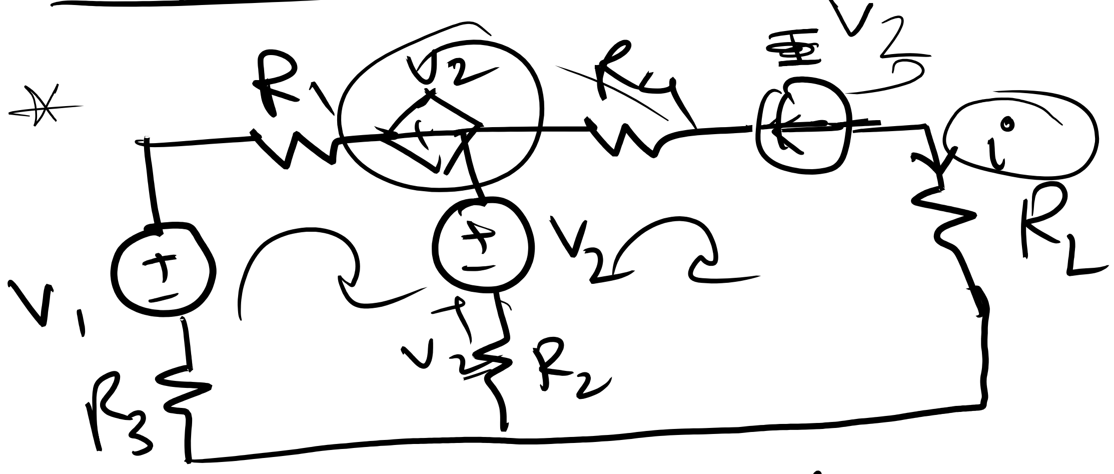


$\Rightarrow$

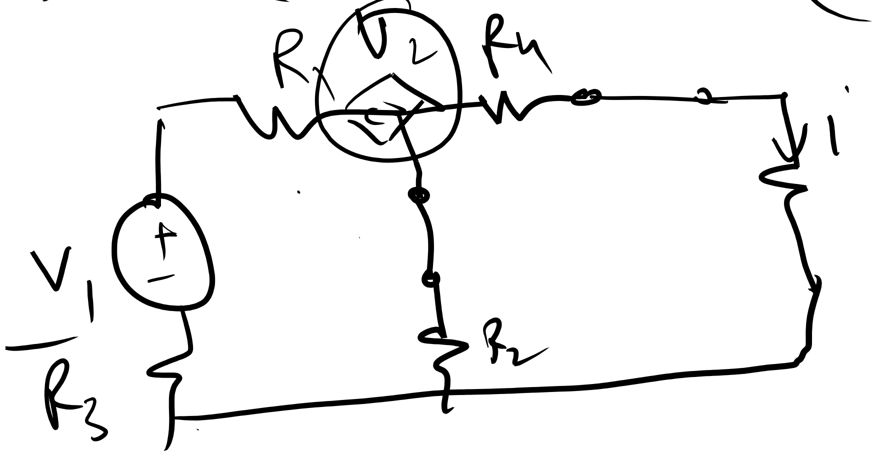


* Superposition Theorem

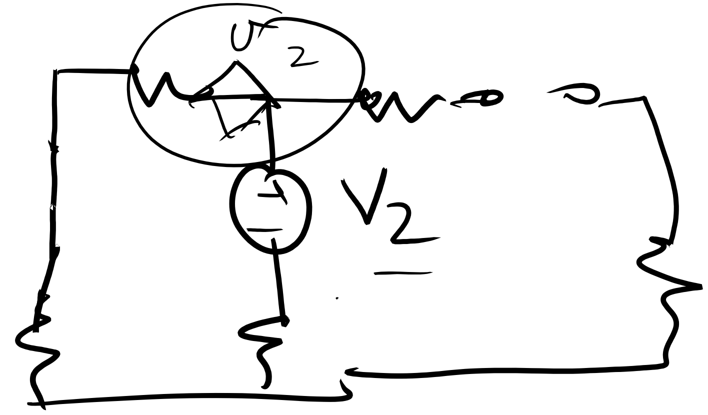
i in R_2



(i) V_1 (kill V_2, I) $\quad (i)_{V_1} = x$ A



(ii) V_2 (V_1, I kill) $\quad (i)_{V_2} = y$ A

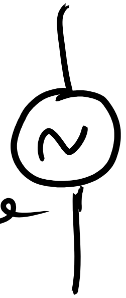


(iii) I (kill V_1 V_2) $\quad (i)_I = Z$ A

$$\boxed{i = x + y + Z}$$

* Applicability → <u>Multi freq. sources</u>

AC source



110V, 50Hz

V, f

Input

↓

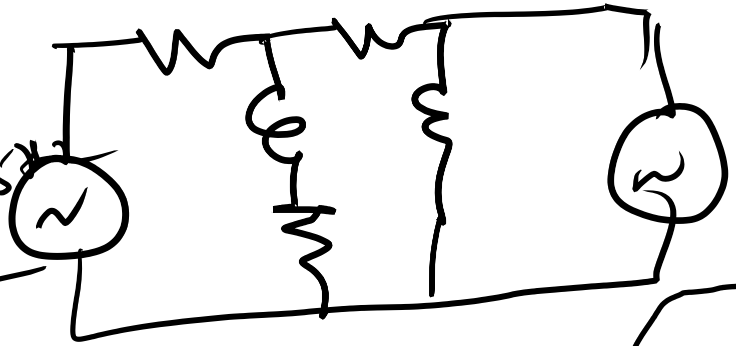
(Excitation)

* <u>Statement</u>:

- Response (O/P ⇒ output)
- Linear

↓

<u>Ohm's law</u>



220V, 75Hz

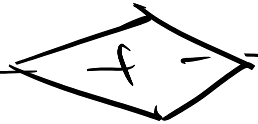
110V, 50Hz

$$V_s = 0.6 i_1 - 4 V_2 \rightarrow \text{linear}$$

$$V_s = 0.6 i_1^2 \rightarrow \times \text{ Not linear}$$

V_2

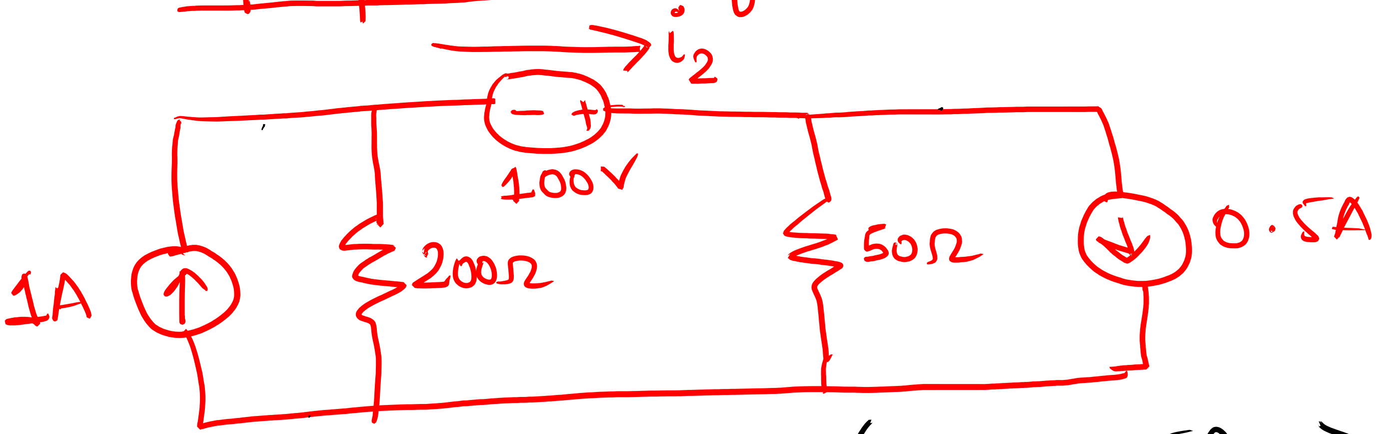
VCVS →



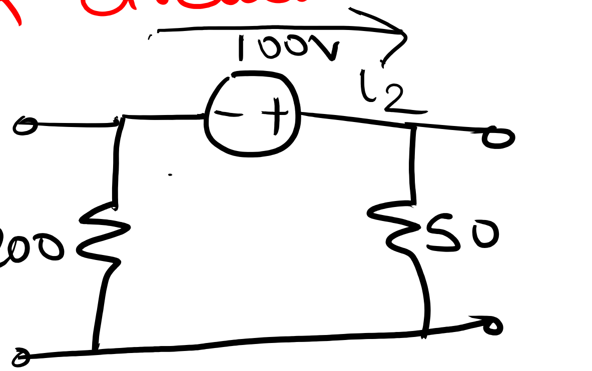
$2V_1$ ✓ $3V_2$ ✓

$2V_1^2$ × Not linear

* Use superposition to find current i_2 in the given circuit.

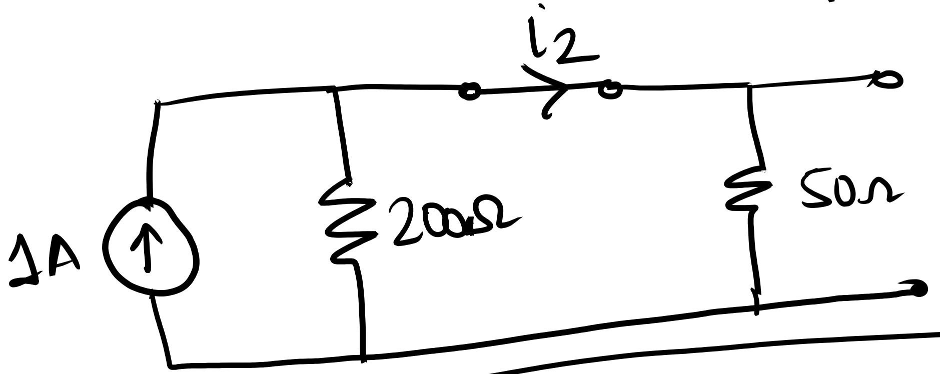


(2)



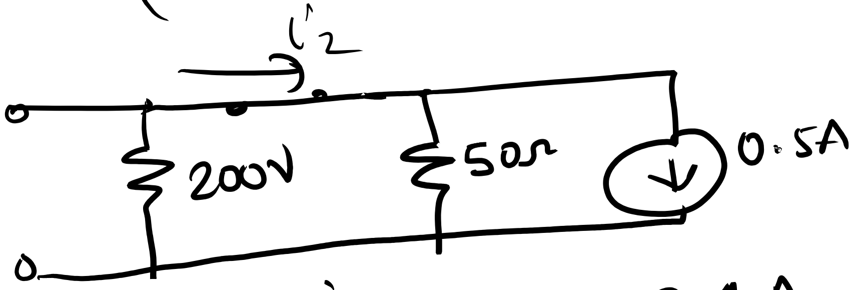
$i_{2(100V)} = 0.4A$

(i) Consider 1A source only (100V; 0.5A → killed)



$i_{2(1A)} = 0.8A$

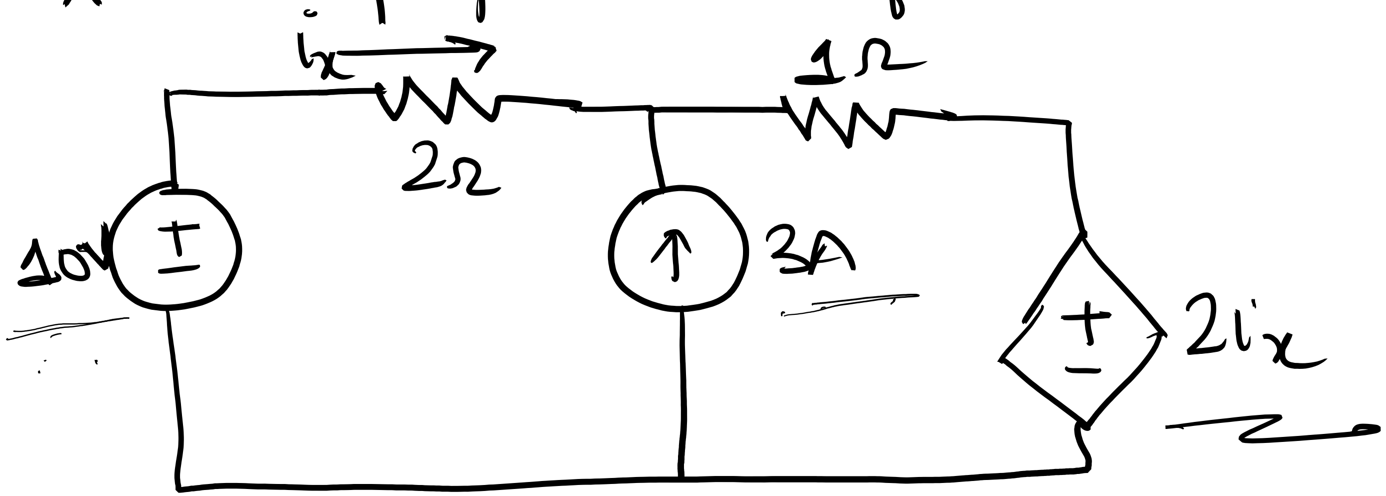
(3) Consider 0.5A only

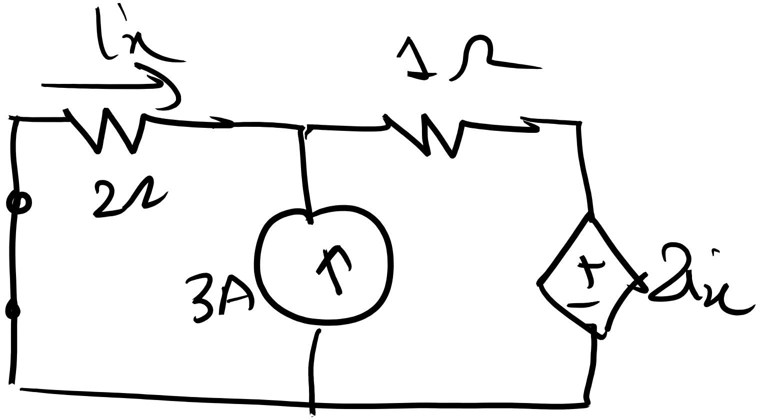


$i_{2\,(0.5A)} = 0.1A$

$$\boxed{i_2 = 0.8 + 0.4 + 0.1 = 1.3A}$$

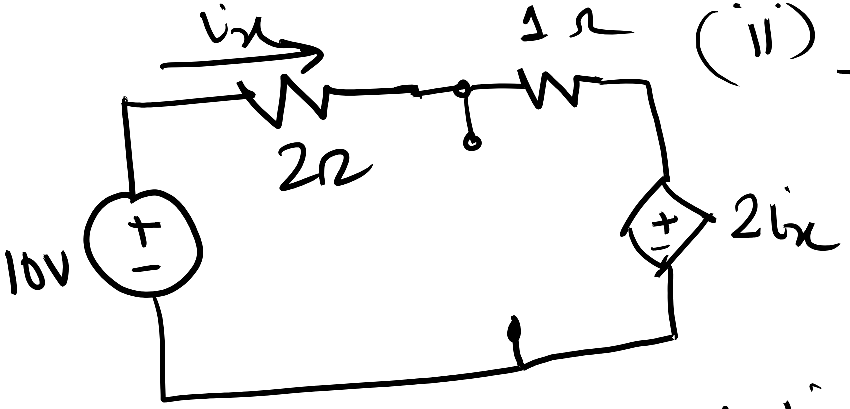
* Use superposition to find i_x





(i) Only 10V

$i_{x(10V)} = 2A$



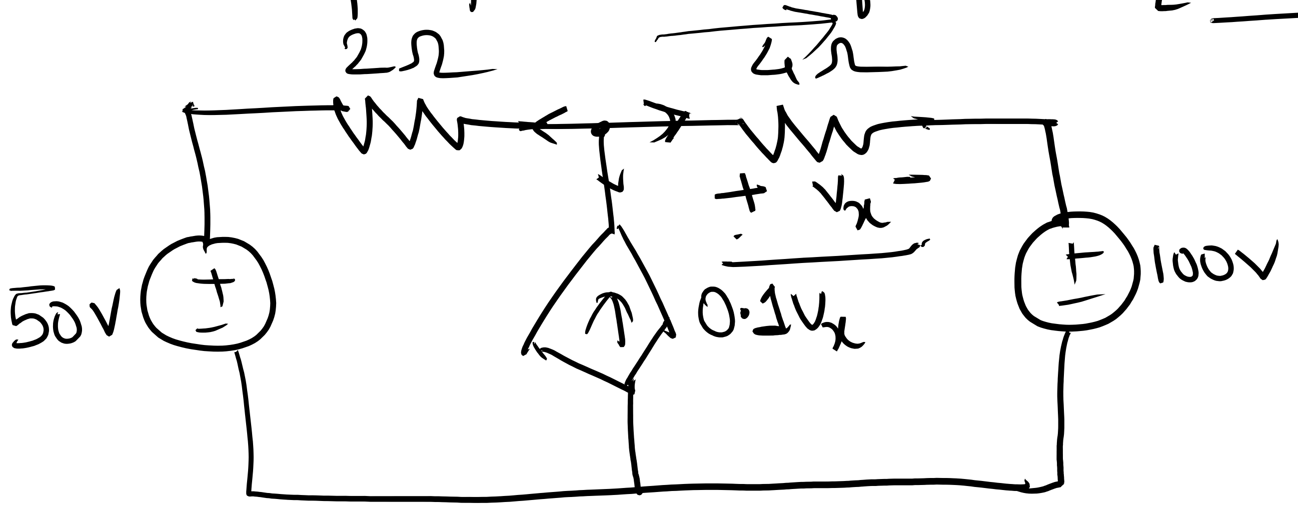
(ii) Only 3A

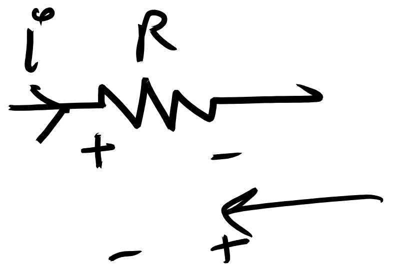
$i_{x(3A)} = -0.6A$

$i_x = i_{x(10V)} + i_{x(3A)}$

$= 2 + (-0.6) = 1.4A$

* Use superposition to find V_x [$\underline{-38.5V}$]

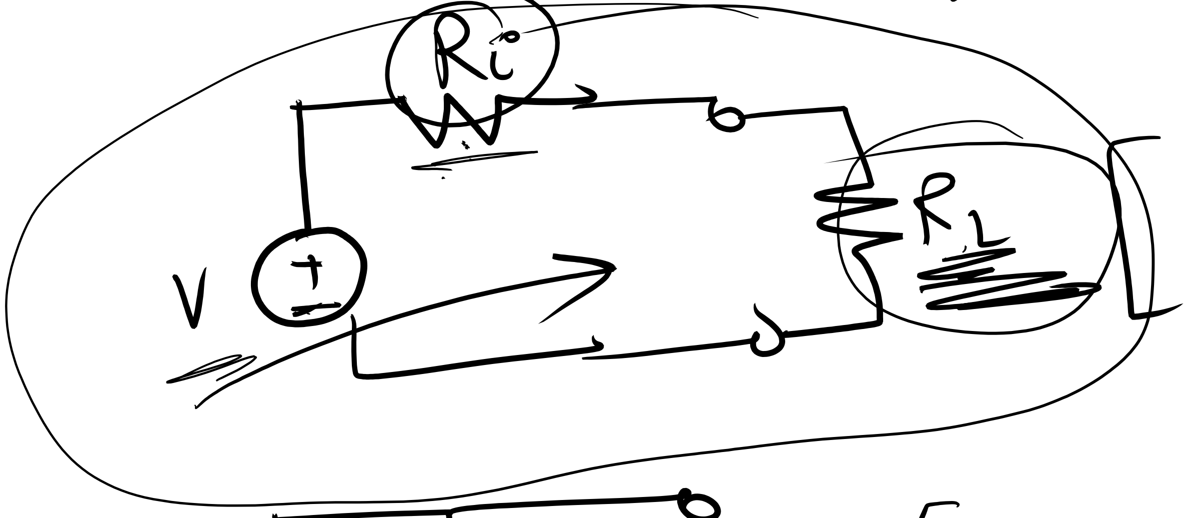




$$V_{x(50V)} = +38.461\ V$$

$$V_{x(100V)} = -76.92\ V$$

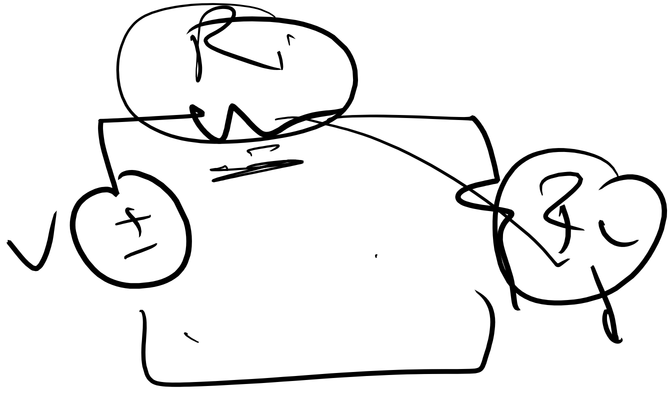
* Maximum Power Transfer Theorem

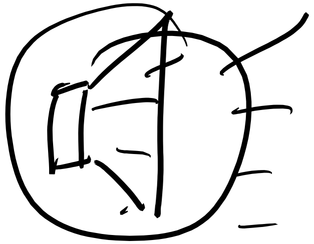


$[R_L = R_i]$

$[R_L = R_i]$

⇒ Amplifiers



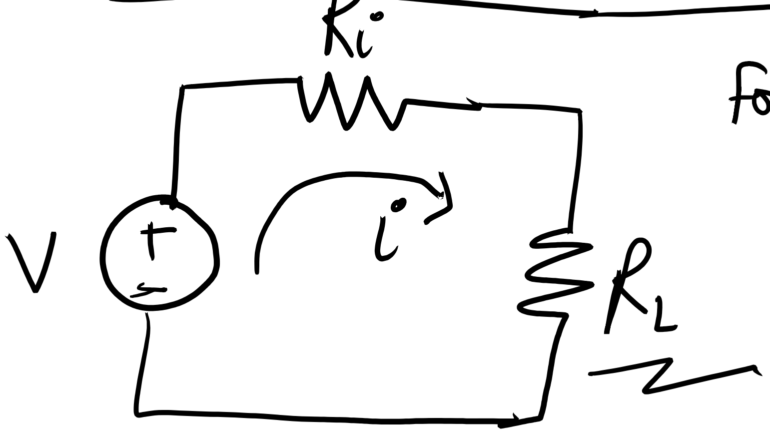


max.

* Statement:

$$\boxed{R_L = R_i}$$

Max. Power Tf Theorem :-



for Max. Power to be delivered to load;

$$\boxed{R_L = R_i}$$

Proof:

$$i = \frac{V}{R_i + R_L} \quad \text{— } (1)$$

$$P_L = i^2 R_L \quad \text{— } (2)$$

Put value of i from eq (1) in (2)

$$P_L = \frac{V^2}{(R_i + R_L)^2} \cdot R_L \quad \text{— } (3)$$

Differentiate eq (3) w.r.t R_L

$$\frac{dP_L}{dR_L} = 0 \quad ; \Rightarrow (\quad)$$

$$\left(\frac{d^2 P_L}{dR_L^2}\right) < 0 \text{ negative}$$

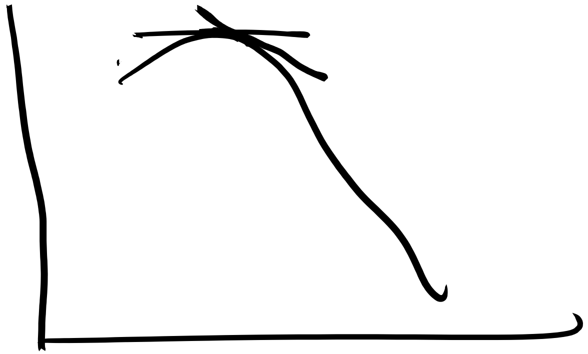
$(\ ) \longrightarrow$ maxima

$$\Rightarrow \frac{V^2 \cdot \cancel{R_L}}{4R_i^{\cancel{2}}} = \frac{V^2}{4R_L}$$

$$\frac{dP_L}{dR_2} = \frac{(R_i+R_2)^2\left[V^2\right] - V^2R_L\left[2(R_i+R_L)(0+1)\right]}{(R_i+R_L)^4} = 0$$

$$2R_L = R_i + R_2$$

$$\boxed{R_L = R_i}$$



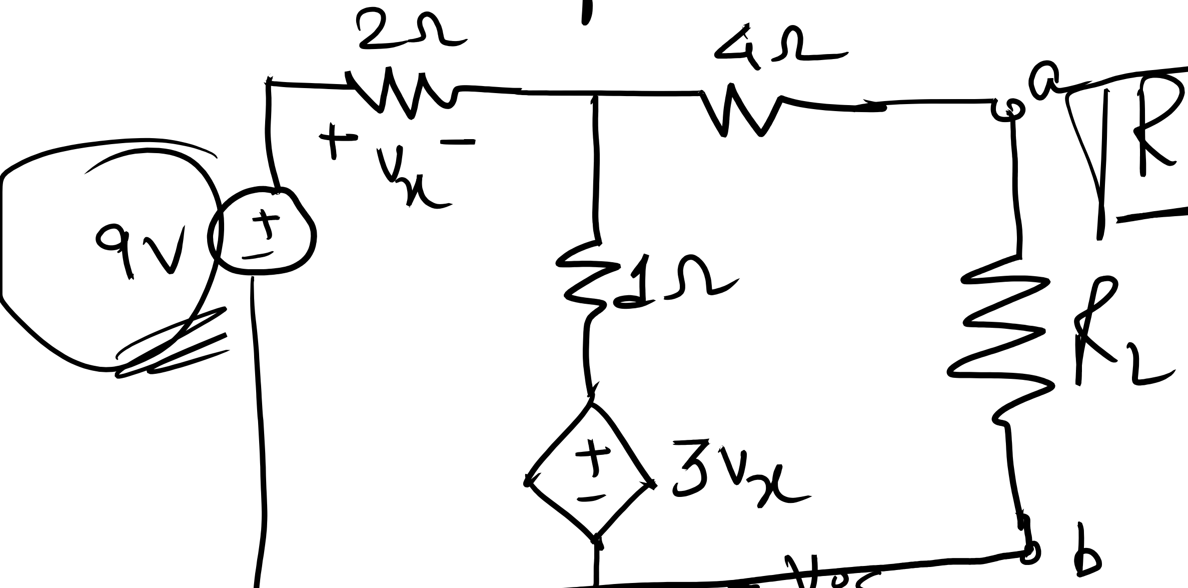
For Maxima ;

$$\left(\frac{d^2P_L}{dR_L^2}\right)_{R_L=R_i} < 0 \quad \left[\underline{\text{Negative}}\right]$$

Max. Power $\Rightarrow$

$$\boxed{P_{max} = \frac{V^2}{4R_L}}$$

* Determine the value of R_L that will draw max. power from the rest of the circuit. Also calculate the max. power.



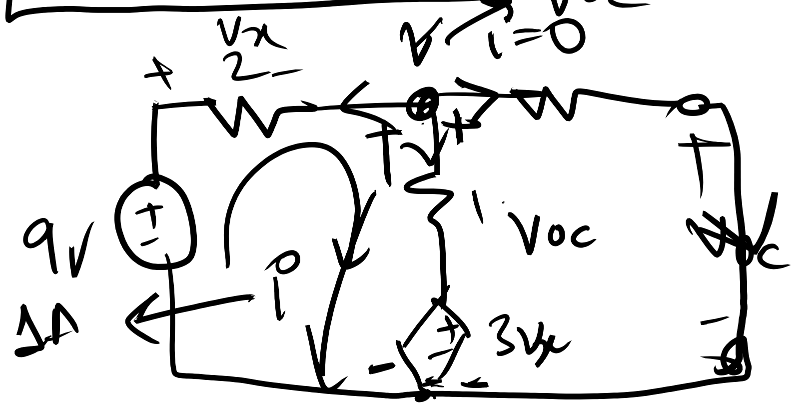
$\boxed{R_L = 4.2\Omega}$ R_{Th} (a-b)

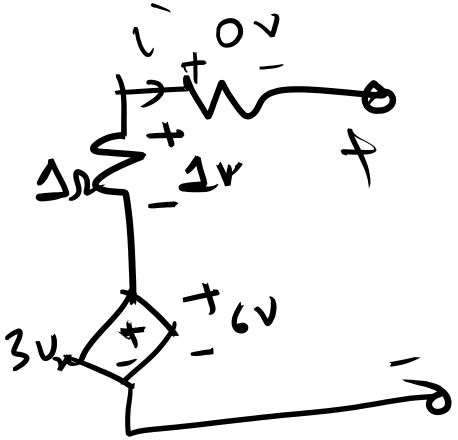
D.S
Yes – Voc, Isc
Voc/Isc
No → Req

$V_{oc} = \cancel{1V}$ (7V)

$I_{sc} = 1.65\,A$

$R_{Th} = 4.24\,\Omega$

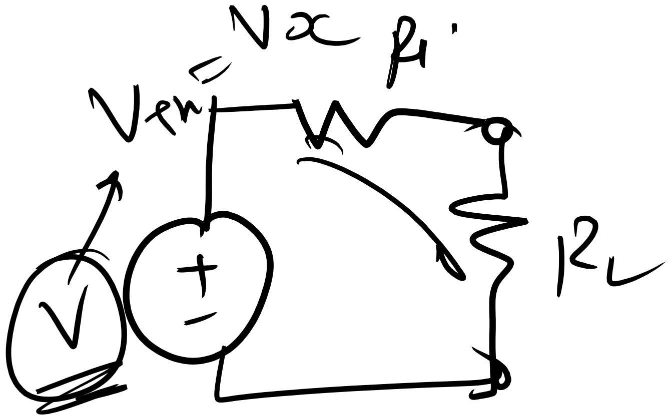




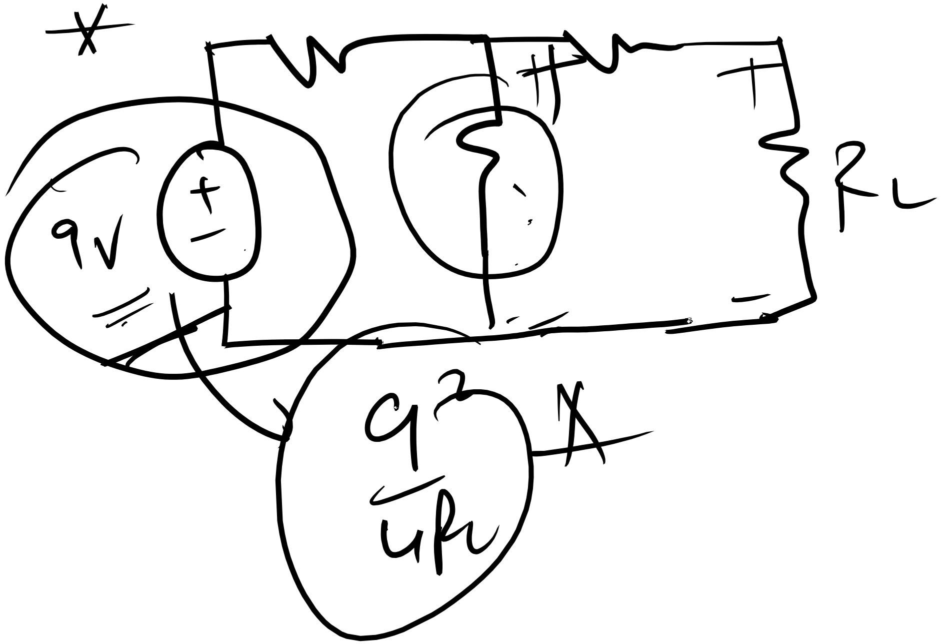
$-6-1+V_{oc}=0$

$\boxed{V_{oc} = 7V}$

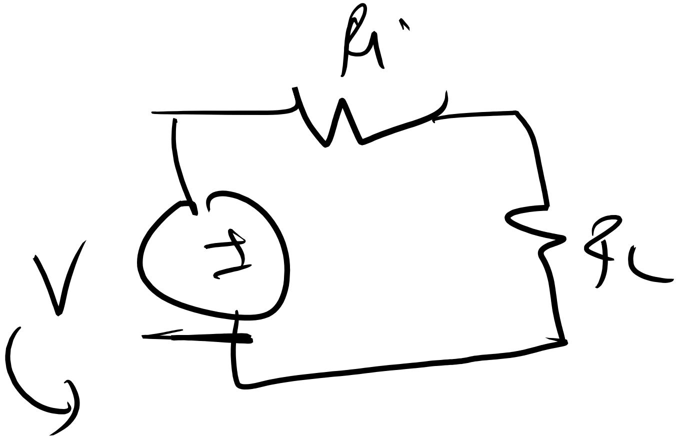
$P = \frac{V^2}{4R_L} = \frac{7\times7}{4\times4.2} = 2.91\,W$



$$P_L = \frac{V^2}{4R_L}$$

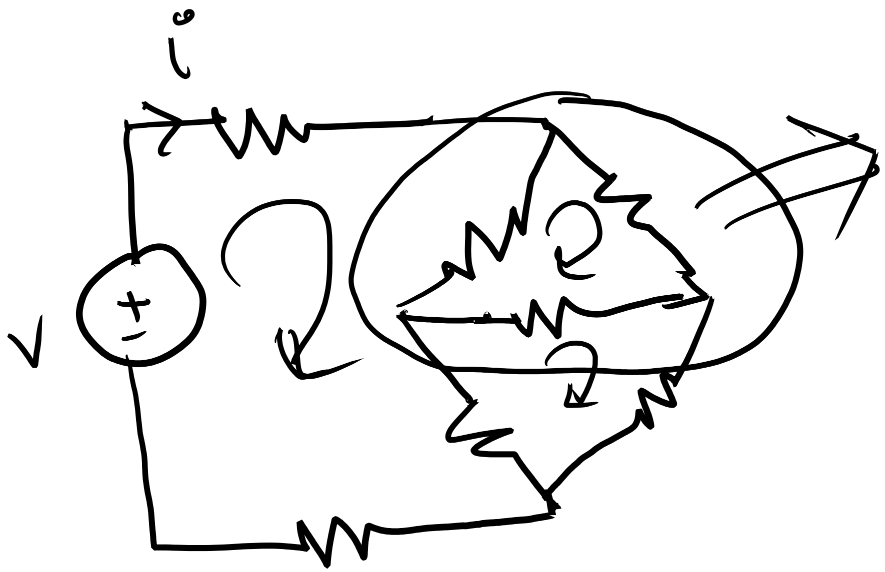


$\Rightarrow$

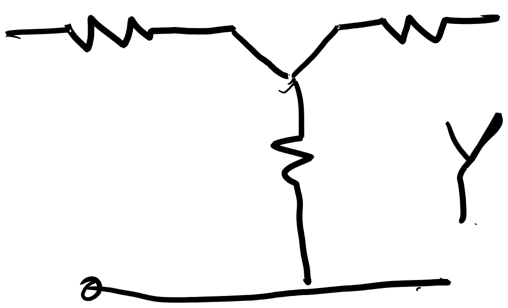


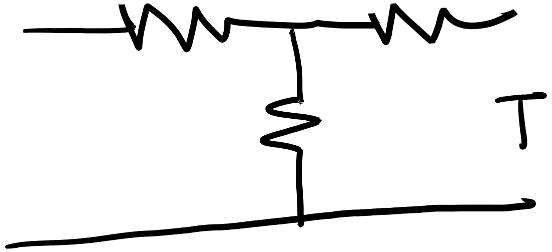
$$P_L = \frac{V^2}{4R_L}$$

* Star Delta Transformation

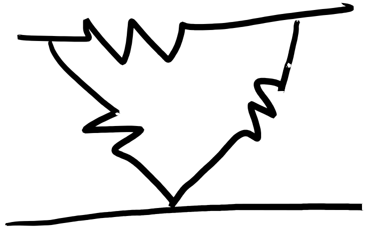


(1) Star (λ)

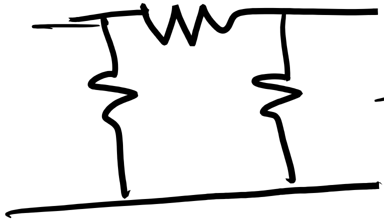




(2) Delta (Δ)



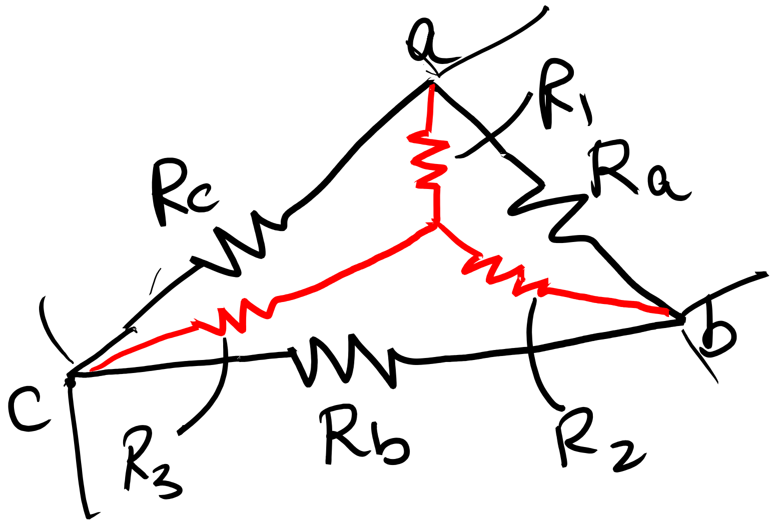
Δ



π

① Delta to Star Conversion

$\Delta \rightarrow \lambda$



$(R_{ab})_\Delta = (R_b + R_c) \| R_a$

$(R_{ab})_\lambda = R_1 + R_2$

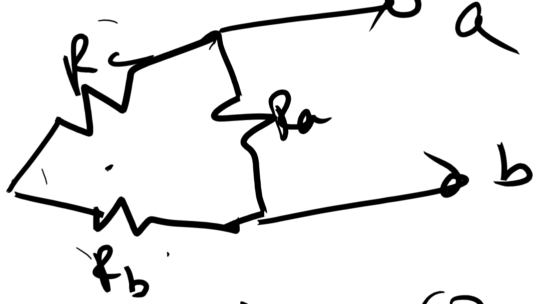
$R_a, R_b, R_c \rightarrow$ Known

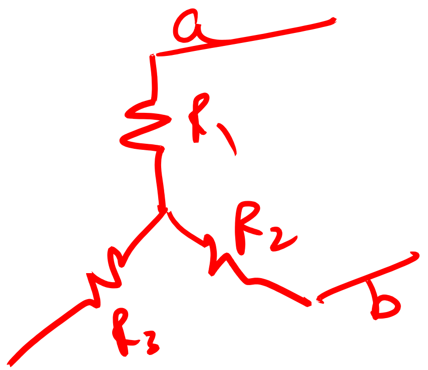
$R_1, R_2, R_3 \rightarrow$ Unknowns

$R_1 = f(R_a, R_b, R_c)$

$R_2 =$ ''

$R_3 =$ ''





$(R_{ab})_\Delta = (R_{ab})_\lambda$

$R_a \| (R_b + R_c) = R_1 + R_2$ —— ①

Similarly;

$(R_{bc})_\Delta = (R_{bc})_\lambda$

$R_b \| (R_a + R_c) = R_2 + R_3$ —— ②

$(R_{ca})_\Delta = (R_{ca})_\lambda$

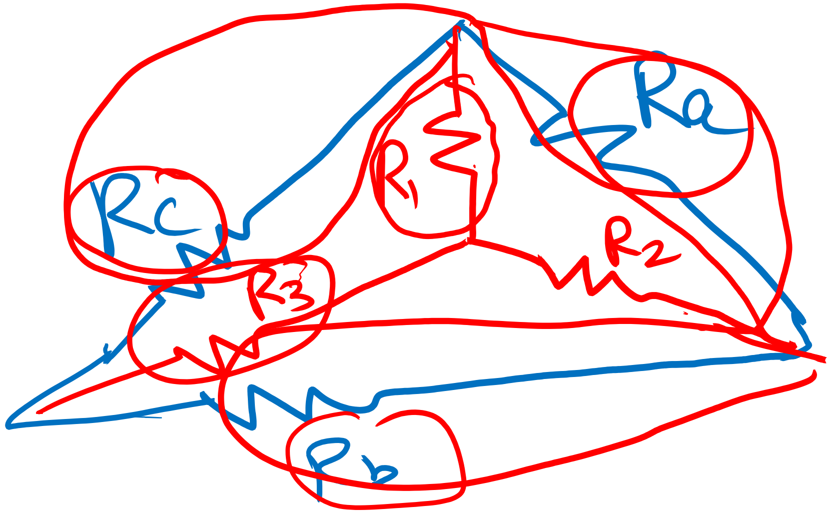
$R_c \| (R_a + R_b) = R_3 + R_1$ → ③

$$R_1 = f(R_a, R_b, R_c) = \frac{R_a R_c}{R_a + R_b + R_c}$$

$$R_2 = f(R_a, R_b, R_c) = \frac{R_a R_b}{R_a + R_b + R_c}$$

$$R_3 = f(R_a, R_b, R_c) = \frac{R_b R_c}{R_a + R_b + R_c}$$

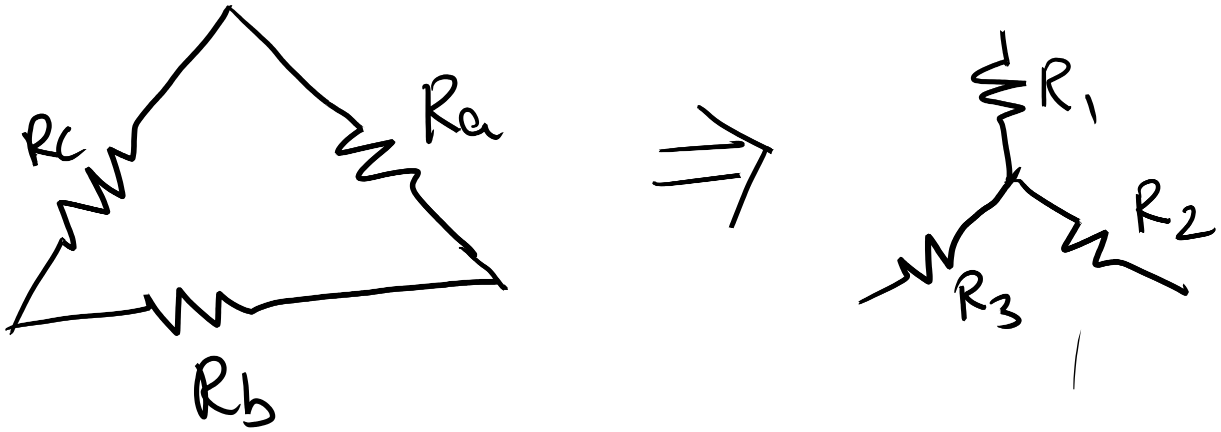
$$R_3 = \frac{R_c \cdot R_b}{R_a + R_b + R_c}$$



$\Rightarrow$

$$R_1 = \frac{R_a \cdot R_c}{(R_a + R_b + R_c)}$$

$$R_2 = \frac{R_a \cdot R_b}{(R_a + R_b + R_c)}$$



$$R_1 = \frac{R_a \cdot R_c}{(R_a + R_b + R_c)} \quad \text{— } (1)$$

$$R_2 = \frac{R_a \cdot R_b}{(R_a + R_b + R_c)} \quad \text{— } (2)$$

$$R_3 = \frac{R_b \cdot R_c}{(R_a + R_b + R_c)} \quad \text{— } (3)$$

* Star to Delta Conversion

Knowns $\rightarrow$ R_1, R_2, R_3

Unknown $\rightarrow$ R_a, R_b, R_c

$$\boxed{R_a, R_b, R_c = f\,(R_1, R_2, R_3)}$$

from ①, ②, ③

$$\Rightarrow \quad R_1R_2 + R_2R_3 + R_3R_1 = \frac{R_a^2R_bR_c + R_b^2R_aR_c + R_c^2R_aR_b}{(R_a+R_b+R_c)^2}$$

$$= \frac{R_aR_bR_c\,\cancel{(R_a+R_b+R_c)}}{(R_a+R_b+R_c)^{\cancel{2}}} = \frac{R_aR_bR_c}{R_a+R_b+R_c} \quad \text{④}$$

Divide eq (4) by $R_1 \Rightarrow$

$$\frac{R_1R_2+R_2R_3+R_3R_1}{R_1} = \frac{R_aR_bR_c}{(R_a+R_b+R_c)} \Big/ \frac{R_aR_c}{(R_a+R_b+R_c)}$$

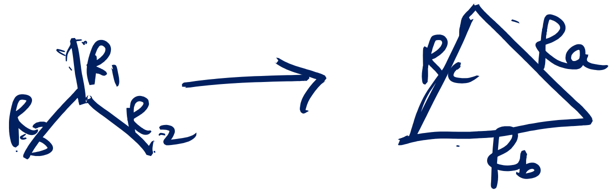
$$\boxed{R_2+R_3+\frac{R_2R_3}{R_1} = R_b} \rightarrow (5)$$

Divide eq (4) by $R_2 \Rightarrow$

$$\boxed{R_1+R_3+\frac{R_1R_3}{R_2} = R_c} \rightarrow (6)$$

Divide eq (4) by $R_3 \Rightarrow$

$$\boxed{R_2+R_1+\frac{R_2R_1}{R_3} = R_a} \rightarrow (7)$$



$$R_1 = \frac{R_a R_c}{(R_a + R_b + R_c)}$$

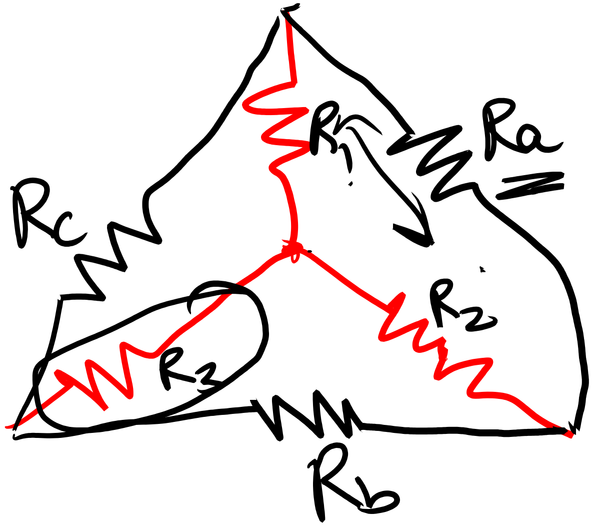
$$R_2 = \frac{R_a R_b}{(R_a + R_b + R_c)}$$

$$R_3 = \frac{R_c R_b}{(R_a + R_b + R_c)}$$

$$R_a = R_1 + R_2 + \frac{R_1 R_2}{R_3}$$

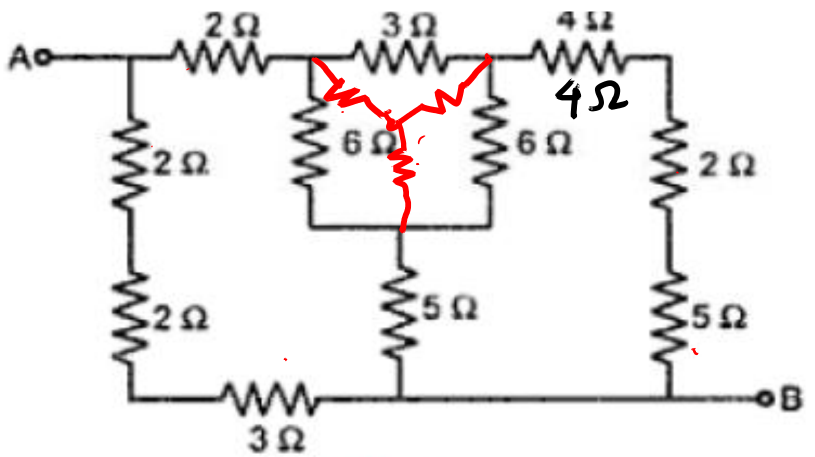
$$R_b = R_2 + R_3 + \frac{R_2 R_3}{R_1}$$

$$R_c = R_1 + R_3 + \frac{R_1 R_3}{R_2}$$



$$R_a = R_1 + R_2 + \frac{R_1 R_2}{R_3}$$

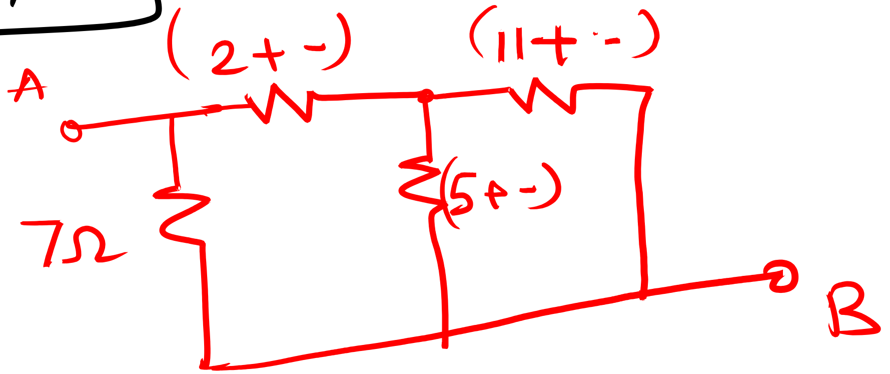
$$R_c = R_1 + R_3 + \frac{R_1 R_3}{R_2}$$



Find eq. Resistance b/w A & B :

$\boxed{R_{eq} = 3.69\,\Omega}$

$\Rightarrow$



$\Rightarrow$ Transients (L & C)

(super Node, Mesh)

— KVL, KCL, Nodal, Mesh, Thevenin, Norton, Superposition, Max. Power Tf, Source Transformation, $\Delta \rightleftharpoons \lambda$