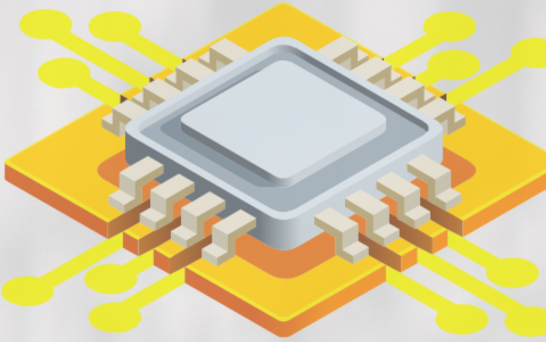
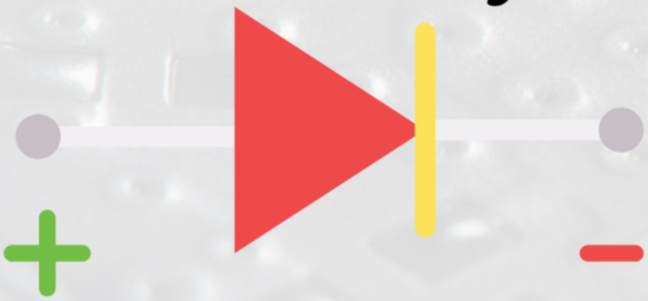
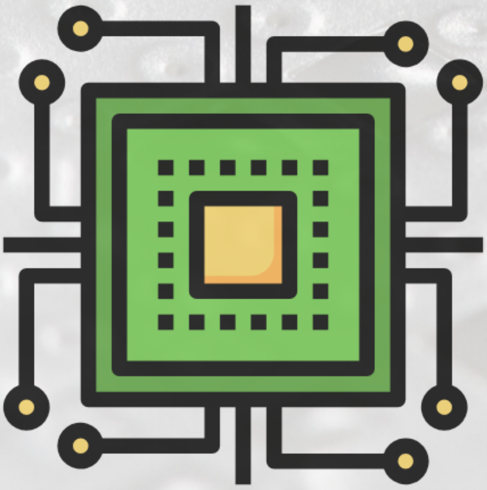


Circuits Analysis

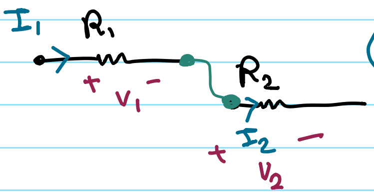
By Rawan Alfares





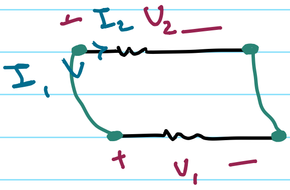
Series: two elements Connected at Single node

Parallel: two elements Connected at a Single node pair.



$(I_1 = I_2)$

$(V_1 \neq V_2)$



$(I_1 \neq I_2)$

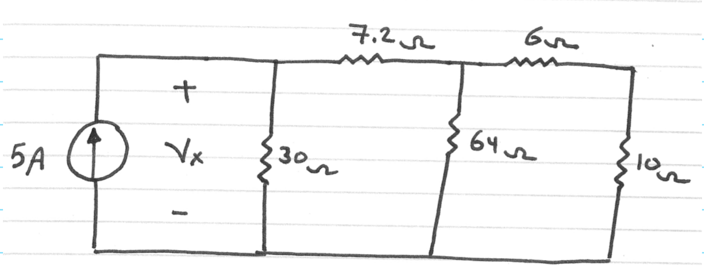
$(V_1 = V_2)$

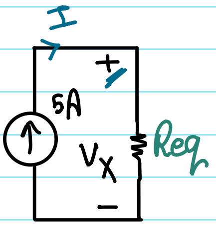
* when we have only two Resistors in parallel :

$$R_{eq} = \frac{R_1 \times R_2}{R_1 + R_2} < \min(R_1, R_2)$$

* Connecting Resistors in Series $R_{eq} > \max(R_1, R_2)$

Example :





$Vx = + IR$

$$(6, 10) \xrightarrow{S} 6 + 10 = 16$$

$$(16, 64) \xrightarrow{P} \frac{16 \times 64}{16 + 64} = 12.8$$

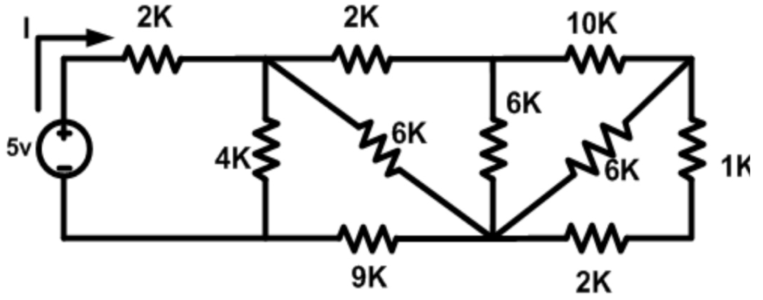
$$(7.2, 12.8) \xrightarrow{S} 7.2 + 12.8 = 20$$

$$(20, 30) \xrightarrow{P} \frac{20 \times 30}{50} = 12$$

$R_{eq} = 12\Omega$

$$Vx = + IR$$
$$= (5)(12)$$
$$= 60$$

Example 2:- find I?



$1+2=3$

$3//6 = 2$

$2+10 = 12$

$12//6 = 4$

$4+2 = 6$

$6//6 = 3$

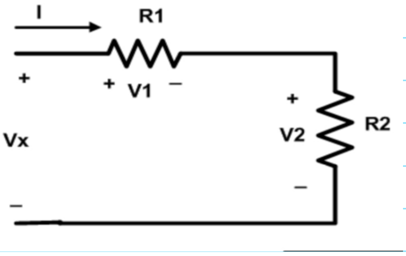
$3+9 = 12$

$12//4 = 3$

$3+2 = 5 \rightsquigarrow R_{eq} = 5$

$$I = \frac{V}{R} = \frac{5}{5\times10^3} = 1mA$$

Voltage Divider Rule



1. by using KVL

$-V_x + V_1 + V_2 = 0$

$V_x = \underline{V_1} + \underline{V_2}$

$V_x = IR_1 + IR_2$

$V_x = I(R_1+R_2) \longrightarrow I = \dfrac{V_x}{R_1+R_2}$

to find $V_1 = IR_1$

$V_1 = \dfrac{R_1}{R_1+R_2} V_x$

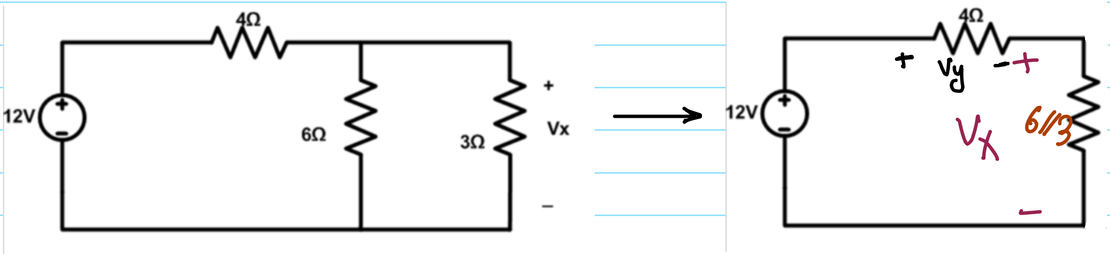
$V_2 = \dfrac{R_2}{R_1+R_2} V_x$

any V for Resistors

$\boxed{V_1 = \dfrac{R_1}{R_1+R_2} V_x}$ V source , $\boxed{V_2 = \dfrac{R_2}{R_1+R_2} V_x}$, $\boxed{V_1 + V_2 = V_x}$

* إذا كان عندك Voltage موزع على مقاومتين you can use Voltage divider Rule.

Example 3: find Vx?



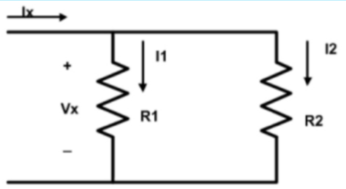
$6//3 = 2\Omega$

$V_x = \frac{2}{6} * 12 = 4\ V$

$V_y = \frac{4}{8} * 12 = 8\ V$

to make Sure
$V_1 + V_2$ should equals V_s
$8 + 4 = \underline{12}$ ✓

Current Divider Rule

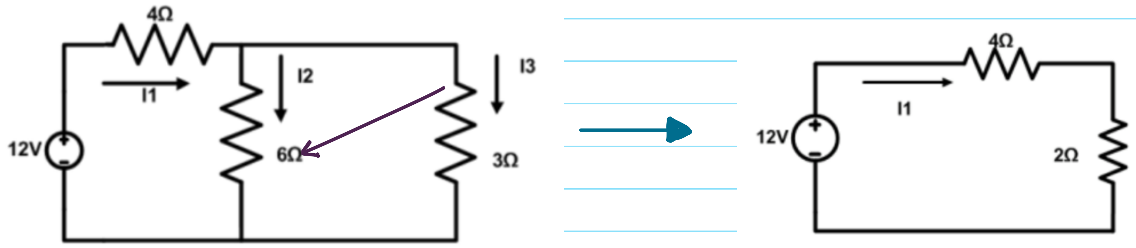


⟶ parallel Combination

+ في تيار يتجزّأ ..

$\boxed{I_1 = \frac{R_2}{R_1+R_2} I_x}$, $\boxed{I_2 = \frac{R_1}{R_1+R_2} I_x}$, $\boxed{I_x = I_1 + I_2}$

Example 4 :-



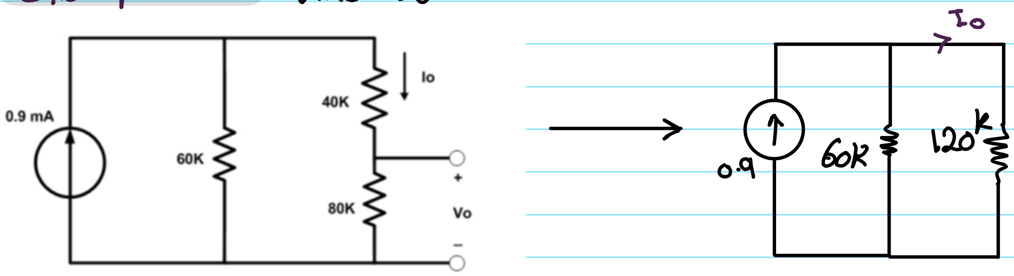
$3//6 = 2\Omega$

$I_1 = \frac{V}{R} = \frac{12}{6} = 2A$

$I_3 = 2 * \frac{6}{9} = 1.3\ A$

$I_2 = I_3 - I_1$
$= 2 - 1.3 = 0.7A$

Example 5 :- find V_o

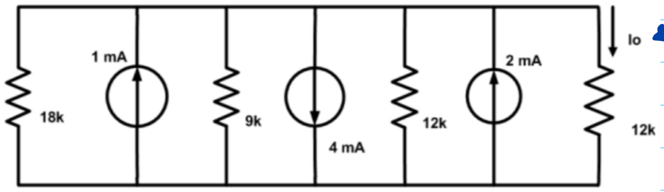


$V_o = I_o R$
$= 80 \times 10^3 \times I_o \longrightarrow ①$

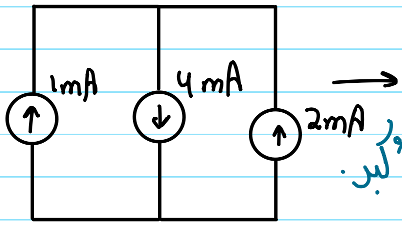
$I_o = 0.9 * \frac{60k}{180k} = 0.3 mA$

$V_o = 80 \times 10^3 \times 0.3 \times 10^{-3}$
$= 24 V$

Example 6 : find I_o :-



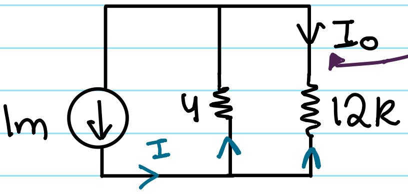
الإشي المجهول
دائماً مابنقرب
عليه ولا بنبسطه



$\longrightarrow I_T = -1+4-2$
$= 1$

اتجاهه نفس اتجاه الأكبر.

$18 // 9 \longrightarrow 6 \Omega$
$6 // 12 \longrightarrow 4 \Omega$

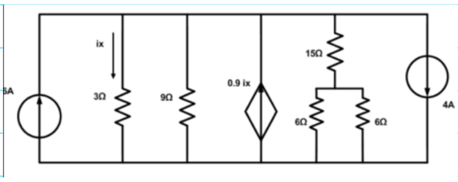


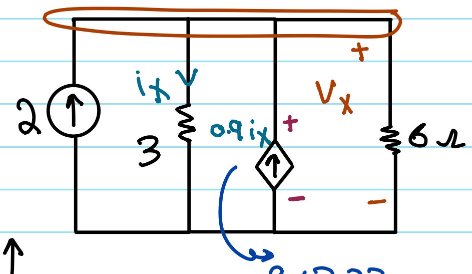
لكن هم فارضين
التيار لتحت عكس
المطلوب فلذلك
نضع سالب في
الجواب النهائي

$I_o = 1 \times 10^{-3} * \frac{4}{4+12}$

$I_o = -0.25 mA$

Example 7: find the power Supplied by 0.9 ix Source?





= 0.9×3.33
= 3

6 // 6 = 3
3 + 15 = 18
18 // 9 = 6 Ω = Req.

$6\uparrow - 4\downarrow = 2\uparrow$

By using KCL:-

$\Sigma I_{in} = \Sigma I_{out}$

$2 + 0.9 i_x = i_x + \frac{V_x}{6}$

$2 + 0.9 i_x = i_x + \frac{\cancel{3} i_x}{2\ \cancel{6}}$

$2 = 0.6\ i_x$

$i_x = 3.33\ \Omega$

$V_x = 3\ i_x$

$= (3)(3.33)$

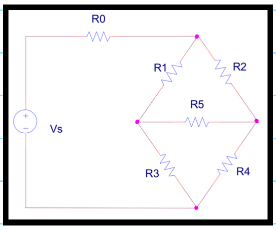
$V_x = 10\ V$

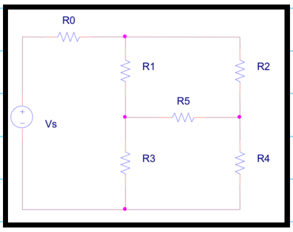
Power = - V i
= - (10)(3)
power = - 30 watt.

Supplying

Bridge Circuits

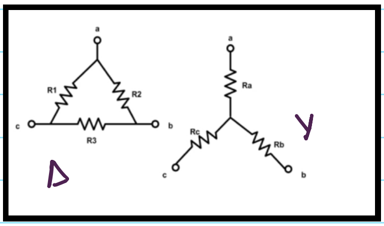
one type of resistive Circuit that Can't be simplified through Series or parallel Combinations.





Delta to wye and wye to delta transformation

Δ Y



Y-Δ transformation

1. $R_1 = \frac{R_{ab} + R_{ac} + R_{bc}}{R_b}$

اللي قبالها

2. $R_2 = \frac{R_{ab} + R_{ac} + R_{bc}}{R_c}$

3. $R_3 = \frac{R_{ab} + R_{ac} + R_{bc}}{R_a}$

Δ-Y transformation

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

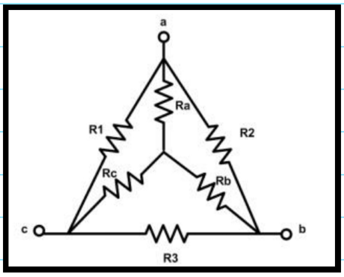
المحصورة بينهم

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

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

Note:

the equations above must be used along with the Circuit diagrams shown. the labeling of the resistors and nodes in the diagrams is Critical.

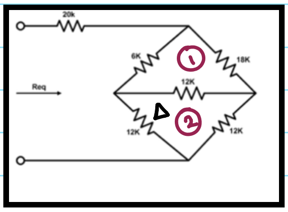


→ for Balance Case :-

1. $R_1 = R_2 = R_3 = R_\Delta$
2. $R_a = R_b = R_c = R_y$

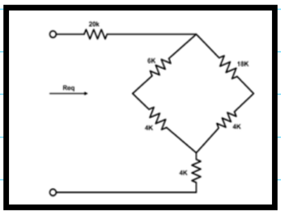
$$\boxed{R_\Delta = 3R_y}$$

Example: find Req :-



$R_\Delta = 12$, $R_y = \frac{R_\Delta}{3} = \frac{12}{3} = 4$

substitute

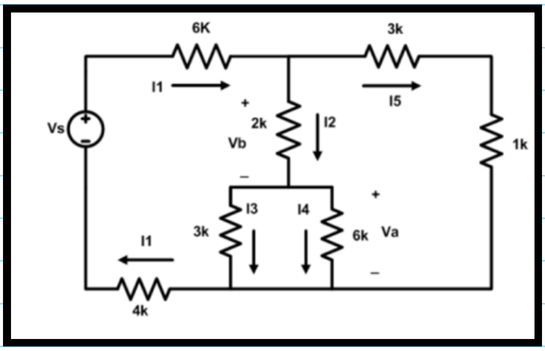


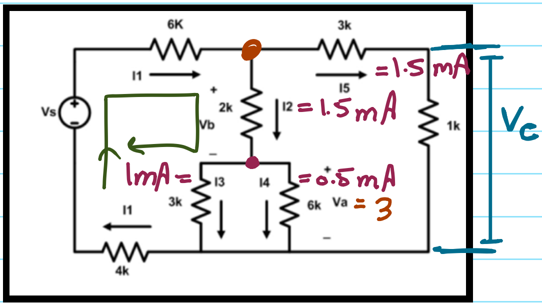
$18 + 4 = 22K$
$6 + 4 = 10K$

$22 // 10 = 6.875K$

$6.875 + 4 + 20 = 30.875K = R_{eq}$

Example: given $I_4 = 0.5\,mA$, find V_s





$V_a = +IR$
$= 0.5m \times 6k$
$= 3$

$I_3 = \frac{V_a}{3k} = \frac{3}{3k} = 1mA.$

by KCl :-
$I_2 = 1m + 0.5m$
$I_2 = 1.5\,mA$

$V_b = (2)(1.5)$
$= 3\,V$

$V_c = V_b + V_a$
$= 3 + 3 = 6\,V$

$I_5 = \frac{V_c}{4k} = \frac{6}{4k} = 1.5\,mA$

$I_1 = I_5 + I_2$
$= 1.5 + 1.5$
$= 3\,mA$

$-V_s + (10)(3) + 6$

$V_s = 36\ V$

Ammeter → designed to measure Current

Voltemeter → designed to measure Voltage.

ربنا تقبّل منّا إنّك أنتَ السميعُ العليم