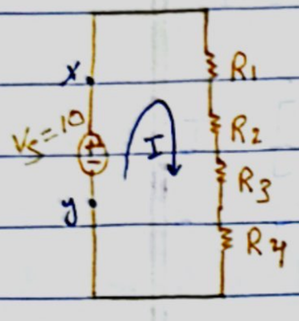
Chapter 3:
Simple Resistive circuits

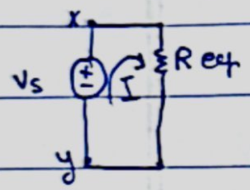
Resistors in series



Series connected resistors carry the same current.

using KVL

$$-V_s + R_1 I + R_2 I + R_3 I + \text{---} + R_m I = 0$$



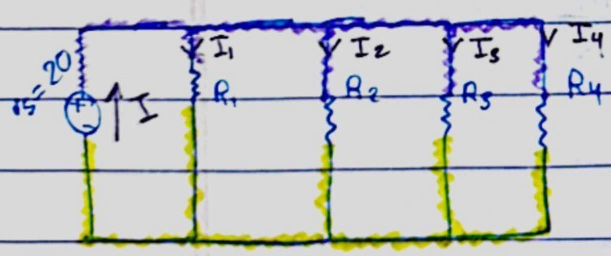
$$I = \frac{V_s}{R_{eq}}$$

$$V_s = (R_1 + R_2 + \text{---} + R_m)\, I$$

$$V_s = R_{eq}\, I$$

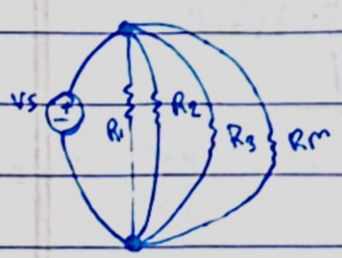
$$R_{eq} = \sum_{i=1}^{m} R_i$$

Resistors in parallel



parallel connected resistors have the same voltage across their terminal.

↓



Number of nodes = 2

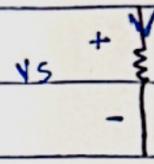
Based on KCL

$$\sum I = 0$$

التيارات يلي طالعة من ال node pos

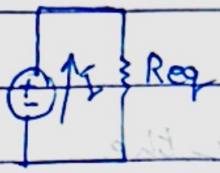
$$I = I_1 + I_2 + I_3 + I_4$$

$$I_1 + I_2 + I_3 + I_4 - I = 0$$



$$I_1 + I_2 + I_3 + I_4 - I = 0$$

$$\frac{V_s}{R_1} + \frac{V_s}{R_2} + \frac{V_s}{R_3} + \cdots + \frac{V_s}{R_m} = I$$



$$I = \frac{V_s}{R_{eq}}$$

$$\frac{V_s}{R_1} + \frac{V_s}{R_2} + \frac{V_s}{R_3} + \cdots = I$$

$$V_s \left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots \right] = I$$

$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \cdots \frac{1}{R_m}}$$

Cases :

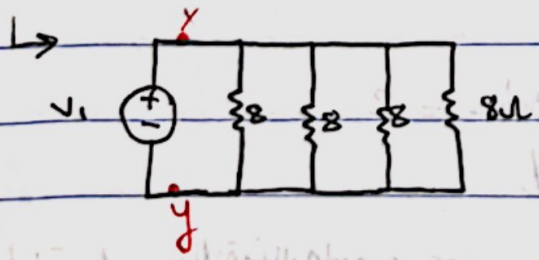
1. If $m = 2$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \longrightarrow R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

2. If $R_1 = R_2 = R_3 = \cdots = R_m$

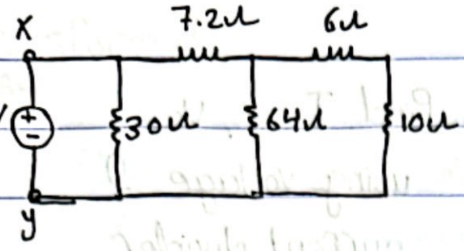
$$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \cdots + \frac{1}{R} = \frac{m}{R}$$

$$R_{eq} = \frac{R}{m} \quad \frac{\text{قيمة وحدة منهم}}{\text{عددهم}}$$



$$R_{xy} = \frac{8}{4} = 2\Omega$$

Ex:

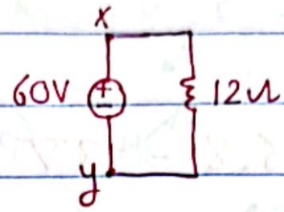


1. calculate R_{xy}

$((6+10)//64) = 12.8$

$(20 // 30) = 12$

$R_{xy} = 12$



2. calculate I

$V = RI \qquad 60 = 12\,I \qquad I = 5A$

Voltage Divider

لما نستخدم مقاومات على التوالي

$-V_s + R_1 I + R_2 I = 0$

$I(R_1 + R_2) = V_s$

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

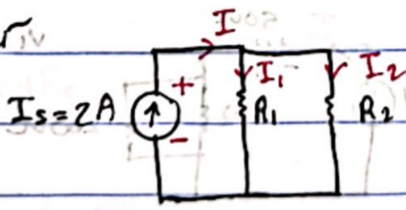
$V_1 = R_1 I = \frac{R_1}{R_1 + R_2}$

1. $R_{eq} = R_1 + R_2$
2. $I_s = \frac{V_s}{R_{eq}}$
3. $V_1 = R_1 I_s = \frac{R_1}{R_1 + R_2} V_s$

$V_2 = R_2 I_s$

$V_2 = R_2 I = \frac{R_2}{R_1 + R_2} V_s$

Current Divider



$V = R_1 I_1 = R_2 I_2 = (R_1 // R_2) I$

$I_1 = \frac{R_{eq}}{R_1} \cdot I_s$

$I_2 = \frac{R_{eq}}{R_2} \cdot I_s$

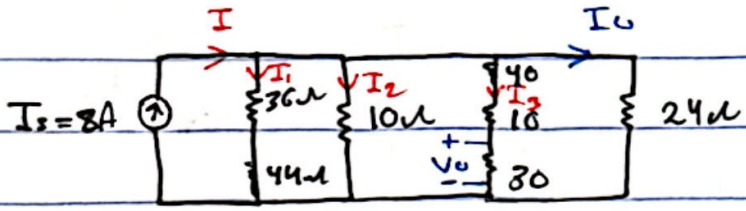
التيار الكلي الداخل للتفرع

$i_1 = \frac{R_2}{R_2 + R_1} i_s$

$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$

$I_1 = \frac{R_2}{R_1 + R_2} \cdot I_s$

$i_2 = \frac{R_1}{R_1 + R_2} i_s$



Find I_o, V_o using voltage & current divider.

$R_{eq} = 6\Omega$

$V = RI \rightarrow V = 6 \cdot 8 = 48\,V$

$48 = I_1 \cdot 80 \rightarrow I_1 = 0.6\ A$

$48 = 24\, I_o \quad I_o = 2A$

$48 = I_3 \cdot 80 \quad I_3 = 0.6A$

$V_o = I_3 \cdot 30 \quad V_o = 18\ V$

current $4/. - 1 - 2. = 1mA \downarrow$

Req للمقاومات على التوالي

Find I_o ?

$V = I_o R$

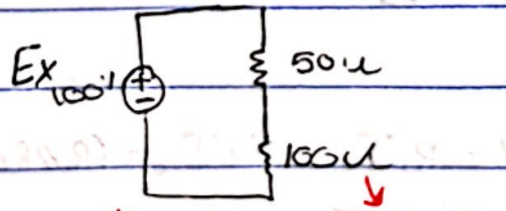
$V =$

$I_1 = -I_o$

$V_1 - V_2 = 0$

$12K\, I_1 - 4K\, I_2 = 0$

Ex



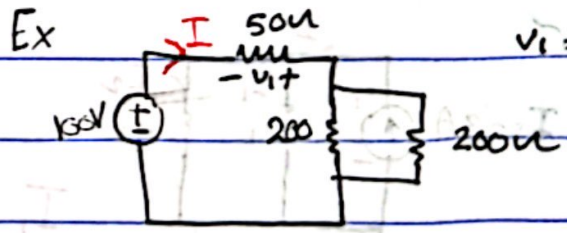
المقاومة الأكبر بتوخذ الجهد الأكبر

$R_{eq} = 150$

$I_s = \frac{V_s}{R_{eq}} = \frac{100}{150}$

$V_1 = \frac{50}{150} \cdot 100 = 33.33$

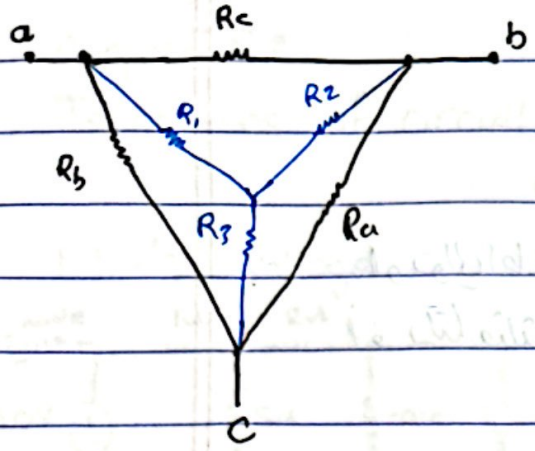
Ex



$V_1 = ??$

$V_1 = (-)\frac{50}{100+50} \times 100$

Y - Δ Transformation

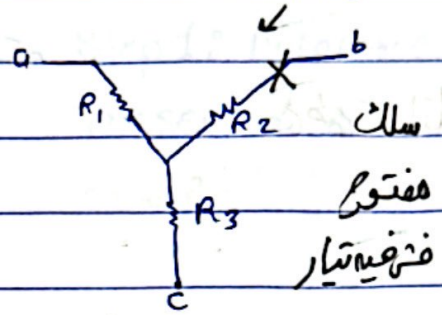


$R_{ab} = R_1 + R_2 = (R_a + R_b) // R_c$

$R_{bc} = R_2 + R_3 = (R_c + R_b) // R_a$

لو بشوف بس الأزرق

$R_{ca} = R_1 + R_3 = (R_c + R_a) // R_b$



سلك مفتوح فرضياً

Y → Δ R_1, R_2, R_3 are given

$$R_a = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_1}$$ ← بقسمة Ra

$$R_b = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_2}$$

$$R_c = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_3}$$

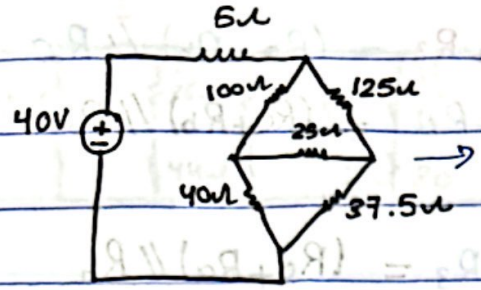
Δ → Y R_a, R_b, R_c are given

$$R_1 = \frac{\text{حاصل ضرب المجاورات}}{\text{المجموع}} = \frac{R_bR_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_aR_c}{R_a + R_b + R_c}$$

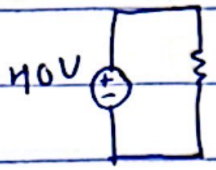
$$R_3 = \frac{R_aR_b}{R_a + R_b + R_c}$$

Ex

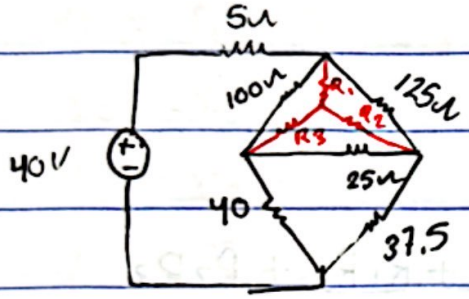


calculate I ?

نقدر نحلها توازي
أو توالي اما بعمل دلتا مثلث فوق
أو دلتا مثلث تحت



عن طريق دلتا

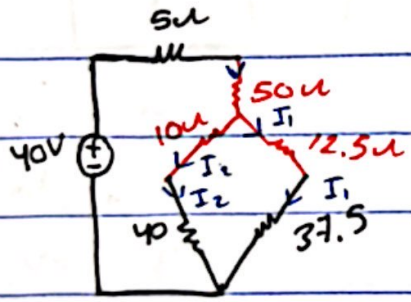


$R_1 = \frac{\text{حاصل ضرب المجاورات}}{\text{المجموع}} = \frac{100 \times 125}{125+125} = 50\Omega$

بتحول شكلها ل

$R_2 = \frac{125 \times 25}{250} = 12.5\Omega$

$R_3 = \frac{100 \times 25}{250} = 10\Omega$



صرت بقدر احلها
توالي وتوازي

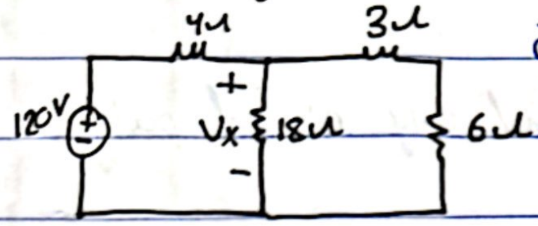
$$Req = [(12.5+37.5) // (10+40)] + 50 + 5$$

$$= 25 + 55 = 80$$

$$I = \frac{V}{R} = \frac{40}{80} = 0.5\,A$$

Extra on voltage & current divider

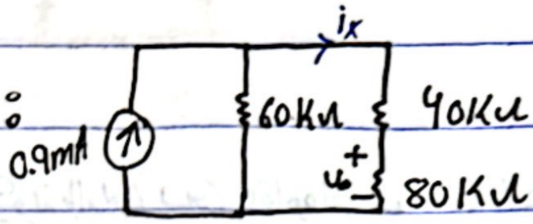
Ex:



نفس = يلي الهم نفس الفولتية

$V_x = \frac{(18//9)}{(18//9)+4} \times 120 = \frac{6}{10} = 72$

Ex:



find Vo ?

للأفي orientation

$V_o = (80K)\,(i_x)$

$= (80K)\left(\frac{60K}{60K + (40+80K)}\right)$ العكس / العكس+الكل $\cdot\ 0.9\,mA$

$= 24\,V$

Ex: