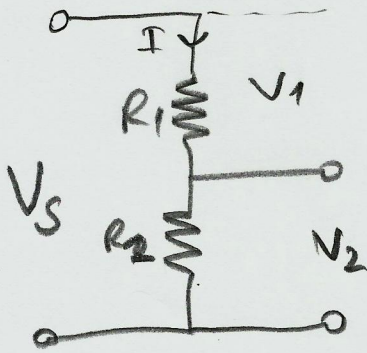


Voltage Divider

(1)



$$I = \frac{V_s}{R_1 + R_2} \Rightarrow V_1 = R_1 \cdot I = R_1 \cdot \frac{V_s}{R_1 + R_2}$$

$$V_1 = \frac{R_1}{R_1 + R_2} \cdot V_s$$

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

Example-1

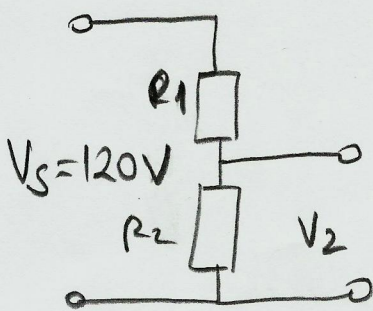


Figure-1

In Fig.1, total power of R_1 and R_2 is 30W. Voltage of R_2 is 20V. ($V_2 = 20V$) Then

a) Calculate $R_1 = ?$, $R_2 = ?$

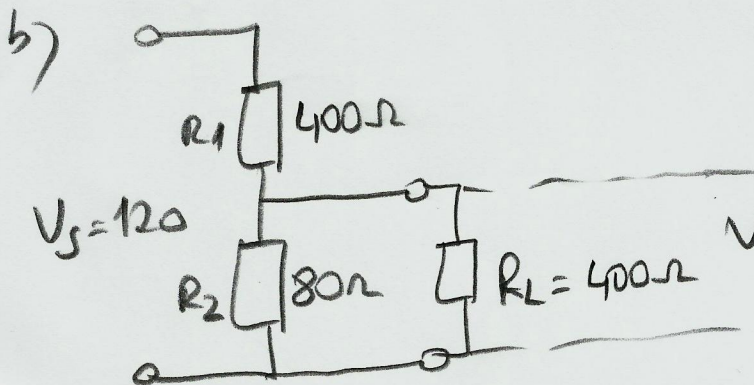
b) The load $R_L = 400\Omega$ is connected as parallel to R_2 . Then calculate $V_2' = ?$

Solution

$$a) P_T = 30W = \frac{V_s^2}{R_1 + R_2} \Rightarrow 30 = \frac{120^2}{R_1 + R_2} \Rightarrow R_1 + R_2 = 480\Omega$$

$$\frac{V_2}{V_s} = \frac{20}{120} = \frac{R_2}{R_1 + R_2} \Rightarrow \frac{1}{6} = \frac{R_2}{480} \Rightarrow R_2 = 80\Omega$$

$$R_1 + R_2 = 480 \Rightarrow R_1 = 480 - R_2 = 480 - 80 \Rightarrow R_1 = 400\Omega$$



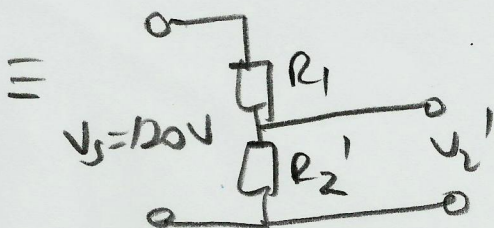
$$R_2' = R_2 \parallel R_L$$

$$R_2' = \frac{R_2 \cdot R_L}{R_2 + R_L} = \frac{80 \cdot 400}{80 + 400}$$

$$R_2' = 66,67\Omega$$

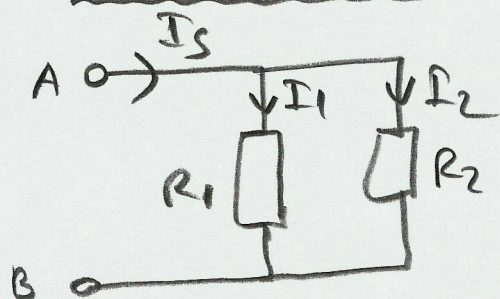
$$V_2' = \frac{R_2'}{R_1 + R_2'} \cdot V_s = \frac{66,67}{400 + 66,67} \cdot 120$$

$$V_2' = 17,14V$$



Current Divider

(2)



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

$$V_{AB} = R_{eq} \cdot I_s$$

$$V_{AB} = \frac{R_1 \cdot R_2}{R_1 + R_2} \cdot I_s$$

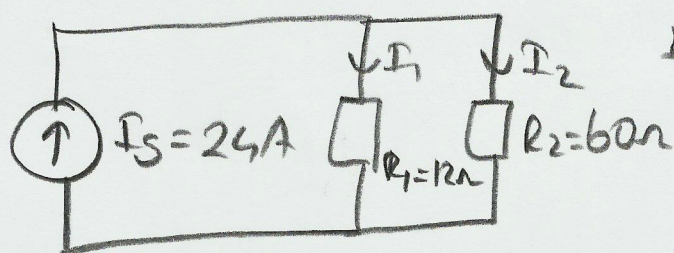
$$I_1 = \frac{V_{AB}}{R_1} = \left(\frac{R_1 \cdot R_2}{R_1 + R_2} \cdot I_s \right) \frac{1}{R_1} \Rightarrow \boxed{I_1 = \frac{R_2}{R_1 + R_2} \cdot I_s}$$

$$I_2 = \frac{V_{AB}}{R_2} = \left(\frac{R_1 \cdot R_2}{R_1 + R_2} \cdot I_s \right) \frac{1}{R_2} \Rightarrow \boxed{I_2 = \frac{R_1}{R_1 + R_2} \cdot I_s}$$

Example

a) $I_2 = ?$

b) Tolerance of R_1 and R_2 resistor is $\pm 10\%$. Then calculate minimum and maximum value of I_2



Solution

$$I_2 = \frac{R_1}{R_1 + R_2} \cdot I_s = \frac{12}{12 + 60} \cdot 24 = 4A$$

I_2 is minimum when R_1 is min and R_2 is max.

$$I_{2min} = \frac{R_{1min}}{R_{1min} + R_{2max}} \cdot I_s = \frac{12 \cdot 0,9}{12 \cdot 0,9 + 60 \cdot 1,1} \cdot 24 \Rightarrow \boxed{I_{2min} = 3,37A}$$

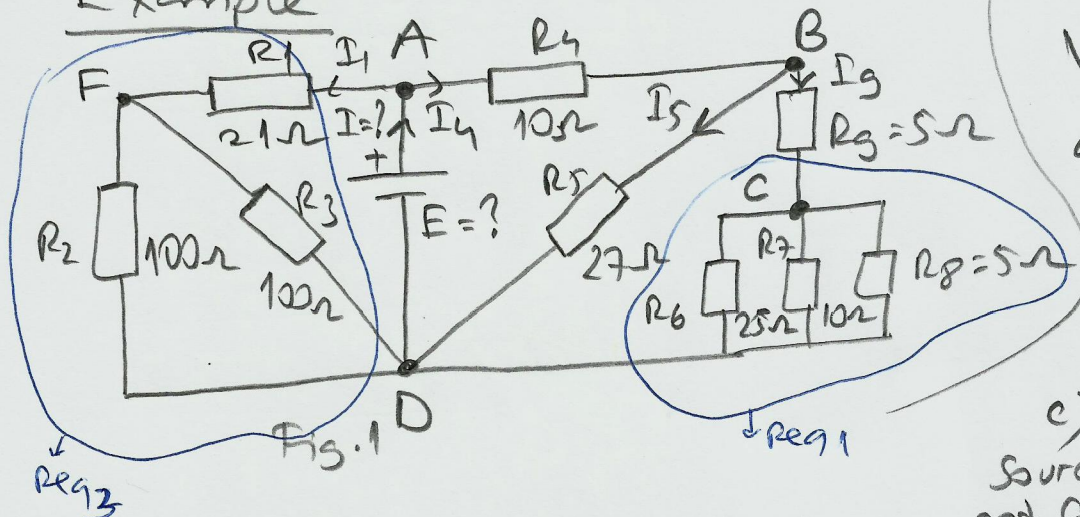
I_2 is maximum when R_1 is max and R_2 is min.

$$I_{2max} = \frac{R_{1max}}{R_{1max} + R_{2min}} \cdot I_s = \frac{12 \cdot 1,1}{12 \cdot 1,1 + 60 \cdot 0,9} \cdot 24$$

$$\boxed{I_{2max} = 4,71A}$$

3

Example



In Fig. 1

$V_{BD} = 270\text{ V}$ then

a) Calculate Voltage of source

$E = ?$ Calculate

b) Current of source

$I = ?$

c) Calculate charge of source ($Q = It$) as Amper-hour and Coulombs for a day

Solution

$$a) R_{eq1} = R_6 // R_7 // R_8 \Rightarrow \frac{1}{R_{eq1}} = \frac{1}{25} + \frac{1}{10} + \frac{1}{5} \Rightarrow R_{eq1} = \frac{50}{17} \Omega$$

$$R_{eq2} = R_9 + R_{eq1} = 5 + \frac{50}{17} = \frac{135}{17} \Omega \Rightarrow I_9 = \frac{V_9}{R_{eq2}} = \frac{V_{BD}}{R_{eq2}} = \frac{270}{\frac{135}{17}}$$

$$I_9 = 34\text{ A} \quad I_5 = \frac{V_5}{R_5} = \frac{V_{BD}}{R_5} = \frac{270}{27} = 10\text{ A}$$

$$I_4 = I_5 + I_9 = 10 + 34 \Rightarrow I_4 = 44\text{ A}$$

$$V_{AB} = V_4 = R_4 \cdot I_4 = 10 \cdot 44 = 440\text{ V}$$

$$E = V_{AD} = V_4 + V_5 = V_{AB} + V_{BD} = 440 + 270$$

$$E = 710\text{ V}$$

$$b) R_{eq3} = R_1 + \frac{R_2 \cdot R_3}{R_2 + R_3} = 21 + \frac{100 \cdot 100}{100 + 100} = 71 \Omega$$

$$I_1 = \frac{E}{R_{eq3}} = \frac{710}{71} = 10\text{ A}$$

$$I = I_1 + I_4 = 10 + 44 \Rightarrow I = 54\text{ A}$$

$$c) Q = I \cdot t = 54 \cdot 24 = 1296\text{ Ah}$$

$$Q = I \cdot t = 54 \cdot 24 \cdot 3600 = 4,661,760\text{ C}$$

$$1\text{ h} = 60\text{ min} = 60 \cdot 60 = 3600\text{ s}$$