



# Sinais e Sistemas Electrónicos

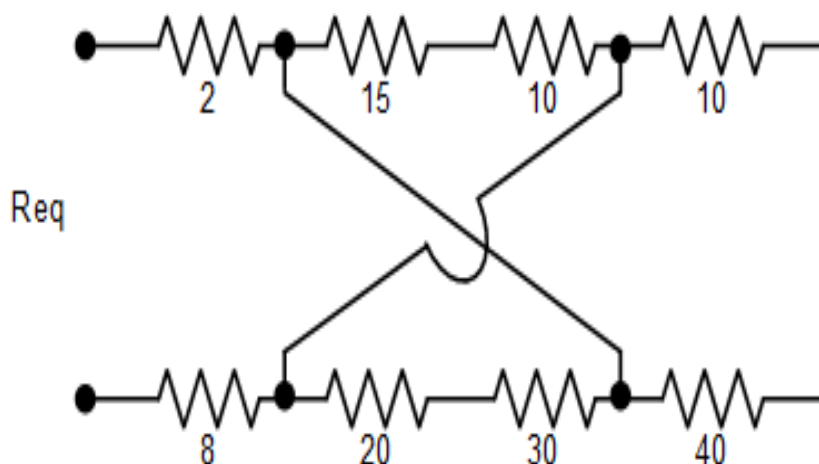
## Problemas resolvidos II

Ernesto Martins  
[evm@ua.pt](mailto:evm@ua.pt)  
 DETI (gab. 4.2.38)  
 Universidade de Aveiro



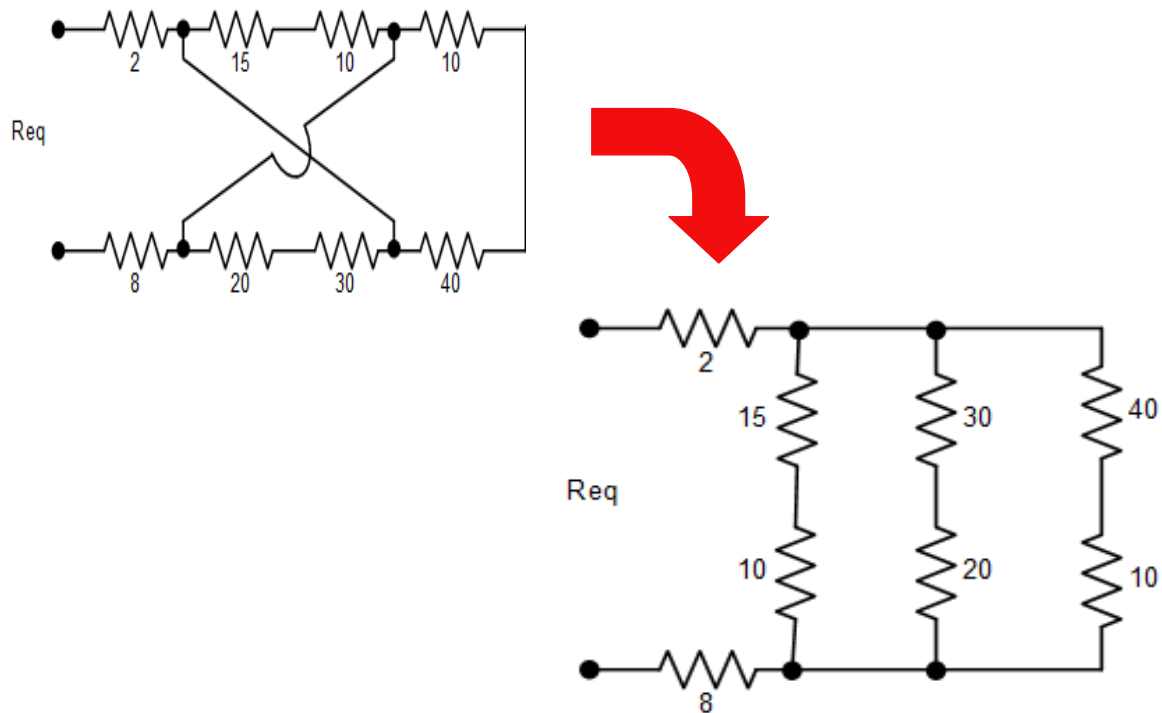
Sinais e Sistemas Electrónicos – 2022/2023

**1 - Calcule  $R_{eq}$**  (valores das resistências em  $\Omega$ )



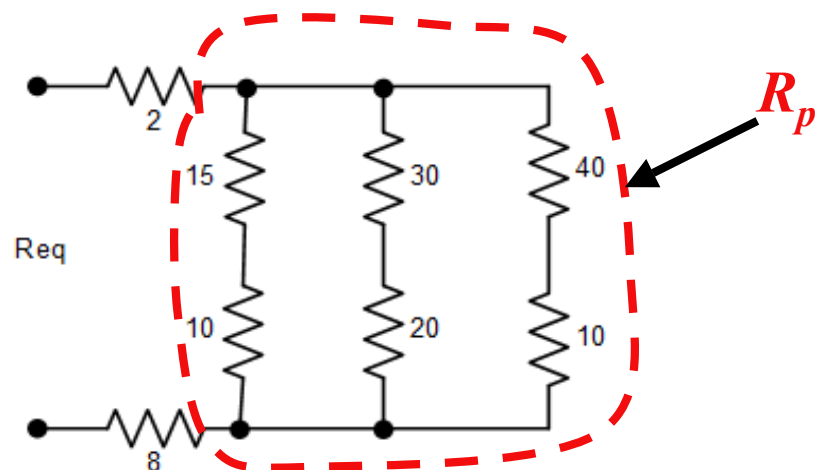
Prob. 23-b

**1º Passo: redesenhar o circuito de maneira a evidenciar séries e paralelos...**



II-3

**2º Passo: associar resistências por partes...**

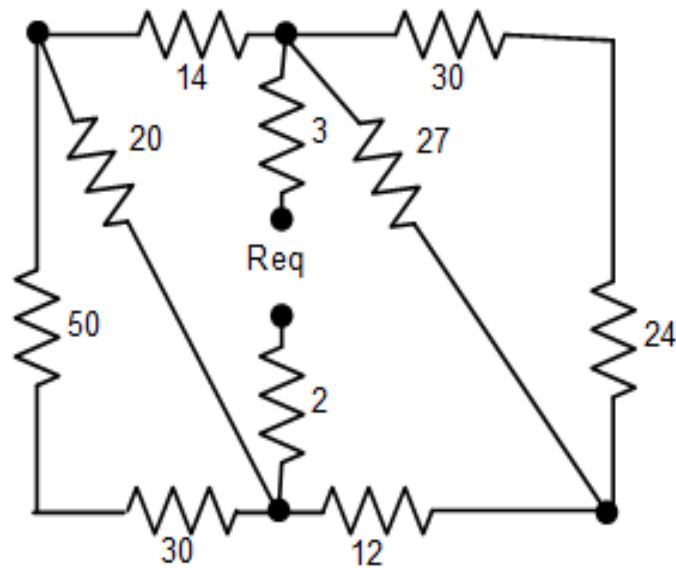


$$\frac{1}{R_p} = \frac{1}{15+10} + \frac{1}{30+20} + \frac{1}{40+10} \Leftrightarrow R_p = 12.5\Omega$$

$$R_{eq} = 2 + R_p + 8 = 22.5\Omega$$

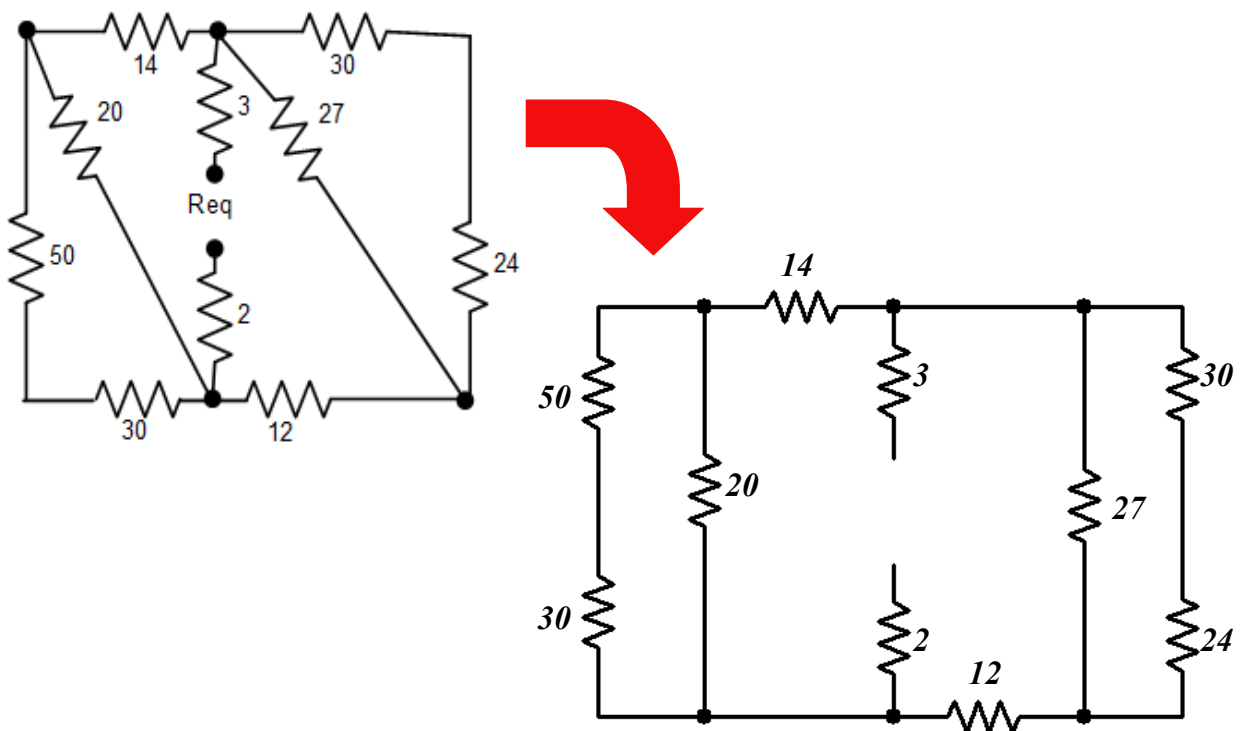
II-4

## 2 - Calcule *Req* (valores das resistências em *Ohm*)



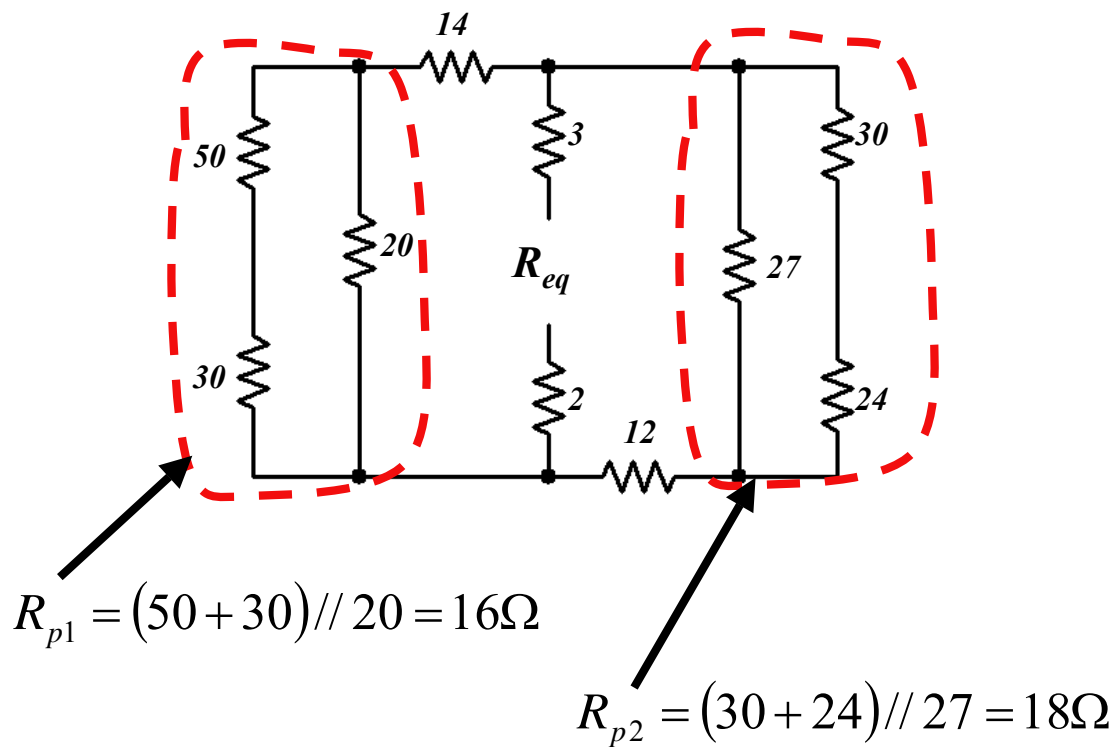
II-5

**1º Passo:** redesenhar o circuito de maneira a evidenciar séries e paralelos (e evitar elementos oblíquos)...



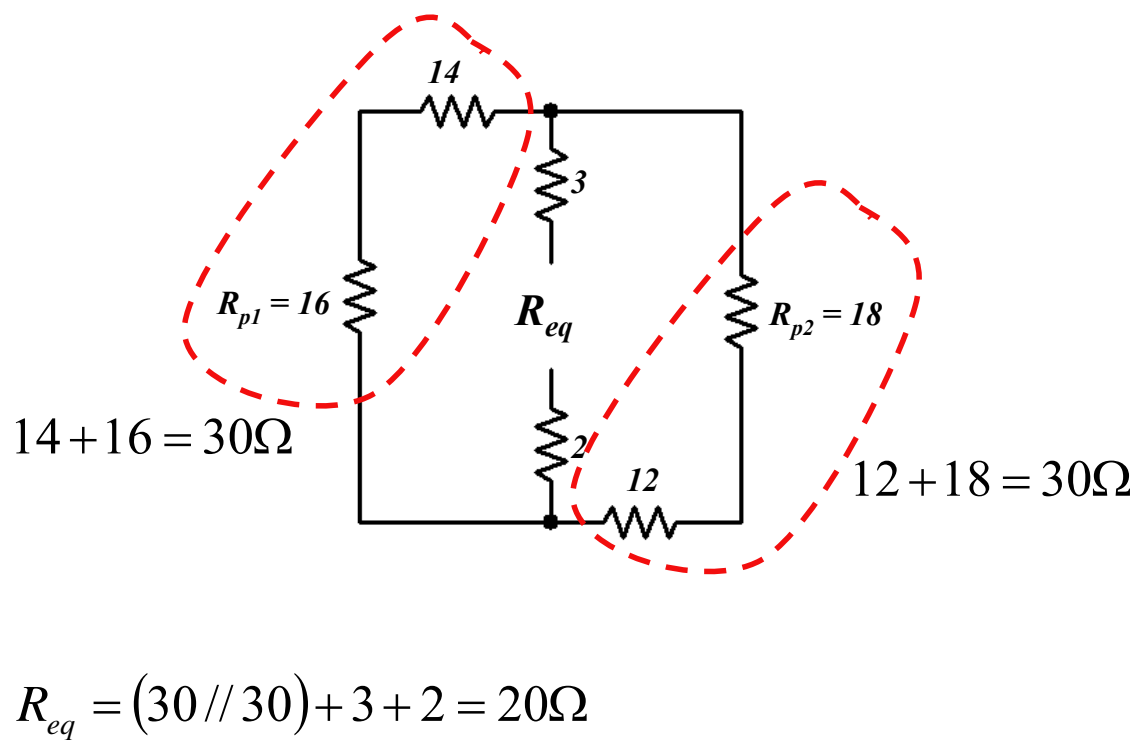
... 3

## 2º Passo: associar resistências por partes...



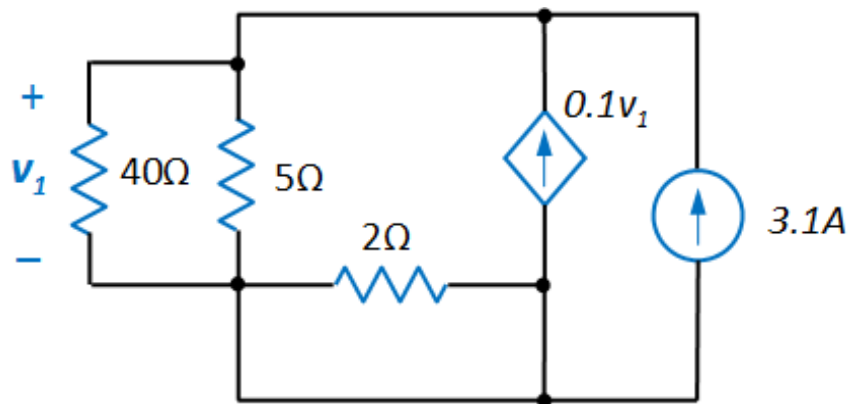
II-7

## 3º Passo: associar o resto...



II-8

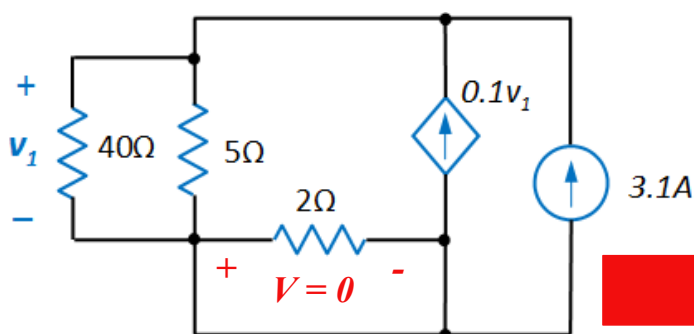
### 3 - Calcule a potência absorvida por cada um dos elementos do circuito.



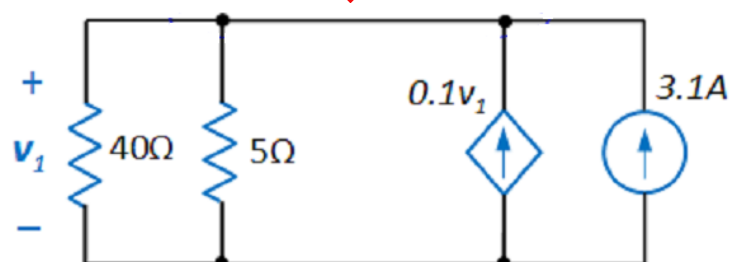
Prob. 19

II-9

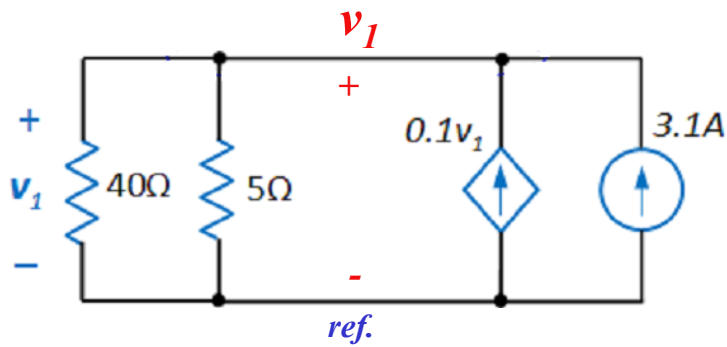
#### 1º Passo: redesenhar o circuito...



$$P_{2\Omega} = 0W$$



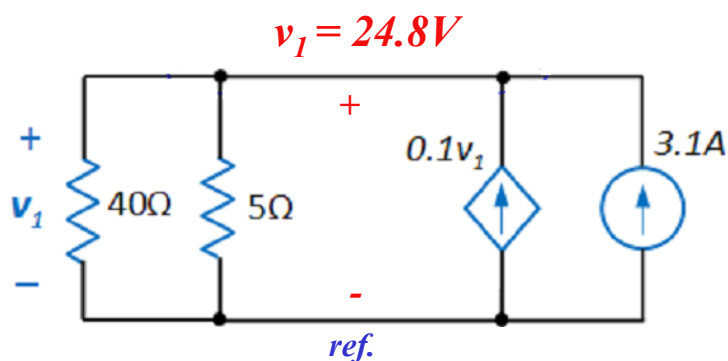
II-10

**2º Passo: aplicar Análise Nodal...**

$$\frac{v_1}{40} + \frac{v_1}{5} - 0.1v_1 - 3.1 = 0$$

$$v_1 = 24.8V$$

II-11

**3º Passo: calculamos a potências absorvidas****Resistências:**

$$P_{40\Omega} = \frac{(v_1)^2}{40} = \frac{(24.8)^2}{40} = 15.4W$$

$$P_{5\Omega} = \frac{(v_1)^2}{5} = 123W$$

**Fontes:**

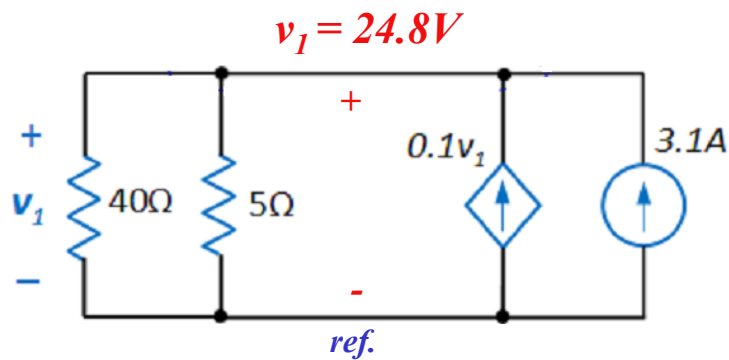
$$P_{0.1v_1} = V \times I = -v_1(0.1v_1) = -61.5W$$

$$P_{3.1} = V \times I = -v_1(3.1) = -76.9W$$

● Ambas as fontes fornecem energia!

II-12

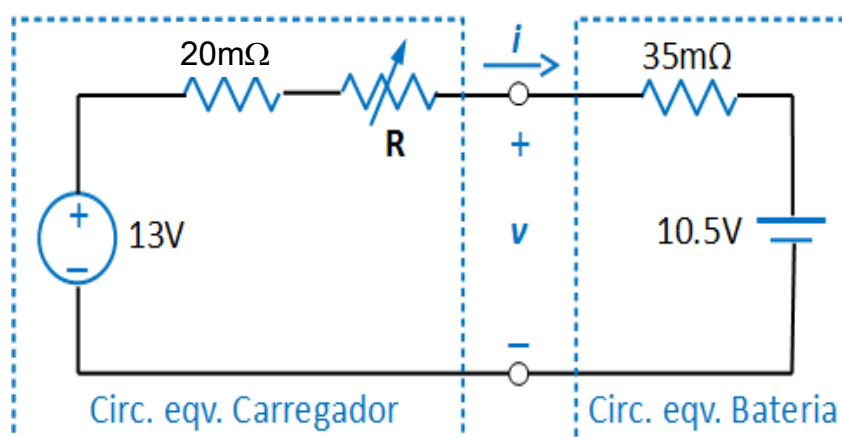
#### 4º Passo: verificar o balanço das potências



$$\sum_i P_i = 15.4 + 123 - 61.5 - 76.9 = 0$$

II-13

#### 4 - Circuito representa um carregador ligado a uma bateria.



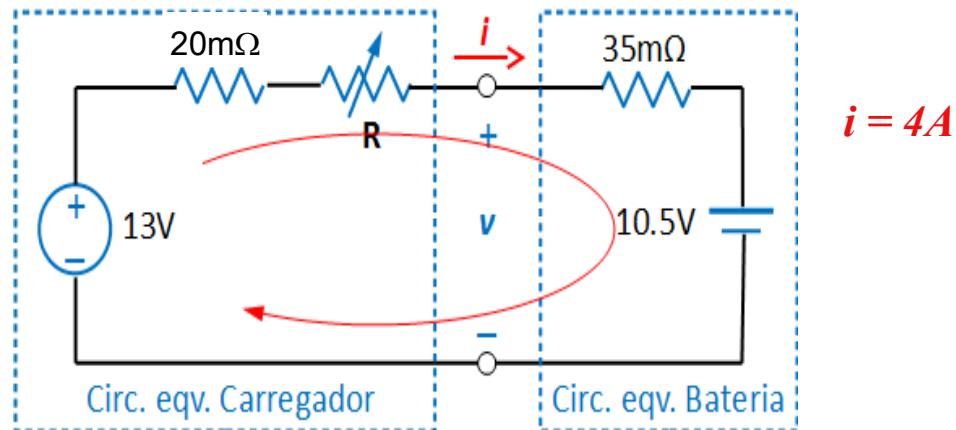
Prob. 20

Calcular o valor de  $R$  de maneira que:

- a) a corrente de carga seja  $4A$ ;
- b) a potência fornecida à bateria seja  $25W$ ;
- c) a tensão aos terminais da bateria seja  $11V$ .

II-14

## a) Aplicar KVL



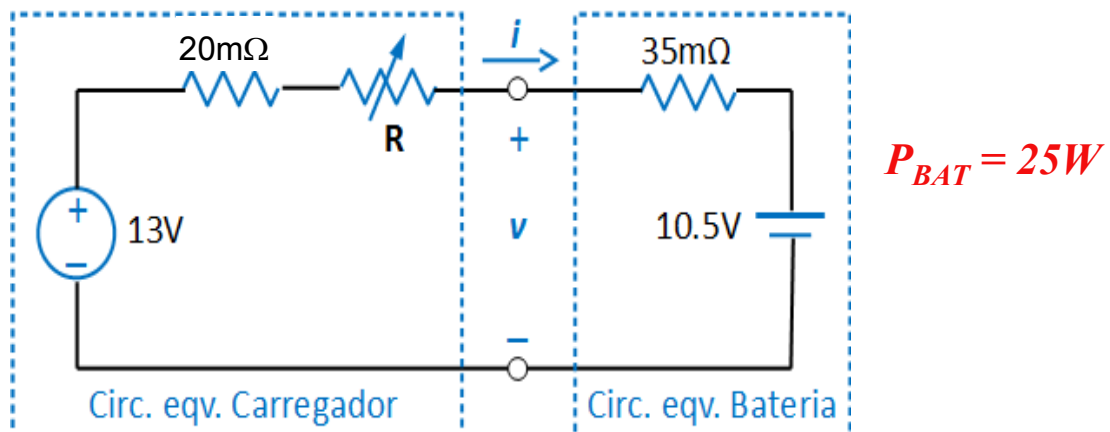
$$-13 + 0.02i + Ri + 0.035i + 10.5 = 0$$

$$R = \frac{2.5}{i} - 0.055$$

Para  $i = 4A$ ,  $R = 0.57\Omega$

II-15

## b) Começamos por calcular $i$ ...



$$P_{Bat} = 25$$

$$P_{Bat} = P_{35} + P_{10.5} = 25$$

$$0.035i^2 + 10.5i = 25$$

$$i^2 + 300i - 714.3 = 0$$

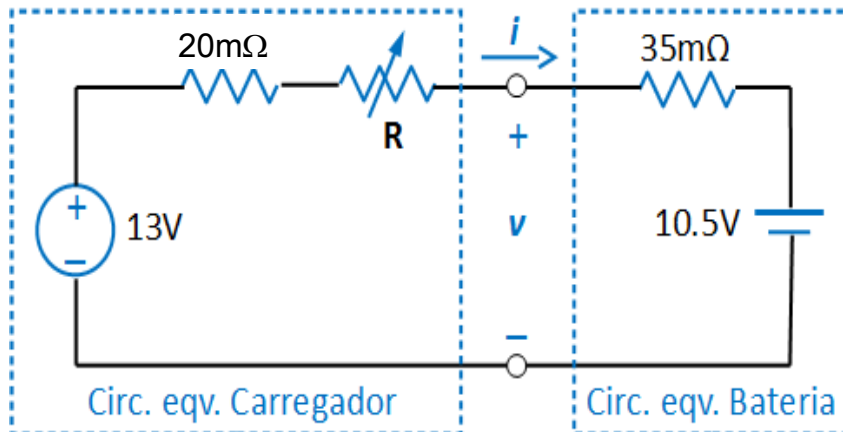
$$i = \frac{-300 \pm \sqrt{300^2 - 4(-714.3)}}{2}$$

$$i = 2.36A \quad \vee \quad i = -302.4A$$

II-16



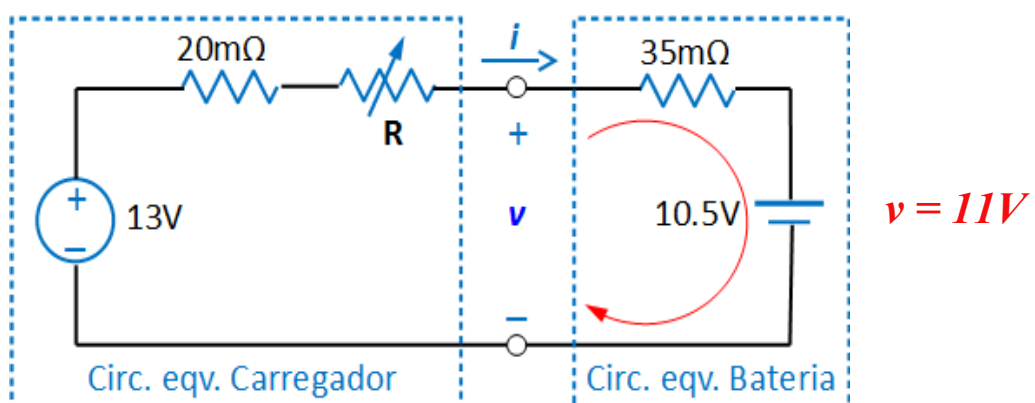
**b) ... e depois calculamos o valor de  $R$  para esse  $i$**



$$R = \frac{2.5}{i} - 0.055 \quad \text{Para } i = 2.36A, \mathbf{R = 1\Omega}$$

II-17

**c) Começamos por aplicar KVL no *loop* de saída para obter  $i$**



$$\begin{aligned} -11 + 0.035i + 10.5 &= 0 \\ i &= 14.29A \end{aligned}$$

$$R = \frac{2.5}{i} - 0.055$$

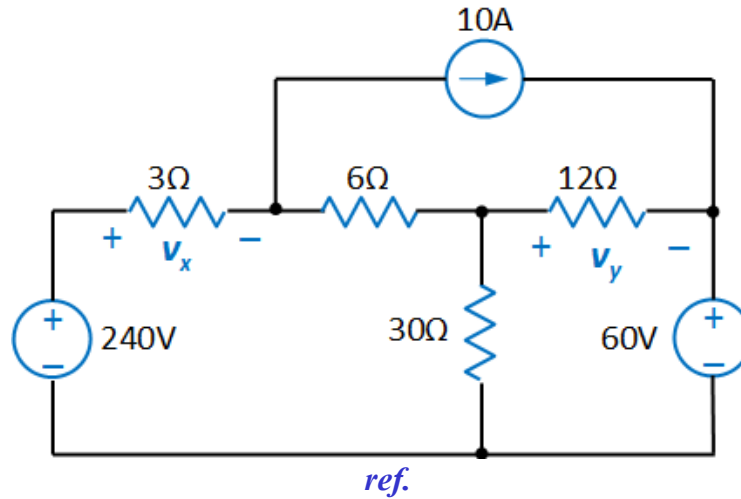
$$\text{Para } i = 14.29A, \mathbf{R = 0.12\Omega}$$

II-18

## 5 - Use a Análise Nodal para calcular

a)  $v_x$  e  $v_y$

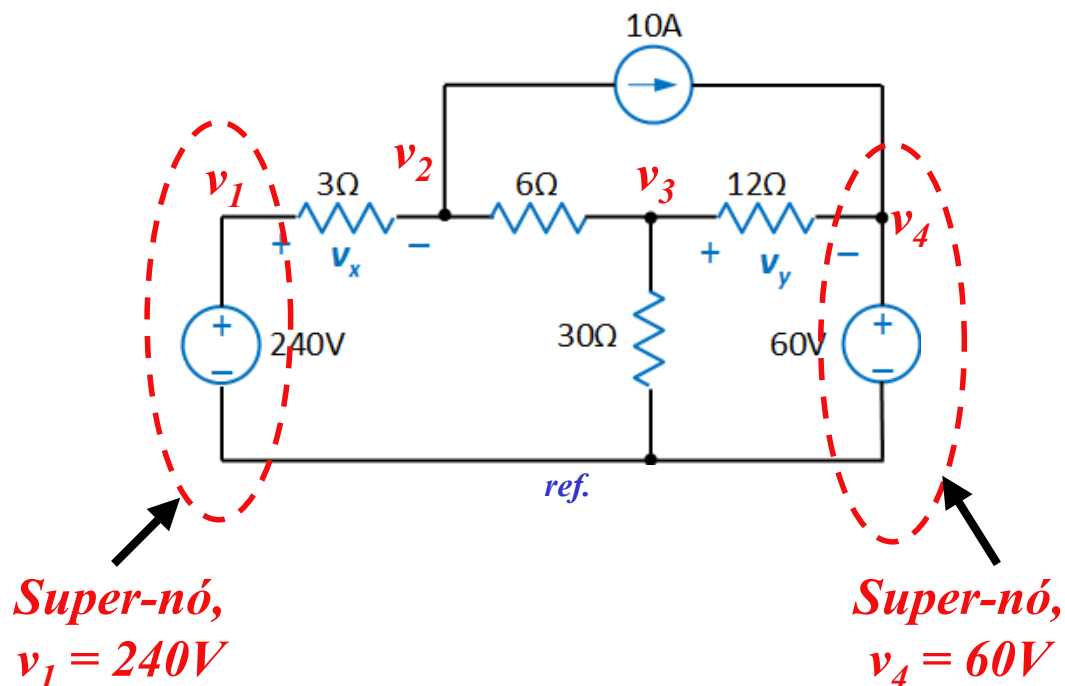
b) a potência absorvida pela resistência de  $6\Omega$



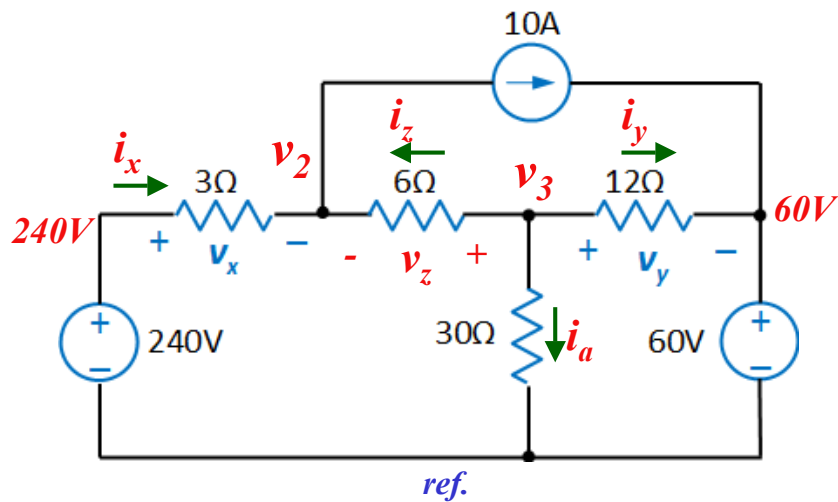
Prob. 25

II-19

**1º Passo:** identificar nós do circuito e tensões nodais...

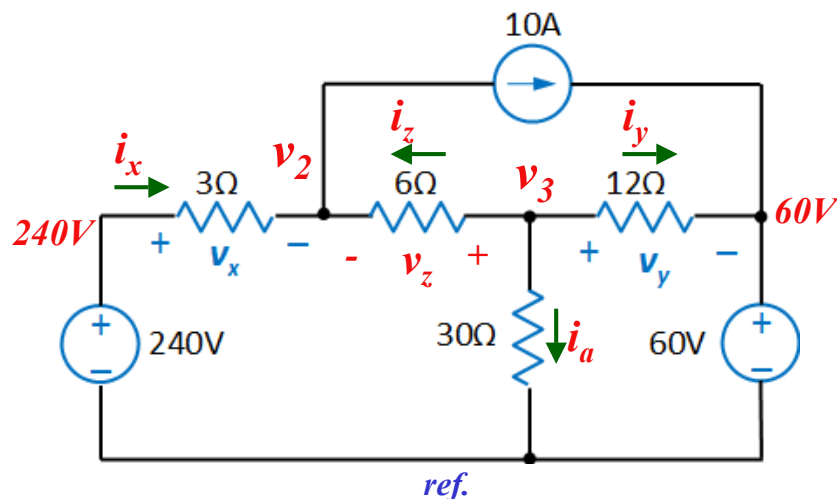


II-20

**2º Passo:** marcar correntes e tensões nas resistências...

**NOTA:** Os sentidos das correntes e as polaridades das tensões são **de referência** – por isso são arbitrárias!

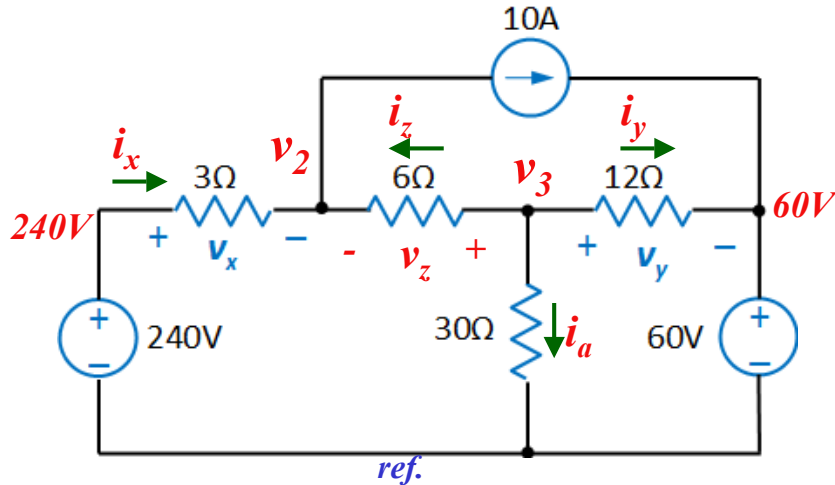
II-21

**3º Passo:** Aplicar KCL aos nós cuja tensão é desconhecida...

**Nó  $v_2$ :**  $i_x + i_z = 10$

**Nó  $v_3$ :**  $i_z + i_a + i_y = 0$

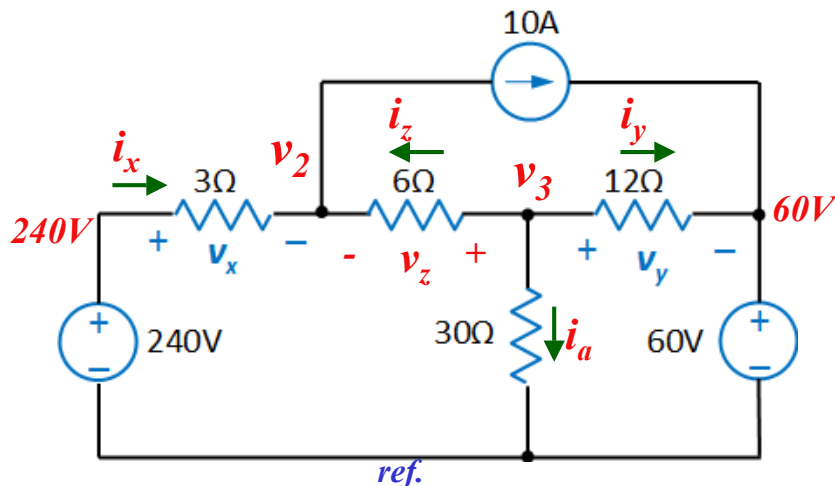
II-22

**4º Passo: Expressar correntes em função das tensões ...**

$$\text{Nó } v_2: i_x + i_z = 10 \Leftrightarrow \frac{v_x}{3} + \frac{v_z}{6} = 10$$

$$\text{Nó } v_3: i_z + i_a + i_y = 0 \Leftrightarrow \frac{v_z}{6} + \frac{v_3}{30} + \frac{v_y}{12} = 0$$

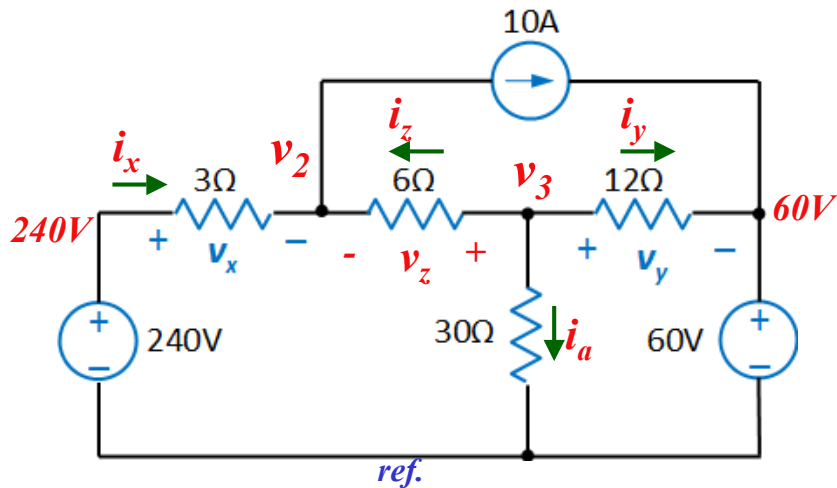
II-23

**5º Passo: Expressar correntes em função das tensões nodais...**

$$\text{Nó } v_2: \frac{v_x}{3} + \frac{v_z}{6} = 10 \Leftrightarrow \frac{240 - v_2}{3} + \frac{v_3 - v_2}{6} = 10$$

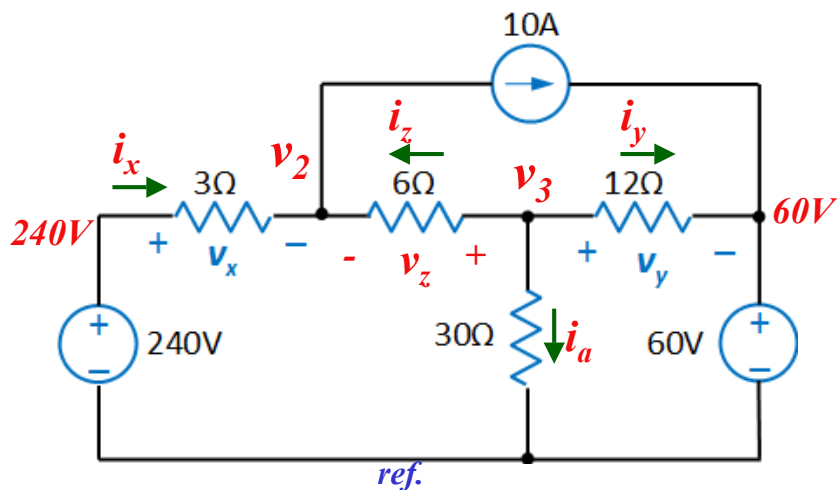
$$\text{Nó } v_3: \frac{v_z}{6} + \frac{v_3}{30} + \frac{v_y}{12} = 0 \Leftrightarrow \frac{v_3 - v_2}{6} + \frac{v_3}{30} + \frac{v_3 - 60}{12} = 0$$

II-24

**6º Passo: Resolver sistema de equações...**

$$\begin{cases} \frac{240 - v_2}{3} + \frac{v_3 - v_2}{6} = 10 \\ \frac{v_3 - v_2}{6} + \frac{v_3}{30} + \frac{v_3 - 60}{12} = 0 \end{cases} \quad \begin{cases} v_2 = 181.5V \\ v_3 = 124.4V \end{cases}$$

II-25

**7º Passo: Calcular o que é pedido.****a)**

$$v_x = 240 - v_2 = 58.5V$$

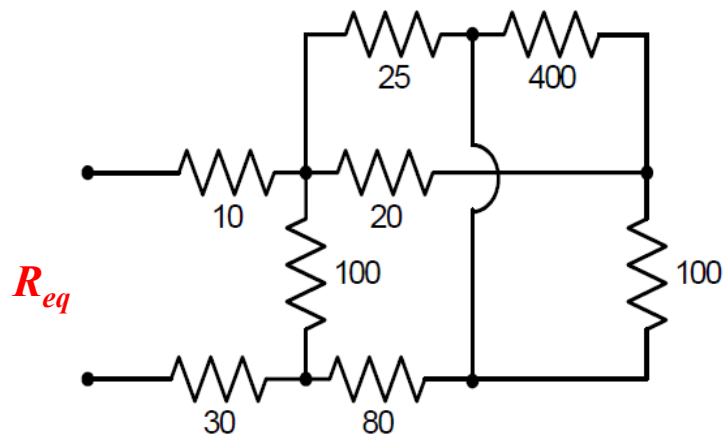
$$v_y = v_3 - 60 = 64.5V$$

**b)**

$$P_{6\Omega} = \frac{(v_z)^2}{6} = \frac{(v_3 - v_2)^2}{6} = 543.4W$$

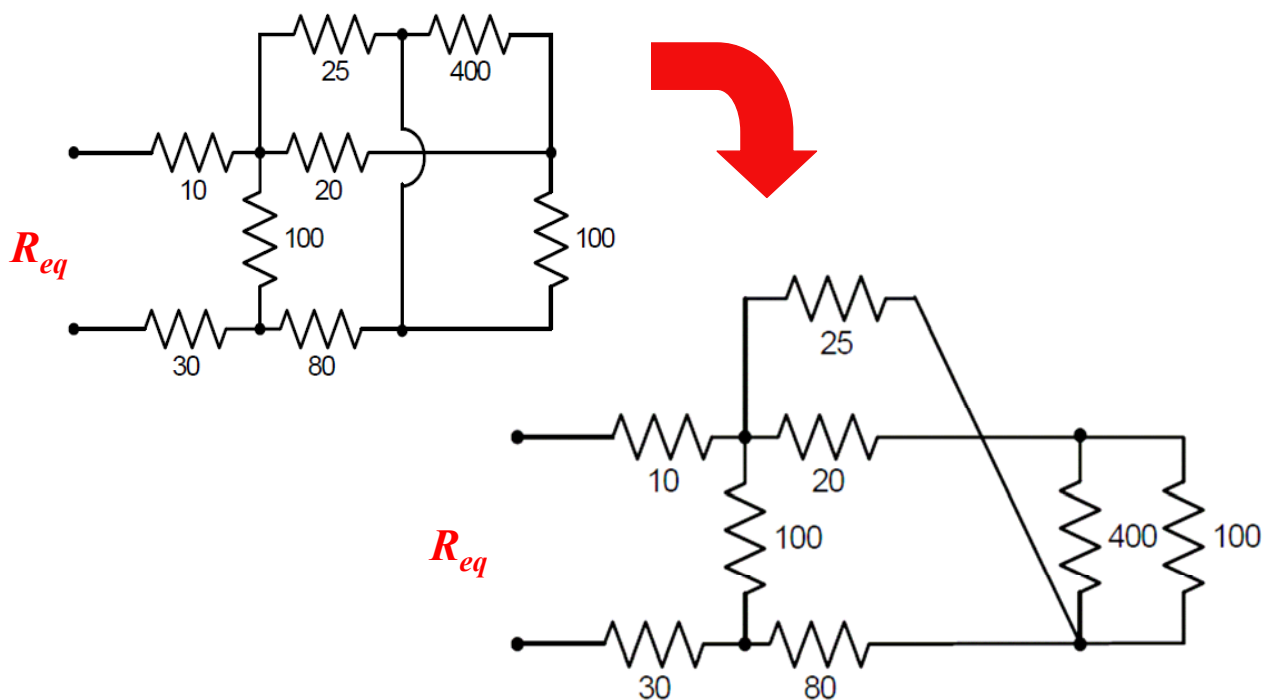
II-26

## 6 - Calcule $R_{eq}$ (valores das resistências em $\Omega$ )



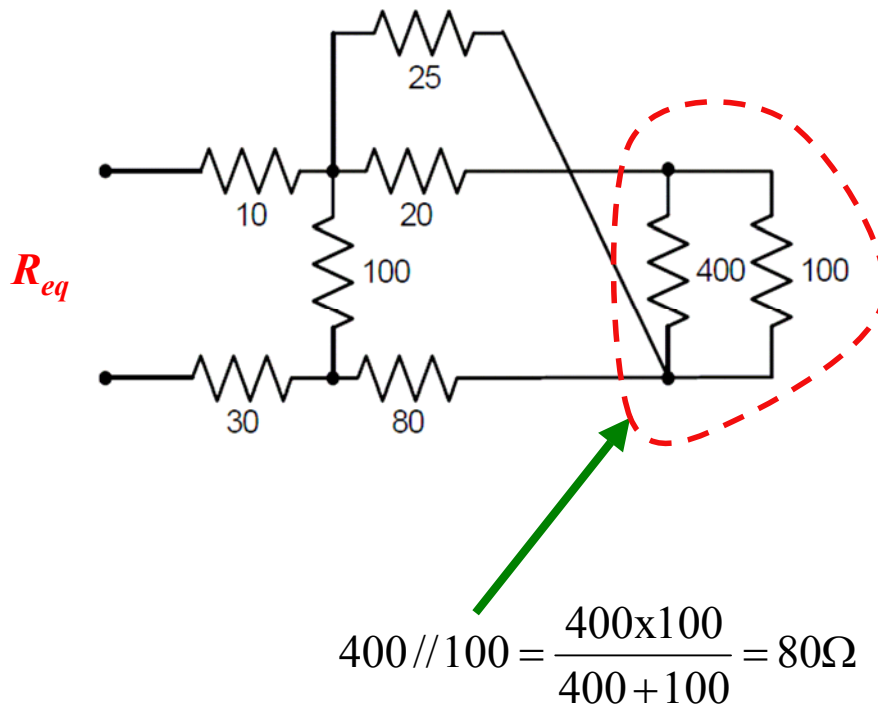
II-27

**1º Passo:** redesenhar o circuito de maneira a evidenciar séries e paralelos...

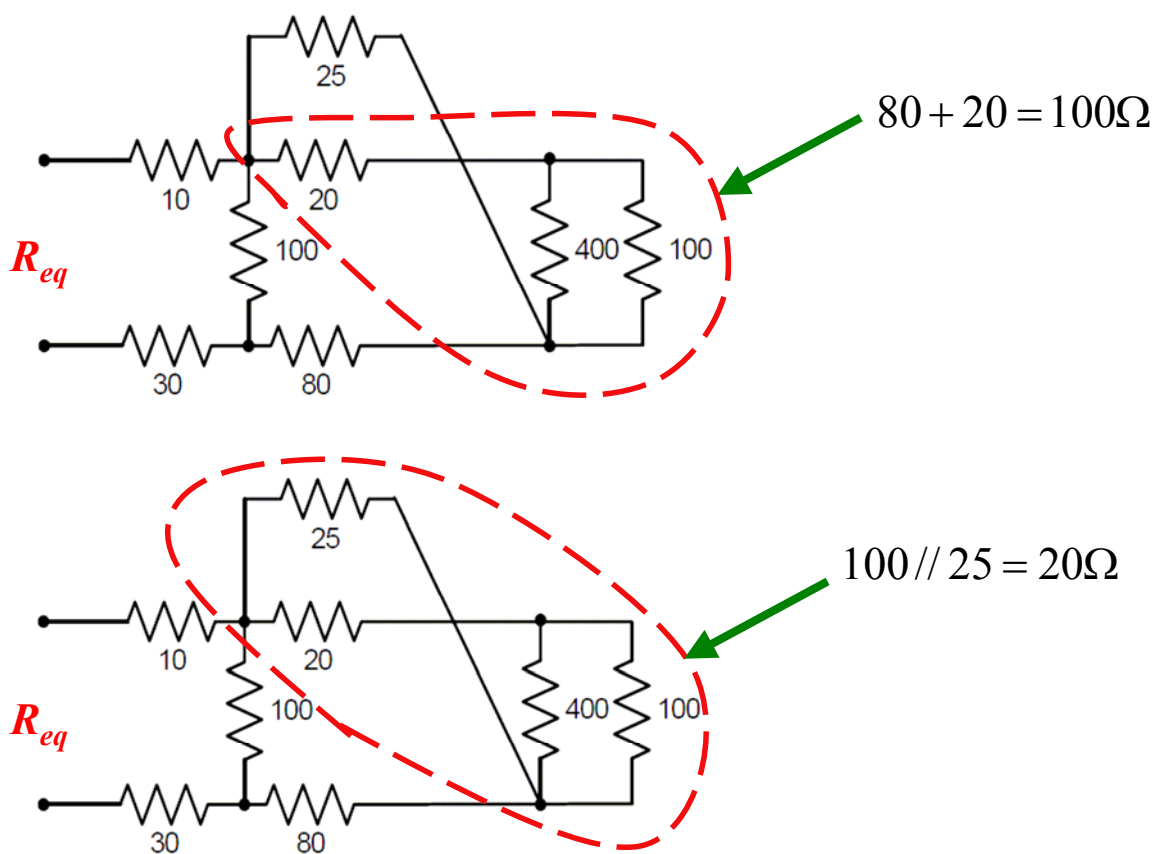


II-28

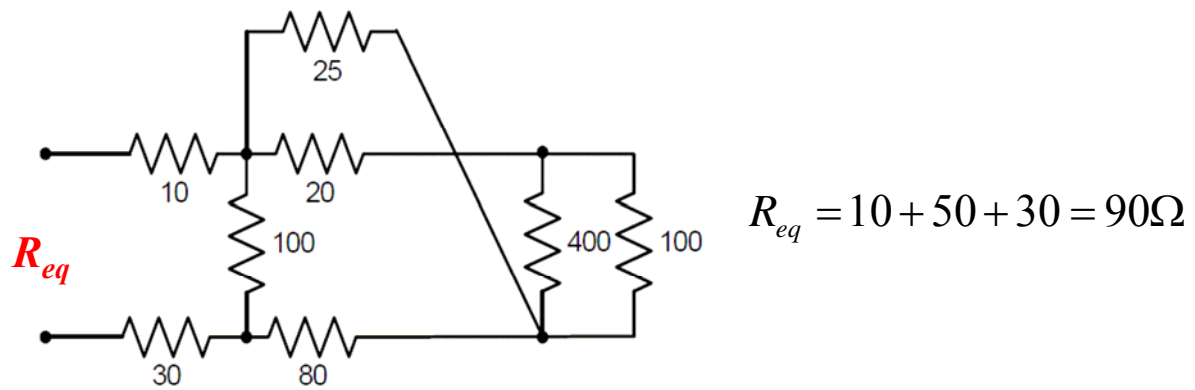
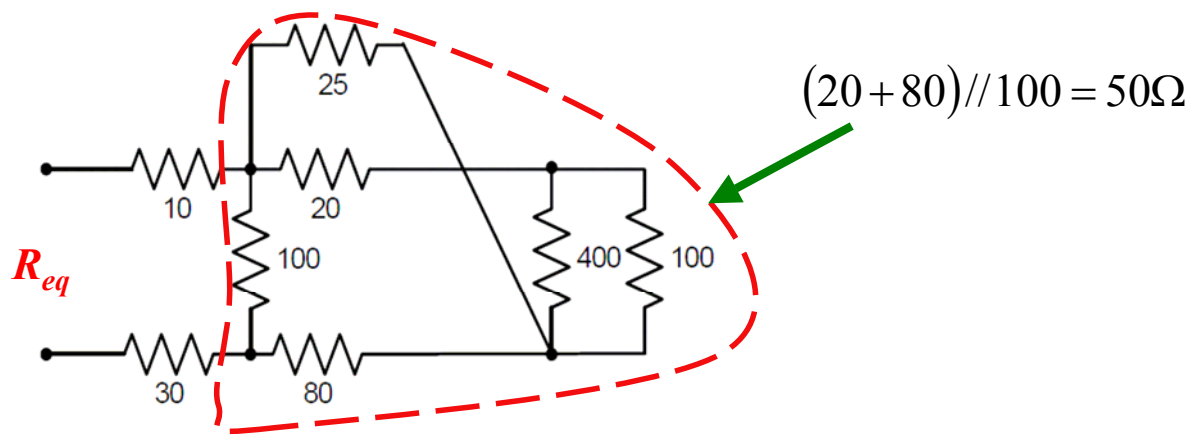
**2º Passo: Associar resistências gradualmente da direita para a esquerda...**



II-29

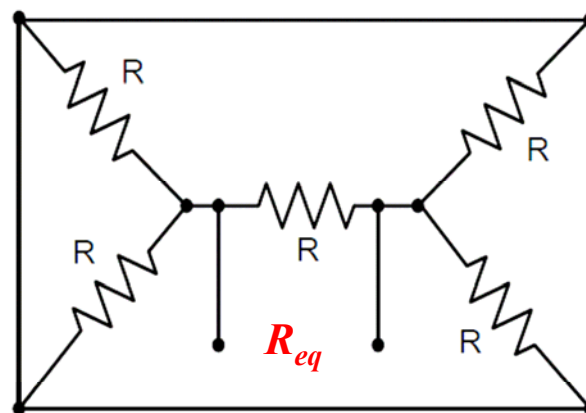


II-30



II-31

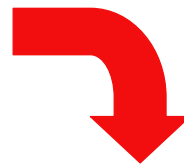
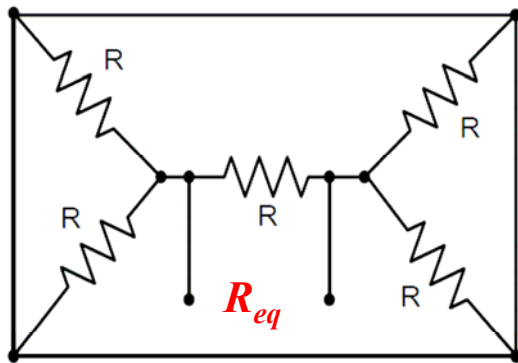
## 7 - Calcule $R_{eq}$



II-32

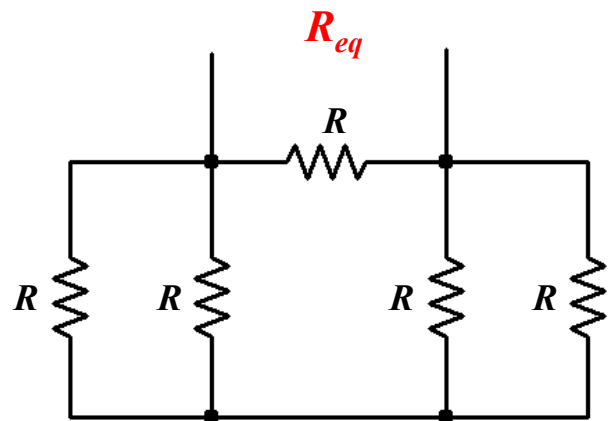


## Redesenhar o circuito de maneira a evidenciar séries e paralelos...



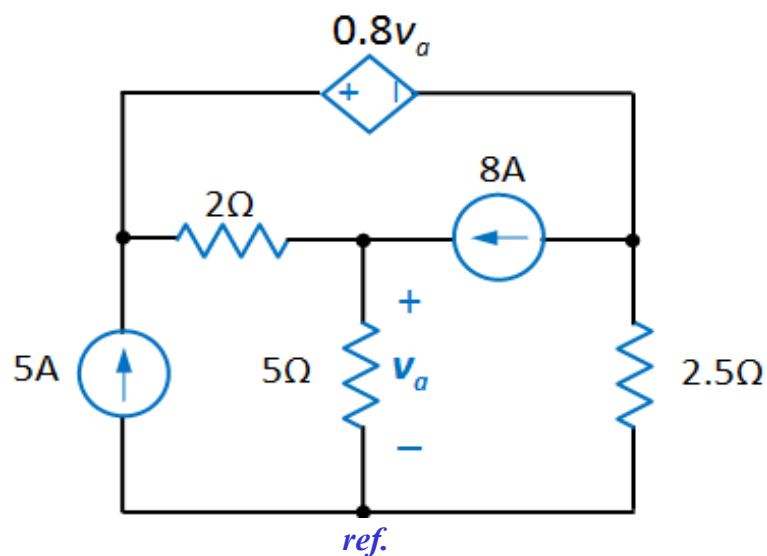
$$R_{eq} = R // [(R // R) + (R // R)]$$

$$R_{eq} = \frac{R}{2}$$



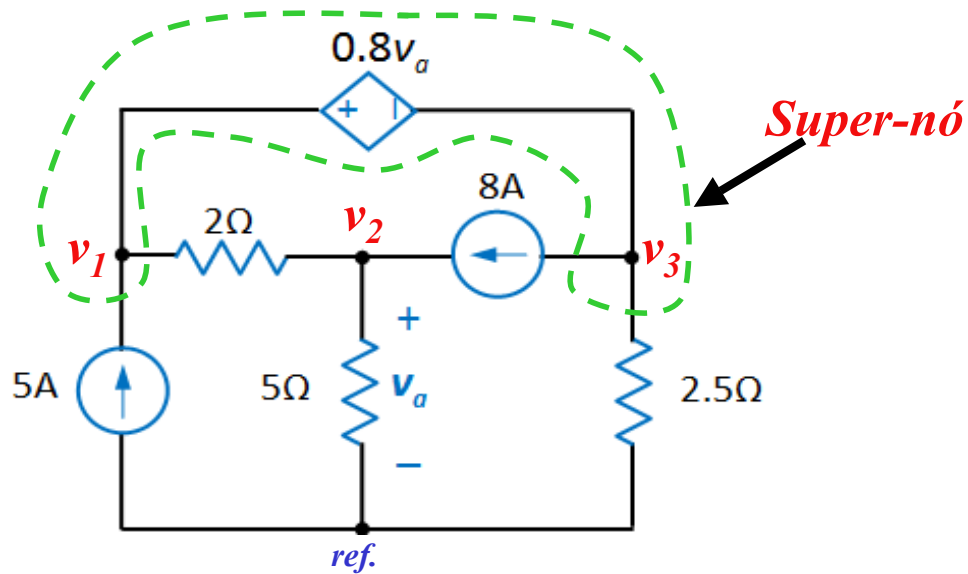
II-33

## 8 – Calcular $v_A$ usando Análise Nodal.

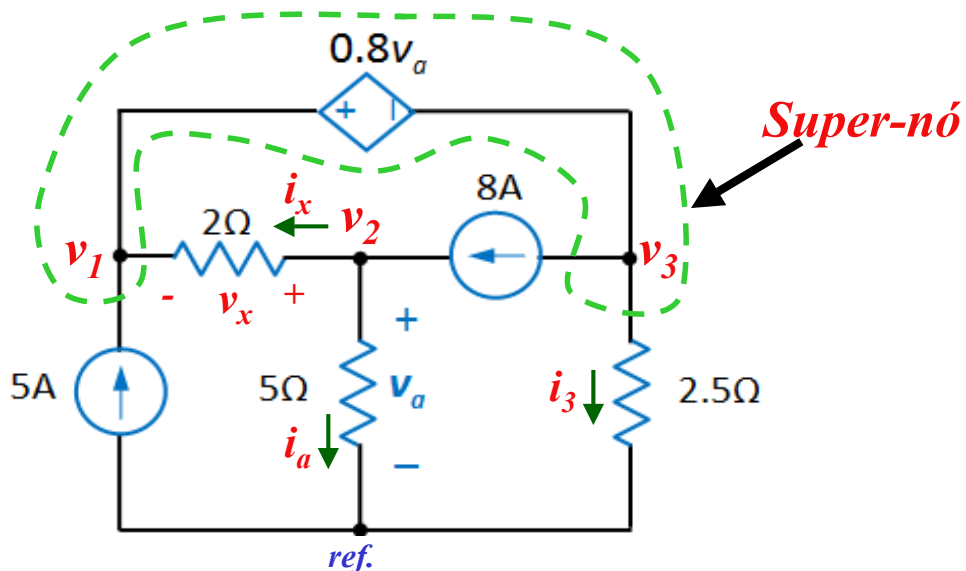


Prob. 28

II-34

**1º Passo: identificar nós do circuito e tensões nodais...**

II-35

**2º Passo: marcar correntes e tensões nas resistências...**

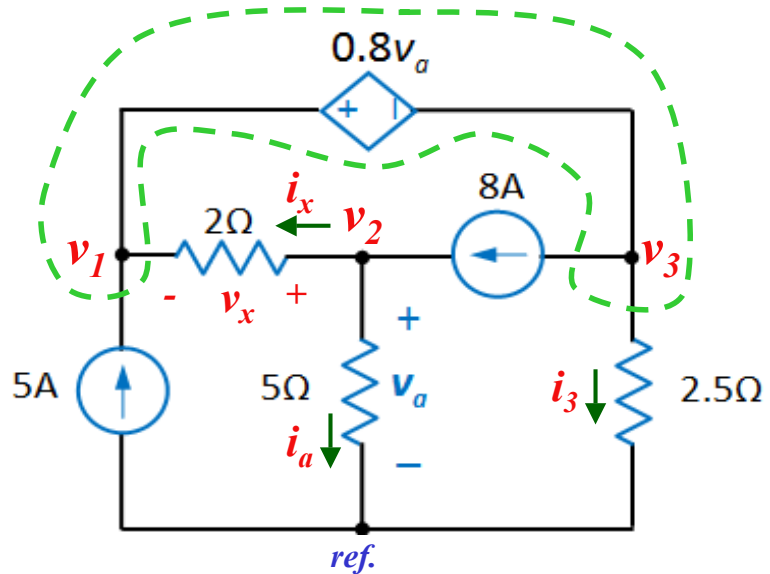
Mais uma vez, não esquecer que estas marcações têm sentidos e polaridades arbitrárias!

II-36

**3º Passo: Aplicar KCL aos nós cuja tensão é desconhecida...**

Temos que escrever  
**duas** equações  
nodais:

- nó  $v_2$  e
- Super-nó



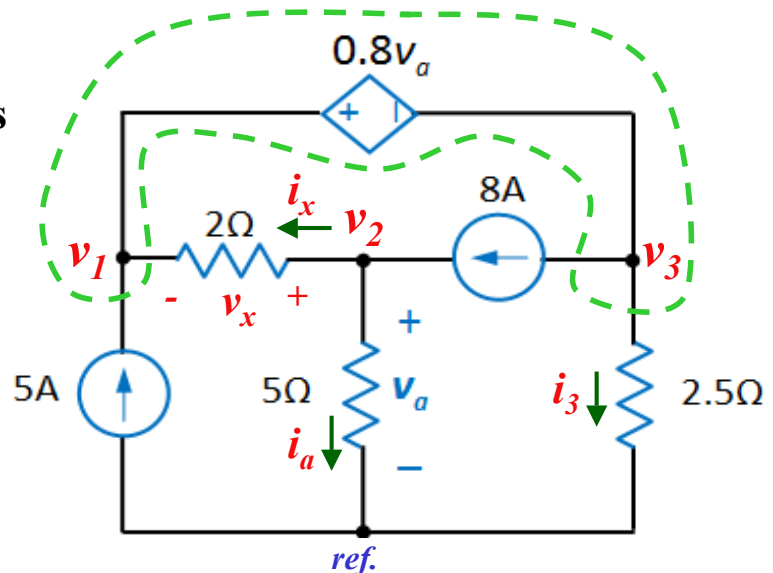
**Nó  $v_2$ :**  $i_x + i_a = 8$

**Super-nó:**  $i_3 + 8 = i_x + 5$

II-37

**4º Passo: Expressar  
correntes em função das  
tensões...**

Notar que  $v_a = v_2$

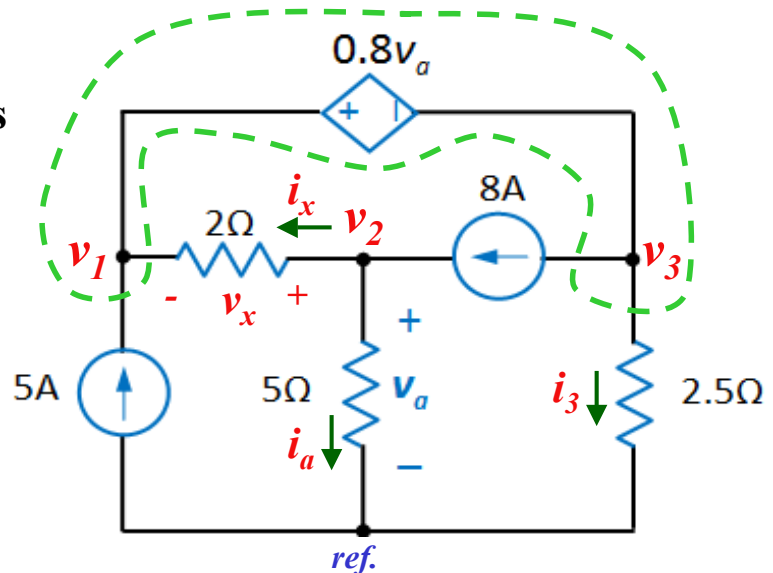


**Nó  $v_2$ :**  $i_x + i_a = 8 \Leftrightarrow \frac{v_x}{2} + \frac{v_2}{5} = 8$

**Super-nó:**  $i_3 + 8 = i_x + 5 \Leftrightarrow \frac{v_3}{2.5} + 8 = \frac{v_x}{2} + 5$

II-38

**5º Passo:** Expressar correntes em função das tensões nodais...



**Nó  $v_2$ :**  $\frac{v_x}{2} + \frac{v_2}{5} = 8 \Leftrightarrow \frac{v_2 - v_1}{2} + \frac{v_2}{5} = 8$

**Super-nó:**  $\frac{v_3}{2.5} + 8 = \frac{v_x}{2} + 5 \Leftrightarrow \frac{v_3}{2.5} + 8 = \frac{v_2 - v_1}{2} + 5$

II-39

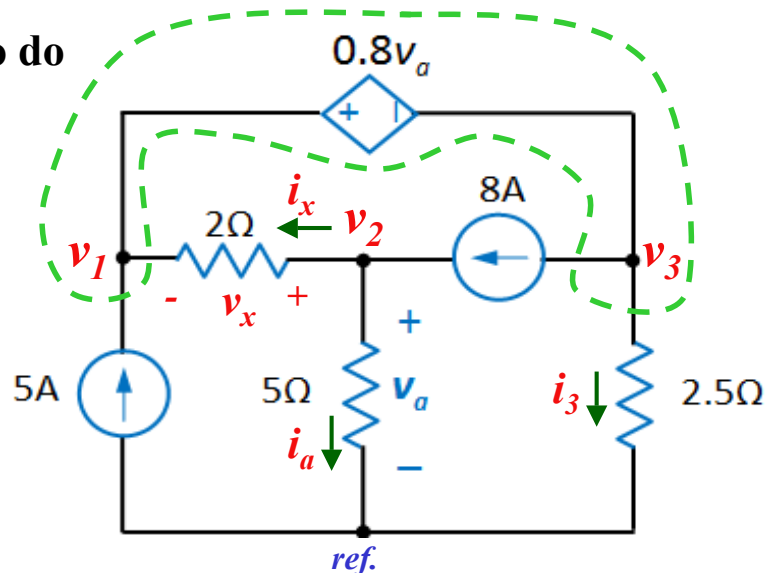
**6º Passo:** Obter equação do super-nó e resolver...

**Equação do super-nó:**

$$0.8v_a = v_1 - v_3$$

Ou, como  $v_a = v_2$

$$0.8v_2 = v_1 - v_3$$

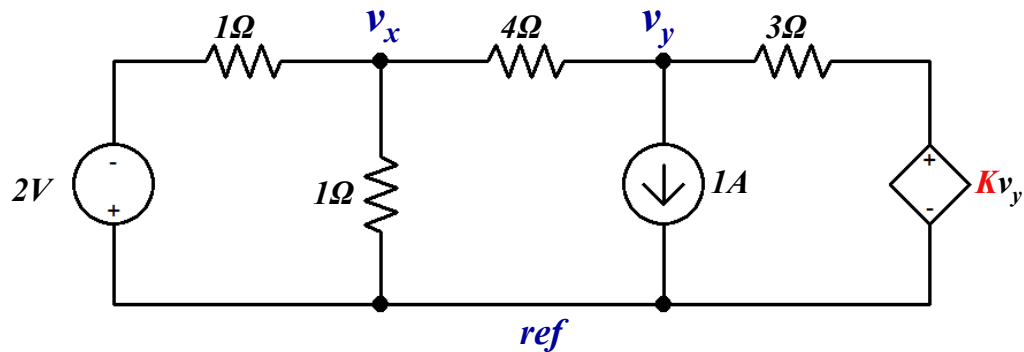


Juntando esta às duas equações anteriores...

$$\begin{cases} -0.5v_1 + 0.5v_2 - v_3/2.5 = 3 \\ 0.5v_1 - 0.7v_2 = -8 \\ v_1 - 0.8v_2 - v_3 = 0 \end{cases} \Rightarrow \begin{cases} v_1 = 20.3V \\ v_2 = 25.9V \\ v_3 = -0.45V \end{cases}$$

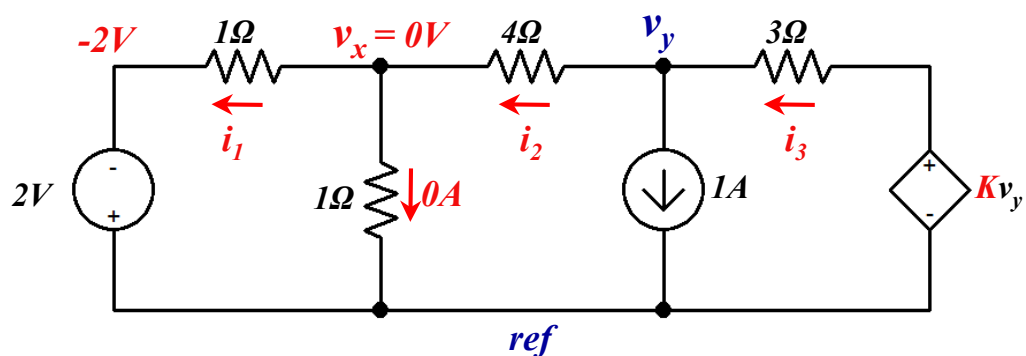
II-40

## 9 – Calcular $K$ de modo que a tensão $v_x$ seja $0V$



II-41

O problema resolve-se partindo da suposição  $v_x = 0V$  ...

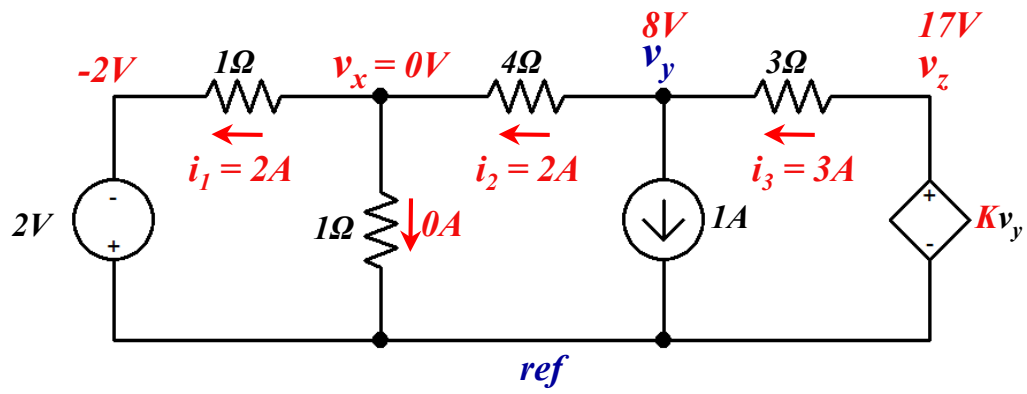


$$i_1 = \frac{v_x - (-2)}{1} = 2A$$

$$i_2 = i_1 = 2A$$

$$i_3 = i_2 + 1 = 3A$$

II-42



$$\frac{v_y - v_x}{4} = i_2 \Leftrightarrow v_y = 4i_2 = 8V$$

$$\frac{v_z - v_y}{3} = i_3 \Leftrightarrow v_z = 3i_3 + v_y = 17V$$

$$v_z = Kv_y \Leftrightarrow K = 17/8$$