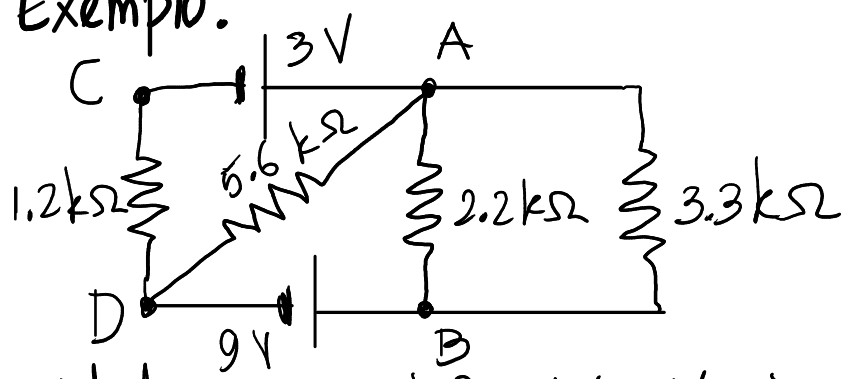
MÉTODO DE SOBREPOSIÇÃO

Circuito com $n(>1)$ f.e.m.'s $\Leftrightarrow$ sobreposição de n circuitos com apenas uma das f.e.m. e as outras em curto-circuito.

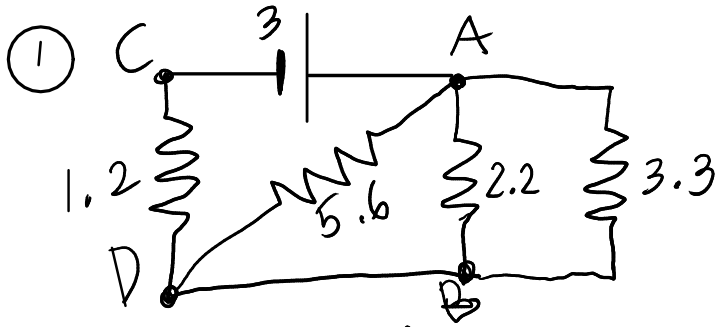
Exemplo.



Determine a corrente e voltagem em cada uma das resistências.

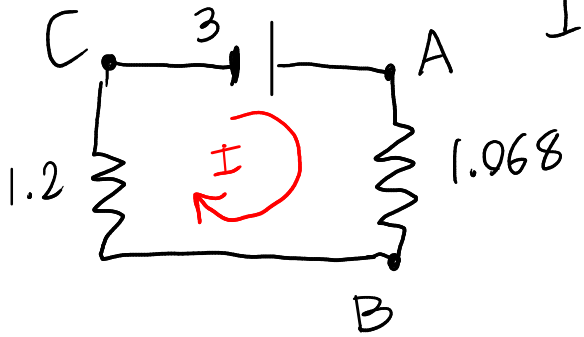
unidades: $R \to k\Omega$, $\Delta V \to V \Rightarrow I \to mA$

dois circuitos mais simples:



$V_B = V_D$

$\Updownarrow$



3 resistências em paralelo entre A e B

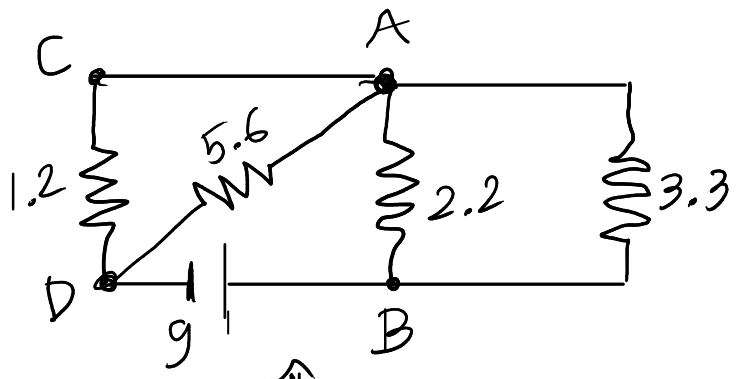
$$R_p = \left(\frac{1}{2.2} + \frac{1}{3.3} + \frac{1}{5.6}\right)^{-1} = 1.068$$

$$I_{1.2} = I = \frac{3}{1.2 + 1.068} = 1.323$$

$$V_{AB} = -I \times 1.068 = -1.413$$

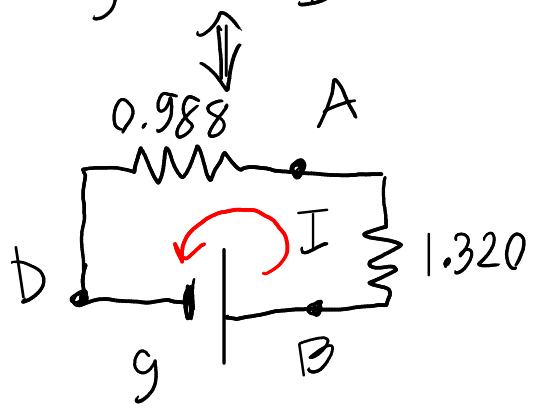
$$V_{BC} = -I \times 1.2 = -1.587$$

$$I_{5.6} = \frac{-V_{AB}}{5.6} = 0.253 \qquad I_{3.3} = \frac{-V_{AB}}{3.3} = 0.428 \qquad I_{2.2} = \frac{-V_{AB}}{2.2} = 0.642$$

② 

$$R_{AB} = \left(\frac{1}{2.2} + \frac{1}{3.3}\right)^{-1} = 1.320$$

$$R_{AD} = \left(\frac{1}{1.2} + \frac{1}{5.6}\right)^{-1} = 0.988$$



$$I = \frac{9}{0.988 + 1.32} = 3.899$$

$$V_{AB} = +1.32I = -5.147$$

$$V_{AD} = -0.988I = -3.853$$

$$I_{1.2} = \frac{3.853}{1.2} = 3.211 \quad I_{5.6} = \frac{3.853}{5.6} = 0.688 \quad I_{2.2} = \frac{5.147}{2.2} = 2.339$$

$$I_{3.3} = \frac{5.147}{3.3} = 1.560$$

Resultado final (sobreposição):

$I_{3.3} = 1.560 - 0.428 = 1.132$ mA (de B para A)

$I_{2.2} = 1.697$ mA (de B para A)

$I_{5.6} = 0.941$ mA (de A para D)

$I_{1.2} = 1.888$ mA (de C para D)

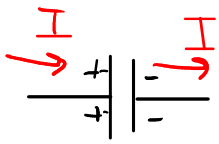
$V_{BA} = 3.734$ V

$V_{AD} = 0.941$ V ~~X~~ → -5.266 V

$V_{CD} = 2.266$ V

CIRCUITOS COM RESISTÊNCIAS E CONDENSADORES

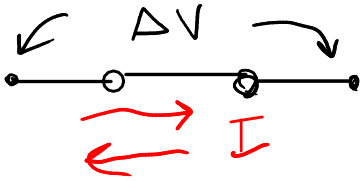
Condensadores.



① descarregado: $Q=0 \Rightarrow \Delta V = \frac{Q}{C} = 0$

mas $\frac{dQ}{dt} \neq 0 \quad \left(I = \frac{dQ}{dt}\right)$ I = qualquer valor

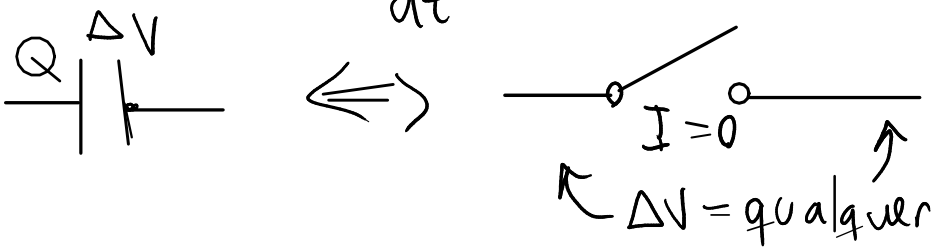
Equivalente a um interruptor fechado



(curto-circuito)

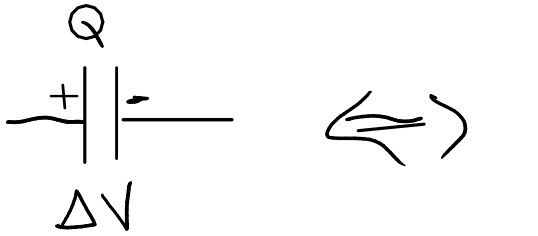
② estado estacionário: Q = constante $(\Delta V$ = constante$)$

$\Rightarrow I = \frac{dQ}{dt} = 0$



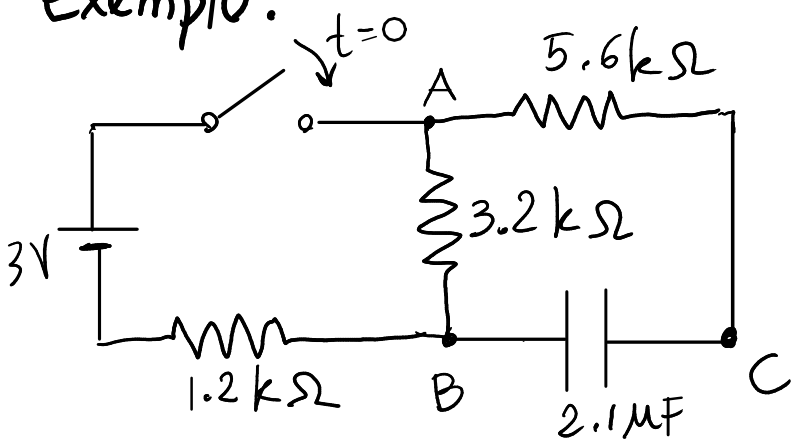
interruptor aberto

③ estado transitório: $I = \frac{dQ}{dt} \neq 0 \quad Q \neq 0, \Delta V \neq 0$



$\mathcal{E} = \Delta V = \frac{Q}{C} \quad \left(I = -\frac{dQ}{dt}\right)$

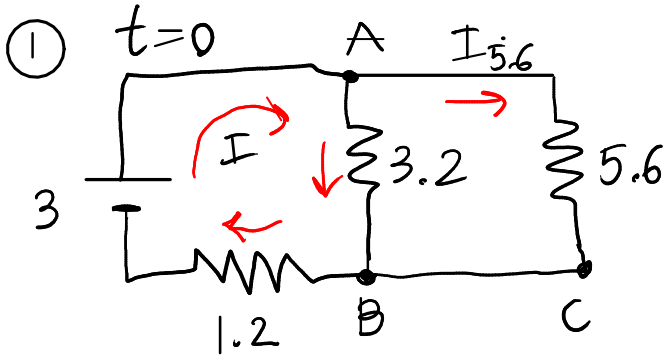
Exemplo.



Em $t=0$, o condensador está descarregado e fecha-se o interrutor. Num instante t_1 posterior (muito maior que 0), abre-se novamente o interrutor. Determine a corrente na resistência de 5.6 kΩ, em $t=0$ e t_1.

unidades: $R \to k\Omega$, $\Delta V \to V$, $I \to mA$

① $t=0$

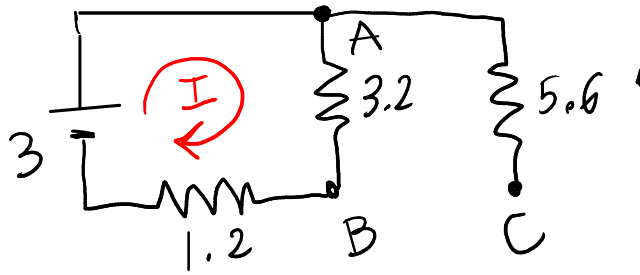


$$R_{AB} = \left(\frac{1}{3.2} + \frac{1}{5.6}\right)^{-1} = 2.036$$

$$I = \frac{3}{1.2 + 2.036} = 0.927$$

$$V_{BA} = 2.036\, I = 1.888\ V \qquad I_{5.6} = \frac{V_{BA}}{5.6} = 0.337\ mA \quad (\text{de A para C})$$

② $t \to t_1^-$ $(t<t_1)$ $\Rightarrow$ estado estacionário



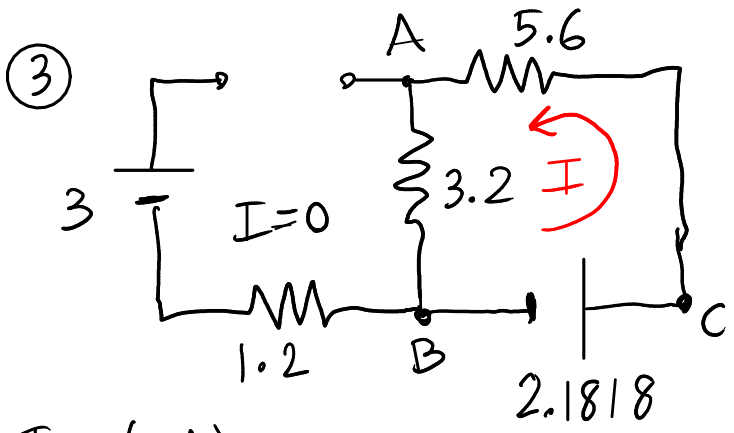
$I_{5.6} = 0 \qquad V_A = V_C$

$$I = \frac{3}{4.4} = 0.618$$

$$V_{BA} = V_{BC} = 3.2\, I = 2.1818\ V$$

↑ voltagem no condensador (carga positiva em C)

③



$$I = \frac{2.1818}{8.8} = 0.248\,mA$$

(de C para A)