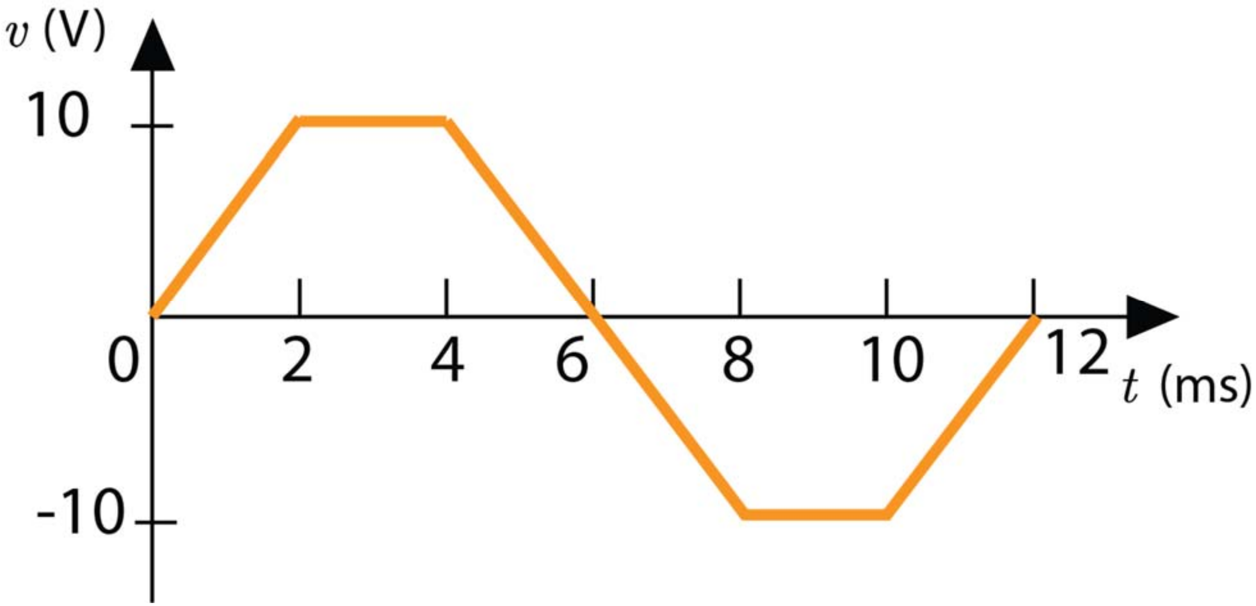
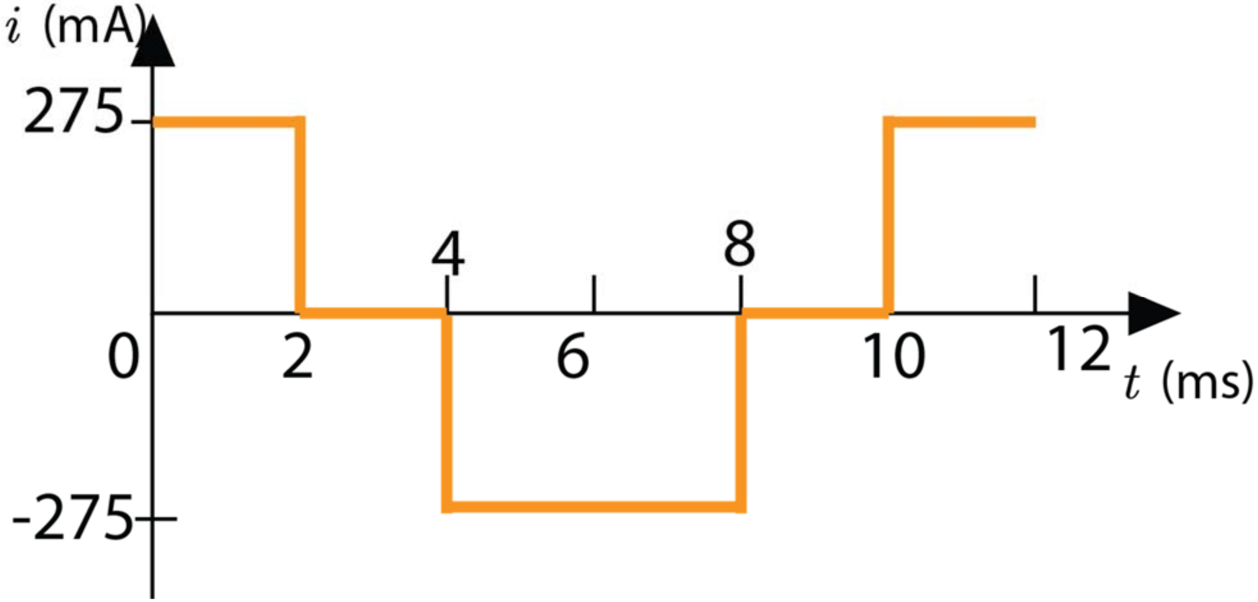




In a capacitor:

$$i = C\frac{dv}{dt}$$

$$C = 55\cdot 10^{-6}\ \text{F}$$

$0 < t < 2\text{ms}$

$$\frac{dv}{dt} = \frac{10-0}{2\cdot 10^{-3}-0} = 5000\ \text{V/s}$$

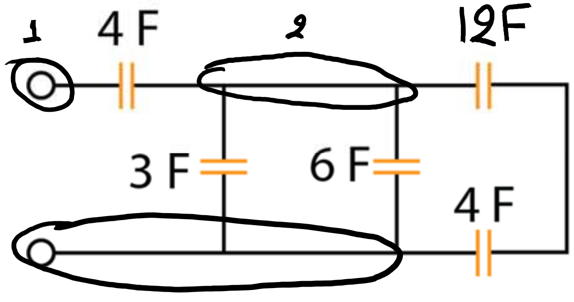
$$i = C\cdot\frac{dv}{dt} = 275\cdot 10^{-3}\ \text{A}$$

$$= 275\ \text{mA}$$

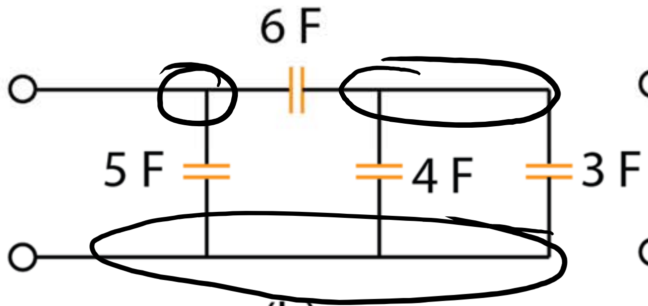
$2 < t < 4\text{ms}$

$$\frac{dv}{dt} = 0 \qquad i = 0$$

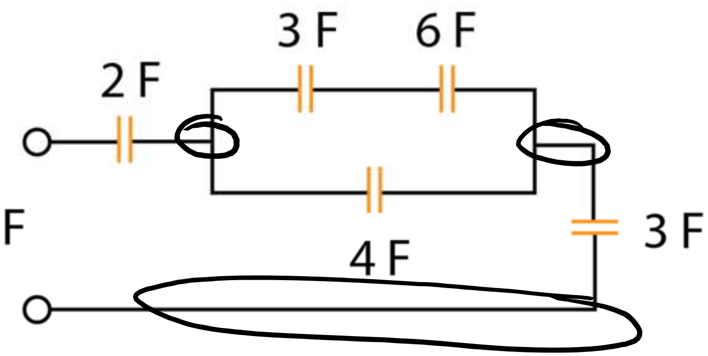
etc



(a)



(b)



(c)

12F in series with 4F

$$\frac{12 \cdot 4}{12+4} = 3F$$

Nodes 2-3

$3F \parallel 6F \parallel 3F = 12F$

$C_{eq} = 4F$ series with $12F$

$$= 3F$$

$C_{eq} = 5 \parallel (6 \text{ series with } 4 \parallel 3)$

$$= 5 \parallel \frac{6 \cdot 7}{6+7} = 5 \parallel \frac{42}{13}$$

$$= 5 + \frac{42}{13} \text{ F}$$

$$= \frac{107}{13} \text{ F}$$

3 series with 6

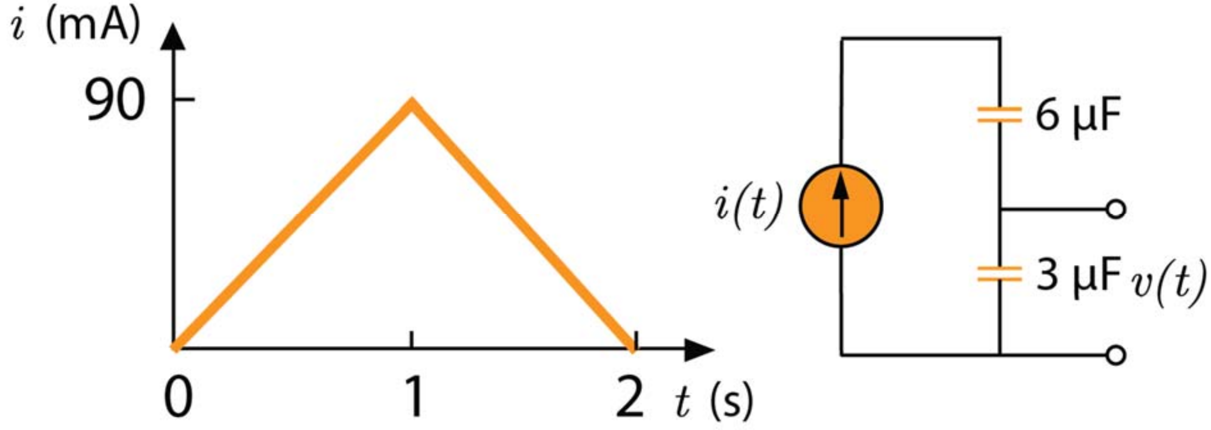
$= 2F$

$2 \parallel 4 = 6F$

2F srs 6F srs 3F

$$\frac{1}{C_{eq}} = \frac{1}{2} + \frac{1}{6} + \frac{1}{3} = 1$$

$$\Rightarrow C_{eq} = 1F$$



$$i = C\frac{dv}{dt} \rightsquigarrow V_o(t) = \frac{1}{C}\int_0^t i(t)\,dt + V_o(0)$$

$0 < t < 1$ s

$i = 90t$ mA or $90t \cdot 10^{-3}$ A

$1 < t < 2$ s

$i = 180 - 90t$ mA or $(180 - 90t)\,10^{-3}$ A

For $0 < t < 1$ s

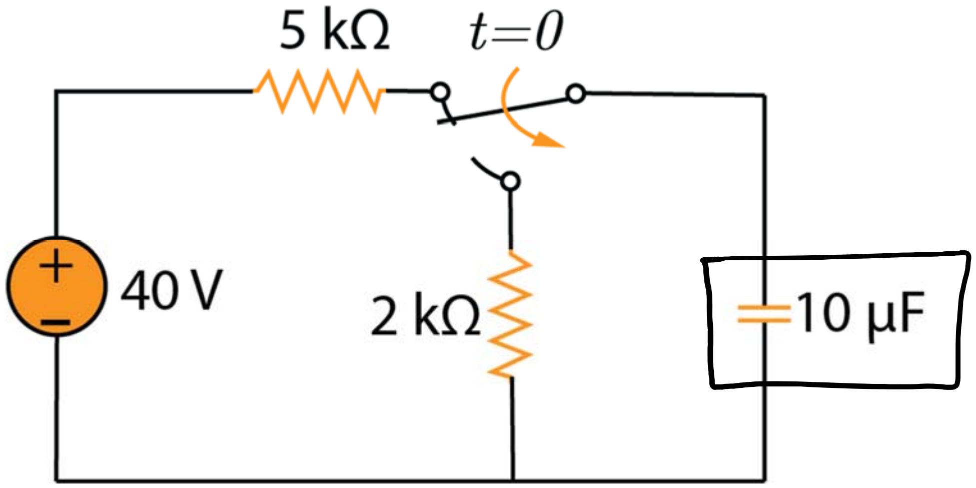
$$V_c(t) = \frac{1}{3\cdot 10^{-6}}\int_0^t 90t \cdot 10^{-3}\,dt = \frac{10^{-3}}{3\cdot 10^{-6}}\int_0^t 90t\,dt$$

$$= 15t^2 \cdot 10^3\,V \text{ or } \underline{\underline{15t^2}}\,kV, \text{ at } t=1 \quad v_c(1) = 15\,kV$$

For $1 < t < 2$ s

$$V_c(t) = \frac{10^{-3}}{3\cdot 10^{-6}}\int_1^t (180 - 90t)\,dt + v_c(1) = \left[60t - 15t^2\right]_1^t + 15\,kV$$

$$= \underline{\underline{\left[60t - 15t^2 - 30\right]\,kV}}$$



First-order circuits

1 capacitor or 1 inductor

RC or RL

i) Find the initial value $x(0)$

either $i_L(0)$ or $v_c(0)$

ii) Find the steady state value $x(\infty)$

either $i_L(\infty)$ or $v_c(\infty)$

iii) Calculate the time constant τ

$\tau = R \cdot C$ or $\tau = L/R$

In steady state

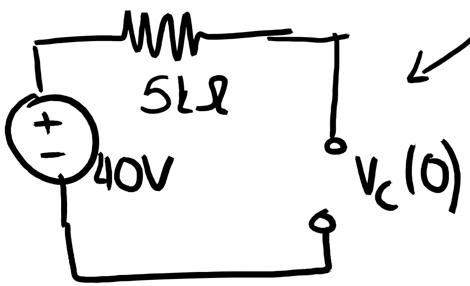
C → open circuit

L → short circuit

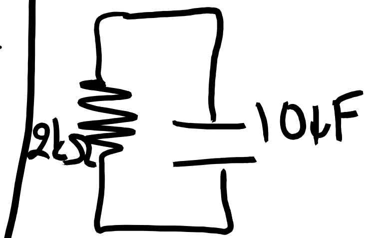
Before $t=0$

$V_c(0) = 40V$

open circuit voltage



after $t=0$



Source-free RC

$V_c(\infty) = 0$

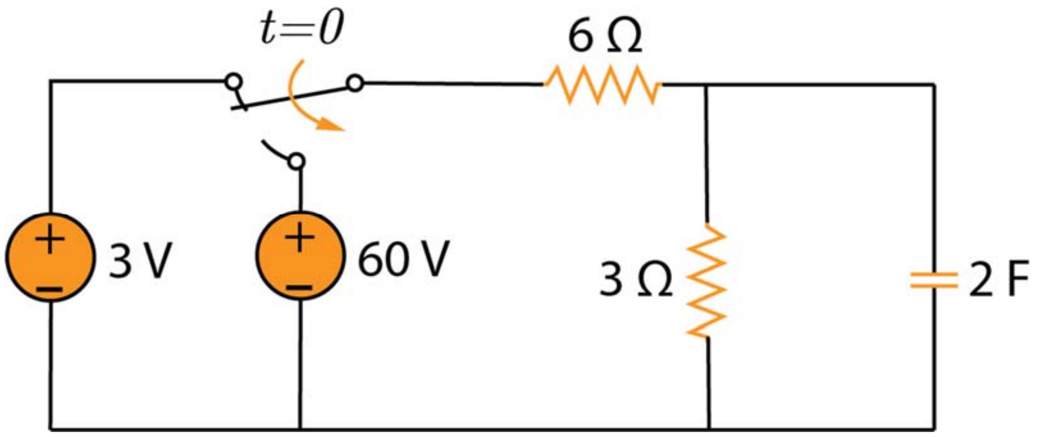
$\tau = R \cdot C$

$= 2 \cdot 10^3 \cdot 10 \cdot 10^{-6} = 0.02 s$

$V_c(t) = V_c(\infty) + [V_c(0) - V_c(\infty)] e^{-t/\tau}$

$= 0 + [40 - 0] e^{-t/0.02} =$

$= \underline{\underline{40 e^{-50t} \, V}}, \; t \rightarrow \underline{\underline{s}}$

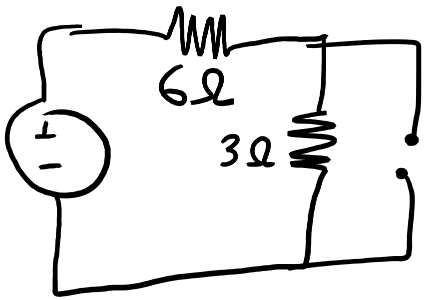


i) $V_c(0)$

ii) $V_c(\infty)$

iii) $\tau = R\,C$

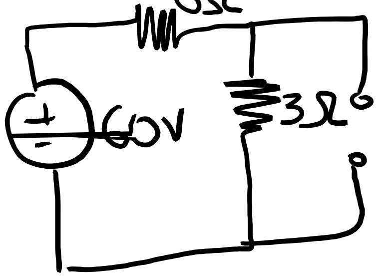
Before $t=0$



C -> open circuit

$$V_c(0) = V_{3\Omega} = \frac{3}{3+6} \cdot 3 = 1\,V$$

After $t=0$

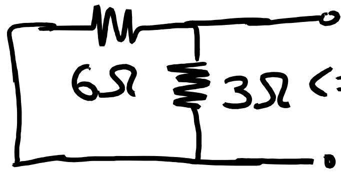


$$V_c(\infty) = \frac{3}{3+6} \cdot 60 = 20\,V$$

$\tau = R \cdot C$

R -> R_{Th} from capacitor terminals

R_{Th}:



$$R_{Th} = 6 \| 3 = 2\,\Omega$$

$$\tau = 2 \cdot 2 = 4\,s$$

$$V_c(t) = V_c(\infty) + [V_c(0) - V_c(\infty)]e^{-t/\tau}$$

$$= 20 + [1 - 20]e^{-t/4}$$

$$= 20 - 19e^{-t/4}\ V,\ t\to s$$

$$i(t) = C \cdot \frac{dv}{dt} = 2\left(-\frac{1}{4}\right)(-19)e^{-t/4} A$$

$$= 9.5e^{-t/4}\ A,\ t\to s\ \ t>0$$