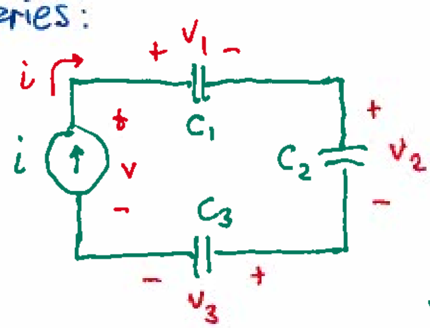
Thursday, March 10, 2016

In series:



By KVL, we have

$$V = V_1 + V_2 + V_3$$

Assuming zero initial V_1, V_2, V_3

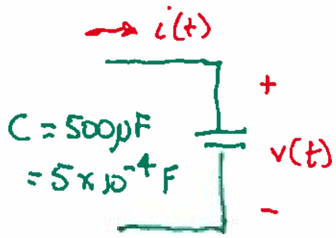
$$V = \frac{1}{C_1}\int_0^t i(x)\,dx + \frac{1}{C_2}\int_0^t i(x)\,dx + \frac{1}{C_3}\int_0^t i(x)\,dx$$

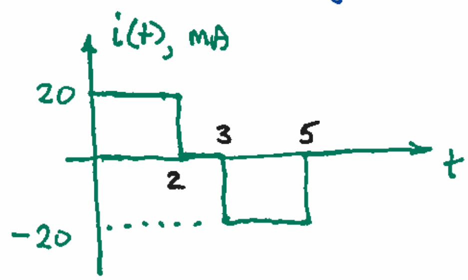
Or, equivalently, $$V = \frac{1}{C_{eq}}\int_0^t i(x)\,dx$$

where $$\boxed{\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

SERIES CAPACITORS ARE LIKE PARALLEL RESISTORS

<u>Example</u>: Given a capacitor, find voltage for a given current waveform. Assume no initial charge on the capacitor.



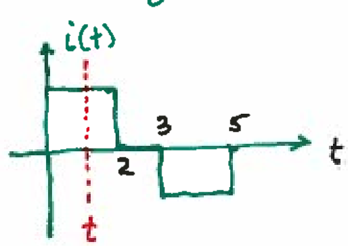


For a capacitor, $$i(t) = C\frac{dv(t)}{dt}$$

and $$v(t) = \frac{1}{C}\int_0^t i(x)\,dx + \cancel{v(0)}^{\,0}$$

Time intervals:

$0 < t \leq 2$



$$V(t) = \frac{1}{5\times10^{-4}}\int_0^t (20\times10^{-3})\,dx = \left.\frac{(20\times10^{-3})\,x}{5\times10^{-4}}\right|_0^t$$

$$V(t) = 40t - 0 = 40t$$

$2 < t \le 3, \quad i(t) = 0$

$$v(t) = \frac{1}{C}\int_2^t \cancel{i(x)}\,dx + v(2)$$

voltage on capacitor at end of the first interval.

where $v(t) = v(2) = 40 \times 2 = 80v$

$3 < t \le 5, \quad i(t) = -20mA$

$$v(t) = \frac{1}{C}\int_3^t i(x)dx + v(3)$$

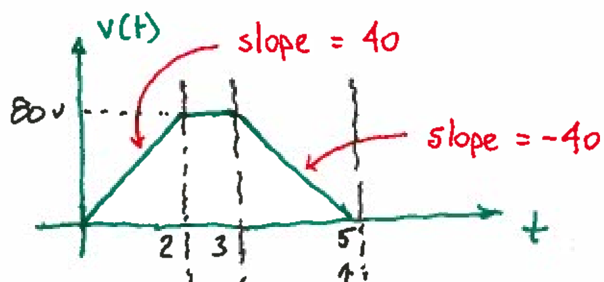
voltage on capacitor at end of the second interval $= 80v$

$$v(t) = \left.\frac{(-20\times10^{-3})x}{5\times10^{-4}}\right|_3^t + 80$$

$$= -40(t-3) + 80$$

$$= -40t + 200$$

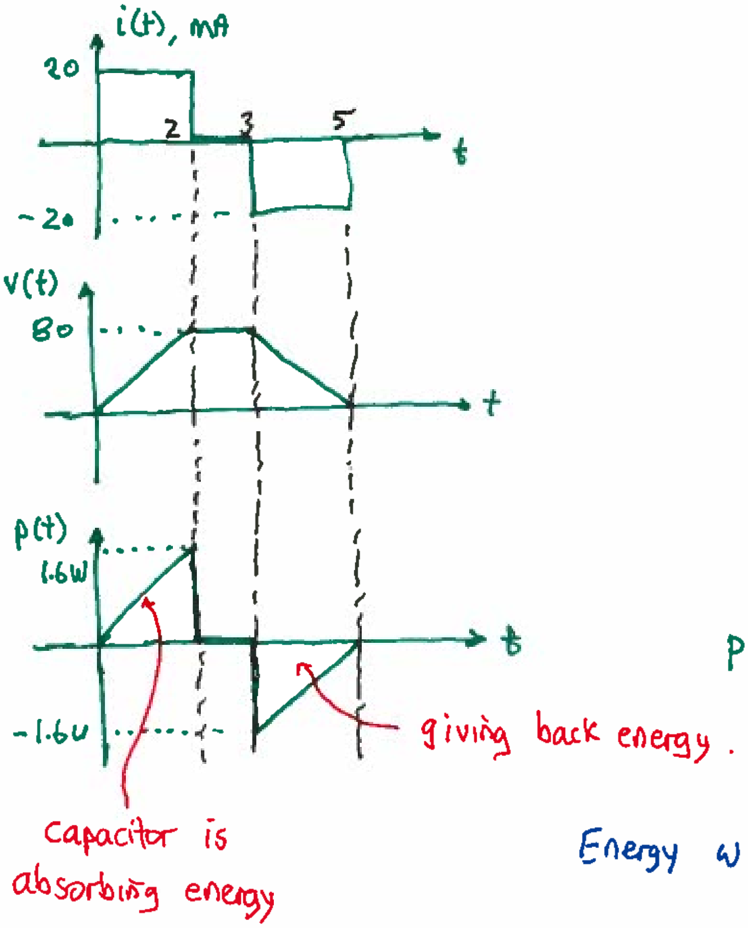
Sketch:



last interval $t > 5$, $i(t) = 0$, so

$$v(t) = v(5)$$
$$= -40\times5 + 200$$
$$= 0$$

What is the power?

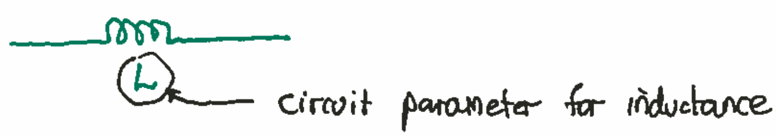


$p = vi$

Energy $w = \frac{1}{2} c v^2$

The inductor

The circuit symbol



Voltage-current relationship

where $\boxed{V = L \frac{di}{dt}}$

V = Voltage in Volts (V)
i = current in Amps (A)
t = time in secs (s)
L = inductance in Henrys (H)

Inductor properties:

- a constant value of current causes zero voltage drop, So the inductor behaves like a short circuit