sinusoidal waveforms:

period T_0

linear frequency $f_0 = \frac{1}{T_0}$

angular frequency $\omega_0 = 2\pi f_0$

Fourier coefficients

$$A\cos(\omega t + \phi) \rightarrow a\cos\omega t + b\sin\omega t$$

---

use Fourier coefficients to combine/add sinusoidal waveforms

$$v_1(t) = A_1\cos(\underline{\underline{\omega}}t + \phi_1) = a_1\cos\omega t + b_1\sin\omega t$$

$$v_2(t) = A_2\cos(\underline{\underline{\omega}}t + \phi_2) = a_2\cos\omega t + b_2\sin\omega t$$

same frequency

$$v_1(t) + v_2(t) = (a_1 + a_2)\cos\omega t + (b_1 + b_2)\sin\omega t$$

---

derivative: $\frac{d}{dt}\left(V_A\cos\omega t\right) = -\omega V_A\sin\omega t = \omega V_A\cos\left(\omega t + \frac{\pi}{2}\right)$

integral: $\int V_A\cos\omega t\,dt = \frac{V_A\sin\omega t}{\omega} = \frac{V_A}{\omega}\cos\left(\omega t - \frac{\pi}{2}\right)$

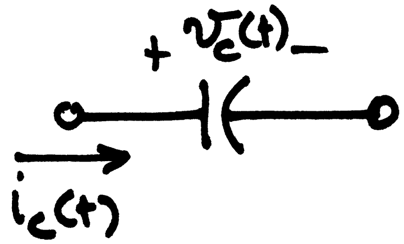
Fourier series

Example 5-15

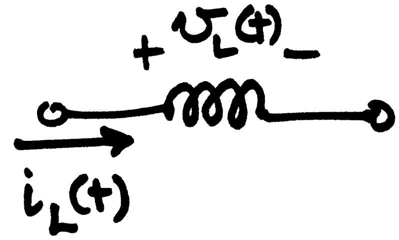
$$v(t) = 5 - \frac{10}{\pi}\sin(2\pi 500t) - \frac{10}{2\pi}\sin(2\pi 1000t)$$
$$- \frac{10}{3\pi}\sin(2\pi 1500t) + \cdots$$

lowest frequency
is called the fundamental.

Reactive component (capacitors, inductors)



$$i_c(t) = C\frac{dv_c(t)}{dt}$$



$$v_L(t) = L\frac{di_L(t)}{dt}$$

Example:
given i_c, find v_c

$$i_c(t) = C\frac{dv_c(t)}{dt}$$

$$\frac{1}{C}\int_{t_0}^{t} i_c(x)\,dx = \int_{t_0}^{t} dv_c(t)$$

$$\frac{1}{C}\int_{t_0}^{t} i_c(x)\,dx = v_c(t) - v_c(t_0)$$

what is t_0?
what is $v_c(t_0)$?

initial condition often be zero

usually (if you can) pick $t_0 = 0$

power: $p_c(t) = i_c(t)\,v_c(t)$

$p_c(t) > 0$ capacitor is absorbing power

$p_c(t) < 0$ capacitor is releasing stored power

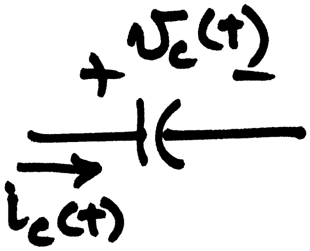
$$p_c(t) = \frac{d}{dt}\left[\frac{1}{2}C\,v_c^2(t)\right]$$

$w_c(t)$ energy in the capacitor

$$P_L(t) = \frac{d}{dt}\Big[\underbrace{\tfrac{1}{2} L\, i_L^2(t)}_{w_L(t)}\Big]$$

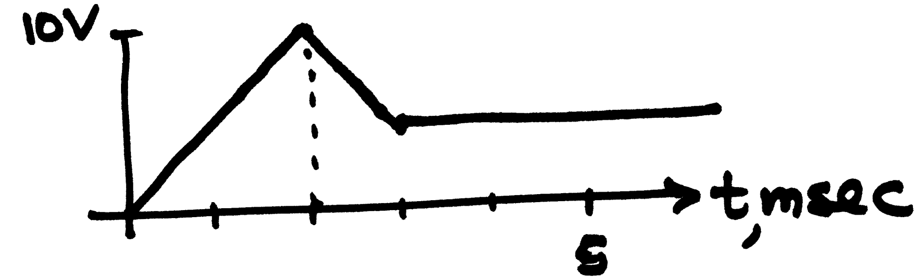
$w_L(t)$ energy in the inductor

Example 6-3



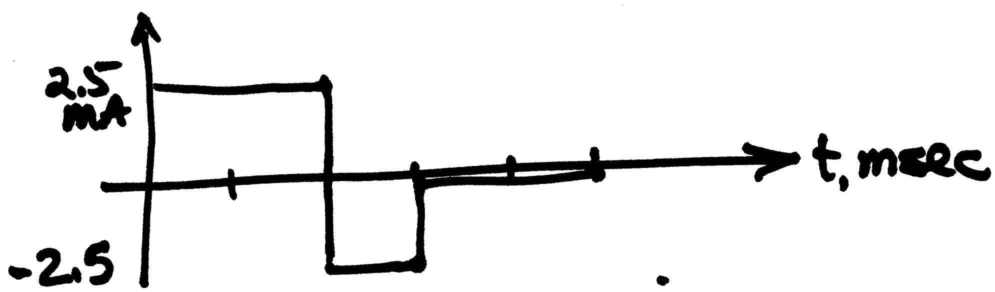
$C = \frac{1}{2}\mu f$
$= \frac{1}{2} \times 10^{-6}$

Given $v_c(t)$

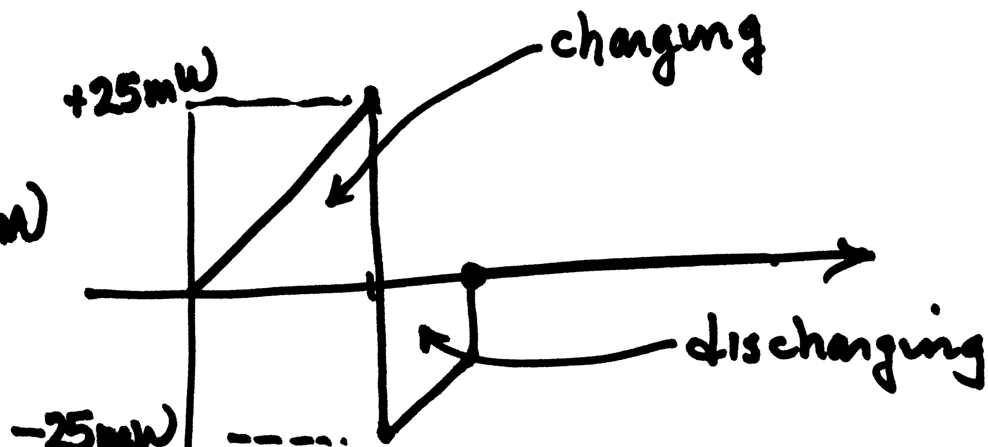


$i_c(t) = C\frac{dv_c}{dt}$

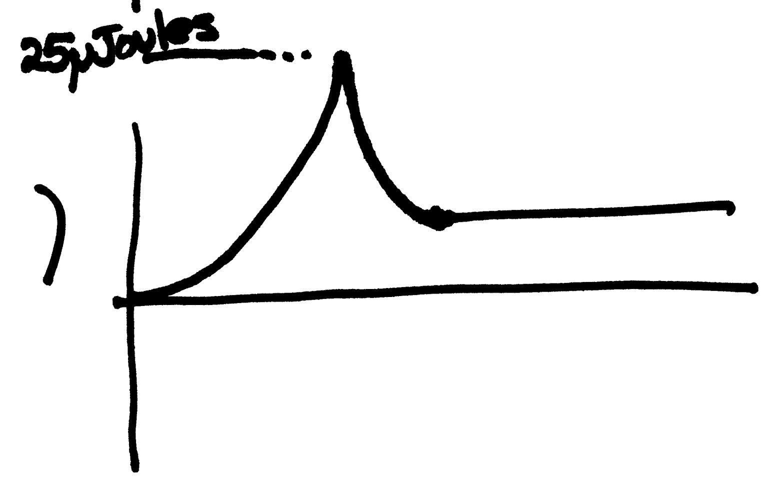
$\left(\frac{1}{2}\times 10^{-6}\right)\left(\frac{10}{2\times 10^{-3}}\right)$



$p = vi$
$= (10)(2.5mA)$
25mW



$w_c = \frac{1}{2}Cv^2$
$= \frac{1}{2}\left(\frac{1}{2}\times 10^{-6}\right)(\quad)$



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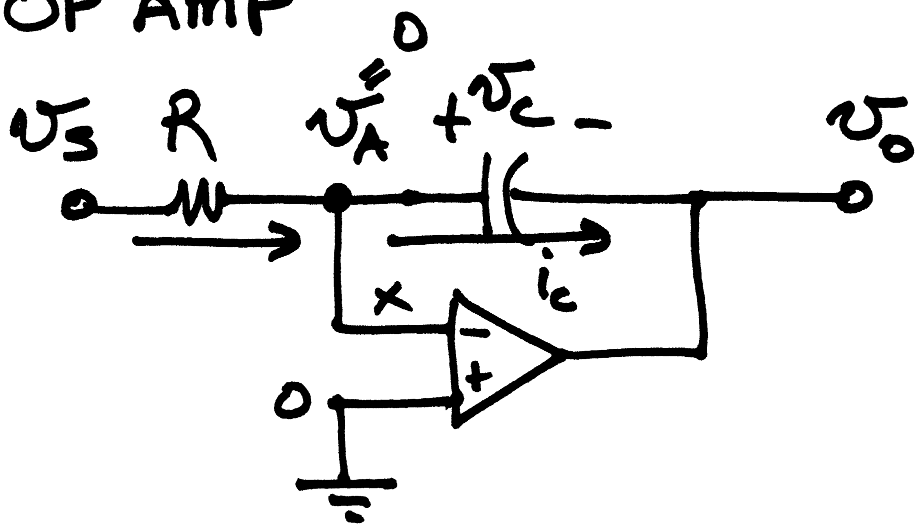

$$\frac{v_s - 0}{R} = \qquad i_c = C\frac{dv_c}{dt}$$

$$\frac{v_s}{R} = C\frac{d}{dt}\left(0 - v_o\right)$$

$$\frac{v_s}{R} = -C\frac{dv_o}{dt}$$

$$-\int_{t_0}^{t}\frac{v_s}{RC}\,dt = \int_{t_0}^{t} dv_o$$

$$-\frac{1}{RC}\int_{t_0}^{t} v_s = v_o(t) - v_o(t_0)$$