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

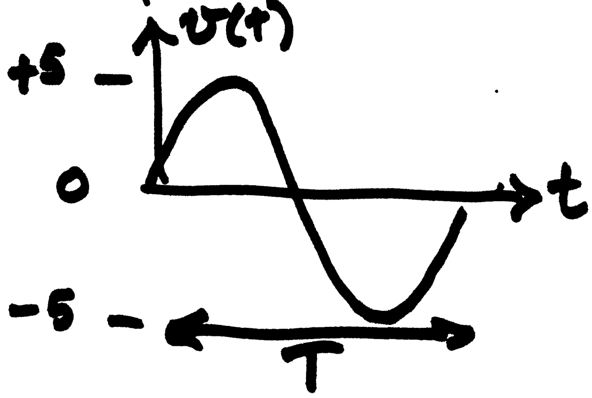
$$v(t) = 5 - \frac{10}{\pi}\sin(2\pi 500t) - \frac{10}{2\pi}\sin(2\pi 1000t) - \frac{10}{3\pi}\sin(2\pi 1500t) + \cdots$$

lowest frequency is called the fundamental.

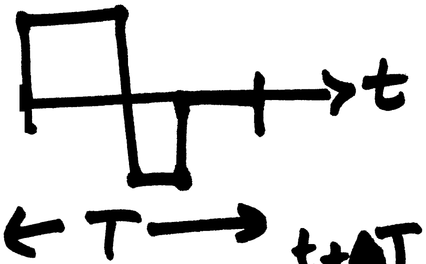
measurements of waveforms

peak +5

peak - peak 10



average



$$V_{avg} = \frac{1}{T}\int_{t}^{t+T} v(x)\,dx$$

period

rms
(root mean square)

$$V_{rms} = \sqrt{\frac{1}{T}\int_{t}^{t+T} v^2(x)\,dx}$$

let us compute <u>average</u> power

average power

inst. power $p(t) = v(t)\,i(t) = v(t)\,\frac{v(t)}{R} = \frac{v^2(t)}{R}$

$$P_{AVG} = \frac{1}{T}\int_t^{t+T} p(x)\,dx$$

$$= \frac{1}{T}\int_t^{t+T} \frac{v^2(x)}{R}\,dx$$

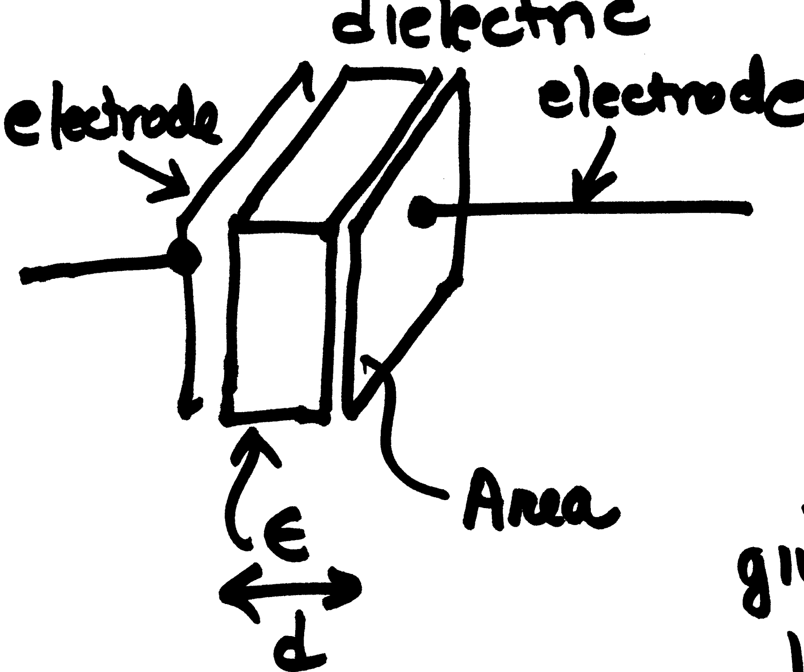
$$P_{AVG} = \frac{v_{RMS}^2}{R}$$ definition of rms

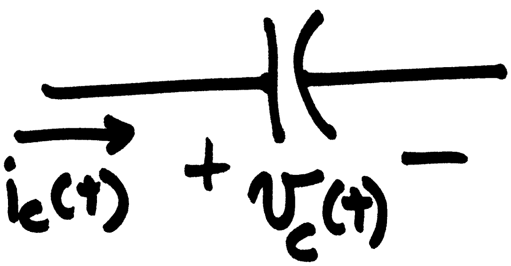
$$v_{rms}^2 = \frac{1}{T}\int_t^{t+T} v^2(x)\,dx$$

$$v_{rms} = \sqrt{\frac{1}{T}\int_t^{t+T} v^2(x)\,dx}$$

Chapter 6

Capacitors & Inductors





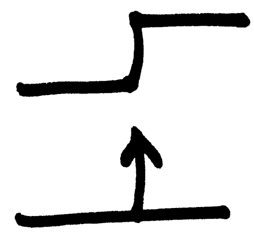
given

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

if v_c = constant (dc) $\quad i_c \to 0$

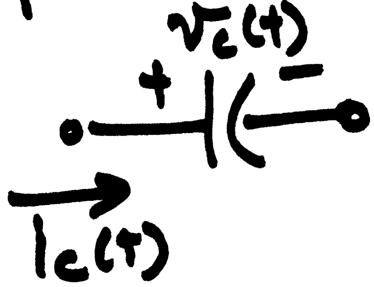
discontinuous voltage

$u(t)$



$\Rightarrow V_c$ to be continuous

capacitors



power

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

$$p_c(t) = C \frac{d v_c(t)}{dt} v_c(t)$$

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

energy