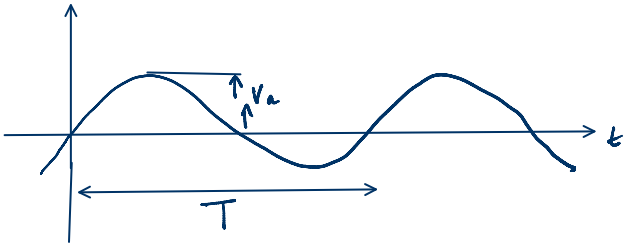
SIGNALS



V_a = amplitude, peak value

$v_a(t) = V_a \sin \omega t$

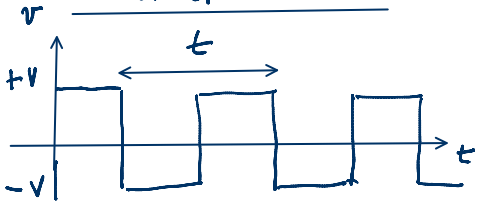
$\omega = 2\pi f$ [rad/s]

f = linear frequency [Hz]

$f = \frac{1}{T}$

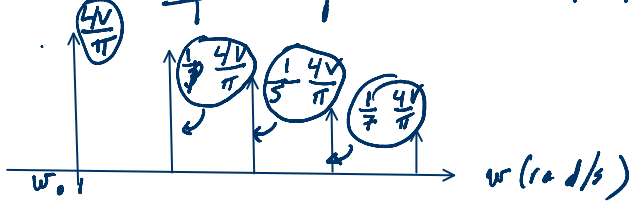
$\frac{V_a}{\sqrt{2}}$ = root-mean-square value (rms)

Fourier Series



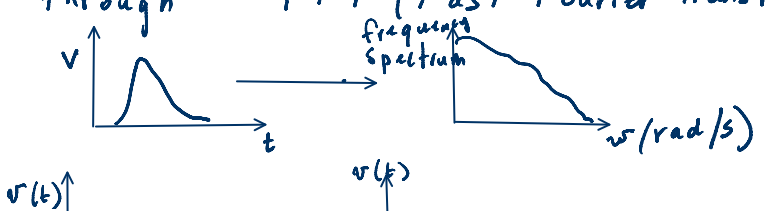
$$v(t) = \frac{4V}{\pi}\left(\sin\omega_0 t + \frac{1}{3}\sin 3\omega_0 t + \frac{1}{5}\sin 5\omega_0 t + \ldots\right)$$

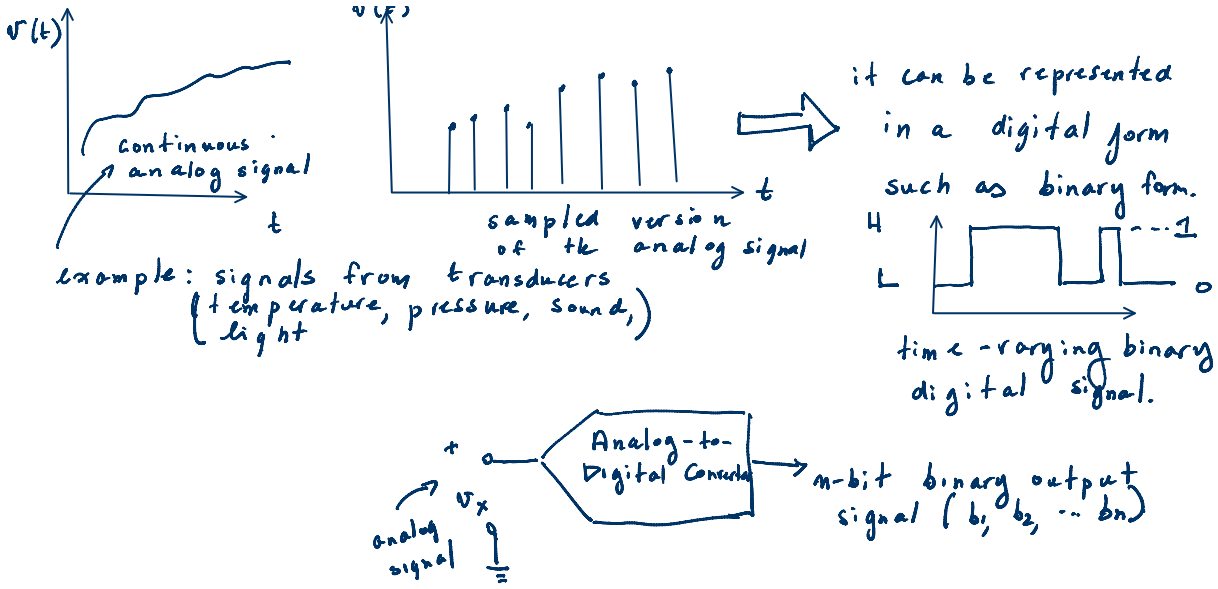
$\omega_0 = \frac{2\pi}{T}$ = fundamental frequency.



relate to applications: ① sensors
② imaging.

You can go from the time-domain to the frequency domain of a signal reppresentation through FFT (Fast Fourier Transform).



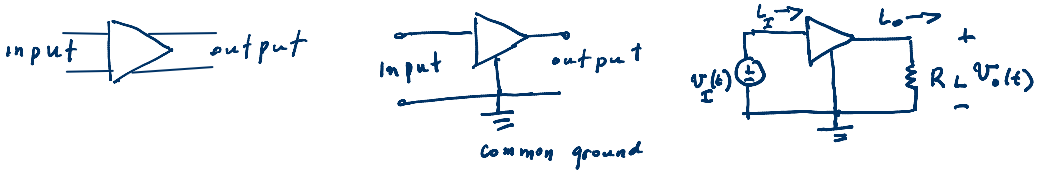


Notational Conventions

$v_T = V_{DC} + v_{sig}$ = total voltage

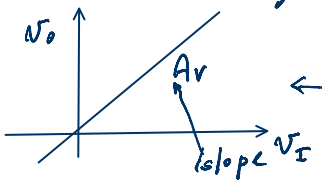
$i_T = I_{DC} + i_{sig}$ = total current

Amplifiers



$v_o(t) = A_v v_i(t)$, A_v = voltage gain

linearity → important property of the Amplifier



← Transfer characteristic of a linear Amplifier

$i_o = A_i i_I$ A_i = current gain

Power gain (A_p) = $\frac{P_L \text{ (load power)}}{P_I \text{ (input power)}}$

Voltage Gain

$A_v(dB) = 20 \log \frac{V_{out}}{V_{in}}$

Current Gain

$$A_I(dB) = 20 \log \frac{I_{out}}{I_{IN}}$$

Power Gain

$$A_p(dB) = 10 \log \frac{P_{out}}{P_{IN}}$$

* $A_p(dB_m) = 10 \log \frac{P_{out}}{1\,mW}$

dB_m = reference with respect to 1 mW

Example

$P_{in} = 100\,\mu W$

$P_{out} = 2\,W$

Calculate dB power gain of the Amp.

$$A_p(dB) = 10 \log \frac{2\,W}{100\,\mu W}$$

$$= 10 \log (20{,}000)$$

$$= 43.1 \quad dB$$

Question: How convert dB power gain to standard numeric form?

$$A_p = \log^{-1} \frac{A_p(dB)}{10} = 10^{\frac{dB}{10}}$$

Example 1

If $A_p(dB) = 3\,dB$ which is the ratio of $\frac{\text{output power}}{\text{input power}}$?

$$A_p = \log^{-1} \frac{A_p(dB)}{10}$$

$$= \log^{-1} \frac{3}{10}$$

$$= 10^{\frac{3}{10}}$$

$$= 1.995$$

Example 2

Example 2

$P_{in} = 50\,mW$

$A_p(dB) = 3\,dB$

Find output power (P_{out}).

$P_{out} = A_p P_{IN}$

$A_p = 10^{\frac{3}{10}} \simeq 2$

$P_{out} = (2) \times 50\,mW = 100\,mW$