Exercise 1:

1. Sketch the following functions

(a)

$$s(t) \quad = \quad A \cdot \mathrm{rect}\left(\frac{t-t_0}{T_0}\right)$$

(b)

$$\varepsilon(t-T_0) \cdot \sin(\omega_0 t + \varphi_0) \qquad \varphi_0 \quad = \quad \frac{2\pi}{3} \quad T_0 = \frac{2\pi}{\omega_0}$$

(c)

$$\Lambda\left(\frac{t}{T}-2\right) + \Lambda\left(\frac{t}{T}+2\right)$$

(d)

$$\mathrm{rect}\left(\frac{t}{T}+\frac{1}{2}\right) \cdot \mathrm{r}(-\frac{t}{T})$$

(e)

$$\mathrm{rect}\left(\frac{t}{2T_0}\right) \cdot \sin(\omega_0 t)$$

(f)

$$\Lambda\left(\frac{t}{T}\right) \cdot \Lambda\left(-\frac{t}{T}\right)$$

(g)

$$\varepsilon\left(-t+\frac{T}{2}\right) \cdot \mathrm{rect}\left(\frac{t}{2T}\right)$$

(h)

$$\Lambda\left(\frac{2t}{T}\right) + \mathrm{rect}\left(\frac{t}{2T}\right)$$

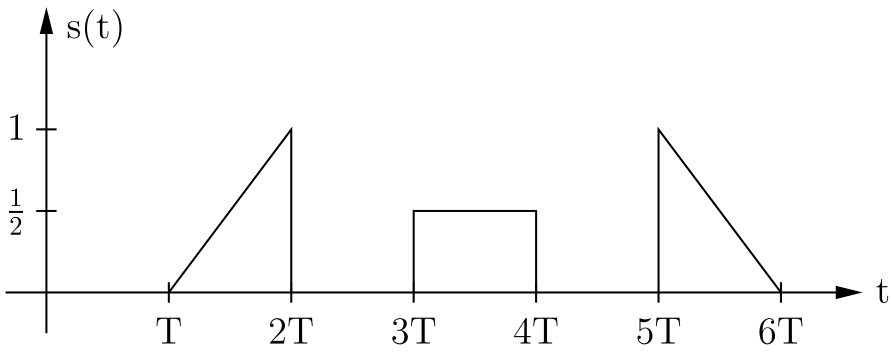
(i)

$$\sum_{n=-2}^{+2} \delta(t-nT) \cdot \Lambda\left(\frac{t}{2T}\right)$$

(j)

$$\delta(2t+T) - 2\delta(-3t-2T); Note : \delta(at) = \frac{1}{|a|}\delta(t)$$

2. Determine the formula describing the following signal



Exercise 2:

A signal $s(t) = \sum_i A \cdot \Lambda\left(\frac{t - iT_0}{\frac{T_0}{2}}\right)$ is given with $A = 1V$ and $T_0 = 1ms$.

(a) Sketch the function $s(t)$
(b) Determine the Fourier coefficients a_n and b_n of the Fourier series of $s(t)$ for all $|n| < 6$

Exercise 3:

The signal $s_1(t)$ is given (T=1ms).

$$s_1(t) = 4 + 2 \cdot \sin\left(\frac{2\pi t}{T}\right) + 3 \cdot \sin\left(\frac{8\pi t}{T}\right) + 4 \cdot \cos\left(\frac{8\pi t}{T}\right)$$

(a) Write $s_1(t)$ in all other forms (trigonometric, polar, exponential resp.)
(b) Which harmonics are present ?
(c) Sketch the two sided magnitude-/phase spectrum (in the form of plots over f = 1/T
(d) Determine the RMS value

Exercise 4:

Given is a periodic voltage signal with the period T_0.

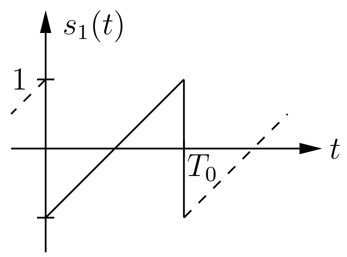
$$\underline{c}_n = \begin{cases} 1V \cdot e^{-j\frac{\pi}{4}} & \text{for} \quad n = -1 \\ 1V \cdot e^{+j\frac{\pi}{4}} & \text{for} \quad n = +1 \\ 0 & \text{else} \end{cases}$$

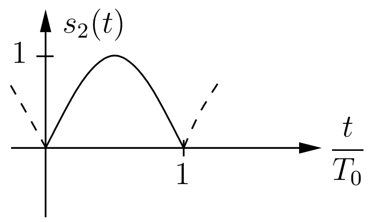
(a) Determine the Fourier coefficients a_n and b_n

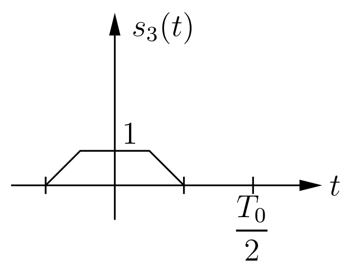
(b)Specify the expression for $s(t)$ including its dimension in trigonometric and polar form
(c) Specify the distortion factor

Exercise 5:

Determine the Fourier coefficients c_n, a_n and b_n for the following signals







Note: $s_3(t)$ is an even signal of the width $\frac{T_0}{2}$!

Exercise 6:

An even signal $s(t) = \sum_i 1V \cdot \Lambda\left(\frac{t - i \cdot T_0}{\frac{T_0}{2}}\right)$ with $T_0 = 1ms$ is given

(a) Determine the Fourier coefficients a_n and b_n

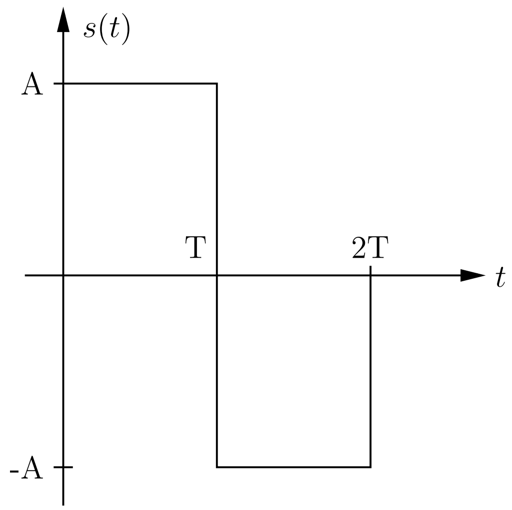
(b) Write down the Fourier transform $S_F(\omega)$ of a single pulse $\Lambda\left(\frac{t}{\frac{T_0}{2}}\right)$ and sketch this function

(c) Show, that for f=1kHz and 3kHz the relation $c_n = \frac{S_F(2\pi f)}{T_0}$ applies

Exercise 7:

Determine the Fourier transform $S_F(\omega)$ of the following signals

(a)



(b)

$$s(t) = \sin(\omega_0 t) + \cos(\omega_0 t)$$

Exercise 8:

Sketch and find $S_F(\omega)$ for:

$$s_1(t) = \exp\left(-2\frac{|t|}{T}\right)$$

$$s_2(t) = \text{rect}\left(\frac{t}{T} - \frac{1}{2}\right) - \Lambda\left(\frac{t - \frac{T}{2}}{\frac{T}{2}}\right)$$

Exercise 9:

Given is a discrete-time system with $g(k) = s(k-1) + \frac{1}{2} \cdot g(k-1)$

(a) Determine $g(k)$ for the case of a stimulation of the system with a unit step function
(b) Determine $H_z\left(e^{j\omega T_a}\right)$
(c) Write down $g(k)$ for a stimulation of the system with the unit impulse

Exercise 10:
Transform the signal $S_z(z)$ into the discrete-time signal $s(k)$

$$S_z(z) = 3 \cdot z^{-1} + 5 \cdot z^{-3} + 2 \cdot z^{-4}$$

Exercise 11:
Transform the signal $S_z(z)$ into the discrete-time signal $s(k)$

$$S_z(z) = \frac{1}{\left(z - \frac{1}{4}\right) \cdot \left(z - \frac{1}{2}\right)}$$