Signals and its properties

Signals and codes (SK)

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Exercise 1

Exercise content

- Signals
  - using MATLAB
  - plotting signals
    - basic types of signals
    - sinusoids
    - complex exponentials
  - computing characteristic values of signals
    - instantaneous value
    - average value
    - signal energy
    - signal power
    - effective value

Exercises

Exercise 01_0: Plotting function, put MATLAB into operation

Consider continuous time signal $x(t) = 3t$

a) Use MATLAB to plot the signal within time interval < 0 , 2 > ms *well enough*. Label your plot carefully, make a title, axes labels, grid.

```
Help: title('title string'); xlabel('time in seconds'); grid on;
```

b) Use *LineSpec* '-o' for the plot to see which samples are shown in the plot.

```
Help: for help type LineSpec into Command Window and press F1 with a cursor
within the word LineSpec.
```

Exercises

Exercise 01_0: Solution

```
% plot linear function

%% initialize

clear; % clears all variables in workspace
close all; % close all figures

%% defining parameters

slope=2;

fs=1e3; % sample frequency of the plot
tmin=0; %time limits
tmax=2e-3;

%% computation

Ts=1/fs;

t=tmin:1/(1*fs):tmax; %defining vector of time
x=slope*t; % defining signal
plot(t,x);  % for subtask a)
%plot(t,x,'-o');  % for subtask b)
grid on
xlabel('time (sec)');
ylabel('x (t)');

title(sprintf('Linear function x = %.2f * t, sample rate fs = %.3E Hz',slope,fs));  %sprintf prints to the string
```

Exercises

Exercise 01_1: Plotting function, instantaneous value

Consider continuous time signal $x(t) = \mathrm{e}^{-50t} \cdot \cos 2\pi 1000t$

a) Use MATLAB to plot the signal within time interval < 0 , 30 > ms *well enough*. Label your plot carefully, make a title, axes labels, grid.

b) Find instantaneous value $x(t_i)$ for time instant $t_i = 20$ ms. Discuss the result value in terms of time constant of exponential function and frequency of cosine function.

c) Is the signal periodic? If so, what is the period?

Exercises

Exercise 01_2: Plotting functions, stem plot

Consider continuous time cosine signal of amplitude $230 \cdot \sqrt{2}$, frequency 50 Hz and initial phase π/6.

a) Use MATLAB to plot 5 periods of the given signal *well enough*. Label your plot carefully, make a title, axes labels, grid.

b) Show a stem plot in the same figure with parameterized sample frequency denoted as *fs_stem*. Substitute values 600, 310, 300, 290, 200, 110, 100, 90, 60, 50, 40, 10 Hz consequently for *fs_stem* and observe the results. Try to make conclusion about the sample frequency.

c) Determine average value, signal energy, signal power and effective value of the original continuous time cosine signal. Use MATLAB for the computation, where it is suitable.

```
Help: use x.^2 for squaring each element of x
```

Exercises

Exercise 01_3: Plotting functions, complex exponentials

Consider discrete time complex signal $x[n] = 3\mathrm{e}^{j2\pi \cdot 10 \cdot n \cdot T_S}$ with sample frequency f_s = 40 Hz. Imaginary unit $\sqrt{-1}$ is denoted as j.

a) Use MATLAB to plot 5 periods in two figures. The first figure will show the given signal in a complex plane. The second one will show the real part of $x[n]$, i.e. $\mathrm{Re}\{x[n]\}$ depending on discrete time. Use *LineSpec* '-o' for both figures.

```
Help: Use symbol 1i for imaginary unit in MATLAB.
plot(x); %plots imaginary part of x as a function of real part of x
```

b) Repeat the same with sample frequency f_s = 39 Hz;

c) Repeat the same with sample frequency f_s = 400 Hz;

d) Repeat the same with sample frequency f_s = 390 Hz;

e) Determine average value, signal energy, signal power and effective value of the signal $x[n]$. Compute for sample frequencies 40, 39 and 400 Hz. Then compare the results with computing these values for signal $x[n] = 3\sqrt{2}\cos(2\pi \cdot 10 \cdot n \cdot T_s)$.