

Test 1

This is a home assignment. You can discuss your ideas with colleagues, but you should upload your individual solution, as a MLX file, with comments, formulas and code snippets.

Exercise 1 *Even and Odd Decomposition of a Signal*

a) Analyse and execute the following Matlab code:

```
% SiSy Test-1: Even/Odd exercise
% =====
clear all, close all, clc;

% Define Signal
tstep = 1e-2;
t = -3:tstep:3;
x_t = 2*t + cos(2*pi*t/2.5);           % original function
x_tm = 2*(-t) + cos(2*pi*(-t)/2.5);    % mirrored function

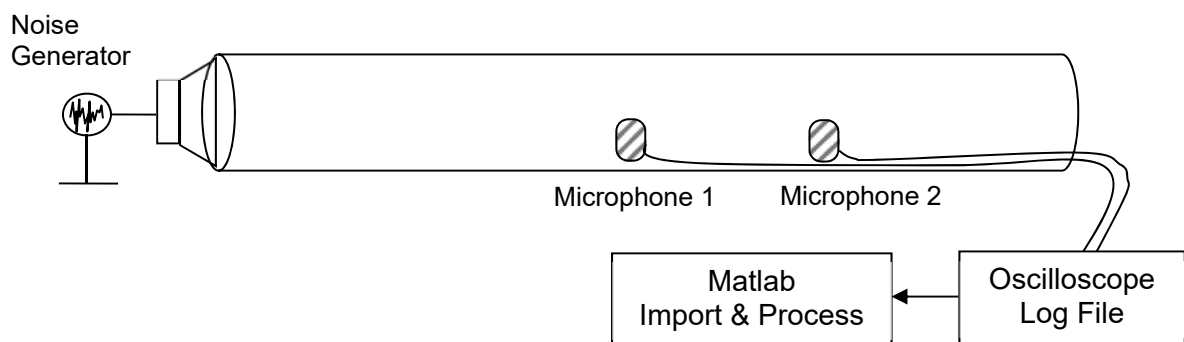
% Decomposition in Even/Odd parts
xe_t = (x_t + x_tm)/2;
xo_t = (x_t - x_tm)/2;

% Visualise
figure()
subplot(311), plot(t,x_t), grid on, ylabel('orig fct')
subplot(312), plot(t,xe_t), grid on, ylabel('even part'),ylim([-3 3])
subplot(313), plot(t,xo_t), grid on, ylabel('odd part')
```

b) What is the mathematical expression being used to decompose the signal in its even and odd parts? Can you apply these expressions to decompose any type of signal? For example, also random signals? Justify your answer with a short mathematical calculation, and an example in Matlab.

Exercise 2 *Distance Measurement using Correlation*

The following experimental setup is used to acquire simultaneously two audio tracks:



- a) The measured data is available as a **.mat* file. Import this file in a Matlab working session, and implement a script determining the distance between the two microphones.
Hint-1 : use the cross-correlation function *xcorr()* .
Hint-2 : Consider the sound velocity as 343m/s
- b) Why a sinusoidal signal is not practical to do this distance measurement as described above? Justify your answer with an example plot in Matlab.

Exercise 3 *Simple Pedometer (Step-Counter)*

- (a) Use the IMU signal acquisition setup, which you prepared for laboratory 1-B, to log a sequence of 3D-accelerometer sensor data, while you walk for about 30 seconds.
Hint: you can start the acquisition, then place the smartphone in your pocket, and walk around for 30 seconds.
- (b) Import the sensor data in Matlab and process it to determine:
 - Number of steps made during the whole acquisition period (step counter);
 - Average frequency of the steps

Obs.: you can choose and/or experiment different processing approaches. Please comment shortly the solution approach you selected.