List 1:

Signals und Systems

Solution:

**Exercise 1**

1. As single cosine function:



1. As sum of sine and cosine functions:



Because:

1. As real part of a complex exponential function:



1. As the sum of 2 complex exponential functions

**Exercise 2**



**Checking with a plot in Matlab**

clear all, close all

t = -2 :0.01 :2 ;

x1\_t = 3\*cos(6\*pi\*t+pi/2);

x2\_t = 2\*cos(6\*pi\*t+pi/4);

x3\_t = x1\_t .\* x2\_t;

figure()

plot(t,x1\_t,'b',t,x2\_t,'r',t,x3\_t,'m')

* =

**Exercise 3**

1. 
2. 
3. Signal (a) is not periodic (cause sinus time limited), is an energy signal and not symmetric.

Signal (b) is periodic, symmetric (even) and a power signal.

1. sig\_d is a random and discrete signal, with average value tending to 0 ( use mean fct), and standard deviation tending to 1 (use std fct). Try also the histfit function.

**Experimenting with a plot in Matlab**

clear all, close all

sig\_d = randn(1,1000);

figure(),histfit(sig\_d)

sig\_e = rand(1,1000);

figure(),histfit(sig\_e)

What are the differences between the *randn()* and the *rand()* functions ?

**Exercise 4**

1. x(t-2) : same shape with a shift of 2 to the right
2. x(2.t) : similar shape, compressed by a factor 2 (non-zero values between 0…2)
3. x(t/2) : similar Form, extended by a factor 2 (non-zero values between 0…8)
4. x(-t) : mirrored about the y-axis (vertical axis where t=0 ) (non-zero values between -4...0)

**Exercise 5**

1. x[n-2] : same shape with a shift of 2 to the right
2. x[2.n] : similar shape, compressed by a factor 2 (non-zero values between 1…2)
3. x[-n] : mirrored about the y-axis (vertical axis where n=0 ) (non-zero values between -4...-1)
4. x[-n+2] : mirrored about the y-axis and shifted by 2 to the right

(non-zero values between -2...+1)



Oder  mit 

**Exercise 6** *Sampling and Discrete Signals.*

1. x(t)

1

0.5

x(t)

-1.5 -1 -0.5 0 0.5 1 1.5 t [s]

1. Ts = 0.25 s

1

0.5

x(t)

-1.5 -1 -0.5 0 0.5 1 1.5 t [s]

1. Ts = 0.5 s

1

0.5

x(t)

-1.5 -1 -0.5 0 0.5 1 1.5 t [s]

1. Ts = 1 s

1

0.5

x(t)

-1.5 -1 -0.5 0 0.5 1 1.5 t [s]

**Exercise 7**

1. : no
2. : yes
3. : yes
4. : no

In order to test check the superposition principle (required for a linear system)



**Exercise 8**

1. **Simplified LTI (only amplitude effect)**



1. **LTI with amplitude and phase effect**

