Lab 3

Discrete-Time Signals and Systems

Exercise 1 (4 points)

Matlab filename must be `exer01.m`. The following analog signal is sampled at a rate of 2150 Hz:

- $x(t) = \sin(2\pi \cdot 1250 \cdot t) + \cos(2\pi \cdot 1775 \cdot t + \pi/2) - \sin(2\pi \cdot 775 \cdot t)$

Answer the following questions, and help yourself using Matlab to corroborate the results.

1. Determine the period of the sampled signal.
2. Determine the discrete frequencies present in the sampled signal
3. Is there aliasing in x[n]? Which terms of x(t) produces aliasing? Why?
4. What are the alias frequency of the aliasing terms?
5. Plot x(t) and x[n] in the same plot showing the sampling instants and explain the result.

Exercise 2 (6 points)

Matlab filename must be `exer02.m`.

The impulse response of a system is given by the following equation: $h[n] = 0.6^n \cdot (u[n+5] - u[n-5])$. Given the following input signals:

- $x_1[n] = \cos(2\pi n/5) \cdot u[n]$
- $x_2[n] = \cos(2\pi n/5)$

Calculate the system's response to the given inputs with zero initial conditions (relaxed system)

1. Obtain the mathematical expressions for both outputs

2. Compute outputs using the `conv()` function of Matlab and plot both results in the same figure.

3. What's the duration of the output signals? Why are the analytical solution and the one obtained with `conv()` different with $x_1[n]$? Explain

4. Discuss the stability and causality of the system.

5. Is the system a FIR or IIR system?

6. Regarding the output of the system to signal $x_1[n]$ plot the Transient and Stationary responses.

7. Explain the differences between the outputs to $x_1[n]$ and $x_2[n]$.

```
% Both conv() and filter() functions can be used to compute the response
% of a system to a given input. The difference between them is the way we
% describe the system in question.
% conv(x,h) uses the impulse response to describe the system. Therefore,
%           is only able to compute the output of a relaxed system (zero
%           initial conditions).
%           x[n] * h[n] = conv(x,h) = conv(h,x)
%           In Matlab both x and h variables are given as vectors of
%           sampled values.
%           If x[n] and h[n] are signals of infinite duration you have to
%           cut the signal to the most relevant parts. Because of that,
%           if infinite duration signals are involved in a convolution,
%           Matlab is only able to produce an approximation to the real
%           convolution.
%           Important: the output sequence of conv() is always the sum of
%           the lengths of x and h minus 1.
% filter(B,A,x) uses a description with a difference equation with constant
%           coefficients. B and A are the vector coefficients and x is the
%           input sequence.
%           The output sequence using filter() is exact. The only restricction
%           is that the length of the output sequence is always the same as
%           the length of the input sequence.
%           Additionally, we can use filter() to introduce non-zero initial
%           conditions, as explained above
```