

Digital Signal Processing

Assignment 2: frequency analysis, z-transforms

Frequency analysis

We can already apply our knowledge of DSP to create a guitar tuning program. Read in the audio file and determine which open guitar string is being struck. The sampling frequency of the audio signal is 44100 Hz.

1. Plot the single-sided frequency spectrum from 0 Hz till 1 kHz.
2. Determine the frequency of the guitar string. Which string is it ?

Useful MATLAB commands: `audioread()`, `fft()`, `xlim()`

Z-transform

When applicable use sample time $T_s = 0.1s$

Z-transform: manual work

In this part all calculations are to be done **manually**, without use of MATLAB. Show how you calculated the answers. Where necessary use the table of transforms, available in in the sheets of lecture 2.

1. What is the z-transform of the following series:

$$x[n] = \{0, 1, 2, 3, 2, 7, 0, 0, 0, \dots\}$$

2. Given the following function:

$$x(t) = 4t - 4t \cdot e^{-3t}$$

- a. Find x_0, x_1, x_2, x_3 (numerical values in $x[n]$)
 - b. Find the z-transform of this function
3. Find the z-transform of the following function:
 - a. $x(t) = 3 \sin(4t) + 4 \cos(4t)$
 - b. $x_k = 7 \cdot 4^k$
 - c. $x_k = 7k \cdot 7^{k-1}$

4. Given the following transfer function in the Laplace domain:

$$H(s) = \frac{2s + 1}{(s + 1)(s + 2)}$$

- a. Perform a partial fraction expansion (NL: breuksplitsen)

Z-transform: MATLAB

Use MATLAB as much as possible for the following questions.

1	Ref, question 1. Plot the samples like “needles” (“dirac pulses”)	stem
2	Ref, question 2. Plot the first 10 samples as a staircase	stairs
3	Ref, question 3. Let MATLAB find the answer	syms, ztrans, pretty, simple, simplify
4	Ref, question 3a. Let MATLAB find the answer	
5	Ref, question 3b. Let MATLAB find the answer	
6	Let MATLAB expand $\frac{2s+1}{s(s+1)(s+2)}$ in partial fractions Attention: Numerator in this expression differs from numerator in number 4 above.	residue