AET 5420 Test 1

Name : _____

March 10th, 2021

1 SPECTRAL ANALYSIS OF SYSTEMS

Given the following system, analyze its spectral characteristics with the frequency response.

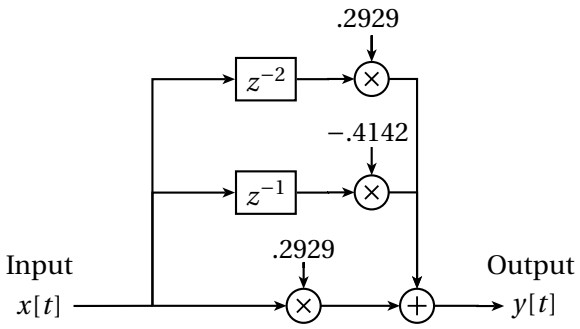

Figure 1.1: Block Diagram

Write the difference equation for this block diagram:

What is the impulse response of this system:

```
h = [                          ]
```

Derive the transfer function in the Z-domain for this system:

Draw the magnitude response for this system (use Matlab):

2 Combining HPFs in Series

A basic high-pass filter (HPF) can be created by adding together a sample of a signal with the previous sample of a signal after it has been phase inverted. A block diagram for this effect is shown in Fig. 2.1, along with the difference equation.

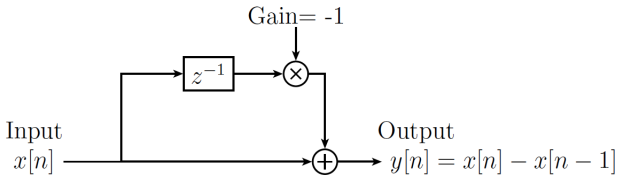

Figure 2.1: First-order HPF Block Diagram

Consider the result if several of these first-order HPFs are combined together in series. Each individual block will roll-off the low frequencies by a little bit more. This is one approach to designing filters where the slope can be changed. An example is shown in Fig. 2.2.

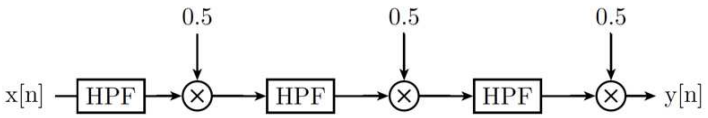

Figure 2.2: Series HPF Block Diagram

Use the following space to write the difference equation for the block diagram in Figure 2.2. *Hint:* The result should be a function for $y[n]$ as a function of $x[n]$ and its previous samples.

2.1 Block Diagram with Parallel Delay

Based on the difference equation, draw a block diagram for the HPF as a single stage with multiple feed-forward parallel paths. Label the gains on each path with the coefficients you just found.

3 WRITING MATLAB CODE

Write the following code in MATLAB. When completed, create a new compressed zip folder with your solution. Please submit all the files provided to you, in addition to the files you create. Name the zip file: XXXX_AET5420_Midterm .zip, where XXXX is your last name. Then email the zip file to: eric.tarr@belmont.edu. Confirm the receipt of your file before leaving.

4 AURAL EXCITER AUDIO EFFECT

One specialized type of audio effect is the *aural exciter*. The perceptual result of this effect is to add clarity and excitment to a dull sound. There are several common places to use this effect including on vocals, acoustic guitar, and (tastefully) on an entire mix.

The basic processing of the aural exciter is to saturate the high frequencies of the signal without saturating the low frequencies. This can be accomplished with parallel processing where the "wet" path uses a high-pass filter and arctangent distortion (Figure 4.1).

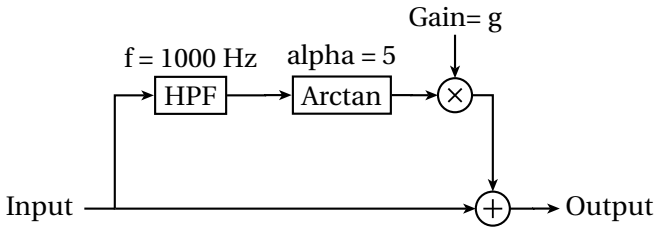

Figure 4.1: Aural Exciter Block Diagram

4.1 PROBLEM

Write a MATLAB function the implements the block diagram shown in Fig. 4.1. Your function should have the following specifications:

- Name the function: **auralExciter.m**
- Function input variables:
  - **in** : input signal.
  - **Fs** : sampling rate.
  - **gain** : amplitude amount of the "wet" path (from 0-1)
- Function output variable:
  - **out** : processed, output signal.
- Use the following recommendations within the function
  - Create an FIR HPF
  - Process the input signal with the HPF

- Process the resulting signal with an arctangent distortion algorithm
  - alpha = 5;
- Scale the gain of the distorted signal based on the input variable to the funciton
- Combine the “dry” path with the “wet” path

Next, use the `exciterTest.m` to demonstrate your function. You should use the sound file **AcGtr.wav**, as the input signal for your function. You should test the function with several different gain values (0, 0.5, 1). In your exam submission folder, include the **test script and the function**.