MAS160: Signals, Systems & Information for Media Technology

Problem Set 8

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Problem 1: Return of the rabbits!

HINT :

This problem is supposed to demonstrate that z-transforms are useful outside the realm of signal processing. Luckily this problem can be solved using just the things we've taught you so far. The idea is to transform the equation for $r[n]$ into an equation for $R[z]$ by taking the transform. You should be able to solve for $R[z]$ directly after the transform.

There are 2 potentially tricky things about this problem. The first is figuring out what happens to the terms that look like $r[n-1]$. You'll want to use the z-transform rules to make them look more like $R[z]$. The second problem is that you need to specify the initial condition, namely $r[1] = 1$. Think δ function.

Problem 2: Inverse z-Transforms

HINT :

The inverse z-transforms are all solved in the same fashion: do a partial fraction expansion and perform the inversion on the terms individually. Since the inverse is typically not unique, you'll need to use the requirements (like causal or stable) to pick out which of the possible inverse functions we're looking for.

Problem 3: Utilizing the z-transform (*DSP First* 8.12)

HINT :

In part (a) you'll determining the system function $H(z)$ of the filter described in this problem. When applying the filter, resist the temptation to take an inverse transform of $H(z)$ directly. It will be much easier to take the forward transform of the input signal, multiply, and then invert the transform of the whole expression.

Problem 4: MAS 510 Additional Problem

HINT :

If you want the overall system function to be unity (i.e. the identity function) you're looking for $\hat{h}(n)$ such that $\hat{h}(n) * h(n) = 1$. In the z domain however this just means $\hat{H}(z)H(z) = 1$. If you know $H(z)$ you can solve this directly.

Problem 5: Discrete Fourier Transforms (*DSP First* 9.2)

Problem 6: Inverse DFT (*DSP First* 9.3)

HINT :

Both of these problems make liberal use of the geometric series summation formula and the simple values of $e^{j2\pi x}$ (like $e^{j\pi} = -1$). In every case the summation can be evaluated to either give the answer in either a direct or case by case way.

Problem 7: Convolution revisited

HINT :

Just follow the problem. Don't get ahead of yourself and start padding the lists with zeros. That's the next problem!

Problem 8: MAS 510 Additional Problem

HINT :

This is a problem designed to teach you about windowing and the trade off between getting good resolution in different domains. Think about how the shape of the Hanning window will effect the FFT. It will help to look at the shape of the Hanning window directly (i.e. look at `hanning(32)` *as well as* `hanning(32).*x`*). Multiplication in the time domain is convolution in the frequency domain, so you can think of windowing functions as filters that are applied in the frequency domain.*