Enrichment Problems

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Introduction

I want to give you guy some problems that help in our fundamental understanding of discrete time systesm.

FIR Filter

An LTI system has a frequency response

$$H(e^{j\hat{\omega}} = (1 - e^{j\pi/2}e^{-j\omega})(1 - e^{-j\pi/2}e^{-j\omega})(1 + e^{-j\omega})$$

The input to the system is

$$x[n] = 5 + 20\cos(0.5\pi n + 0.25\pi) + 10\delta[n - 3]$$

Find the output of the system

Another one

An LTI system has the difference equation

$$y[n] = -x[n] + 2x[n - 2] - x[n - 4]$$

I. Find the impulse response h[n] and plot it

II. Determine an equation for the frequency response $H(e^{j\hat{\omega}})$ and express it in the form

$$R(e^{j\hat{\omega}})e^{-j\hat{\omega}n_0}$$

where n_0 is an integer.

Sample and Reconstruct

The signal $x(t)$ is to be reconstructed by directly putting an ideal continuous to discrete converter in cascade with an ideal digital to discrete converter, each samples at a rate of $f_s = 500$(samples/sec). $x(t)$ is defined as follows.

$$x(t) = 5\cos(200\pi t) + 10\cos(800\pi t + \frac{\pi}{3}) + 2\cos(2200\pi t + \frac{\pi}{6})$$

I. Draw the block diagram of the entire process

II. Determine the output function $y(t)$.

Discrete Fourier Transform

Find the N point DFT of $u = [\sin(ja)]_{j=0}^{N-1}$, in which N is a positive integer and a is a given complet number. To avoid trivialities suppose a is not an integer multiple of π.