دانشگاه صنعتی امیرکبیر
(پلی تکنیک تهران)

Signals and Systems

Assignment 6

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Question 1

Determine the Fourier Transform for the following signals:

(a) $x_1[n] = 4 + cos(\frac{\pi}{6}n + \frac{\pi}{8}) + 2sin(\frac{\pi}{4}n)$

(b) $x_2[n] = u[n-2] - u[n-13]$

(c) $x_3[n] = \frac{sin(\frac{\pi}{4}n)}{\pi n}$

(d) $x_4[n] = \left(\frac{1}{4}\right)^{|n|} u[-n-7]$

(e) $x_5[n] = 2^n sin(\frac{\pi}{4}n)u[-n]$

Question 2

Determine the Fourier Transform for the following signals in terms of $X(e^{j\omega})$:

(a) $x[5-n]+x[-2-n]$

(b) $x^*[-n]$ (the signal is real)

Question 3

Determine the inverse Fourier Transform for the following signals:

(a) $\hat{X}(e^{j\omega}) = \begin{cases} 1 & \frac{\pi}{2} < |\omega| < \frac{3\pi}{4} \\ 0 & otherwise \end{cases}$

(b) $X(e^{j\omega}) = 3 + 3e^{-j2\omega} + 5e^{j144\omega}$

(c) $X(e^{j\omega}) = \frac{7e^{-j\omega}+10}{e^{-j2\omega}+2e^{-j\omega}-8}$

Question 4

Consider a system consisting of the cascade of two LTI systems with frequency responses

$$H_1(e^{j\omega}) = \frac{3 - e^{-j8\omega}}{1 + e^{-j\omega}}$$

and

$$H_2(e^{j\omega}) = \frac{1}{1 - \frac{1}{4}e^{-j\omega} + \frac{1}{8}e^{-j2\omega}}$$

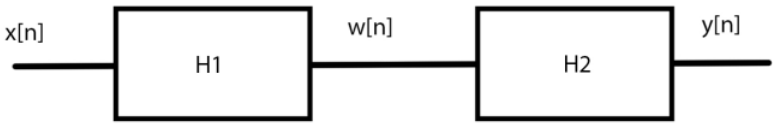
Find the difference equation describing the overall system.

Question 5

Determine the output of an LTI system with impulse response $h[n] = \frac{sin(\frac{\pi}{3}n)sin(\frac{\pi}{4}n)}{\pi^2 n^2}$ if the input is $x[n] = sin(\frac{\pi}{12}n) - 12cos(\frac{2\pi}{3}n)$

Question 6

Consider the following system:



$$w[n] = 3x[n]$$

$$h_2[n] = \frac{sin(\frac{\pi}{2}n)}{\pi n}$$

$$x[n] = cos(0.4\pi n) + sin(0.6\pi n) + 2$$

(a) Determine $W(e^{j\omega})$ in terms of $X(e^{j\omega})$

(b) Determine $H_1(e^{j\omega})$

(c) Determine $H_{eq}(e^{j\omega})$

(d) Determine $X(e^{j\omega})$

(e) Determine $y[n]$

Question 7

Consider a causal LTI system described by the difference equation

$$y[n] - \frac{1}{3}y[n-1] = 2x[n]$$

(a) Determine the frequency response $H(e^{j\omega})$ of this system.

(b) Determine the output if the input is $x[n] = \left(\frac{1}{3}\right)^n u[n]$

(c) Determine the output if the input is $x[n] = \left(\frac{-1}{3}\right)^n u[n]$

(d) Determine the output if the input has the following Fourier Transform

$$X(e^{j\omega}) = \frac{1 - \frac{1}{4}e^{-j\omega}}{1 + \frac{1}{2}e^{-j\omega}}$$