ECE301

HW 7

Due on Thursday Dec. 8th

Please provide steps to explain your answer

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Office Hour change: MSEE180 (9:30am - 10:30am Monday and Wednesday)

Question 1

A signal x(t) with Fourier transform $X(jw)$ undergoes impulse-train sampling to generate

$$x_p(t) = \sum_{n=-\infty}^{\infty} x(nT)\delta(t - nT)$$

where $T = 10^{-4}s$. For each of the following sets of constraints on $x(t)$ and/or$X(jw)$, does the sampling theorem guarantee that $x(t)$ can be recovered exactly from $x_p(t)$?
a.) $X(jw) = 0$ for $|w| > 4000\pi$
b.) $X(jw) = 0$ for $|w| > 14000\pi$
c.) $Re\{X(jw)\} = 0$ for $|w| > 4000\pi$
d.) $x(t)$ real and $X(jw) = 0$ for $w > 4500\pi$
e.)$X(jw) * X(jw) = 0$ for $|w| > 14000\pi$
f.) $|X(jw)| = 0$ for $|w| > 4500\pi$

Question 2

a.) The signal $x_a(t) = u(t + 2) - u(t - 2)$ is sampled every $T_s = 0.5s$ to form $x[n] = x_a(nT_s)$. Determine a closed-form expression for the DTFT $X(e^{jw})$ of the $x[n]$. Check table 5.2 in the textbook

b.) The signal $x_a(t) = t\{u(t + 2) - u(t - 2)\}$ is sampled every $T_s = 0.5s$ to form $x[n] = x_a(nT_s)$. Determine a closed-form expression for the DTFT $X(e^{jw})$ of the $x[n]$.

Question 3

Consider the input signal $x_p(t)$ below

$$x_0(t) = e^{-j25t} + e^{-j15t} + e^{-j5t} + 1 + e^{j5t} + e^{j15t} + e^{j25t}$$

This signal is first input to an analog filter with impulse response (hints check table 4.2)

$$h_{LP}(t) = \frac{sin(16t)}{\pi t} + \frac{sin(20t)}{\pi t} + \frac{sin(30t)}{\pi t}$$

to form $x(t) = x_0(t) * h_{LP}(t)$. x(t) is sampled as a rate of $w_s = 60$ to form $x[n]$. The DT signal $x[n]$ is then went through DT LTI system with impulse response

$$h[n] = \frac{sin(\frac{\pi}{3}n)}{\pi n} + \frac{sin(\frac{2\pi}{3}n)}{\pi n}$$

a.) Plot both Fourier Transform of $h_{LP}(t)$ and the DTFT of h[n].
b.) Write your expression for the output $y[n]$

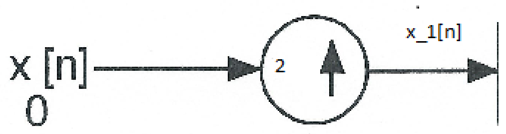

Figure 1

Question 4

Consider the continuous-time signal $x_a(t)$ below.

$$x_a(t) = T_s\{\frac{sin(15t)}{\pi t} + \frac{sin(20t)}{\pi t} + \frac{sin(30t)}{\pi t}\}$$

a.) A discrete-time signal is created by sampling $x_a(t)$ according to $x[n] = x_a(nT_s)$ for $T_s = \frac{2\pi}{60}$. Plot the DTFT of $x[n]$, over $-\pi < w < \pi$

b.) Repeat part (a) for $T_s = \frac{2\pi}{50}$. Sketch the DTFT of $x[n]$, over $-\pi < w < \pi$.

hints: check table 5.2 from text book

Question 5

a.) Consider the continuous time signal $x(t)$ below. A discrete time signal is created by sampling $x(t)$ according to $x[n] = x(nT_s)$ with $T_s = \frac{\pi}{10}$. Plot the magnitude of the DTFT of $x[n]$, over $-\pi < w\pi$

$$x(t) = T_s\left(\frac{sin(10t)}{\pi t} + \frac{sin(5t)}{\pi t}\right)$$

b.) The discrete-time signal, $x_1[n]$, is created by running $x[n]$ from part(a) through the DT system see Fig.1

$$h_1[n] = 3\frac{sin(\frac{\pi n}{3})}{\pi n}$$

hints: Upsampling