ECE301

Final Exam

Please provide steps to explain your answer

name:

student ID:

Question 1

a.)Consider any sequence $x[n]$ whose Fourier transform is $X(e^{jw})$

$$X(e^{jw}) = 0,\ \frac{2\pi}{7} \leq |w| \leq \pi$$

Can you explain a scheme that achieve the most efficient representation (Hint: Down/Up Sampling)?

b.)Consider any sequence x[n] whose Fourier transform is $X(e^{jw})$

$$X(e^{jw}) = 0,\ \frac{2\pi}{7} < |w| \leq \pi$$

Can you use the same scheme? why?

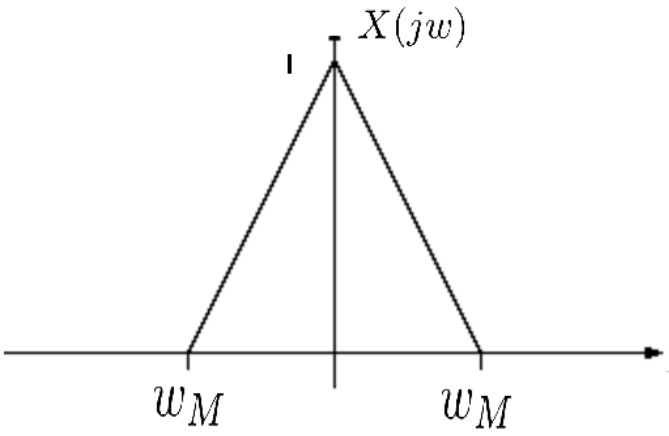

Figure 1

Question 2

Consider the input signal $x(t)$ whose Fourier transform is $X(jw)$ see fig.1.
a.) Suppose the sampling frequency $w_s = 8w_M$, determine the Fourier transform of the sampled signal $x_p(t)$, $X_p(jw)$. $x_p(t)$ is defined as

$$x_p(t) = \sum_{k=-\infty}^{\infty} x_c(kT)\delta(t - nT).$$

b.) Converting the sampled signal into a discrete time signal $x_d[n]$, determine the Fourier transform of $x_d[n]$, $X_d(e^{jw})$. $x_d[n]$ is defined as

$$x_d[n] = x(nT)$$

c.) Is there aliasing?
d.) Is there a more efficient representation for $x_d[n]$? Explain your answer in detail.

Question 3

a.) What property in frequency-domain does a signal have if it is periodic in time domain?

b.) What property in time-domain does a signal have if it is periodic in frequency-domain?
c.) State all the duality relationships that exist among the following operations:
1.) Discrete-time Fourier series,
2.) Discrete-time Fourier transform,
3.) Continuous-time Fourier series,
Explain why the stated relationships exist.

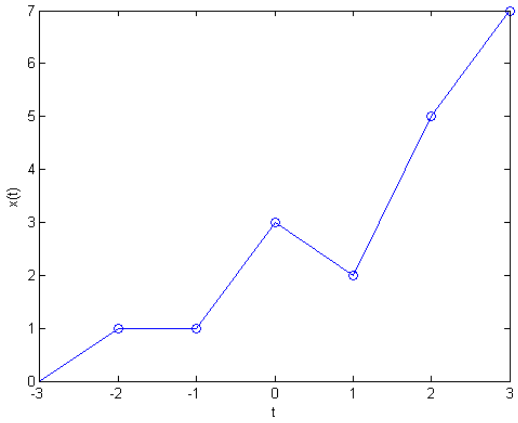

Figure 2

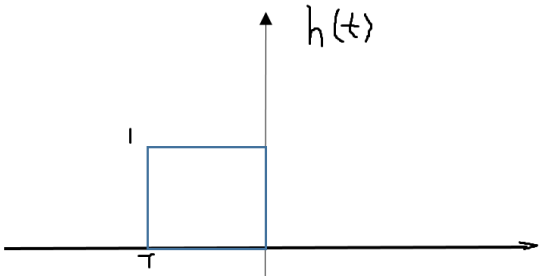

Figure 3

Question 4

a.) Consider the continuous-time signal $x(t)$ plotted in Figure 2. Determine the Fourier transform of $x(t)$.
b.) Consider an input signal $x_p(t)$ to an LTI system such that the input signal $x_p(t)$ can be expressed as

$$x_p(t) = \sum_{k=-\infty}^{\infty} x_c(kT)\delta(t - nT),$$

and the impulse response of the LTI system is defined as h(t) which is in fig.3 Determine the Fourier transform of output y(t) in term of $x_c(t)$

$$y(t) = x_p(t) * h(t).$$

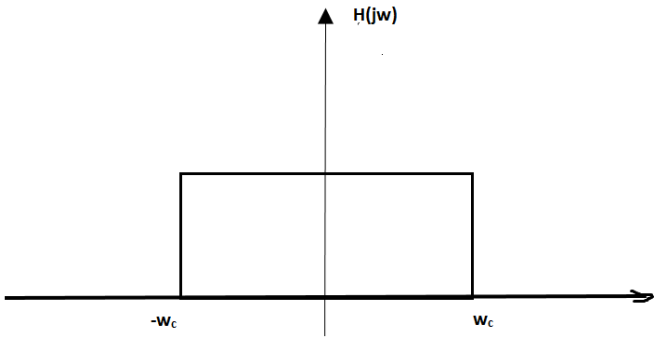

Figure 4

Question 5

Consider an LTI system with frequency response $H(jw)$ in fig.4
a.) What is the inverse Fourier transform of $H(jw)$, $h(t)$.
b.) What is the functionality of the system?
c.) Is this system practical? If not, suggest a practical alternative design and analyze its time-domain and frequency domina signal.

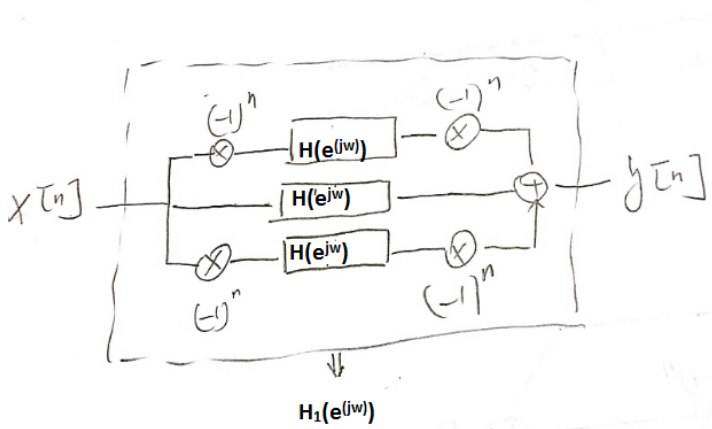

Figure 5

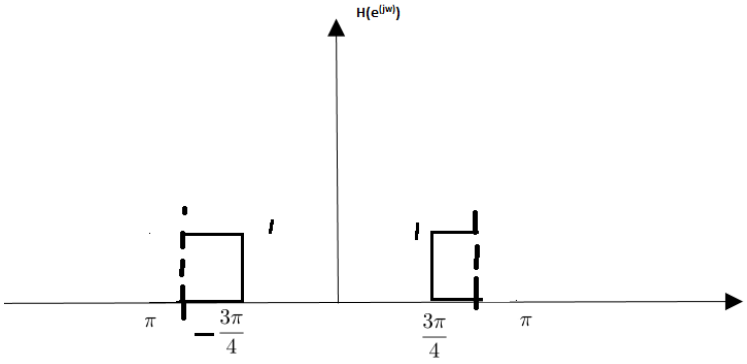

Figure 6

Question 6

Consider the system shown in fig.5 with input $x[n]$ and output $y[n]$. The filter $H(e^(jw)$ is shown in fig.6.
a.) What is the functionality of the system.
b.) Determine $H_1(e^{jw})$.