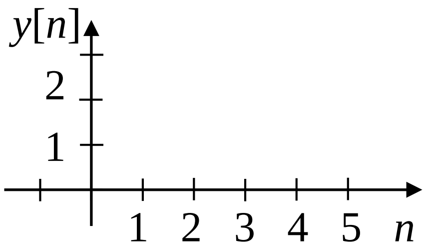
Question

If $h[n] = u[n] - u[n-2]$ and $x[n] = \delta[n] + \frac{1}{2}\delta[n-1]$, sketch $y[n] = (h * x)[n]$.



2018W2 MT2, Q1a (cont.)

iii. For zero initial conditions, find the input $x[n]$ so that $y[n] = 0.5^n u[n]$.

2018W2 MT2, Q1b

Consider a causal LTI system with impulse response $h[n] = u[n] - u[n-2]$.

i. Sketch $y[n]$ for input $x[n] = x_1[n] - x_1[n-2] + x_1[n-4]$ where $x_1[n] = u[n] - u[n-2]$.

2018W2 MT2, Q1b (cont.)

ii. When cascaded with another causal LTI system with impulse response $g[n]$, the overall impulse response is $h_T[n] = \begin{cases} 1, & n = 0,1,2,3 \\ 0, & otherwise \end{cases}$. Determine $g[n]$.

2018W2 MT2, Q4

a) For the system represented by $y_1[n] = x_1[n] \cdot x_1[n+2]$, **show** whether or not the system is linear, time-invariant, causal and/or BIBO stable.

2018W2 MT2, Q4 (cont.)

b) For each of the systems represented by difference equations, classify the system according to its linearity, time-invariance, causality and BIBO stability (it isn't necessary to explain how you concluded these):

i. $y_2[n] = x_2[n] \cdot \cos\frac{n\pi}{4}$

ii. $y_3[n] = x_3[n] + 4$

iii. $y_4[n] = y_4[n-2] + x_4[n] + x_4[n+2]$

WW6, Q2

A periodic signal has a Fourier series representation given by

$$x(t) = \sum_{k=-\infty}^{\infty} \sqrt{0.1^{|k|}} e^{jkt}$$

a) Is this signal band-limited? No

b) Find the power, P_x, of the signal.

$P_x =$ 1.22222

c) Now suppose that the signal is approximated by $\hat{x}(t) = \sum_{k=-N}^{N} \sqrt{0.1^{|k|}} e^{jkt}$ by using only $2N+1$ terms instead. Find the minimum N such that $\hat{x}(t)$ has 90% of the original signal's power, P_x.

$N =$ 1

d) Using the N you found in part **c**, determine the maximum sampling period that can be used to sample $\hat{x}(t)$ without aliasing.

$(T_s)_{max} = \pi$

WW6, Q3

Consider the causal exponential signal $x(t) = 6e^{-9t}u(t)$.

a) Determine the frequency, ω_M for which the energy of $x(t)$ corresponds to 99% of its total energy.

$\omega_M = 9\tan\left(\frac{0.99\pi}{2}\right)$

b) Is $x(t)$ band-limited? No

WW6, Q4

Consider the signal $x(t) = 4cos(8\pi t + \pi/5)$. Determine if the signal is band-limited or not. Then for each of sampling periods $T_s = 0.1, 0.125$ and 1 sec/sample, determine if the Nyquist condition is satisfied, if the sampled signal is aliased, give the expression for the sampled signal, $x_s[n]$, as the simplest discrete-time sinusoid to be used for ideal reconstruction and determine its period.

Sampling Period, T_s	Nyquist condition satisfied?	Signal Aliased?	Sampled Signal $x_s[n]$	Period of Sampled Signal
0.1	Yes	No	$4\cos(8\pi \cdot 0.1n + \frac{\pi}{5})$	5
0.125	No	No	$4\cos(\frac{\pi}{5})\cos(\pi n)$	2
1	No	Yes	$4\cos(\frac{\pi}{5})$	1

Some students were given a phase shift of p/2 which resulted in the expected answers being incorrect (and misleading)!

Consider the signal $x(t) = 8cos(4\pi t + \pi/2)$. Determine if the signal is band-limited or not. Then for each of sampling periods $T_s = 0.1, 0.25$ and 1 sec/sample, determine if the Nyquist condition is satisfied, if the sampled signal is aliased, give the expression for the sampled signal, $x_s[n]$, as the simplest discrete-time sinusoid to be used for ideal reconstruction and determine its period.

Sampling Period, T_s	Nyquist condition satisfied?	Signal Aliased?	Sampled Signal $x_s[n]$	Period of Sampled Signal
0.1	Yes	No	$8\cos(4\pi \cdot 0.1n + \frac{\pi}{2})$	5
0.25	No	No	$8\cos(\frac{\pi}{2})\cos(\pi n)$	2
1	No	Yes	$8\cos(\frac{\pi}{5})$	1

WW6, Q6

For each of the signals given in the table below, determine whether or not it is periodic and find its period if it is. If the signal is aperiodic, enter NA for its period.

	Signal, $x[n]$	Periodic/Aperiodic	Period
1	$cos\left(\frac{\pi n}{3}\right)cos\left(\frac{\pi n}{6}\right)$	Periodic	12
2	$10cos\left(\frac{\pi n}{4}\right) - sin\left(\frac{\pi n}{8}\right) + 2cos\left(\frac{\pi n}{2} - \frac{\pi}{3}\right)$	Periodic	16
3	$15 + cos\left(\frac{\pi n^2}{8}\right)$	Periodic	8
4	$11e^{j(n-3)/3}$	Aperiodic	NA
5	$4cos(6n) + 4sin(4\pi n) - cos(5n)$	Aperiodic	NA
6	$2e^{j\pi(n-8)/8}$	Periodic	16