ICE503 DSP-Homework#1

1. Consider a discrete-time system which can develop the output sequence:

$$y[n] = 3x[n] + 4x[n-1] - x[n-2] + 2x[n-4]$$

(a) Plot the block diagram for this system.

(b) The input sequence $x[n]$ is shown in Figure 1, sketch and label $y[n]$.

(c) Following (b), sketch and label the down sampling sequence $y[3n]$.

(d) Following (b), sketch and label the up sampling sequence $y[\frac{1}{2}n]$.

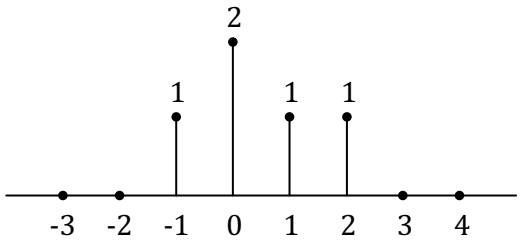

Figure 1: The input sequence $x[n]$

2. Determine whether each of the following signals is periodic. If the signal is periodic, state its fundamental period.

(a) $x[n] = 6\cos\left(\frac{\pi}{2}n\right)$

(b) $x[n] = n\sin\left(\frac{\pi}{12}n\right)$

(c) $x[n] = e^{j\frac{3}{4}\pi n}$

3. MATLAB simulation:

(a) Generate the complex-valued signal.

$$x[n] = e^{j\frac{1}{10}\pi n}, \qquad n = -10, \dots, -1, 0, 1, \dots 10$$

(b) Use `stem` function to plot the real part and the imaginary part of $x[n]$.

(c) Determine whether $x[n]$ is a conjugate symmetric sequence or a conjugate antisymmetric sequence, and explain the reason.

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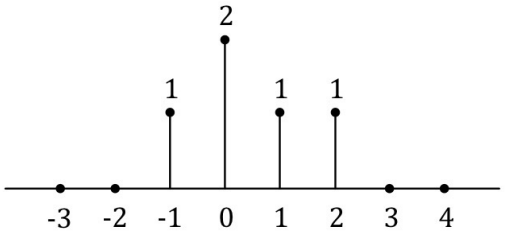
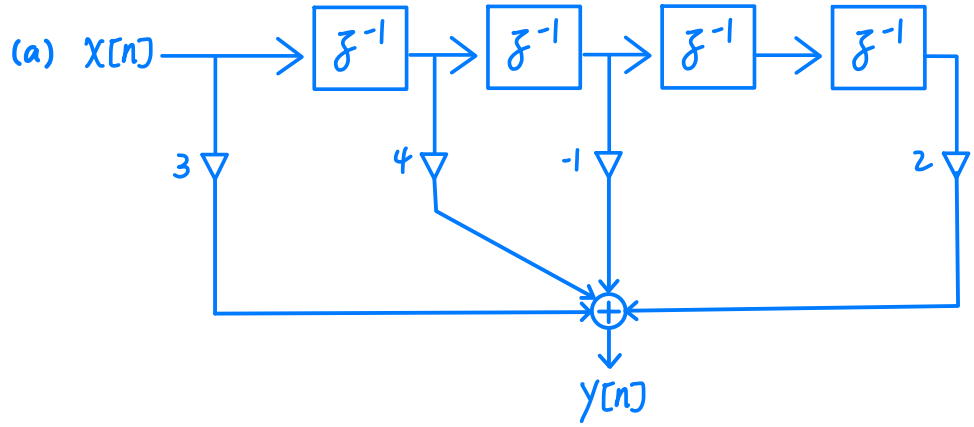


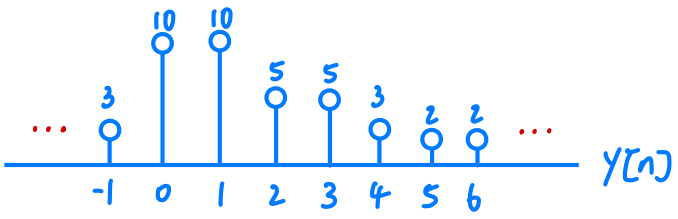
Figure 1: The input sequence $x[n]$

(a)

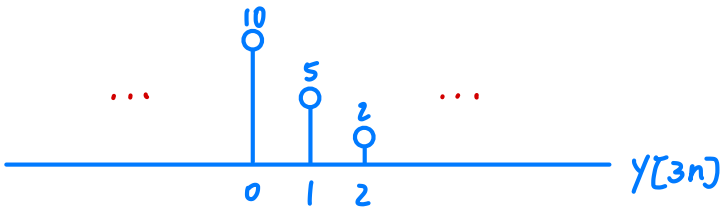


(b) $X[n] = \delta[n+1] + 2\delta[n] + \delta[n-1] + \delta[n-2]$

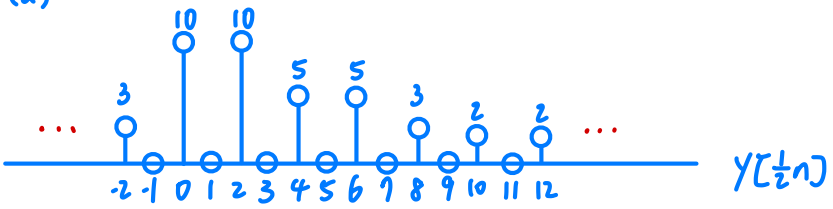
n:	-1	0	1	2	3	4	5	6
	3	6	3	3				
		4	8	4	4			
			-1	-2	-1	-1		
				0	0	0	0	
					2	4	2	2
y[n]:	3	10	10	5	5	3	2	2



(c)



(d)



2. Determine whether each of the following signals is periodic. If the signal is periodic, state its fundamental period.

Happen when Complex exponential sequence ex: $e^{j\theta}$ or sinusoidal sequence ex: sin, cos

(a) $x[n] = 6\cos\left(\frac{\pi}{2}n\right)$ → $T_0 = \frac{2\pi}{a}$ → $a = \frac{\pi}{2}$ → $T_0 = 4$ → $N = 4$

(b) $x[n] = n\sin\left(\frac{\pi}{12}n\right)$ → Not periodic

(c) $x[n] = e^{j\frac{3}{4}\pi n}$ $= \cos\left(\frac{3}{4}\pi n\right) + j\sin\left(\frac{3}{4}\pi n\right)$ → $a = \frac{3}{4}\pi$ → $T_0 = \frac{8}{3}$ → $N = 8$

Euler's Formula

$e^{i\phi} = \cos\phi + i\sin\phi$

(b) Pf. ⇒

(1) $\sin\left(\frac{\pi}{12}n\right)$, $\because T_0 = \frac{2\pi}{a}$ → $a = \frac{\pi}{12}$ → $T_0 = 24$

$\therefore \sin\left(\frac{\pi}{12}n\right) = \sin\left[\frac{\pi}{12}(n+24N)\right]$, $N \in \mathbb{Z}$

(2) $x[n+N'] \neq x[n]$, $\exists N' = 24N$ (① ≠ ②)

① $x[n+N'] = (n+N')\sin\left(\frac{\pi}{12}(n+N')\right) = (n+N')\sin\left(\frac{\pi}{12}(n+24N)\right) = (n+N')\sin\left(\frac{\pi}{12}n\right)$

② $x[n] = n\sin\left(\frac{\pi}{12}(n)\right)$

①-② → $x[n+N'] - x[n] = (n+N')\sin\left(\frac{\pi}{12}n\right) - n\sin\left(\frac{\pi}{12}n\right)$

$= N'\sin\left(\frac{\pi}{12}n\right)$ → when $\sin\left(\frac{\pi}{12}n\right) \neq 0$, $N'\sin\left(\frac{\pi}{12}n\right) \neq 0$

→ $x[n+N'] \neq x[n]$ → Not periodic

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