1º EE 2017.1 Sinais e Sistemas

① $T=5$, $\omega_0 = 2\pi/5$ $\qquad x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\omega_0 t}$

Se $a_k = \begin{cases} e^{-j\frac{\pi}{4}k} \cdot (4-|k|), & |k| \leq 3 \\ 0, & \text{c.c.} \end{cases}$, então $a_0 = 4 \cdot e^0 = 4$

$a_1 = 3 \cdot e^{-j\pi/4}$, $a_{-1} = 3e^{j\pi/4}$, $a_2 = 2\,e^{-j\pi/2}$, $a_{-2} = 2e^{j\pi/2}$

$a_3 = 1 \cdot e^{-j3\pi/4}$, $a_{-3} = 1 \cdot e^{j3\pi/4}$

$$x(t) = a_0 + a_1 e^{j\omega_0 t} + a_{-1} e^{-j\omega_0 t} + a_2 e^{j2\omega_0 t} + a_{-2} e^{-j2\omega_0 t} + a_3 e^{j3\omega_0 t} + a_{-3} e^{-j3\omega_0 t}$$

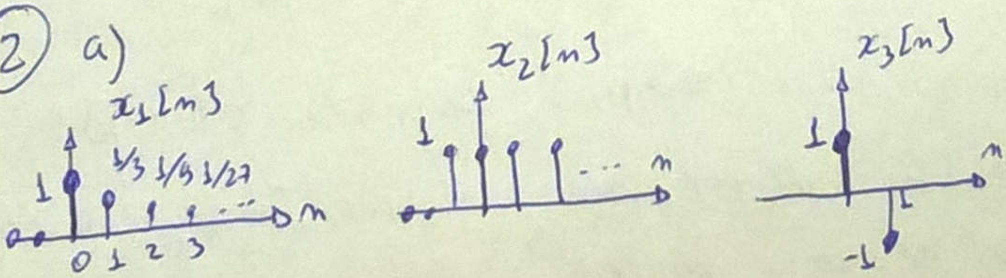
$$x(t) = 4 + 3\left(e^{j(\omega_0 t - \frac{\pi}{4})} + e^{-j(\omega_0 t - \frac{\pi}{4})}\right) + 2\left(e^{2j(\omega_0 t - \frac{\pi}{4})} + e^{-2j(\omega_0 t - \frac{\pi}{4})}\right) + 1 \cdot \left(e^{3j(\omega_0 t - \frac{\pi}{4})} + e^{-3j(\omega_0 t - \frac{\pi}{4})}\right)$$

$$x(t) = 4 + 6\cos\left(\omega_0 t - \frac{\pi}{4}\right) + 4\cos\left(2\omega_0 t - \frac{\pi}{2}\right) + 2\cos\left(3\omega_0 t - \frac{3\pi}{4}\right)$$

$$x(t) = 4 + 6\cos\left(\frac{2\pi}{5}t - \frac{\pi}{4}\right) + 4\cos\left(\frac{4\pi}{5}t - \frac{\pi}{2}\right) + 2\cos\left(\frac{6\pi}{5}t - \frac{3\pi}{4}\right)$$

— // —

② a)



b) $y_1[n] = x_1[n] * x_2[n] = \sum_{k=-1}^{n} \left(\frac{1}{3}\right)^{n+1}$

$y_1[-1] = 1$; $y_1[0] = 1 + 1/3$; $y_1[1] = 1 + \frac{1}{3} + \frac{1}{9}$; $y_1[n] = y_1[n-1] + \frac{1}{3}^{n+}$

$$y[n] = \frac{1\left[1-(\frac{1}{3})^{n+2}\right]}{1-1/3} = \frac{3}{2}\left(1 - \left(\frac{1}{3}\right)^{n+2}\right) \quad \text{p/ } n \geq -1$$

$y_2[n] = x_2[n] * x_3[n] = x_2[n] * \delta[n] - x_2[n] * \delta[n-1] = x_2[n] - x_2[n-1]$

$y_2[n] = u[n+1] - u[n] = \delta[n+1]$

2) c) $y_1[n] * x_3[n] = y_1[n] - y_1[n-1] = \frac{3}{2}\left(1-(1/3)^{n+2}\right) - \frac{3}{2}\left(1-(1/3)^{n+1}\right)$

$= \frac{3}{2}\left(\frac{1}{3}\right)^{n+1}\left(-\frac{1}{3}+1\right) = \left(\frac{1}{3}\right)^{n+1} u[n+1]$

$x_1[n] * y_2[n] = \left(\frac{1}{3}\right)^{n} u[n] * \delta[n+1] = \left(\frac{1}{3}\right)^{n+1} u[n+1]$

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3) a) $x_a[n] = [9\ 2\ 8\ 11]$ //

$x_b[n] = [10\ 6\ 12\ 11]$ //

$d[n] = x_b[n] - x_a[n] =$

$= [10\ 6\ 12\ 11] - [9\ 2\ 8\ 11] =$

$d[n] = [1\ 4\ 4\ 0]$ //

$c[n] = x_a[n] + \left\lfloor \frac{d[n]}{2} \right\rfloor =$

$= [9\ 2\ 8\ 11] + [0\ 2\ 2\ 0] = [9\ 4\ 10\ 11]$ //

$\left\lfloor \left[\frac{1}{2}\ \frac{4}{2}\ \frac{4}{2}\ \frac{0}{2}\right] \right\rfloor = [0\ 2\ 2\ 0]$

n	$x[n]$	$x_a[n]$ $x[2n]$	$x_b[n]$ $x[2n+1]$	$d[n]$	$c[n]$
0	9	9	10	1	9
1	10	2	6	4	4
2	2	8	12	4	10
3	6	11	11	0	11
4	8	–	–	–	
5	12	–	–	–	
6	11	–	–	–	
7	11	–	–	–	

b) O sistema é linear, mas não é invariante. Fazendo $x[n+1]$ como entrada, x_a passa a "capturar" as amostras ímpares de $x[n]$, e não as pares como no caso anterior.

O sistema é estável, a resposta é finita e com coeficientes finitos.

Tem memória e não causal $x_b[n] = x[2n+1]$ é antecipativo

c) item b)

$x_a[n] = c[n] - \left\lfloor \frac{d[n]}{2} \right\rfloor = [9\ 4\ 10\ 11] - [0\ 2\ 2\ 0] = [9\ 2\ 8\ 11]$

$x_b[n] = d[n] + x_a[n] = [1\ 4\ 4\ 0] + [9\ 2\ 8\ 11] = [10\ 6\ 12\ 11]$

$x[n] = x_a\left[\frac{1}{2}n\right] + x_b\left[\frac{1}{2}n+1\right] = [9\ 0\ 2\ 0\ 8\ 0\ 11\ 0] + [0\ 10\ 0\ 6\ 0\ 12\ 0\ 11]$

$x[n] = [9\ 10\ 2\ 6\ 8\ 12\ 11\ 11]$