

# PTC2324: Processamento Digital de Sinais I

## Respostas: Lista de exercícios 7

MDM,FRMP-2014

1. (b)

$$V(e^{j\omega}) = 2(\cos(\omega) - 1).$$

(d) i.

$$P(e^{j\omega}) = \frac{2\pi}{5} \sum_{k=-\infty}^{+\infty} \delta\left(\omega - \frac{2\pi}{5}k\right).$$

ii.

$$X(e^{j\omega}) = \frac{4\pi}{5} \sum_{k=-\infty}^{+\infty} \left[ \cos\left(\frac{2\pi}{5}k\right) - 1 \right] \delta\left(\omega - \frac{2\pi}{5}k\right).$$

iv.

$$x(n) = -2\delta(\lfloor n \rfloor_5) + \delta(\lfloor n - 1 \rfloor_5) + \delta(\lfloor n - 4 \rfloor_5).$$

(e) i.

$$P(e^{j\omega}) = \pi \sum_{k=-\infty}^{+\infty} \delta(\omega - \pi k).$$

ii.

$$X(e^{j\omega}) = 2\pi \sum_{k=-\infty}^{+\infty} \left[ (-1)^k - 1 \right] \delta(\omega - \pi k).$$

iv.

$$x(n) = -2\delta(\lfloor n \rfloor_2) + 2\delta(\lfloor n - 1 \rfloor_2).$$

2. (a)

$$\tilde{x}(n) = \cos\left(\frac{\pi}{5}n\right) + 3\cos\left(\frac{4\pi}{5}n\right).$$

(b)

$$N = 10 \text{ amostras.}$$

(c)

$$\tilde{x}(n) = \sum_{\ell=-4}^4 a(\ell) e^{j\frac{2\pi}{10}\ell n},$$

em que

$$a(\ell) = \begin{cases} \frac{1}{2}, & \text{se } \ell = \pm 1 \\ \frac{3}{2}, & \text{se } \ell = \pm 4 \\ 0, & \text{demais valores de } \ell \end{cases}$$

(d)

$$\tilde{X}(k) = 5\delta(\lfloor k - 1 \rfloor_{10}) + 15\delta(\lfloor k - 4 \rfloor_{10}) + 15\delta(\lfloor k - 6 \rfloor_{10}) + 5\delta(\lfloor k - 9 \rfloor_{10}).$$

(e)

$$\tilde{G}(k) = 10\delta(\lfloor k \rfloor_{10}) + 5\delta(\lfloor k - 1 \rfloor_{10}) + 5\delta(\lfloor k - 9 \rfloor_{10}).$$

(f)

$$\begin{aligned}\tilde{G}(k) *_p \tilde{X}(k) &= 50\delta(\lfloor k \rfloor_{10}) + 50\delta(\lfloor k - 1 \rfloor_{10}) + 25\delta(\lfloor k - 2 \rfloor_{10}) \\ &\quad + 75\delta(\lfloor k - 3 \rfloor_{10}) + 150\delta(\lfloor k - 4 \rfloor_{10}) + 150\delta(\lfloor k - 5 \rfloor_{10}) \\ &\quad + 150\delta(\lfloor k - 6 \rfloor_{10}) + 75\delta(\lfloor k - 7 \rfloor_{10}) + 25\delta(\lfloor k - 8 \rfloor_{10}) \\ &\quad + 50\delta(\lfloor k - 9 \rfloor_{10}).\end{aligned}$$

(g)

$$\begin{aligned}\tilde{Y}(k) &= 5\delta(\lfloor k \rfloor_{10}) + 5\delta(\lfloor k - 1 \rfloor_{10}) + 2,5\delta(\lfloor k - 2 \rfloor_{10}) \\ &\quad + 7,5\delta(\lfloor k - 3 \rfloor_{10}) + 15\delta(\lfloor k - 4 \rfloor_{10}) + 15\delta(\lfloor k - 5 \rfloor_{10}) \\ &\quad + 15\delta(\lfloor k - 6 \rfloor_{10}) + 7,5\delta(\lfloor k - 7 \rfloor_{10}) + 2,5\delta(\lfloor k - 8 \rfloor_{10}) \\ &\quad + 5\delta(\lfloor k - 9 \rfloor_{10}).\end{aligned}$$

3.

$$\tilde{y}(n) = -3\delta(\lfloor n \rfloor_5) - 2\delta(\lfloor n - 1 \rfloor_5) + 2\delta(\lfloor n - 2 \rfloor_5) + 2\delta(\lfloor n - 3 \rfloor_5) + \delta(\lfloor n - 4 \rfloor_5).$$

4.

$$\begin{aligned}\tilde{Y}(k) &= 40\delta(\lfloor k - 2 \rfloor_{20}) + 40\delta(\lfloor k - 3 \rfloor_{20}) + 40\delta(\lfloor k - 4 \rfloor_{20}) \\ &\quad + 10\delta(\lfloor k - 7 \rfloor_{20}) + 10\delta(\lfloor k - 8 \rfloor_{20}) + 10\delta(\lfloor k - 9 \rfloor_{20}) \\ &\quad + 10\delta(\lfloor k - 11 \rfloor_{20}) + 10\delta(\lfloor k - 12 \rfloor_{20}) + 10\delta(\lfloor k - 13 \rfloor_{20}) \\ &\quad + 40\delta(\lfloor k - 16 \rfloor_{20}) + 40\delta(\lfloor k - 17 \rfloor_{20}) + 40\delta(\lfloor k - 18 \rfloor_{20}).\end{aligned}$$

5.

$$\tilde{X}(k) = \text{SFD}_{2N}\{\tilde{x}(n)\} = a \cdot 2N \cdot \delta(\lfloor k - 2 \rfloor_{2N}) + b \cdot 2N \cdot \delta(\lfloor k - 4 \rfloor_{2N}).$$

6. (a)

$$X_1(k) = 1 + (-1)^k.$$

(b)

$$X_2(k) = \frac{\sin\left(\frac{\pi}{10}n_d k\right)}{\sin\left(\frac{\pi}{10}k\right)} e^{-j\frac{\pi}{10}(n_d-1)k}.$$

7.

$$x(n) = \frac{1}{5} + \delta(n) + \frac{(-1)^n}{5} \cos\left(\frac{2\pi}{5}n\right).$$

8. (a)

$$X(k) = -2 + 3e^{-j\frac{2\pi}{3}k}.$$

(b)

$$y(n) = -2\delta(n - 7) + 3\delta(n - 11).$$

9. (a)

$$h(n) \otimes_4 v(n) = -\delta(n - 1) + \delta(n - 3).$$

(b) Não, pois para serem iguais é preciso que  $N \geq 5$ .

(c)

$$h(n) \otimes_5 v(n) = 2\delta(n) - \delta(n - 1) + \delta(n - 3) - 2\delta(n - 4).$$

10.

$$\begin{aligned}y(n) &= 2\delta(n - 1) + 2\delta(n - 2) + 4\delta(n - 3) + 4\delta(n - 4) \\ &\quad + 5\delta(n - 5) + 5\delta(n - 6) + 4\delta(n - 7) + \delta(n - 8) + \delta(n - 9).\end{aligned}$$