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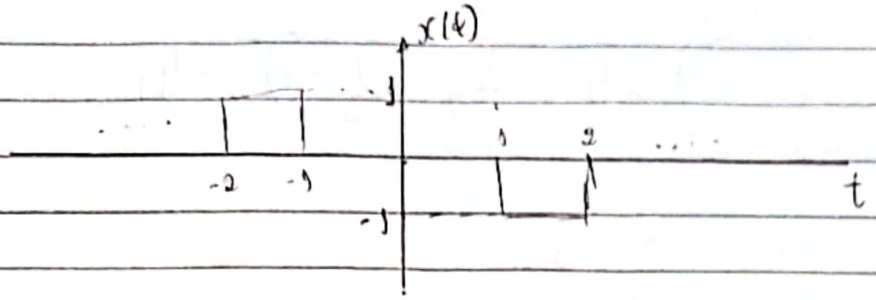
1.



$$D_n = \frac{1}{T_0}\int_{T_0} x(t).e^{-jn\omega_0 t}\,dt$$

Período fundamental:

$T_0 = 2$

Frequência fundamental:

$\omega_0 = \frac{2\pi}{T_0} = \frac{2\pi}{2} = \pi$ rad/s

$$D_n = \frac{1}{T_0}\int_{T_0} x(t)\,e^{-jw_0 nt}\,dt$$

$$D_n = \frac{1}{2}\int_{-1}^{1} 1.e^{-jw_0 nt}\,dt \Rightarrow \begin{matrix} u = -jw_0 nt \\ du = -jw_0 n\,dt \end{matrix} \Rightarrow D_n = 1/2\int e^u \frac{-du}{jw_0 n}$$

$$\Rightarrow \frac{1}{-2jw_0 n}\int e^u du = \frac{-1}{2jw_0 n}\left[e^{-jw_0 nt}\right]\Big|_{-1}^{1} \Rightarrow \frac{-1}{2jw_0 n}\left[e^{-jw_0 n(1)} - e^{-jw_0 n(-1)}\right]$$

$$\Rightarrow \frac{1}{2jw_0 n}\left[e^{jw_0 n} - e^{-jw_0 n}\right] \Rightarrow D_n = \frac{1}{2jw_0 n}\left[\operatorname{sen}(w_0 n)\right]$$

$$D_n = \frac{1}{2\pi n}\left[\operatorname{sen}(\pi n)\right]$$

$$x(t) = \sum_{n=-\infty}^{\infty} D_n . e^{jw_0 nt}$$

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2.

$$D_1 = D_{-1} = 2, \quad D_3 = D_{-3}^* = 4j$$

$T_0 = 8s$

$$\omega_0 = \frac{2\pi}{T_0} = \frac{2\pi}{8} = \frac{\pi}{4} \text{ rad/s}$$

$$x(t) = 2e^{j\pi/4 t} + 2e^{-j\pi/4 t}$$

$$x(t) = \sum_{n=-\infty}^{\infty} C_n \cos(n\omega_0 t + \phi_n)$$

$$x(t) = 2\cos(\pi/4 t)$$

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3. $$H(s) = 2 + \frac{6}{s+2} - \frac{8}{s+1}$$

$$X(s) = (s+2)(s+1)$$
$$Y(s) = 2(s+2)(s+1) + 6(s+1) - 8(s+2)$$

$$Y(s) = H(s) \cdot X(s)$$

a)
$$\left\{\frac{6}{s+2}\right\} = \frac{1}{s-a} = e^{at} = 6e^{-2t}$$

$$\left\{\frac{-8}{s+1}\right\} = \frac{1}{s+a} = -8e^{-t}$$

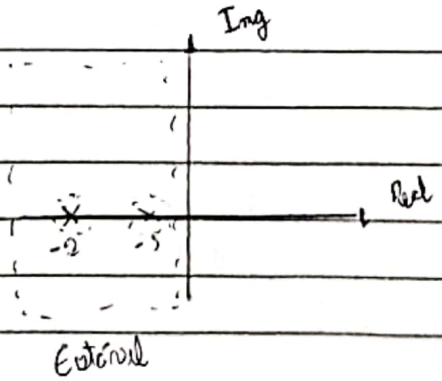
$$\{2\} = 2$$

$$h(t) = (2 + 6e^{-2t} - 8e^{-t})\,u(t)$$

b)

Polos:

$s = -2$; $s = -1$



c)
$$Y(s) = H(s) \cdot X(s)$$
$$Y(s) = \left(2 + \frac{6}{s+2} - \frac{8}{s+1}\right) \cdot (s+2)(s+1)$$

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$$Y(s) = 2(s+2)(s+1) + 6(s+1) - 8(s+2)$$
$$Y(s) = 2(s^2+3s+2) + 6(s+1) - 8(s+2)$$

$$\dot{x}(t) \longleftrightarrow sX(s) - x(0)$$

$$\ddot{x}(t) \longleftrightarrow s^2X(s) - sx(0) - \dot{x}$$

$$x(t) \longleftrightarrow X(s)$$

~~$Y(s) = 2(s^2+3s+2)$~~

~~$Y(s) = 2(s^2+3s+2)Y(s) + 6(s+1)X(s)$~~

$$Y(t) = 2(\ddot{y}(t) + 3\dot{y}(t) + 2y(t)) + 6(\dot{x}(t) + x(t)) - \dots$$
$$\dots - 8(\dot{x}(t) + x(t))$$

$$\therefore Y(t) = 2(\ddot{y}(t) + 3\dot{y}(t) + 2y(t)) + 6(\dot{x}(t) + x(t)) - 8(\dot{x}(t) + x(t))$$

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4. $H(s) = \frac{s}{s^2+3s+2}$

$x(t) = e^{-3t}\,u(t)$

$Y(s) = X(s) \cdot H(s)$

$e^{at} = \frac{1}{s-a}$

$X(s) = e^{-3t}u(t) = \frac{1}{s+3}$

$Y(s) = \frac{s}{s^2+3s+2} \cdot \frac{1}{s+3}$

$s = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$ → $s = \frac{-3 \pm \sqrt{3^2-4(1)(2)}}{2}$ → $s = \frac{-3 \pm \sqrt{9-8}}{2}$ → $s = \frac{-3 \pm 1}{2}$

$s = \frac{-3+1}{2} = s_1 = -1$

$s = \frac{-3-1}{2} = s_2 = -2$

$Y(s) = \frac{s}{(s+1)(s+2)} \cdot \frac{1}{(s+3)}$

$Y(s) = \frac{A}{s+1} + \frac{B}{s+2} + \frac{C}{s+3}$

$A = Y(s) \cdot (s+1)\Big|_{s=-1}$

$Y(s) = \frac{s}{(s+1)(s+2)} \cdot \frac{1}{(s+3)} \cdot (s+1)\Big|_{s=-1} \Rightarrow \frac{-1}{-1+2} \cdot \frac{1}{-1+3} = -\frac{1}{2}$

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$$B = Y(s)(s+2)\Big|_{s=-2}$$

$$Y(s) = \frac{5}{(s+1)(s+2)} \cdot \frac{1}{(s+3)}(s+2)\Big|_{s=-2}$$

$$\frac{-2}{(-2+1)} \cdot \frac{1}{(-2+3)} = 2 \cdot 1 = \boxed{2}$$

$$C = Y(s)\cdot(s+3)\Big|_{s=-3}$$

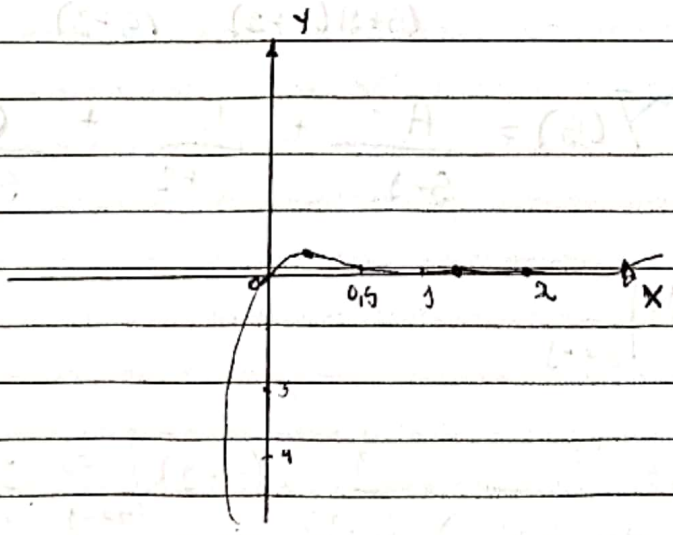
$$Y(s) = \frac{5}{(s+1)(s+2)} \cdot \frac{1}{(s+3)}(s+3)\Big|_{s=-3}$$

$$\frac{-3}{(-3+1)(-3+2)} \cdot 1 = \boxed{-3/2}$$

$$Y(s) = \frac{-1/2}{(s+1)} + \frac{2}{(s+2)} - \frac{3/2}{(s+3)}$$

$$y(t) = -1/2\, e^{-t} + 2e^{-2t} - 3/2\, e^{-3t}$$

Gabeo:



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5.

$$H(S) = \frac{S}{S^3 + 210S^2 + 12000S + 100000}$$

$S^3 + 210S^2 + 12.000S + 100.000$

$S(-10) = 0$

-10	1	210	12.000	100.000
	1	200	10.000	0

$S^2 + 200S + 10.000$

$$S^2 = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad S_{1,2} = -100$$

$$S^2 = \frac{-200 \pm \sqrt{(200)^2 - 4(1)(10.000)}}{2(1)}$$

$$S^2 = \frac{-200 \pm \sqrt{40.000 - 40.000}}{2}$$

$$H(S) = \frac{S}{(S+10)(S+100)^2}$$

Zero na origem: $S = 0$

Polos: $S = -10$; $S = -100$; $S = -100$

$$H(iw) = \frac{iw}{(iw+10)(iw+100)(iw+100)}$$

$$20 \log RA = 20 \log \left| \frac{iw}{(iw+10)(iw+100)(iw+100)} \right| \Rightarrow -20 \log |(iw+10)| - 20 \log |iw+100| - 20 \log \ldots$$

$|iw+100| \Rightarrow -20 \log RA = -20 \log \sqrt{w^2+10} - 20 \log \sqrt{w^2+100} - 20 \log \sqrt{w^2+100}$

$\theta = \angle 1 - \angle (iw+10) - \angle (iw+100) - \angle (iw+100) \Rightarrow -\tan^{-1}(w) - \tan^{-1}(w) - \tan^{-1}(w)$

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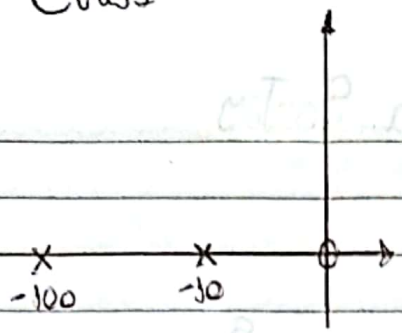

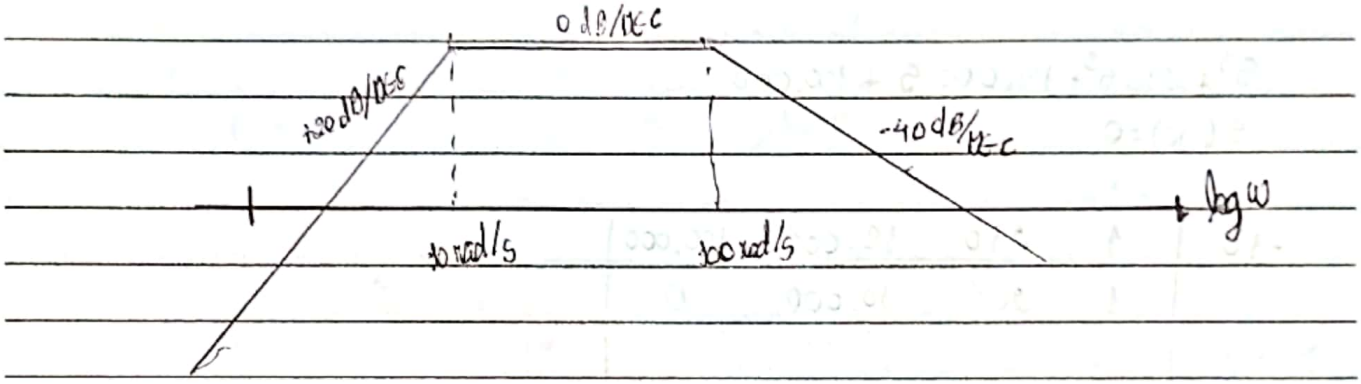

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6.

$$y[n] = x[n] - 9/8\, x[n-1] - 1/3\, y[n-1] + 2/9\, y[n-2]$$

$$H(z) = \frac{Y(z)}{X(z)}$$

$$Y(z) = X(z) - 9/8\, z^{-1} X(z) - 1/3\, z^{-1} Y(z) + 2/9\, z^{-2} Y(z)$$

$$Y(z) + 1/3\, z^{-1} Y(z) - 2/9\, z^{-2} Y(z) = X(z) - 9/8\, z^{-1} X(z)$$

$$Y(z)\left(1 + 1/3\, z^{-1} - 2/9\, z^{-2}\right) = X(z) - 9/8\, z^{-1} X(z)$$

$$Y(z)\left(1 + 1/3\, z^{-1} - 2/9\, z^{-2}\right) = X(z)\left(1 - 9/8\, z^{-1}\right)$$

$$H(z) = \frac{\left(1 - 9/8\, z^{-1}\right)}{\left(1 + 1/3\, z^{-1} - 2/9\, z^{-2}\right)} \cdot \frac{z^2}{z^2}$$

$$H(z) = \frac{\left(z^2 - 9/8\, z\right)}{\left(z^2 + 1/3\, z - 2/9\right)}$$

Pelo: $z^2 + 1/3\, z - 2/9 = 0$

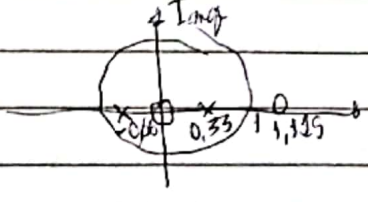
$$z = \frac{-1/3 \pm \sqrt{(1/3)^2 - 4(1)(-2/9)}}{2(1)}$$

$$z = \frac{-1/3 \pm 1}{2} \quad \begin{cases} z_1 = -4/6 \\ z_2 = 2/6 \end{cases}$$

$$H(z) = \frac{z\left(z - 9/8\right)}{\left(z - 2/6\right)\left(z + 4/6\right)} \cdot \frac{z^{-2}}{z^{-2}}$$

$$H(z) = \frac{1 - 9/8\, z^{-1}}{\left(1 - 2/6\, z^{-1}\right)\left(1 + 4/6\, z^{-1}\right)}$$

$$H(z) = \frac{A}{1 - 2/6\, z^{-1}} + \frac{B}{1 - (-4/6)\, z^{-1}}$$



$0{,}33 < |z| < 0{,}66$

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$$A = H(z)(1 - 2/6\,z^{-1})\Big|_{z=2/6} \Rightarrow \frac{1 - 9/8\,z^{-1}}{(1 + 4/6\,z^{-1})}\Big|_{z=2/6} \Rightarrow \frac{1 - 9/8\,(2/6)^{-1}}{1 + 4/6\,(2/6)^{-1}}$$

$$\Rightarrow \frac{1 - 3,375}{1 + 1} \Rightarrow A \approx -0,791$$

$$B = H(z)(1 + 4/6\,z^{-1})\Big|_{z=-4/6} \Rightarrow \frac{1 - 9/8\,z^{-1}}{(1 - 2/6\,z^{-1})}\Big|_{z=-4/6}$$

$$\Rightarrow \frac{1 - 9/8\,(-4/6)^{-1}}{1 - 2/6\,(-4/6)^{-1}} = \frac{1 - (-1,6875)}{1 - (-0,5)} \Rightarrow B \approx 1,791$$

$$H(z) = \frac{-0,791}{1 - 2/6\,z^{-1}} + \frac{1,791}{1 + 4/6\,z^{-1}}$$

$$a^n u[-n-1] \leftrightarrow \frac{1}{1 - a\,z^{-1}}, \quad |z| < a$$

$$a^n u[n] \leftrightarrow \frac{1}{1 - a\,z^{-1}}, \quad |z| > a$$

$$h[n] = +0,791\,(2/6)^n u[-n-1] + 1,791\,(4/6)^n u[n]$$

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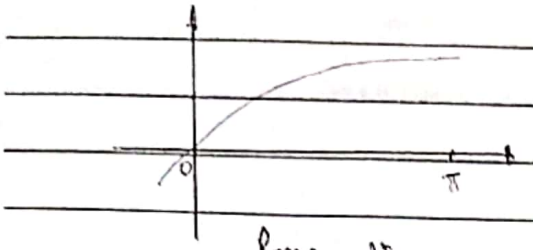
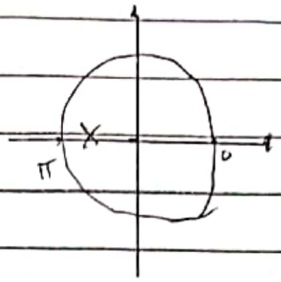
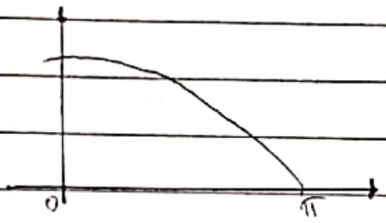
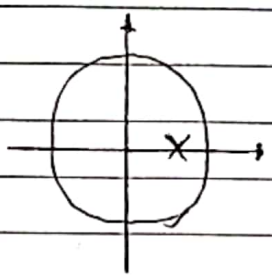
7.



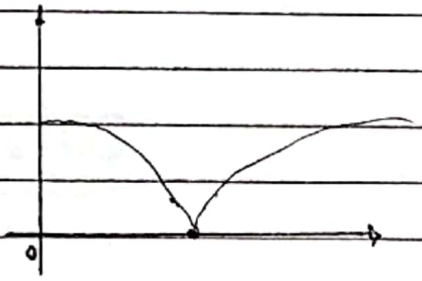


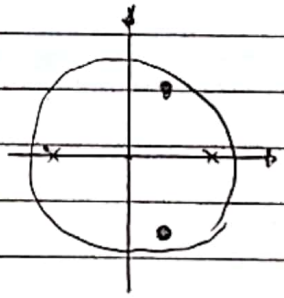
Passa alta



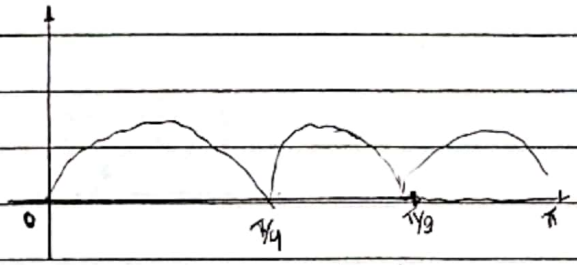


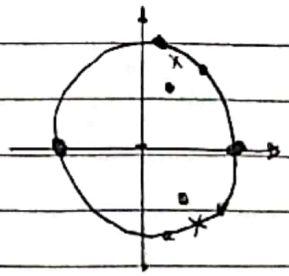
passa baixa





~~Uma~~ rejeita banda





Passa banda