NOTA = 26

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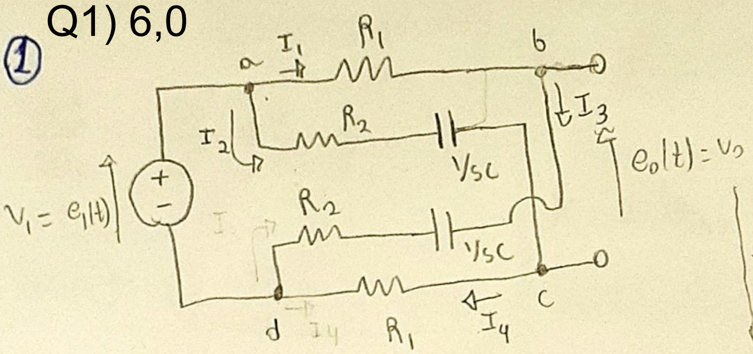
Matrícula: 96708 Data: 10/11/20 Prova 2 ELT 221

Q1) 6,0

1



• Aplicando LKT na malha em (abcda), temos:

$$V_1 - I_1R_1 - V_0 - I_4R_1 = 0 \quad (1)$$

• Aplicando LKT na malha (abda) (2)

$$V_1 - I_1R_1 - I_3\left(\frac{1}{sC} + R_2\right) = V_1 - I_1R_1 - I_3\left(\frac{1 + R_2Cs}{sC}\right) = 0$$

• Aplicando LKT em (acda) (3)

$$V_1 - \left(R_2 + \frac{1}{sC}\right)I_3 - I_4R_1 = V_1 - I_3\left(\frac{R_2sC + 1}{sC}\right) - I_4R_1 = 0$$

• Aplicando LKC em b, temos:

$$-I_1 + I_3 = 0 \Rightarrow I_1 = I_3 \quad (4)$$

• LKC em C, temos:

$$-I_3 + I_4 = 0 \Rightarrow I_4 = I_3 \quad (5)$$

Substituindo (4) em (2) temos:

$$V_1 - I_1\left(\frac{R_1sC + 1 + sCR_2}{sC}\right) = 0$$

$$\boxed{I_1 = \frac{V_1 sC}{R_1sC + 1 + sCR_2}} \quad (6)$$

Substituindo (5) em (3), temos:

$$V_1 - I_3\left(\frac{R_2sC + 1 + R_1sC}{sC}\right) = 0$$

$$\boxed{I_4 = \frac{V_1 sC}{R_2sC + 1 + R_1sC}} \quad (7)$$

Substituindo (6) e (7) em (1), temos:

$$V_1 - \frac{V_1R_1sC}{R_1sC + 1 + sCR_2} - V_0 - \frac{V_1R_1sC}{R_2sC + 1 + R_1sC} = 0$$

$$V_1\left(\frac{\cancel{R_1sC} + 1 + sCR_2 - \cancel{R_1sC} - R_1sC}{R_1sC + 1 + sCR_2}\right) = V_0$$

$$V_1\left(\frac{1 + s(CR_2 - CR_1)}{s(R_1C + R_2C) + 1}\right) = V_0 \Rightarrow \boxed{\frac{e_0}{e_1} = \frac{1 + s(CR_2 - CR_1)}{1 + s(CR_1 + CR_2)}}$$

3,0

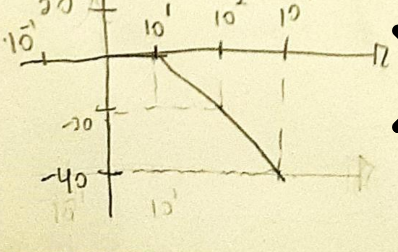
b) $H = \frac{1}{1 + s/10}$

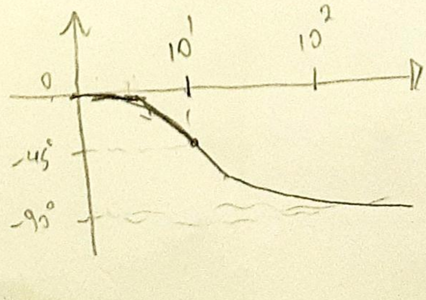
$$\boxed{H(j\omega) = \frac{1}{1 + j\omega/10}}$$

1,0

Fator de 1ª ordem: $-20\log_{10}\left|\frac{\omega}{10}\right| \Rightarrow \varphi = (0°, -45°, -90°)$ $\omega_n = 10$

Não é gráfico em dB!





2,0

Q2) 8,0

2

a) $$H(s)=\frac{10^6(s+10^{-1})}{s(s+10)(s^2+10^2s+10^4)}=\frac{\left(\frac{s}{10^{-1}}+1\right)}{s\left(\frac{s}{10}+1\right)\left(\left(\frac{s}{10^2}\right)^2+2\xi\frac{s}{10^2}+1\right)}\times\frac{10^6\times10^{-1}}{10\times10^4}=\boxed{\frac{\left(\frac{s}{10^{-1}}+1\right)}{s\left(\frac{s}{10}+1\right)\left(\left(\frac{s}{10^2}\right)^2+2\frac{1}{2}\left(\frac{s}{10^2}\right)+1\right)}}$$

$$\frac{2\xi}{\omega_m}=\frac{10^2}{10^4}\Rightarrow\xi=\frac{1}{2}$$

$$H(j\omega)=\frac{\left(1+\frac{j\omega}{10^{-1}}\right)}{(j\omega)\left(1+\frac{j\omega}{10}\right)\left(\left(1-\frac{\omega^2}{10^4}\right)+\frac{j\omega}{10^2}\right)}$$

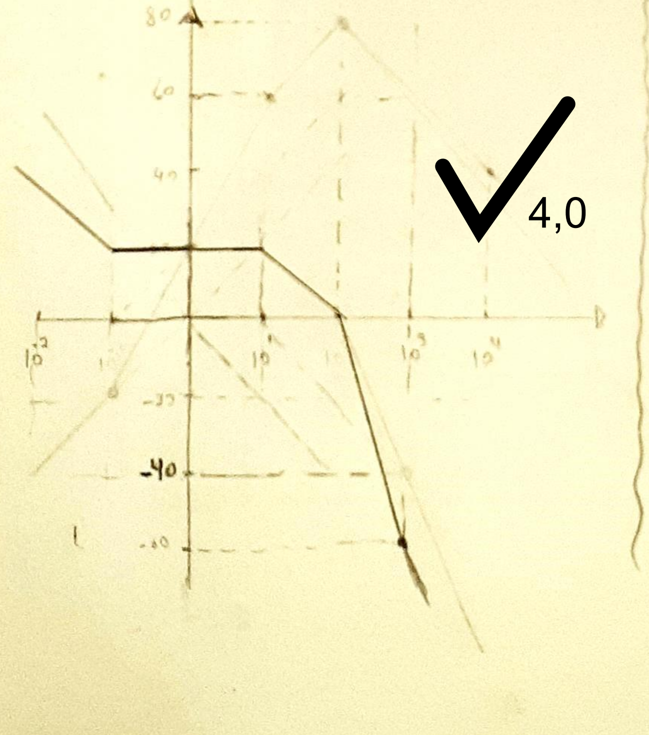
$K = 20\log_{10}|1| = 0 \rightarrow \varphi_1 = 0°$

Fator Integrativo: $-20\log_{10}|\omega| \rightarrow \varphi_2 = -90°$

Fator 1 de 1° ordem: $+20\log_{10}\left|\sqrt{1+\frac{\omega^2}{10^{-2}}}\right| = \begin{cases} 0 \ \forall\, \omega \leq 10^{-1} \\ 20\log_{10}\left|\frac{\omega}{10^{-1}}\right| \ \forall\, \omega > 10^{-1}\end{cases}$ $\quad \omega\rightarrow 0 \Rightarrow \varphi = 0°;\ \omega \rightarrow \omega_m \Rightarrow \varphi = 45°;\ \omega\rightarrow\infty \Rightarrow \varphi = 90°$

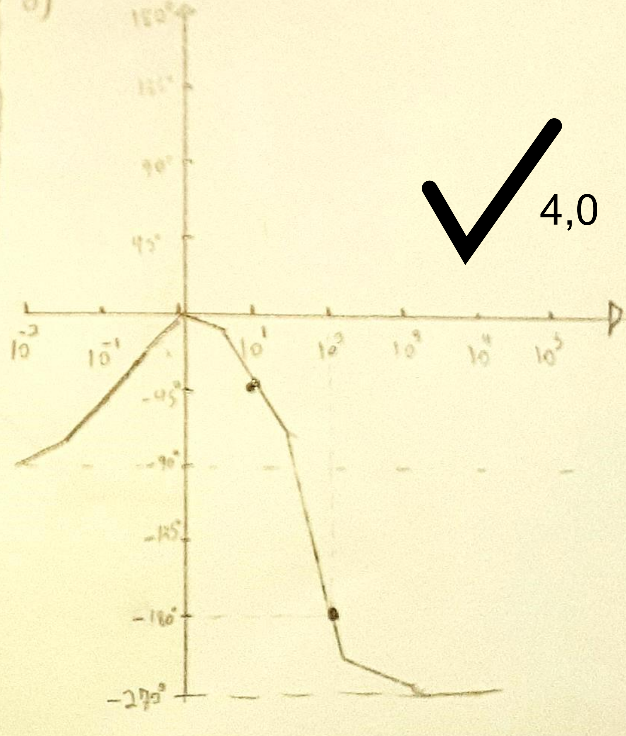
Fator 2 de 1° ordem: $-20\log_{10}\left|\sqrt{1+\frac{\omega^2}{10^2}}\right| = \begin{cases} 0 \ \forall\, \omega \leq 10^{1} \\ -20\log_{10}\left|\frac{\omega}{10}\right| \ \forall\, \omega > 10^{1}\end{cases}$ $\quad \omega\rightarrow 0 \Rightarrow \varphi = 0°;\ \omega \rightarrow \omega_m \Rightarrow \varphi = -45°;\ \omega\rightarrow\infty \Rightarrow \varphi = -90°$

Fator Quadrático: $-20\log_{10}\left|\sqrt{\left(1-\frac{\omega^2}{10^4}\right)^2+\frac{\omega^2}{10^4}}\right| = \begin{cases} 0 \ \forall\, \omega \leq 10^{2} \\ -40\log\left|\frac{\omega}{10^2}\right| \ \forall\, \omega \geq 10^{2}\end{cases}$ $\quad \omega\rightarrow 0 \Rightarrow \varphi = 0°;\ \omega \rightarrow \omega_m \Rightarrow \varphi = -90°;\ \omega\rightarrow\infty \Rightarrow \varphi = -180°$



4,0

b)

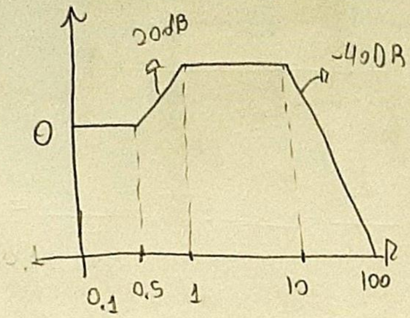


4,0

Q3) 4,0

3

a)



De 0.1 a 0.5 → Ganho constante (0 dB), logo $K_{dB} = 20\log(k) = 0 \Rightarrow \boxed{K = 1}$

De 0.5 a 1 → Ganho de 20dB, logo um fator de 1° ordem $\Rightarrow H_1(S) = \left(\frac{S}{0.5} + 1\right)$

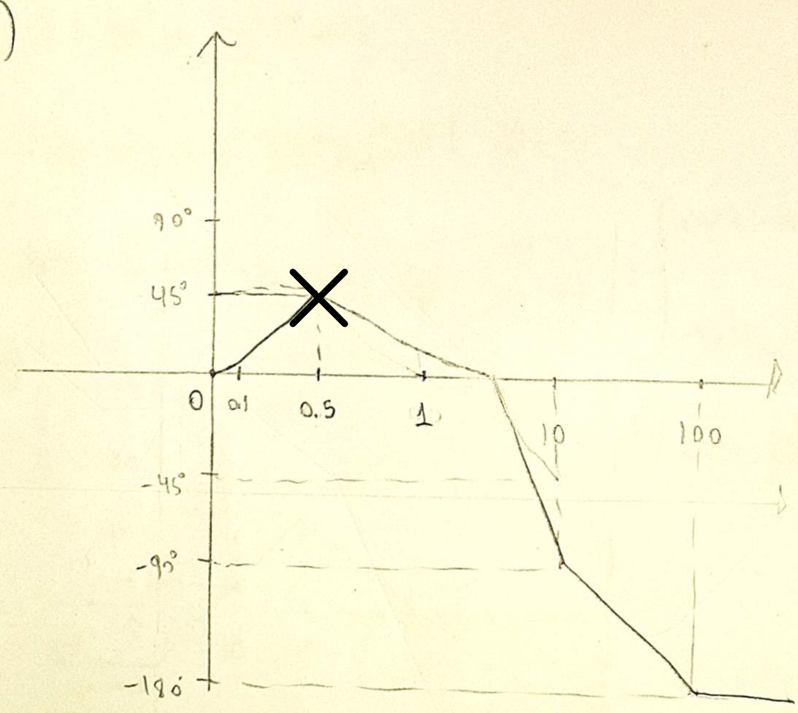
De 1 a 10 → Ganho de -20 dB, logo um fator de 1° ordem $\Rightarrow H_2(S) = \left(\frac{S}{1} + 1\right)^{-1}$

De 10 a 100 → Ganho de -40 dB, $\Rightarrow H_3(S) = \left(\frac{S}{10} + 1\right)^{-2}$

Por fim, $\boxed{H(S) = \frac{1 \cdot \left(\frac{S}{0.5} + 1\right)}{(S+1)\left(\frac{S}{10} + 1\right)^2}}$

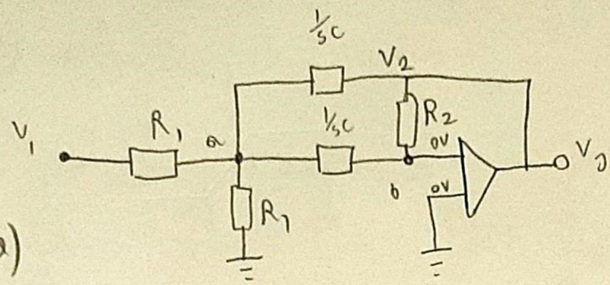
4,0

b)



4

Q4) 4,0



$R_1 = 1/4$ } $Y_R = 1/4$

$C = 1/20$ } $X_C = 20/s$

$R_2 = 8$

$R_2 = 32R_1$

a)

$$LKC \Rightarrow \frac{V_a}{R_1} - \frac{V_1}{R_1} + \frac{V_a}{R_1} + \frac{sCV_a}{1} - \frac{sCV_2}{1} + \frac{V_a sC}{1} = 0 \Rightarrow V_a\left(\frac{2}{R_1} + 2sC\right) + V_2\left(\frac{-sC}{1}\right) = \frac{V_1}{R_1}$$

$$V_a\left(\frac{2 + 2(R_1C)s}{R_1}\right) + V_2(-sC) = \frac{V_1}{R_1}$$

$$LKC \Rightarrow \frac{-V_a sC}{1} - \frac{V_2}{R_2} = 0 \Rightarrow \boxed{V_a = -\frac{V_2}{R_2 sC}}$$

$$-V_2\left[\left(\frac{1}{s(R_2C)}\right)\left(\frac{2 + (2R_1C)s}{R_1}\right) + sC\right] = \frac{V_1}{R_1}$$

$$-V_2\left[\left(\frac{5}{2s}\right)\left(\frac{2 + s/40}{1/4}\right) + \frac{s}{20}\right] = \frac{V_1 4}{1} \Rightarrow -V_2\left[\frac{20 + s/4}{s} + \frac{s}{20}\right] = 4V_1 \Rightarrow$$

$$-V_2\left[\frac{400 + 5s + s^2}{20s}\right] = 4V_1 \Rightarrow \boxed{\frac{V_2}{V_1} = \frac{-80s}{s^2 + 5s + 400}}$$

2,0

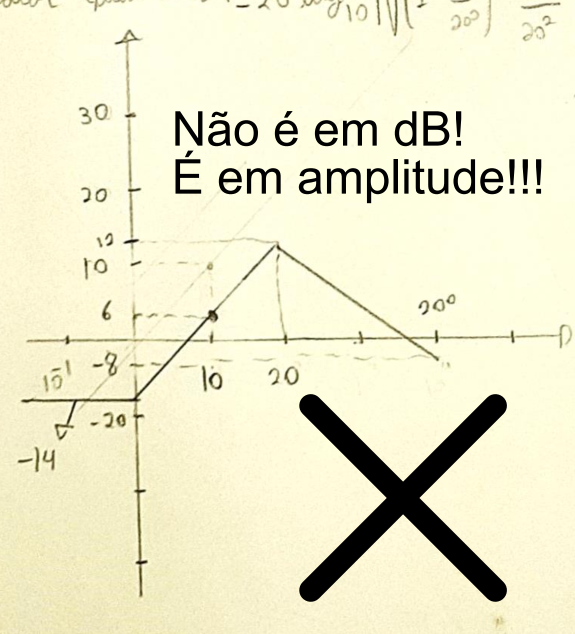
$$H(j\omega) = \frac{\quad j\omega}{\left(1 - \frac{\omega^2}{20^2}\right) + \frac{5j\omega}{20^2}}$$

$$K = 20\log_{10}\left|-\frac{1}{5}\right| \cong -14$$

Fator Derivativo: $20\log_{10}|\omega|$ $\varphi = 90°$

Fator quadrático: $-20\log_{10}\left|\sqrt{\left(1 - \frac{\omega^2}{20^2}\right)^2 + \frac{\omega^2}{20^2}}\right| = \begin{cases} 0 \; \forall \omega \leq 20 \\ -40\log_{10}\left|\frac{\omega}{20}\right| \; \forall \omega > 20 \end{cases}$ $\begin{cases} \omega \to 0 \Rightarrow 0° \\ \omega \to \omega_n \Rightarrow -90° \\ \omega \to \infty \Rightarrow -180° \end{cases}$

b)



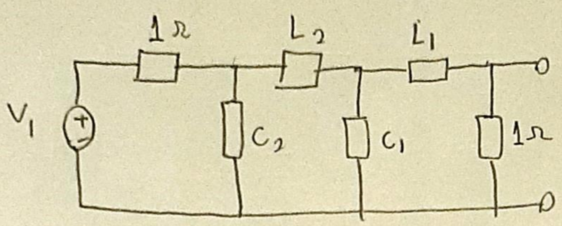
Não é em dB!
É em amplitude!!!

c) Esse filtro é o passa faixa.

2,0

Q5) 4,0

5) 4ª ordem, $W_c = 1 \text{ rad/s}$



a)

$W_c' = K_f W_c \Rightarrow K_f = \frac{W_c'}{W_c} =$

$1 \text{ rad} = 2\pi \cancel{W} \Rightarrow W = 0.16 \text{ Hz}$

$K_f = \frac{50k}{0.16} = \boxed{\pi 10^5}$ //

$R' = K_i R \Rightarrow K_i = \frac{R'}{R} = \frac{10k}{1} \Rightarrow \boxed{K_i = 10K}$ N

3,0

b) Sendo $K_i = 10k$ e $K_f = 10^5 \pi$, temos:

$R'' = K_i R = 10 k\Omega$

$C_1'' = \frac{C_1}{K_i K_f} = \frac{1,848}{K_i K_f} = 0.588 \text{ nF}$ N

$C_2'' = \frac{0,765}{K_i K_f} = 0,244 \text{ nF}$ N

$L_1'' = \frac{K_i}{K_f} L = \frac{K_i}{K_f} \times 0,765 = 24,35 \text{ mH}$ N

$L_2'' = \frac{K_i}{K_f} L = \frac{K_i}{K_f} \times 1,848 = 58,82 \text{ mH}$ N

1,0

Faltou o circuito com os elementos novos!!!