Calculs de l'APP

Calcul du filtre passe bas :

$s \to \dfrac{s}{w_c}$

$K = 1 = \dfrac{R_2}{R_1}$ donc $R_2 = R_1$

$\boxed{\text{Voir table}}$

$$\frac{V_{so}}{V_{en}} = H(s) = \frac{-K w_c^2}{s^2 + \frac{w_c}{Q}s + w_c^2}$$

$$w_c^2 = \frac{1}{R_2 R_3 C_2 C_3}$$

$$\frac{w_c}{Q} = 1,4141$$

$$W_c^2 = 700\,Hz \cdot 2\pi = 1400\pi \to \frac{-1 \cdot 1400\pi}{s^2 + 1,4141s + 1400\pi}$$

$$1,4141 = \frac{1}{100 \cdot 10^{-9}}\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) \to R_1 = R_2$$

$$1,4141 = \frac{1}{100 \cdot 10^{-9}}\left(\frac{2}{R_2} + \frac{1}{R_3}\right)$$

$$W_c^2 = \frac{1}{R_2 R_3 C_3 C_2} = 1400\pi$$

$$\frac{1}{R_2 R_3 \cdot 2,2 \cdot 10^{-15}} = 1400\pi$$

$$\frac{1}{R_2 R_3} = 3,08\pi \cdot 10^{-12}$$

$$\frac{1}{3,08\pi \cdot 10^{-12} R_2} = R_3$$

$$\frac{1}{3{,}08\pi \cdot 10^{-12} R_2} = R_3$$

$$\frac{1}{100 \cdot 10^{-9}} \left(\frac{2}{R_2} + \frac{1}{R_3} \right) = 1{,}4141$$

$$\frac{1}{100 \cdot 10^{-9}} \left(\frac{2}{R_2} + 3{,}08\pi \cdot 10^{-12} R_2 \right) = 1{,}4141$$

$$\frac{2}{100 \cdot 10^{-9} R_2} + 0{,}0000308\pi R_2 = 1{,}4141$$

$$\frac{20\,000\,000}{R_2} + 0{,}0000308\pi R_2 = 1{,}4141$$

$$0{,}0000308\pi R_2^2 - 1{,}4141 R_2 + 20\,000\,000$$

$$\frac{1{,}4141 \pm \sqrt{\overbrace{(-1{,}4141)^2}^{1{,}99967} - \overbrace{4 \cdot 0{,}0000308\pi \cdot 20\,000\,000}^{7740}}}{2 \cdot 0{,}0000308\pi} = \frac{1{,}4141 \pm 87{,}9709\,J}{0{,}000193522}$$

$$= 7307{,}17 \pm 454\,578{,}29\,J = R_2$$

$$|R_2| = 454\,637{,}0162\ \Omega$$

$$|R_1| = |R_2|$$

$$\frac{1}{3{,}08\pi \cdot 10^{-12} R_2} = R_3$$

$$\frac{1}{3{,}08\pi \cdot 10^{-12} \cdot 454\,637{,}01} = R_3$$

$$R_3 = 227\,318{,}4144\ \Omega$$

$$R_1 = 454\,637{,}0162\ \Omega$$
$$R_2 = 454\,637{,}0162\ \Omega$$
$$R_3 = 227\,318{,}4144\ \Omega$$

$$1.41141 = \frac{1}{C_2}\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$C_2 = 100\,nF$

$R_1 = R_2 = 4750\ \Omega$

$R_3 = ?$

$C_3 = 22\,nF$

$$1.4141 = \frac{1}{100\cdot 10^{-9}}\left(\frac{1}{4750} + \frac{1}{4750} + \frac{1}{R_3}\right)$$

$$1400\pi^2 = \frac{1}{22\cdot 10^{-9}\cdot 100\cdot 10^{-9}\cdot 4750\cdot R_3}$$

$$0.0000000141 = 0.000421052 + \frac{1}{R_3}$$

$$0.000202144 R_3 = 1$$

$$-0.00042091 = \frac{1}{R_3}$$

$$R_3 = 4946,84$$

$$\boxed{-2375,80 = R_3}$$

$$S = \frac{\omega_c}{s} \qquad H(s) = \frac{1}{S^2 + \frac{\omega_c}{Q} S + \omega_c}\Bigg|_{S = 14000\pi/s}$$

Passe-haut 7000Hz

$$H(s) = \frac{1}{\left(\frac{14000\pi}{s}\right)^2 + 1{,}4141\left(\frac{14000\pi}{s}\right) + 1}$$

$$H(s) = \frac{s^2}{(14000\pi)^2 + 19797\pi s + s^2}$$

Passe bas 700Hz

$$S = s/\omega_c \qquad H(s) = \frac{1}{S^2 + 1{,}4141 S + 1}\Bigg|_{S = s/1400\pi}$$

$$H(s) = \frac{1}{\left(\frac{s}{1400\pi}\right)^2 + \frac{1{,}4141 s}{1400\pi} + 1}$$

$$H(s) = \frac{1400\pi^2}{s^2 + 6219.53 s + 1400\pi^2}$$

Passe-haut 1000 Hz

$$H(\omega) = \frac{1}{s^2 + 1{,}4141s + 1}\Bigg|_{s = 2000\pi/s}$$

$$H(\omega) = \frac{1}{\left(\frac{2000\pi}{s}\right)^2 + 1{,}4141\left(\frac{2000\pi}{s}\right) + 1}$$

$$H(s) = \frac{s^2}{s^2 + 2828{,}2\pi s + (2000\pi)^2}$$

Passe-bas 5000 Hz

$S = s/\omega_c$

$$H(s) = \frac{1}{s^2 + 1{,}4141s + 1}\Bigg|_{s = s/10000\pi}$$

$$H(s) = \frac{1}{\left(\frac{s}{10000\pi}\right)^2 + \frac{1{,}41415}{10000\pi} + 1}$$

$$H(s) = \frac{10000\pi^2}{s^2 + 41425\,s + (10000\pi)^2}$$

Passe Haut 1000Hz :

$$H_{(s)} = \frac{s^2}{s^2 + 2828{,}2\pi s + (2000\pi)^2}$$

Passe-bas 5000Hz :

$$H_{(s)} \frac{(10000\pi)^2}{s^2 + 44\,428 s + (10000\pi)^2}$$

$$\frac{986\ 960\ 440\ s^2}{(s^2 + 2828{,}2\pi s + 39\ 478\ 417)(s^2 + 44\ 428 s + 986\ 960\ 440}$$

$s^4 + 44\ 428 s^3 + 986\ 960\ 440 s^2$

$8\ 885 s^3 + 394\ 745\ 105 s^2 + 8{,}76 \cdot 10^{12} s$

$39\ 478\ 417 s^2 + 1{,}75 \cdot 10^{12} s + 3{,}90 \cdot 10^{16}$

$$\frac{986\ 960\ 440\ s^2}{s^4 + 53\ 313 s^3 + 1\ 421\ 183\ 962 s^2 + 1{,}051 \cdot 10^{13} s + 3{,}90 \cdot 10^{16}} = H_{(s)}$$

$$H_{(s)\,Bande} = \frac{986\,960\,440\, s^2}{s^4 + 53\,313\, s^3 + 1{,}421 \cdot 10^9 s^2 + 1{,}05 \cdot 10^{13} s + 3{,}90 \cdot 10^{16}}$$

Au maximum on est à la frequence 4650 Hz. Dans le passe bande à 4650 Hz on est a -2.08 dB donc nous on veut 1 dB donc +1 -1.08 dB

$$10^{-1{,}08/20} = A_v \qquad A_v = 0.8830$$

Gain = 0,47
0.88

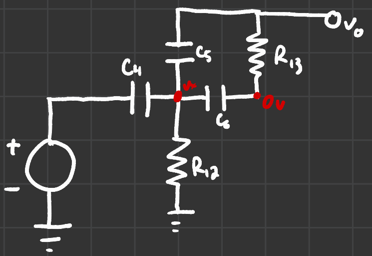
On connait R_{71} donc 0,8830

$$0{,}8830 = \frac{47500}{R_{25}}$$

$R_{25} = 53\,793.88\ \Omega$

53 793
59 375
59 823
60 352

55 232



$C_4 = C_5 = C_6 = 1nF$

$R_{13} = 34\,000\ \Omega$

$R_{12} = 7500\ \Omega$

$$I_{C_6} = I_{R_{13}}$$

$$\frac{V_x}{1/sC} = \frac{-V_s}{R_{13}}$$

$$V_x = \frac{-V_s}{R_{13}sC}$$

$$I_{C4} = I_{R12} + I_{C5} + I_{R13}$$

$$(V_e - V_x)sC = \frac{V_x}{R_{12}} + (V_x - V_s)sC - \frac{V_s}{R_{13}}$$

$$V_e sC - V_x sC = \frac{V_x}{R_{12}} + V_x sC - V_s sC - \frac{V_s}{R_{13}}$$

$$V_e sC + \frac{V_s}{R_{13}} = \frac{V_x}{R_{12}} + V_x sC + V_x sC$$

$$= V_x\left(\frac{1}{R_{12}} + 2sC\right) = \frac{-V_s}{R_{13}sC}\left(\frac{1}{R_{12}} + 2sC\right)$$

$$V_e sC = \frac{-V_s}{R_{13}R_{12}sC} - \frac{2V_s}{R_{13}} - \frac{V_s}{R_{13}} - V_s sC$$

$$V_e SC = \frac{-V_s}{R_{13} R_{12} SC} - \frac{3V_s}{R_{13}} - V_s SC$$

$$V_e SC = V_s \left(\frac{-1}{R_{13} R_{12} SC} - \frac{3}{R_{13}} - SC \right)$$

$$V_e = V_s \left(\frac{-1}{R_{13} R_{12} (SC)^2} - \frac{3}{R_{13} SC} - 1 \right)$$

$$\frac{1}{\frac{-1}{R_{13} R_{12} (SC)^2} - \frac{3}{R_{13} SC} - 1} = \frac{V_s}{V_e} \quad \cdot -s^2$$

$$\frac{-S^2}{S^2 + \frac{3}{R_{13} C} S + \frac{1}{R_{13} R_{12} C^2}} = H_{(s)}$$

$$\frac{-s^2}{s^2 + \frac{3}{R_{13} C} s + \frac{1}{R_{13} R_{12} C^2}} = H_{(s)}$$

$s = 2000\pi j$

$H_{(s)} = -3\,dB = 0.707$

$R_{13} = 340\ 000\ \Omega$

$$X = \frac{(2000\pi)^2}{-(2000\pi)^2 + 17\,647\,058\pi j + \frac{2{,}94 \cdot 10^{12}}{R_{12}}}$$

$$-X w^2 + \frac{3X}{R_{13} C} w + \frac{X}{R_{13} R_{12} C^2} = w^2$$

$$R_{12} = \frac{1}{(w^2 + Xw^2) - \frac{3X}{R_{13} C} w + \frac{R_{13} C^2}{X}}$$

Sinus

Calcul Sommateur:

$$H_{(s)\,\text{Bande}} = \frac{986\ 960\ 440\, s^2}{s^4 + 53\ 313 s^3 + 1\ 421\ 183\ 962 s^2 + 1{,}051 \cdot 10^{13} s + 3{,}90 \cdot 10^{16}} = \frac{A}{B + C + D + E + F}$$

$$H_{(s)\,\text{bas}} = \frac{(1400\pi)^2}{s^2 + 6219 s + (1400\pi)^2} = \frac{G}{H + I + J}$$

$$H_{(s)\,\text{haut}} = \frac{s^2}{s^2 + 19\ 797\pi s + (14000\pi)^2} = \frac{K}{L + M + N}$$

En paralèle c'est une addition

Numérateur:

$$A(H+I+J)(L+M+N) + G(B+C+D+E+F)(L+M+N) + K(H+I+J)(B+C+D+E+F)$$

$$= AHL + AHM + AHN + AIL + AIM + AIN + AJL + AJM + AJN + GBL + GBM + GBN + GCL + GCM + GCN$$
$$+ GDL + GDM + GDN + GEL + GEM + GEN + GFL + GFM + GFN + KBH + KBI + KBJ + KCH + KCI + KCJ$$
$$+ KDH + KDI + KDJ + KEH + KEI + KEJ + KFH + KFI + KFJ$$

$986\ 960\ 440\, s^6 + 6{,}13 \cdot 10^{13} s^5 + 1{,}90 \cdot 10^{18} s^4$

$6{,}13 \cdot 10^{12} s^5 + 3{,}8 \cdot 10^{17} s^4 + 1{,}9 \cdot 10^{22} s^3$

$1{,}9 \cdot 10^{16} s^4 + 1{,}2 \cdot 10^{21} s^3 + 3{,}7 \cdot 10^{25} s^2$

$1{,}9 \cdot 10^7 s^6 + 1{,}20 \cdot 10^{12} s^5 + 3.7 \cdot 10^{16} s^4$

$1 s^8 + 6219 s^7 + 1{,}03 \cdot 10^{12} s^5 + 6{,}4 \cdot 10^{16} s^4 + 1{,}99 \cdot 10^{19} s^3$

$+ 53\ 313 s^7$

$+ 2{,}7 \cdot 10^{16} s^4 + 1{,}7 \cdot 10^{21} s^3 + 5{,}3 \cdot 10^{25} s^2$

$+ 2{,}0 \cdot 10^{20} s^3 + 1{,}3 \cdot 10^{25} s^2 + 3{,}9 \cdot 10^{29} s^1$

$+ 7{,}5 \cdot 10^{23} s^2 + 4{,}7 \cdot 10^{28} s^1 + 1{,}45 \cdot 10^{33}$

$1{,}9 \cdot 10^7 s^6$

$3.3 \cdot 10^8 s^6 + 1{,}03 \cdot 10^{12} s^5$

$1{,}4 \cdot 10^9 s^6 + 8{,}8 \cdot 10^{12} s^5 + 2{,}7 \cdot 10^{16} s^4$

$1{,}0 \cdot 10^{13} s^5 + 6{,}5 \cdot 10^{16} s^4 + 2{,}0 \cdot 10^{20} s^3$

$3{,}9 \cdot 10^{16} s^4 + 2{,}4 \cdot 10^{20} s^3 + 7{,}5 \cdot 10^{23} s^2$

$$s^8 + 5.9 \cdot 10^4 s^7 + 2{,}7 \cdot 10^9 s^6 + 8{,}95 \cdot 10^{13} s^5 + 2{,}5 \cdot 10^{18} s^4 + 2{,}26 \cdot 10^{22} s^3 + 1{,}75 \cdot 10^{x} s^2$$
$$+ 4{,}37 \cdot 10^{29} s + 1{,}45 \cdot 10^{33}$$