

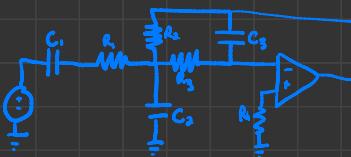
Calcul des
filters
DESM 1210, KILV 1201
PLAM 1001 

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Filtre passe bas:

$$I_{R_3} = I_{C_3}$$

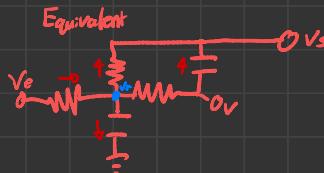


Exemple ampli- op de 700 Hz

$$\frac{(V_x - 0)}{R_3} = \frac{0 \cdot V_s}{j\omega C_3}$$

$$V_x = \frac{-V_s R_3}{j\omega C_3}$$

$$V_x = -V_s R_3 S C_3$$



$$I_{R_1} = I_{R_2} + I_{C_2} + I_{C_3}$$

$$\frac{V_C - V_X}{R_1} = \frac{V_X - V_S}{R_2} + (V_X - 0) S C_2 - (V_S) S C_3$$

$$\frac{V_C}{R_1} - \frac{V_X}{R_1} = \frac{V_X}{R_2} - \frac{V_S}{R_2} + V_X S C_2 - V_S S C_3$$

$$\frac{V_C}{R_1} + \frac{V_S}{R_2} + V_S S C_3 = \frac{V_X}{R_2} + \frac{V_X}{R_1} + V_X S C_2$$

$$= V_X \left(\frac{1}{R_2} + \frac{1}{R_1} + S C_2 \right)$$

$$= -\frac{V_S R_3 S C_3}{R_2} - \frac{V_S R_3 S C_3}{R_1} - V_S R_3 C_2 C_3 S^2$$

$$\frac{V_C}{R_1} + \frac{V_S}{R_2} + V_S S C_3 = -\frac{V_S R_3 S C_3}{R_1} - \frac{V_S R_3 S C_3}{R_2} - V_S R_3 C_2 C_3 S^2$$

$$\frac{V_C}{R_1} = -\frac{V_S R_3 S C_3}{R_1} - \frac{V_S R_3 S C_3}{R_2} - V_S R_3 C_2 C_3 S^2 - \frac{V_S}{R_2} - V_S S C_3$$

$$\frac{V_C}{R_1} = V_S \left(-\frac{R_3 S C_3}{R_1} - \frac{R_3 S C_3}{R_2} - R_3 C_2 C_3 S^2 - \frac{1}{R_2} - S C_3 \right)$$

$$V_C = V_S \left(-R_3 C_3 S - \frac{R_3 R_1 C_3}{R_2} S - R_1 R_3 C_2 C_3 S^2 - \frac{R_1}{R_2} - R_1 C_3 S \right)$$

$$\frac{V_S}{V_C} = -\frac{1}{R_1 R_3 C_2 C_3 S^2 - \frac{R_3 R_1 C_3}{R_2} S - R_3 C_3 S - R_1 C_3 S - \frac{R_1}{R_2}}$$

$$\frac{V_S}{V_C} = \frac{-1/R_1 R_3 C_2 C_3}{S^2 + 1/R_2 C_3 S + 1/R_1 C_2 S + 1/R_3 C_2 + 1/R_2 R_3 C_2 C_3}$$

$$\frac{V_S}{V_C} = \frac{-1/R_1 R_3 C_2 C_3}{S^2 + \frac{1}{C_2} \left(\frac{1}{R_1} + \frac{1}{R_3} + \frac{1}{R_2} \right) + 1/R_2 R_3 C_2 C_3}$$

Calcul bon pour passe bas 700Hz et 7000 Hz pour 1000 Hz

$$C_1 = C_4$$

$$C_2 = C_7$$

$$C_3 = C_8$$

$$R_1 = R_{15}$$

$$R_2 = R_{16}$$

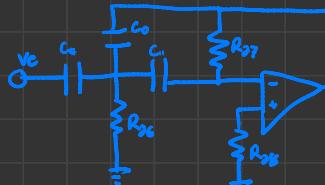
$$R_3 = R_7$$

Filtre passe haut

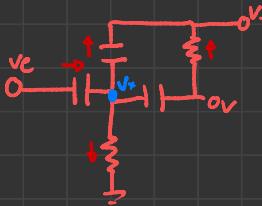
$$I_{C_{11}} = I_{R_{27}}$$

$$(V_x - 0) \leq C_{11} = \frac{(0 - V_s)}{R_{27}}$$

$$V_x = \frac{-V_s}{R_{27} SC_{11}}$$



Exemple Ampli-op
7000 Hz



$$I_{C_0} = I_{C_{10}} + I_{R_{27}} + I_{R_{26}}$$

$$(V_c - V_x) SC_q = (V_x - V_s) SC_{10} + \frac{(0 - V_s)}{R_{27}} + \frac{V_x - 0}{R_{26}}$$

$$V_c SC_q - V_x SC_q = V_x SC_{10} - V_s SC_{10} - \frac{V_s}{R_{27}} + \frac{V_x}{R_{26}}$$

$$V_c SC_q + \frac{V_s}{R_{27}} + V_s SC_{10} = V_x SC_q + V_x SC_{10} + \frac{V_x}{R_{26}}$$

$$= V_x \left(SC_q + SC_{10} + \frac{1}{R_{26}} \right)$$

$$= \frac{-V_s}{R_{27} SC_{11}} \left(SC_q + SC_{10} + \frac{1}{R_{26}} \right)$$

$$V_c SC_q + \frac{V_s}{R_{27}} + V_s SC_{10} = \frac{-V_s C_q}{R_{27} C_{11}} - \frac{V_s C_{10}}{R_{27} C_{11}} - \frac{V_s}{R_{26} R_{27} SC_{11}}$$

$$V_C S C_9 + \frac{V_S}{R_{27}} + V_S S C_{10} = -\frac{V_S C_4}{R_{27} C_{11}} - \frac{V_S C_{10}}{R_{27} C_{11}} - \frac{V_S}{R_{26} R_{27} S C_{11}}$$

$$V_C S C_9 = -\frac{V_S C_4}{R_{27} C_{11}} - \frac{V_S C_{10}}{R_{27} C_{11}} - \frac{V_S}{R_{26} R_{27} S C_{11}} - \frac{V_S}{R_{27}} - V_S S C_{10}$$

$$V_C S C_9 = V_S \left(-\frac{C_4}{R_{27} C_{11}} - \frac{C_{10}}{R_{27} C_{11}} - \frac{1}{R_{26} R_{27} S C_{11}} - \frac{1}{R_{27}} - S C_{10} \right)$$

$$\frac{V_S}{V_C} = \frac{1}{-\frac{1}{R_{27} C_4 S} - \frac{C_{10}}{R_{27} C_4 S C_9} - \frac{1}{R_{26} R_{27} C_{11} C_4 S^2} - \frac{1}{R_{27} S C_9} + \frac{C_{10}}{C_9}}$$

$$\frac{V_S}{V_C} = \frac{-S^2}{\frac{C_{10}}{C_4} S^2 + \frac{1}{R_{27} C_4} S + \frac{C_{10}}{R_{27} C_{11} C_4} S + \frac{1}{R_{27} C_{11}} S + \frac{1}{R_{26} R_{27} C_{11} C_4}}$$

$$\frac{V_S}{V_C} = \frac{-\frac{C_4}{C_{10}} S^2}{S^2 + \frac{1}{R_{27} C_{10}} S + \frac{1}{R_{27} C_{11}} S + \frac{C_4}{R_{27} C_{10} C_{11}} S + \frac{1}{R_{26} R_{27} C_{11} C_{10}}} \\ \frac{C_{11}}{R_{27} C_{10} C_{11}} S + \frac{C_{10}}{R_{27} C_{11} C_{10}} S + \frac{C_4}{R_{27} C_{10} C_{11}} S$$

$$\boxed{\frac{V_S}{V_C} = \frac{-\frac{C_4}{C_{10}} S^2}{S^2 + \frac{C_4 + C_{10} + C_{11}}{R_{27} C_{10} C_{11}} S + \frac{1}{R_{26} R_{27} C_{11} C_{10}}}}$$

Calcul bon pour passe haut 7000Hz et 1000Hz

$$C_4 = C_H$$

$$C_{11} = C_G$$

$$R_{27} = R_{13}$$

$$C_{10} = C_S$$

$$R_{26} = R_D$$

Calcul Sortie

Passe bas 5000 Hz :

$$s = \omega_c / \omega_0$$

$$\omega_0 = 10000\pi$$

$$H(s) = \frac{1}{s^2 + 1.414s + 1} \quad | s = s/10000\pi$$

$$H(s) = \frac{1}{\left(\frac{s}{10000\pi}\right)^2 + 1.414\left(\frac{s}{10000\pi}\right) + 1}$$

$$H(s) = \frac{(10000\pi)^2}{s^2 + 44425s + (10000\pi)^2}$$

$$\text{à } 2500 \text{ Hz} = 5000\pi$$

$$H_{2500} = \frac{-(10000\pi)^2}{-5000\pi)^2 + 44425(5000\pi)s + (10000\pi)^2}$$

$$|H_{2500}| = \frac{986960440}{\sqrt{740226330^2 + 697826268}s^2}$$

$$|H_{2500}| = \frac{986960440}{1017294375} \approx 0.97$$

\angle passe bas = \angle numérateur - \angle dénominateur

$$= \tan^{-1}\left(\frac{0}{-986960440}\right) - \tan^{-1}\left(\frac{697826268}{740226330}\right)$$

$$= -\pi - 0.7559$$

$$= -3.8975 \text{ rad}$$

Passe-haut 1000 Hz :

$$s = \omega_0 / s \quad \omega_0 = 2000\pi$$

$$H(s) = \frac{1}{s^2 + 1.414s + 1} \quad | s = 2000\pi/s$$

$$H(s) = \frac{1}{\left(\frac{2000\pi}{s}\right)^2 + 1.414\left(\frac{2000\pi}{s}\right) + 1}$$

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

$$\text{à } 2500 \text{ Hz} = 5000\pi$$

$$H_{2500} = \frac{-(5000\pi)^2}{(2000\pi)^2 + 2828\pi(5000\pi)s + (5000\pi)^2}$$

$$|H_{2500}| = \frac{246740110}{\sqrt{-207261690 + 134556206}s^2}$$

$$|H_{2500}| = \frac{246740110}{249866651} \approx 0.987$$

\angle passe-haut = \angle numérateur - \angle dénominateur

$$= \tan^{-1}\left(\frac{0}{-246740110}\right) - \tan^{-1}\left(\frac{134556206}{-207261690}\right)$$

$$= -\pi - -0.5926 \quad \rightarrow$$

$$= -2.55 \text{ rad}$$

Sorbie au point ① :

$$K_{PH} = 0,987 \quad K_{PB} = 0,47$$

$$\angle_{PH} = -2,55 \text{ rad} \quad \angle_{PB} = -3,8975 \text{ rad}$$

En sorte donc on multiplie

$$V_c = 0,25 \cdot \sin(2500 \cdot 2\pi \cdot t + 0)$$

$$V_s = 0,25 \cdot 0,987 \cdot 0,47 \cdot \sin(2500 \cdot 2\pi \cdot t + (-2,55) + (-3,8975))$$

$$V_s = 0,2393 \cdot \sin(500\pi t - 6,4465)$$

Donc on peut simplifier en enlevant $2\pi t$

$$V_s = 0,2393 \cdot \sin(500\pi t - 0,1633)$$

Sorbie au point ② :

$$H_{(s)} = \frac{1}{s^2 + 1,4141 s + 1} \quad \left| \begin{array}{l} s = \omega_t / \zeta \\ \zeta = w_t / s \end{array} \right.$$

$$\text{Obtenir } u(t) = \frac{1}{s}$$

$$H_{(s)} = \frac{1}{\frac{(\omega_t)^2}{s^2} + 1,4141 \left(\frac{\omega_t}{s} \right) + 1}$$

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

$$V_{s(u)} = V_{c(s)} H_{(s)}$$

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

$$V_{SCS} = \frac{S}{S^2 + 19792\pi(5 + (14000\pi)^2)}$$

$$re^{-\alpha t} \cos(\omega t + \Theta) u(t) \rightarrow \frac{As + B}{S^2 + 2\alpha S + \omega^2}$$

$$A = 1$$

$$B = 0$$

$$a = 9898.5\pi$$

$$c = (14000\pi)^2$$

$$\rightarrow r = \frac{A^2 c + B^2 - 2AB\alpha}{c - \alpha^2}$$

$$\rightarrow \Theta = \tan^{-1} \frac{A\alpha - B}{A\sqrt{c - \alpha^2}}$$

$$\rightarrow b = \sqrt{c - \alpha^2}$$

$$r = \sqrt{\frac{1^2 (14000\pi)^2 + 0 - 2 \cdot 1 \cdot 0 \cdot 9898.5\pi}{(14000\pi)^2 - (9898.5\pi)^2}}$$

$$r = \sqrt{\frac{1934442463}{967415640}} = \sqrt{1,99959} = 1.41406$$

$$\Theta = \tan^{-1} \left(\frac{1 \cdot 9898.5\pi - 0}{1 \sqrt{967415640}} \right) = 0.78529 \text{ rad}$$

$$b = \sqrt{967415640} = 31103.30$$

$$y(t) = r e^{-\alpha t} \cos(\omega t + \Theta) u(t)$$

$$y(t) = 1.999 e^{-9898.5\pi t} \cos(31103.30t + 0.78529)$$

Calcul passe-Bande 2

$$\text{Passe-haut} \rightarrow H_{(s)} = \frac{s^2}{s^2 + 2828\pi s + (2000\pi)^2}$$

$$\text{Passe-bas} \rightarrow H_{(s)} = \frac{(10000\pi)^2}{s^2 + 44405s + (10000\pi)^2}$$

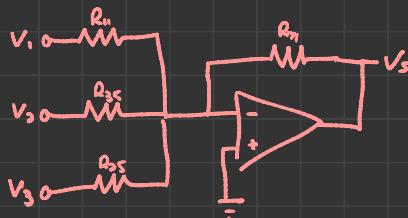
En serie c'est une multiplication ~~de~~

$$\frac{(10000\pi)^2 s^2}{(s^2 + 2828\pi s + (2000\pi)^2)(s^2 + 44405s + (10000\pi)^2)} = H_{(s)}$$

$$\begin{array}{r} s^4 + 44408s^3 + 986460440s^2 \\ + 0 + 8885s^3 + 344745105s^2 + 8,76 \cdot 10^9 s \\ + 0 + 0 + 39478417s^2 + 1,75 \cdot 10^{13}s + 3,90 \cdot 10^{16} \\ \hline s^4 + 53313s^3 + 1421183462s^2 + 1,051 \cdot 10^{13}s + 3,90 \cdot 10^{16} \end{array}$$

$H_{(s)}$	$\frac{986460440s^2}{s^4 + 53313s^3 + 1421183462s^2 + 1,051 \cdot 10^{13}s + 3,90 \cdot 10^{16}}$
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Calcul du sommateur :



$$I_{R_{11}} + I_{R_{35}} + I_{R_{25}} = I_{R_{71}}$$

$$\frac{(V_1 - 0)}{R_{11}} + \frac{(V_2 - 0)}{R_{35}} + \frac{(V_3 - 0)}{R_{25}} = \frac{(0 - V_S)}{R_{71}}$$

$$-R_{71} \left(\frac{V_1}{R_{11}} + \frac{V_2}{R_{35}} + \frac{V_3}{R_{25}} \right) = V_S$$

Sortie du sommateur

$$\frac{-V_1 R_{35} R_{25} R_{71} - V_2 R_{25} R_{11} R_{71} - V_3 R_{11} R_{35} R_{71}}{R_{11} R_{35} R_{25}} = \frac{V_S R_{11} R_{35} R_{25}}{R_{11} R_{35} R_{25}}$$

$$V_S R_{11} R_{35} R_{25} = -V_1 R_{35} R_{25} R_{71} - V_2 R_{25} R_{11} R_{71} - V_3 R_{11} R_{35} R_{71}$$

Si $V_1 = 0$ et $V_2 = 0$

$$V_3 = -V_S R_{25} / R_{71}$$

Si $V_1 = 0$ et $V_3 = 0$

$$V_2 = -V_S R_{35} / R_{71}$$

Si $V_2 = 0$ et $V_3 = 0$

$$V_1 = -V_S R_{11} / R_{71}$$

$$V_1 + V_2 + V_3 = -V_S \left(\frac{R_{25}}{R_{71}} + \frac{R_{35}}{R_{71}} + \frac{R_{11}}{R_{71}} \right)$$

$$\frac{V_S}{V_1 + V_2 + V_3} = -R_{71} \left(\frac{1}{R_{25}} + \frac{1}{R_{35}} + \frac{1}{R_{11}} \right)$$

Fonction de transfert du sommateur