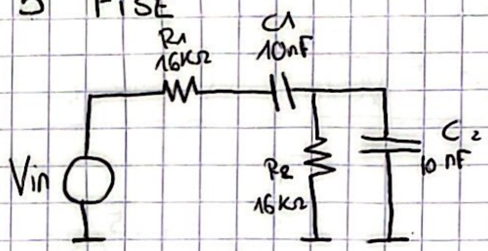
Estudi previ practica 5 FISE

~~Qüestió EP1~~



Analisi del filtre possabanda passiu RC

Qüestió EP1

$$V_{out} = \frac{Z_2}{Z_1 + Z_2} V_{in} \qquad \begin{cases} Z_1 = R + \dfrac{1}{Cs} = \boxed{\dfrac{R(s+1)}{RCs}} \\[2ex] Z_2 = R /\!/ \dfrac{1}{Cs} = \dfrac{R \cdot 1/Cs}{R + 1/Cs} = \boxed{\dfrac{R}{R(s+1)}} \end{cases}$$

$$H(s) = \frac{V_o}{V_i} = \frac{Z_2}{Z_1+Z_2} = \frac{\dfrac{R}{R(s+1)}}{\dfrac{R(s+1)^2 + RCs}{Cs(R(s+1))}} = \frac{R}{\cancel{R(s+1)}} \cdot \frac{Cs(\cancel{R(s+1)})}{R(s+1)^2 + RCs} =$$

$$= \frac{RCs}{R^2C^2s^2 + 2RCs + 1 + RCs} = \frac{RCs}{R^2C^2s^2 + 3RCs + 1} = \frac{RCs}{R^2C^2\left(s^2 + \frac{3s}{RC} + \frac{1}{R^2C^2}\right)} =$$

$$= \boxed{\frac{s/RC}{s^2 + \dfrac{3s}{RC} + \dfrac{1}{R^2C^2}}}$$

Qüestió EP2

$$\boxed{\omega_0 = \frac{1}{RC}} \; ; \; \boxed{A = 1} \; ; \; \frac{3}{RC} = \frac{1}{RC} \cdot \frac{1}{Q} \longrightarrow \boxed{Q = \frac{1}{3}}$$

Qüestió EP3

$$s = \frac{-\frac{3}{RC} \pm \sqrt{(3/RC)^2 - 4\cdot(1/RC)^2}}{2} = \frac{-3/RC \pm \sqrt{5(1/RC)^2}}{2} =$$

$$= \begin{cases} \dfrac{-3/RC + \sqrt{5}/RC}{2} = \dfrac{-3+\sqrt{5}}{2RC} \\[2ex] \dfrac{-3/RC - \sqrt{5}/RC}{2} = \dfrac{-3-\sqrt{5}}{2RC} \end{cases}$$

$$|H(j\omega_0)| = \frac{\omega \cdot \omega_0}{\sqrt{\omega^2 + (0{,}38\cdot\omega_0)^2}\cdot\sqrt{\omega^2+(2{,}62\cdot\omega_0)^2}} =$$

$$= \frac{\omega_0^2}{\omega_0\sqrt{1+(0{,}38)^2}\cdot\omega_0\sqrt{1+(2{,}62)^2}} =$$

$$= \frac{1}{\sqrt{9}} = \boxed{\frac{1}{3}}$$

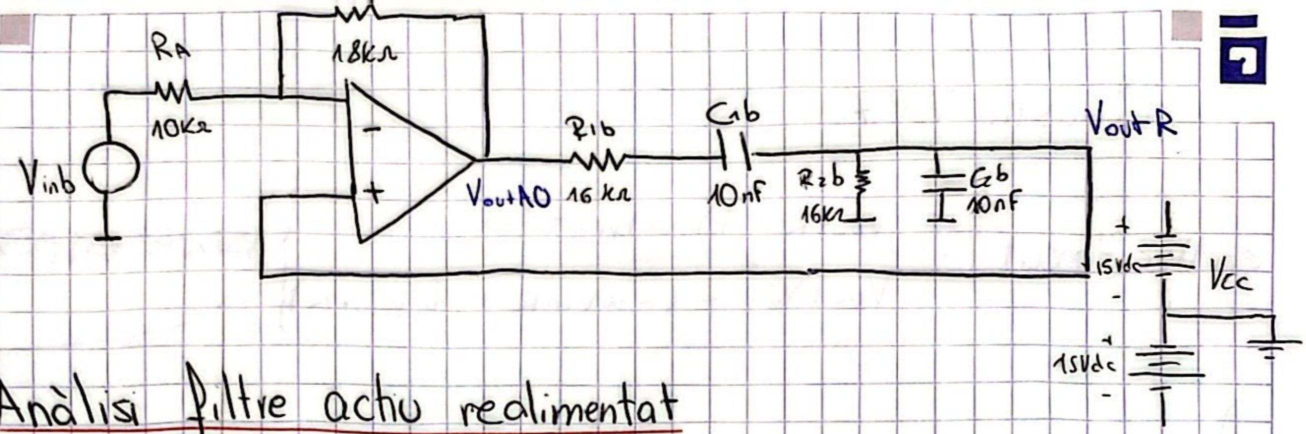
Qüestió EP4

$$\omega_0 = \frac{1}{RC} = \frac{1}{16\cdot10^3\cdot10\cdot10^{-9}} = \boxed{6250\ rad/s}$$

$$\hookrightarrow f_0 = \frac{\omega_0}{2\pi} = \frac{6250}{2\pi} = \boxed{994{,}72\ Hz}$$

$$\boxed{Q = \frac{1}{3}}$$

$$A\varepsilon\omega_0\cancel{s} = 6250\cancel{s} = \cancel{A} \rightarrow \boxed{A = 1}$$



Anàlisi filtre actiu realimentat

Qüestió EP5

· Al considerar l'AO ideal, llavors

$$\left.\begin{array}{l} V_{outR} = 0 \\ V_{inR} = 0 \end{array}\right\} \text{pota positiva AO } \boxed{CCV}$$

$$V_{outAO} = \frac{-R_F}{R_A} \cdot V_{inR}$$

$$\frac{V_{outAO}}{V_{inR}} = \left[\frac{-R_F}{R_A} = \alpha\right]$$

$$\boxed{\alpha = \frac{-R_F}{R_A}}$$

$$\frac{-V_{outR}}{R_A} = \frac{V_{outR} - V_{outAO}}{R_F}$$

$$\frac{V_{outAO}}{R_F} = \frac{V_{outR}}{R_A} + \frac{V_{outR}}{R_F}$$

$$\frac{V_{outAO}}{R_F} = V_{outR}\left(\frac{1}{R_A} + \frac{1}{R_F}\right)$$

$$\frac{V_{outAO}}{V_{outR}} = \left(1 + \frac{R_F}{R_A} = -f_R\right)$$

$$\boxed{-f_R = 1 + \frac{R_F}{R_A}}$$

Qüestió EP6

$$T(s) = H(s) \cdot f_R =$$

$$= \frac{1/RC \cdot s}{s^2 + s\,3/RC + (1/RC)^2}(-1)\left(\frac{R_F}{R_A} + 1\right) =$$

$$\boxed{= \frac{-\frac{s}{RC}\left(1 + \frac{R_F}{R_A}\right)}{s^2 + s\frac{3}{RC} + \left(\frac{1}{RC}\right)^2}}$$

es tracta d'una realimentació positiva ja que $\boxed{k = -\frac{1}{RC}\left(1 + \frac{R_F}{R_A}\right) < 0}$

Qüestió EP7

en llaç tancat :
$$\left.\begin{aligned} V_{outR} &= H(s) V_{out\,AO} \\ V_{out\,AO} &= -(-\alpha V_{inR} + f_R V_{outR}) \end{aligned}\right\}$$

$$V_{outR} = -H(s)\cdot(-\alpha V_{inR} + f_R V_{outR})$$

$$V_{outR} = H(s)\,\alpha V_{inR} - f_R H(s)\, V_{outR}$$

$$V_{outR}\,(1 + f_R H(s)) = H(s)\,\alpha V_{inR}$$

$$\frac{V_{outR}}{V_{inR}} = \frac{H(s)\alpha}{1 + f_R H(s)} = H_R(s)$$

$$H_R(s) = \frac{\underbrace{-\frac{R_F}{R_A}\cdot\frac{1/RC\cdot s}{s^2 + s\,3/RC + (1/RC)^2}}_{H(s)\alpha}}{\underbrace{1 - \left(\frac{R_F}{R_A}+1\right)\frac{1/RC\cdot s}{s^2 + s\frac{3}{RC} + (1/RC)^2}}_{1+f_R H(s)}} =$$

$$= \frac{-\frac{R_F}{R_A}\cdot\frac{1/RC\cdot s}{s^2 + s\frac{3}{RC} + (1/RC)^2}}{\frac{s^3 + s\frac{3}{RC} + (1/RC)^2 - \left(\frac{R_F}{R_A}+1\right)1/RC\cdot s}{s^2 + s\frac{3}{RC} + (1/RC)^2}} =$$

$$= \frac{-\frac{R_F}{R_A}\cdot 1/RC\cdot s}{s^2 + s\frac{3}{RC} + \left(\frac{1}{RC}\right)^2 - \left(\frac{R_F}{R_A}+1\right)\cdot 1/RC\cdot s} =$$

$$\boxed{= \frac{-\frac{R_F}{R_A}\cdot 1/RC\cdot s}{s^2 + s\left(\frac{2}{RC} - \frac{R_F}{R_A RC}\right) + \left(\frac{1}{RC}\right)^2}}$$

✓

Qüestió EP8

$$\boxed{\omega_0 = \frac{1}{RC}}$$

$$\boxed{A = -\frac{R_F}{R_A}}$$

$$\frac{2}{RC} - \frac{R_F}{R_A R C} = \frac{1}{RC} \cdot \frac{1}{Q}$$

$$\boxed{Q = \frac{R_A}{2R_A - R_F}}$$

Qüestió EP9

$Q = 5$

$Q = 10$ $\quad R_A = 10K\Omega$

- R_F i f_R per a $Q = 5$

$$Q = \frac{R_A}{2R_A \cdot R_F} \rightarrow 5 = \frac{10K\Omega}{2 \cdot 10K\Omega \cdot R_F}$$

$$\boxed{R_F = 18K\Omega}$$

$$-f_R = \frac{R_f}{R_A} + 1 \rightarrow -f_R = \frac{18K\Omega}{10K\Omega} + 1$$

$$\boxed{f_R = -\frac{14}{5}}$$

- R_F i f_R per a $Q = 10$

$$Q = \frac{R_A}{2R_A \cdot R_F} \rightarrow 10 = \frac{10K\Omega}{2 10K\Omega \cdot R_F}$$

$$\boxed{R_F = 19K\Omega}$$

$$-f_R = \frac{R_f}{R_A} + 1 \rightarrow -f_R = \frac{19K\Omega}{10K\Omega} + 1$$

$$\boxed{f_R = -\frac{29}{10}}$$

Qüestió EP10

$$H_{R(s)} = \frac{-\frac{Rf}{RA} \cdot 1/RC \cdot s}{s^2 + s\left(\frac{2}{RC} - \frac{RF}{RA\,RC}\right) + \left(\frac{1}{RC}\right)^2}$$

$$s^2 + \frac{\omega_0}{Q} s + \omega_0^2 = 0 \rightarrow$$

equació 2n grau

$$s = \frac{-\frac{\omega_0}{Q} \pm \sqrt{\left(\frac{\omega_0}{Q}\right)^2 - 4\omega_0^2}}{2} = \frac{1}{2}\left(-\frac{\omega_0}{Q} \pm \sqrt{\left(\frac{\omega_0^2}{Q^2}\right) - 4\omega_0^2}\right) =$$

$$= \frac{1}{2}\left(\frac{-\omega_0}{Q} \pm \sqrt{\frac{\omega_0^2 - 4\omega_0^2 Q^2}{Q^2}}\right) = \frac{1}{2}\left(-\frac{\omega_0}{Q} \pm \sqrt{\omega_0^2\left(\frac{1-4Q^2}{Q^2}\right)}\right) =$$

$$= \frac{1}{2}\left(-\frac{\omega_0}{Q} \pm \omega_0\sqrt{\frac{1}{Q^2} - 4}\right) = \frac{1}{2}\left(\frac{-\omega_0}{Q} \pm j\omega_0\sqrt{4 - \frac{1}{Q^2}}\right) =$$

$$= \boxed{\frac{-\omega_0}{2Q} \pm j\omega_0 \sqrt{1 - \frac{1}{(2Q)^2}}}$$

$$|H(j\omega_0)| = \frac{-\frac{Rf}{R_A} \cdot \omega_0 \cdot \omega}{\sqrt{\left(\left(\frac{\omega_0}{2Q}\right)^2 + \left(\omega + \omega_0\sqrt{1 - \frac{1}{(2Q)^2}}\right)^2\right) \cdot \left(\left(\frac{\omega_0}{2Q}\right)^2 + \left(\omega - \omega_0\sqrt{1 - \frac{1}{(2Q)^2}}\right)^2\right)}} =$$

$$= \frac{-\frac{Rf}{RA}}{\sqrt{\left(\left(\frac{1}{2Q}\right)^2 + \left(1 + \sqrt{1 - \frac{1}{(2Q)^2}}\right)^2\right)\left(\left(\frac{1}{2Q}\right)^2 + \left(1 - \sqrt{1 - \frac{1}{(2Q)^2}}\right)^2\right)}}$$

- per a $Q = 10 \rightarrow |H(j\omega_0)| = 19$

  $Q = 5 \rightarrow |H(j\omega_0)| = 9$

Questió EP11

$\omega_0 = 6250$ rad/s

$\boxed{Q = 10} \longrightarrow s = \frac{-\omega_0}{2Q} \pm j\omega_0 \sqrt{1 - \frac{1}{(2Q)^2}} =$

$= \frac{-6250}{2 \cdot 10} \pm j6250 \sqrt{1 - \frac{1}{(2 \cdot 10)^2}} =$

$= \boxed{-312,5 \pm j6242,18}$

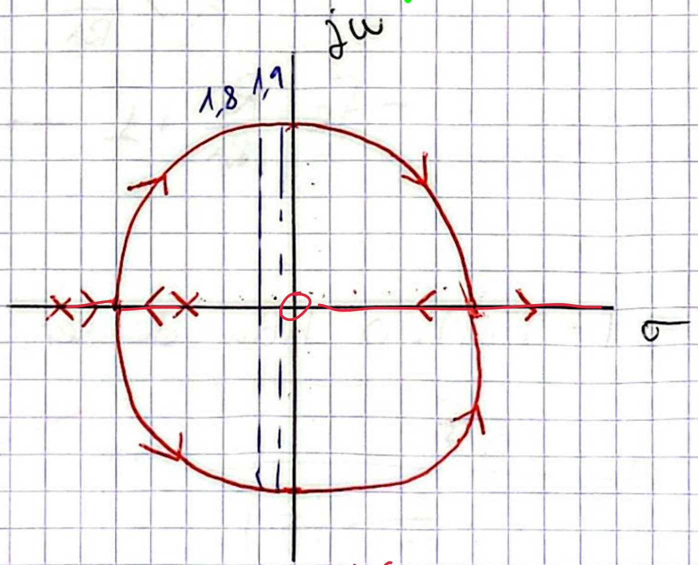
$\boxed{Q = 5} \longrightarrow s = \frac{-\omega_0}{2Q} \pm j\omega_0 \sqrt{1 - \frac{1}{(2Q)^2}} =$

$= \frac{-6250}{2 \cdot 5} \pm j6250 \sqrt{1 - \frac{1}{(2 \cdot 5)^2}} =$

$= \boxed{-625 \pm j6218,67}$

$Q = 5 \longrightarrow \frac{R_F}{R_A} = 1,8$

$Q = 10 \longrightarrow$ " " $= 1,9$



LGA acaba en el zero a l'origen!!

Qüestió EP12

- $-\frac{\omega_0}{2Q} > 0 \rightarrow$ punt real estable

- Sabem que ω_0 es positiu de forma que $-Q>0$ i això implica que:

$$-Q = -\frac{R_A}{2R_A - R_F} = -\frac{1}{2} + \frac{R_A}{R_F}$$

$$-\frac{1}{2} + \frac{R_A}{R_F} > 0$$

$$-\frac{1}{2} > \frac{R_A}{R_F}$$

$$\frac{1}{2} < \frac{R_A}{R_F}$$

$$2 > \frac{R_F}{R_A}$$

$$-f_R = \frac{R_F}{R_A} + 1 \longrightarrow -f_R < 3$$

$$\boxed{f_R > -3}$$

- $1 + T(s) = 0$ han de ser imaginaris (per a oscil·lar).

$$1 - \frac{k's}{s^2 + \frac{3}{RC} + \left(\frac{1}{RC}\right)^2} = 0 \qquad k' = -k = \frac{1}{RC}\left(\frac{R_F}{R_A} + 1\right)$$

↳ nomes valors positius.

$$s^2 + \frac{3}{RC}s + \frac{1}{R^2C^2} - k's = s^2 + \left(\frac{3}{RC} - k'\right)s + \frac{1}{R^2C^2} = 0$$

↳ coeficient ha de ser nul.

$$\frac{3}{RC} - k' = 0 \rightarrow 1 + \frac{R_F}{R_A} = 3 \rightarrow \boxed{\frac{R_F}{R_A} = 2}$$ condició de oscil·lació

$$R_F = 2R_A = 2 \cdot 10k\Omega = \boxed{20k\Omega}$$