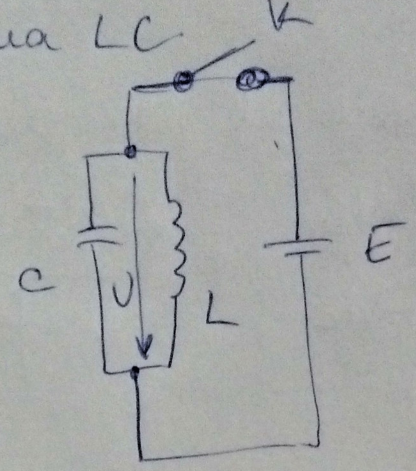
SEMINAR 7 EZ II

Oscilatori

Rețeaua LC



$X_L = X_C$

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

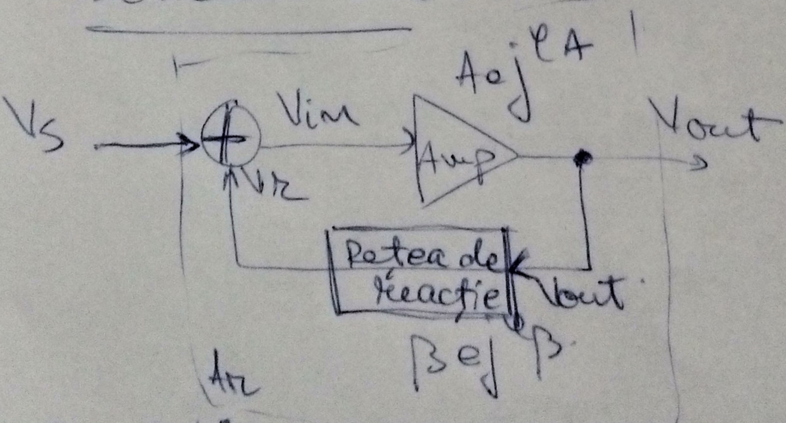
$$\omega L = \frac{1}{\omega C}$$

$$\omega^2 = \frac{1}{LC}$$

$$4\pi^2 f_0^2 = \frac{1}{LC}$$

$$\boxed{f_0 = \frac{1}{2\pi\sqrt{LC}}}$$ f. rez.

Schema bloc:



$Ae^{j\varphi_A}$ - fact. de amp.

$\beta e^{j\varphi_\beta}$ - factorul de transfer al rețelei

Condiții:

- amplificare
- r poz. în fază!
- f_0 determinată de rețeaua de reacție.

$V_{out} = A e^{j\varphi_A} V_{in}$

$V_r = \beta e^{j\varphi_\beta} V_{out}$

$V_{in} = V_s + V_r$

Factorul de amplificare al conexiunii.

$$A_r = \frac{V_{out}}{V_s} = \frac{A e^{j\varphi_A} \cdot V_{in}}{V_{in} - V_r} = \frac{A e^{j\varphi_A} V_{in}}{V_{in} - \beta e^{j\varphi_\beta} \cdot V_{out}} =$$

$$= \frac{A e^{j\varphi_A} \cancel{V_{in}}}{\cancel{V_{in}} - \beta A e^{j\underbrace{(\varphi_A+\varphi_\beta)}_{\varphi_\Sigma}} \cancel{V_{in}}}$$

$$A_r = \frac{A e^{j\varphi_A}}{1 - \beta A e^{j\varphi_\Sigma}}.$$

$$|A_r| = \frac{A}{\sqrt{1 - 2\beta A \cos\varphi_\Sigma + \beta^2 A^2}}$$

$e^{j\varphi_\Sigma} = \cos\varphi_\Sigma + j\sin\varphi_\Sigma.$

$1 - \beta A e^{j\varphi_\Sigma} = 1 - \beta A \cos\varphi_\Sigma - j\beta A \sin\varphi_\Sigma.$

$$|1 - \beta A e^{j\varphi_\Sigma}| = \sqrt{(1 - \beta A \cos\varphi_\Sigma)^2 + \beta^2 A^2 \sin^2\varphi_\Sigma} =$$

$$= \sqrt{1 - 2\beta A \cos\varphi_\Sigma + \beta^2 A^2 \cos^2\varphi_\Sigma + \beta^2 A^2 \sin^2\varphi_\Sigma} =$$

$$= \sqrt{1 - 2\beta A \cos\varphi_\Sigma + \beta^2 A^2}$$

•) Dacă $\varphi_\Sigma = (2k+1)\pi \Rightarrow$ ~~...~~ $\cos \varphi_\Sigma = -1 \Rightarrow$

$\Rightarrow$ reacție negativă $\rightarrow$

$$\Rightarrow A_r = \frac{1}{1+\beta A}$$

•) Dacă $\varphi_\Sigma = 2k\pi \rightarrow \cos \varphi_\Sigma = +1 \Rightarrow$ r. pozitivă

$$\boxed{A_r = \frac{A}{1-\beta A}}$$

•) $\beta A < 1 \rightarrow A_r > A$.

•) $\beta A = 1 \Rightarrow A_r \rightarrow \infty$

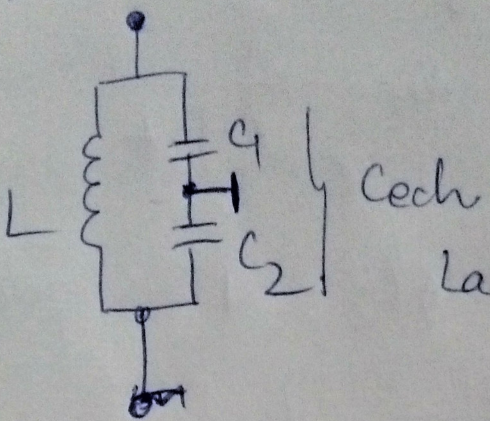
Amplificatorul este un oscilator dacă:

1. Reacție pozitivă (în fază)
2. $\beta A = 1$. - criteriul lui Barkhausen

RF $\rightarrow$ rețele LC, XC.
audio $\rightarrow$ rețele RC

Oscilatorul Colpitts:

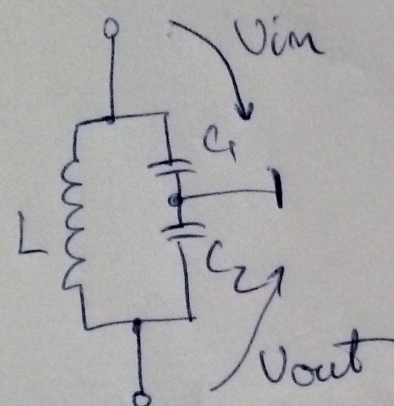
- rețea LC.



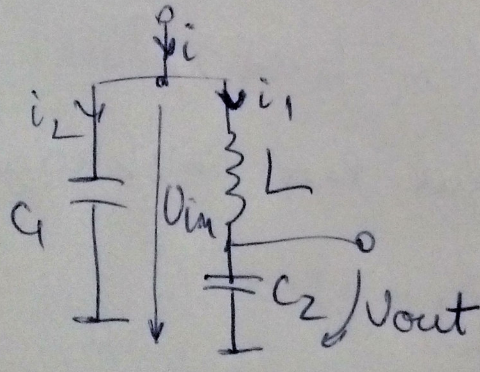
$$C_{ech} = \frac{C_1 C_2}{C_1 + C_2}$$

La rezonanță

$$f_0 = \frac{1}{2\pi\sqrt{L C_{ech}}}$$



$$\frac{V_{out}}{V_{in}} = ?$$



$$V_{in} = i_1 \cdot (Z_L + Z_{C_2})$$

$$V_{out} = i_1 \cdot Z_{C_2}$$

$$\frac{V_{out}}{V_{in}} = \frac{Z_{C_2}}{Z_L + Z_{C_2}} =$$

$$= \frac{-\frac{j}{\omega C_2}}{j\omega L - \frac{j}{\omega C_2}} = -\frac{j}{\omega C_2} \cdot \frac{1}{j(\omega L - \frac{1}{\omega C_2})} =$$

$$= \frac{1}{1 - \omega^2 C_2 \cdot L}$$

La rezonanță:

$$\omega L = \frac{1}{\omega C_{ech}} \Rightarrow L = \frac{1}{\omega^2 C_{ech}}$$

$$\frac{V_{out}}{V_{in}} = \frac{1}{1-\cancel{\omega^2} C_2 \cdot \frac{1}{\cancel{\omega^2} C_{ech}}} = \frac{1}{1-\cancel{C_2} \cdot \frac{C_1+C_2}{C_1 \cancel{C_2}}} =$$

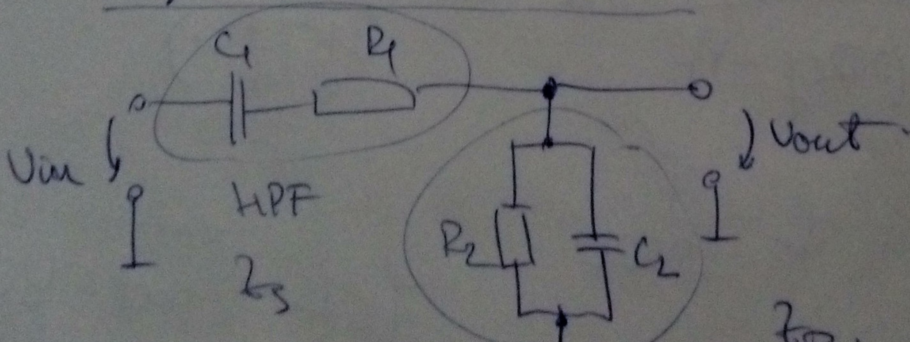
$$= \frac{1}{\frac{\cancel{C_1}-\cancel{C_1}-C_2}{C_1}} = \boxed{-\frac{C_1}{C_2}}$$

defazaj π indus de rețea.

$$\left.\begin{aligned} C_1 &= 24\ nF \\ C_2 &= 240\ nF \end{aligned}\right\} \Rightarrow C_{ech} = 21.82\ nF$$

$$f_0 = 10.8\ KHz.$$

Rețeaua RC Wien:



$$\frac{V_{out}}{V_{in}} = \frac{Z_p}{Z_s+Z_p}$$

De regulă $R_1 = R_2 = R$

$C_1 = C_2 = C.$

$$\frac{V_{out}}{V_{in}} = \frac{1}{1+\frac{Z_s}{Z_p}}$$

$$Z_s = R - \frac{j}{\omega C}, \quad Z_p = \frac{1}{\frac{1}{R}+j\omega C} = \frac{1}{\frac{1+jR\omega C}{R}}$$

$$\frac{V_{out}}{V_{in}} = \frac{1}{1+\frac{\frac{R\omega C-j}{\omega C}}{\frac{R}{1+j\omega CR}}} = \frac{1}{1+\frac{(R\omega C-j)(1+jR\omega C)}{R\omega C}} =$$

$$= \frac{1}{\frac{2R\omega C+j(R\omega C)^2-j-j^2R\omega C}{R\omega C}} = \frac{1}{\frac{3R\omega C}{R\omega C}+j(R\omega C-1)} =$$

$$= \frac{1}{3+j(2\pi fRC-1)}.$$

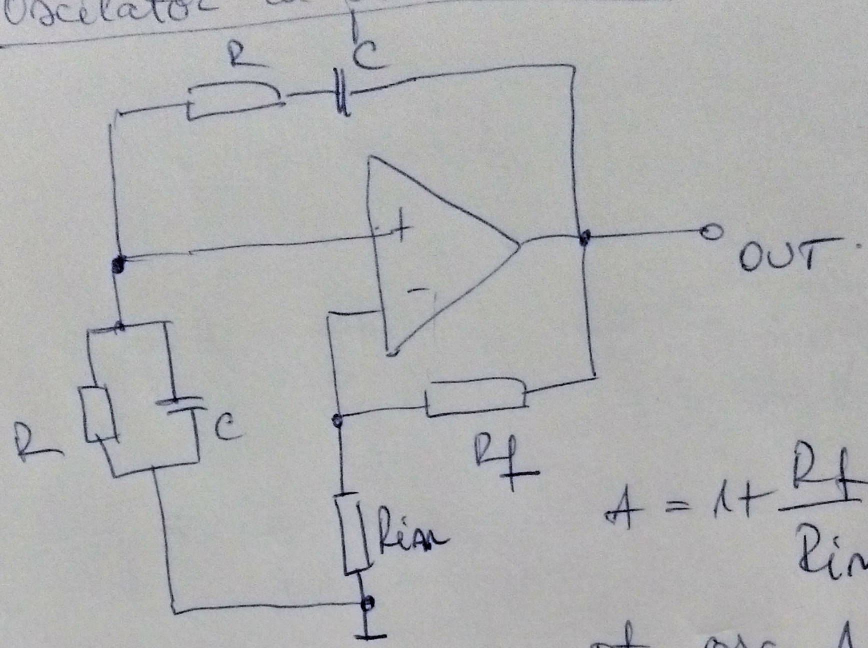
$$V_{out} = \frac{1}{3+j(2\pi RCf-1)} \cdot V_{in} = \frac{1}{3+j\cdot\left(\frac{f}{f_0}-1\right)}$$

$$f_0 = \frac{1}{2\pi RC}$$

$$f = f_0 \Rightarrow \boxed{V_{out} = \frac{V_{in}}{3}}$$

$$\boxed{\varphi = 0 - \operatorname{arctg}\frac{\frac{f}{f_0}-1}{3}}$$

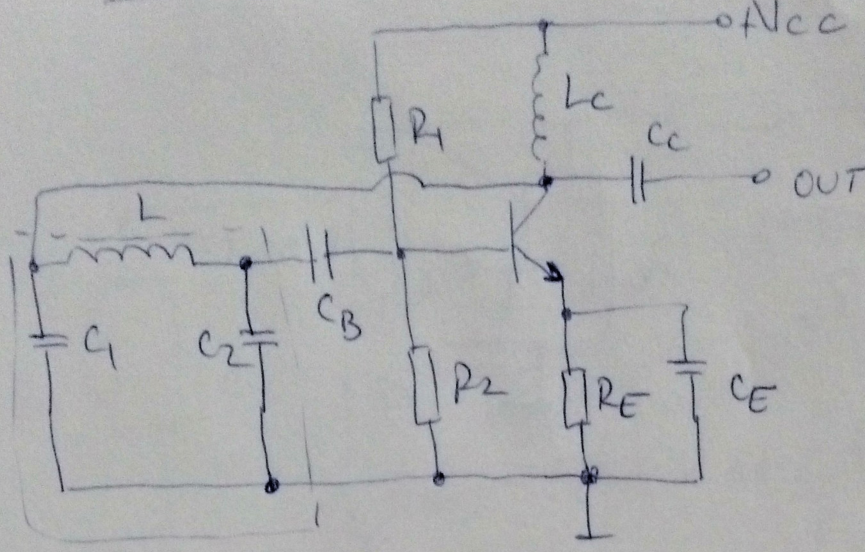
Oscilator cu punte Wien:



$$A = 1 + \frac{R_f}{R_{in}}$$

pt. osc. $\underline{\underline{A \geq 3}}$.

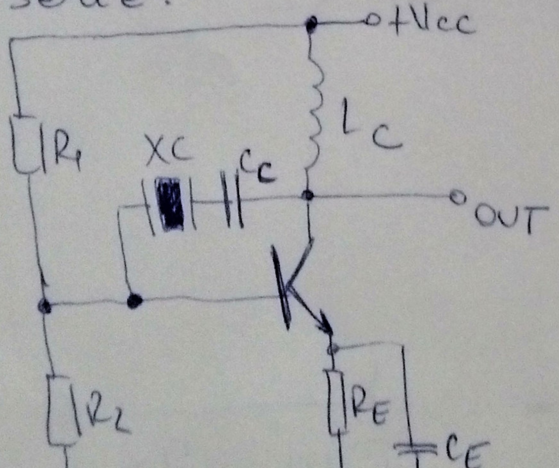
Oscilator Colpitts:



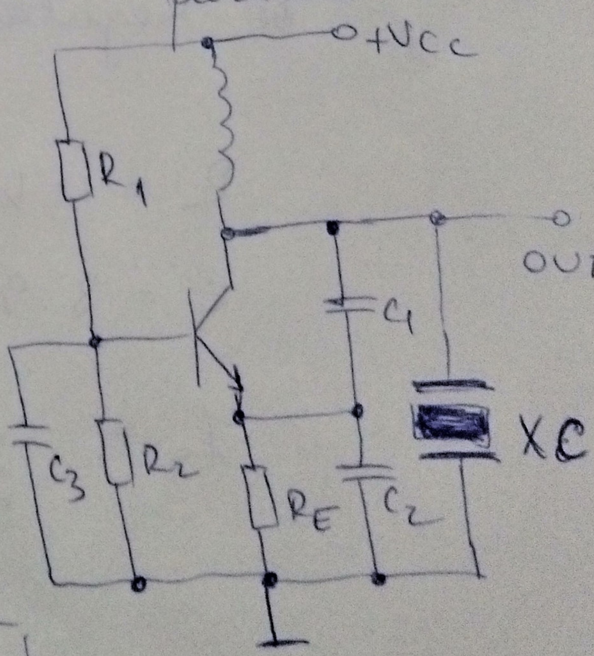
$$f_0 = \frac{1}{2\pi\sqrt{L C_{ech}}} \; ; \quad C_{ech} = \frac{C_1 C_2}{C_1 + C_2}$$

Oscilator cu cristal:

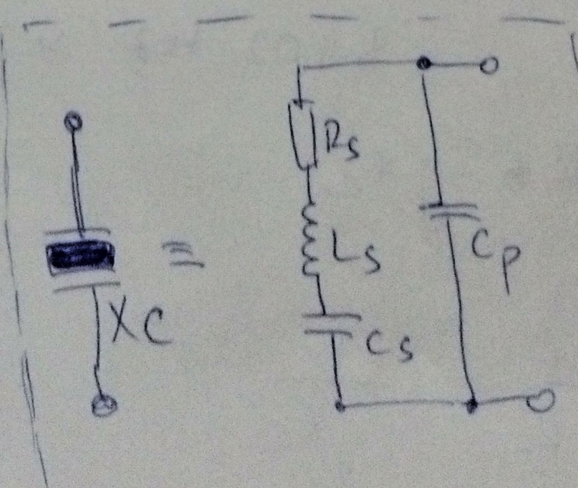
serie:



paralel:



$$f_s = \frac{1}{2\pi\sqrt{L_s C_s}}$$



$$f_p = \frac{1}{2\pi\sqrt{L_s \cdot \frac{C_p C_s}{C_p + C_s}}}$$