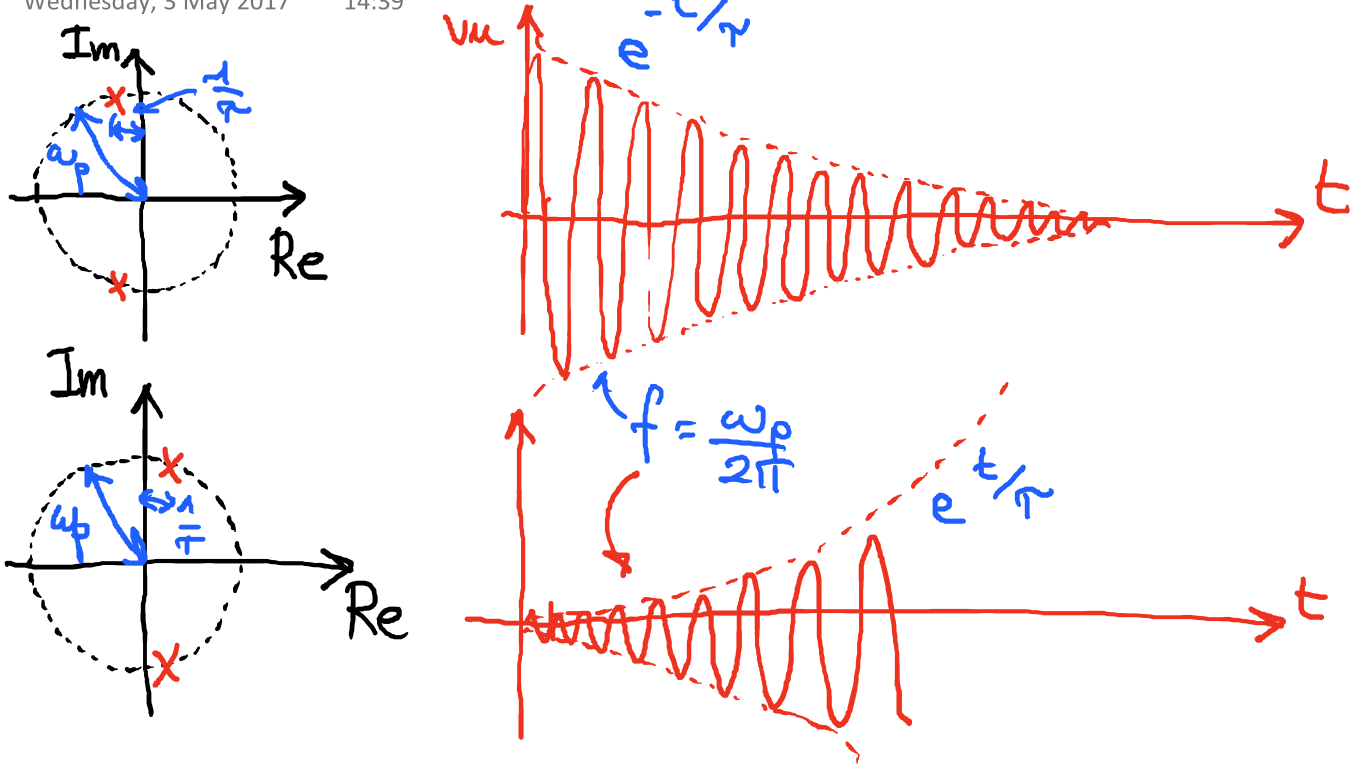
Oscillatore

Wednesday, 3 May 2017 14:36

Un circuito in grado di fornire una forma d'onda periodica in assenza di una sollecitazione d'ingresso

Circuito lineare in reazione

Wednesday, 3 May 2017 14:39



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<u>All'innesco</u> : poli c.c. modulo ω_0
parte reale positiva

<u>A REGIME</u> : poli immaginari puri $(\pm j\omega_p)$
con controllo <u>attivo</u>

A REGIME

Wednesday, 3 May 2017 14:51

$$A_F(j\omega) = \frac{A_e(j\omega)}{1 - \beta A_e(j\omega)}$$

$\pm j\omega_p$ poli $\Longrightarrow$ se $\omega = \omega_p$ il denominatore di A_F è nullo

$\Downarrow$

Condizione NECESSARIA per avere un'oscillazione $\rightarrow$ $\boxed{\beta A_e(j\omega_p) = 1}$

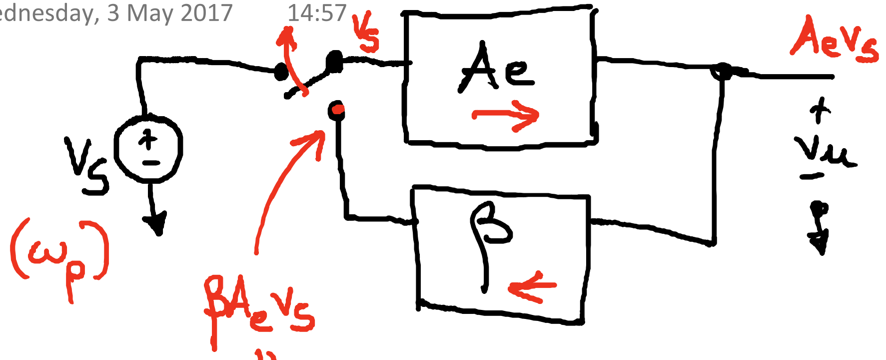
CRITERIO DI BARKHAUSEN A REGIME :

$$|\beta A_e(j\omega_p)| = 1$$

$$\angle \beta A_e(j\omega_p) = 0$$

Regolatore lineare

Wednesday, 3 May 2017 14:57



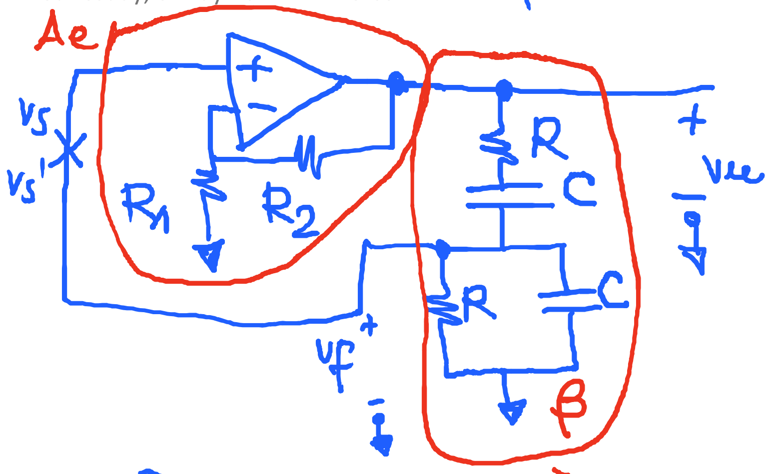
$\beta A_e V_s = V_s$ se $\beta A_e(j\omega_p) = 1$

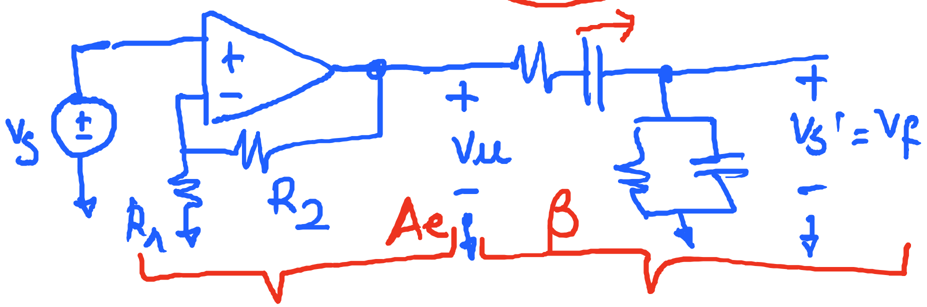
ALL'INNESCO:

$$\left.\begin{aligned} &|\beta A_e(j\omega_p)| > 1 \\ &\angle \beta A_e(j\omega_p) = 0 \end{aligned}\right\} \text{CRITERIO DI BARKHAUSEN ALL' \underline{INNESCO}}$$

Oscillatore di ponte di Wien

Wednesday, 3 May 2017 15:09





$$A_e = \frac{V_u}{V_s} = \left(1 + \frac{R_2}{R_1}\right)$$

β

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$$\beta = \frac{v_f}{v_u} = \frac{\frac{R}{RCs+1}}{\frac{R}{RCs+1} + R + \frac{1}{Cs}} =$$

$$\beta = \frac{RCs}{RCs + RCs(1+RCs) + RCs + 1} = \frac{RCs}{(RCs)^2 + 3RCs + 1}$$

1 zero nell'origine

2 poli reali negativi

$\angle \beta A_e$ è decrescente

per $\omega \to 0$ $\angle \beta A_e = \pi/2$

$\omega \to \infty$ $\angle \beta A_e = \pi/2 - 2\pi/2 = -\pi/2$

$$\beta A_e(j\omega) = \left(1+\frac{R_2}{R_1}\right)\cdot\frac{j\omega RC}{-\omega^2R^2C^2+3j\omega RC+1}$$

$$\angle \beta A_e(j\omega_0) = 0 \Rightarrow 1-\omega_0^2R^2C^2 = 0 \Rightarrow \boxed{\omega_0 = \frac{1}{RC}}$$

$$|\beta A_e(j\omega_0)| = \left(1+\frac{R_2}{R_1}\right)\frac{1}{3}$$

A REGIME: $\left(1+\frac{R_2}{R_1}\right)\frac{1}{3} = 1 \Rightarrow R_2 = 2R_1$

ALL'INNESCO: $\left(1+\frac{R_2}{R_1}\right)\frac{1}{3} > 1 \Rightarrow R_2 > 2R_1$

R_2 : NTC Negative Temperature Coefficient

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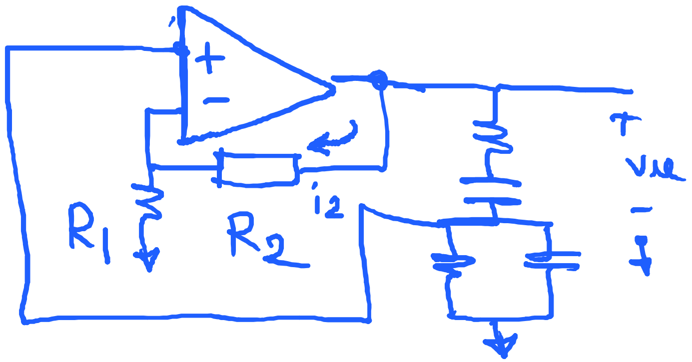


$$i_2 = \frac{v_u}{R_1+R_2}$$

$$P_2 = i_2^2 R_2 \propto v_u^2$$

$$T_2 = T_{AMB} + \frac{P_2}{\theta}$$

$\theta \leftarrow$ Resistenza Termica

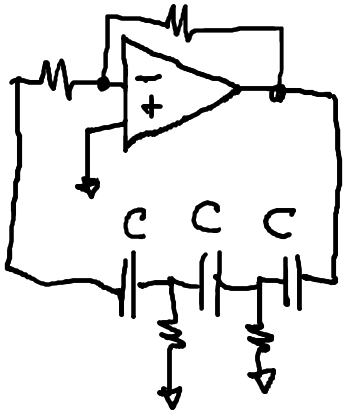
all'innesco $\beta A_e(j\omega_p) > 2$

se $v_u \uparrow \Rightarrow P_2 \uparrow \Rightarrow T_2 \uparrow \Rightarrow R_2 \downarrow \Rightarrow \beta A_e(j\omega_p) \downarrow$

se $v_u \downarrow \Rightarrow P_2 \downarrow \Rightarrow T_2 \downarrow \Rightarrow R_2 \uparrow \Rightarrow \beta A_e(j\omega_p) \uparrow$

Oscillatore a rete di sfasamento

Wednesday, 3 May 2017 15:28



← A_e : invertente $\angle A_e = \pi$

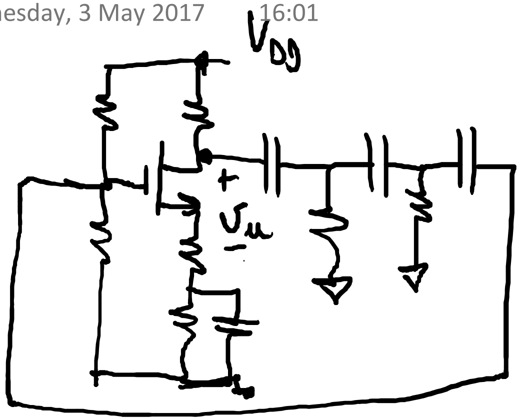
← β : 3 poli + 3 zeri nell'origine

(reali negativi)

$$\lim_{\omega \to 0} (\angle \beta A_e) = \pi + \frac{3}{2}\pi = \frac{\pi}{2}$$

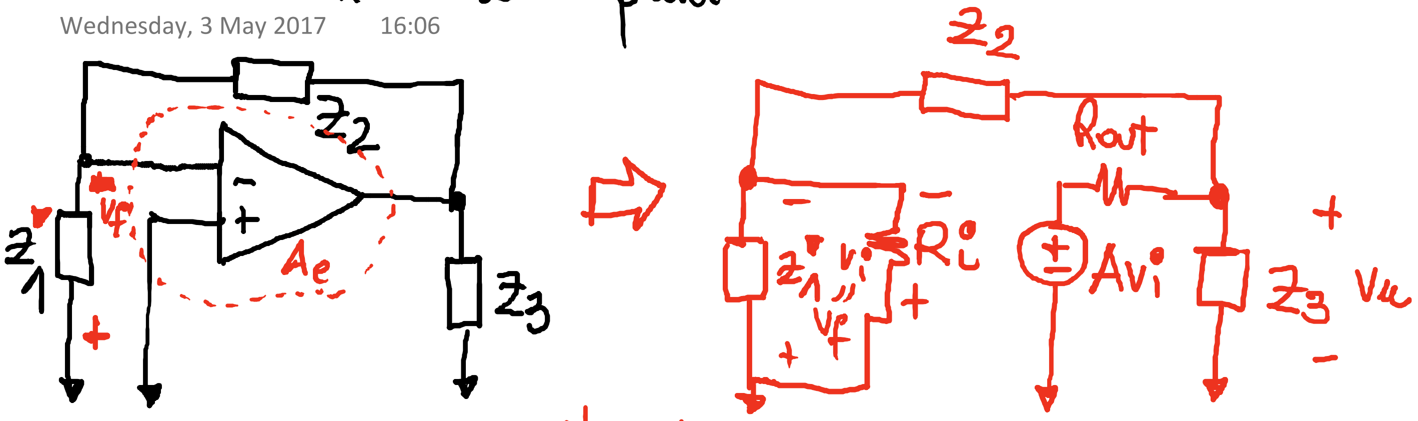
$$\lim_{\omega \to 0} (\angle \beta A_e) = \frac{\pi}{2} - 3 \cdot \frac{\pi}{2} = -\pi$$

monotona → esiste un solo valore di ω_0 per cui $\angle \beta A_e(j\omega_0) = 0$


VDD
+
Vu
−

Oscillatori a 3 punti

Wednesday, 3 May 2017 16:06



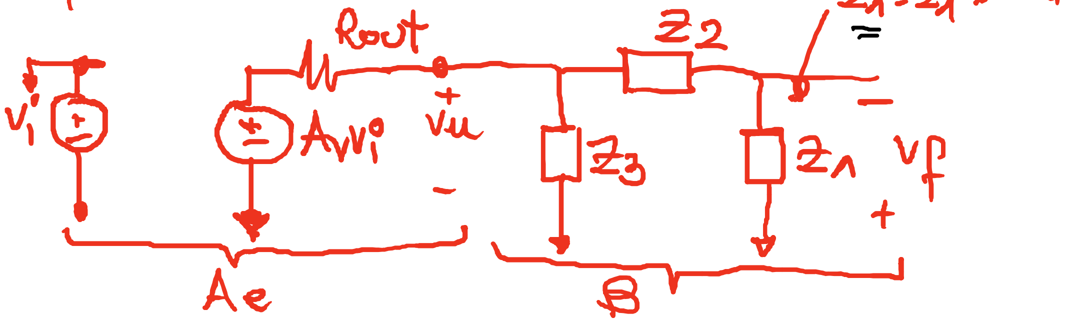
$Z_1 = jX_1$

$Z_2 < jX_2$

$Z_3 = jX_3$

apriamo l'anello di reazione

$Z_1 = Z_1' \,/\!/\, R_i$



$$v_u = A_v v_i \frac{Z_3 // (Z_1 + Z_2)}{R_{out} + Z_3 // (Z_1 + Z_2)}$$

$$v_f = -v_u \frac{Z_1}{Z_1 + Z_2}$$

$$\beta A_e = \frac{v_f}{v_i} = -A_v \frac{Z_1}{\cancel{Z_1 + Z_2}} \cdot \frac{\frac{Z_3 \cancel{(Z_1 + Z_2)}}{Z_1 + Z_2 + Z_3}}{R_{out} + \frac{Z_3 (Z_1 + Z_2)}{Z_1 + Z_2 + Z_3}} =$$

$$\beta A_e = -A_v \frac{Z_1 Z_3}{R_{out}(Z_1 + Z_2 + Z_3) + Z_3 (Z_1 + Z_2)} = \frac{A_v X_1 X_3}{j R_{out}(X_1 + X_2 + X_3) - X_3 (X_1 + X_2)}$$

$\angle \beta A_e(j\omega_0) = 0$ se $X_1(j\omega_0) + X_2(j\omega_0) + X_3(j\omega_0) = 0$

$$\hookrightarrow \beta A_e(j\omega_0) = \frac{A_v X_1 \cancel{X_3}}{-\cancel{X_3}\underbrace{(X_1 + X_2)}_{-X_3}} = \frac{A_v X_1}{X_3}$$

$\angle \beta A = 0$

se X_1 e X_3

hanno lo stesso segno

(X_2 segno opposto)

Criterio di Barkhausen

Wednesday, 3 May 2017 16:23

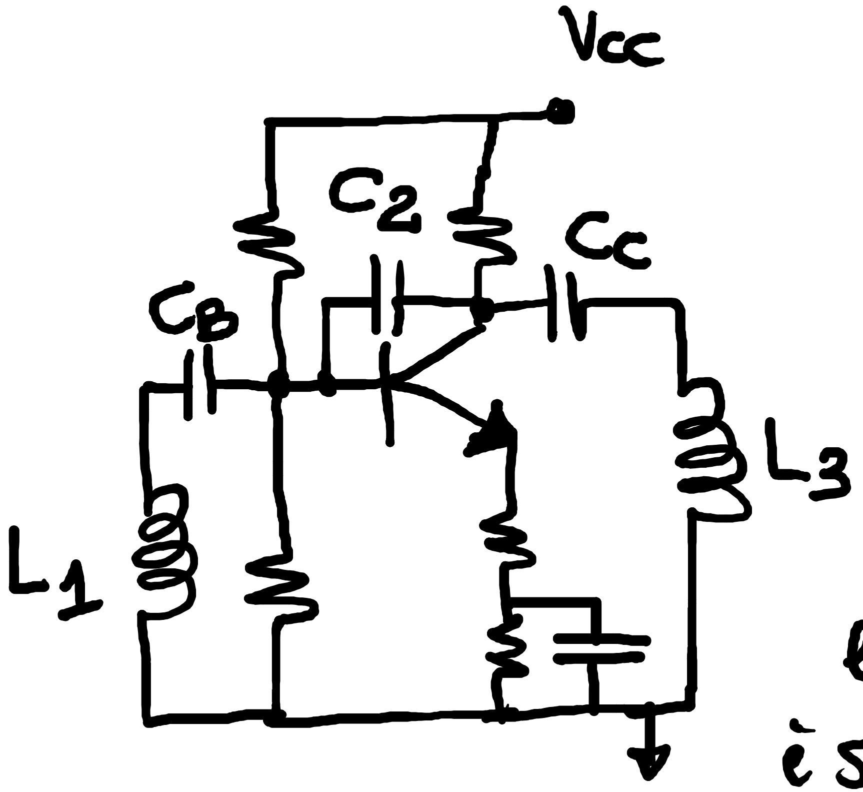
$$\exists \omega_0 : \begin{cases} X_1 + X_2 + X_3 = 0 \\ X_1 \text{ e } X_3 \text{ concordi} \end{cases} \Rightarrow A_v \frac{X_1}{X_3} > 1 \text{ all'innesco}$$

$$= 1 \text{ a regime}$$

$X_1, X_3 > 0$ (L)	$X_1, X_3 < 0$ (C)
$X_2 < 0$ (C)	$X_2 > 0$ (L)
Oscillatore di <u>Hartley</u>	Oscillatore di <u>Armstrong</u>

Oscillatore di Hartley

Tuesday, 9 May 2017 14:07



$$X_1 + X_2 + X_3 = 0$$

$$\omega L_1 - \frac{1}{\omega C_2} + \omega L_3 = 0$$

$$\omega^2 (L_1 + L_3) C_2 = 1$$

$$\omega_0 = \frac{1}{\sqrt{(L_1 + L_3) C_2}}$$

la condizione è soddisfatta solo per ω_0

$$\beta A(j\omega_0) > 1 \Rightarrow \frac{A X_1}{X_3} > 1 \Rightarrow \frac{A L_1}{L_3} > 1$$

Oscillatore di Armstrong

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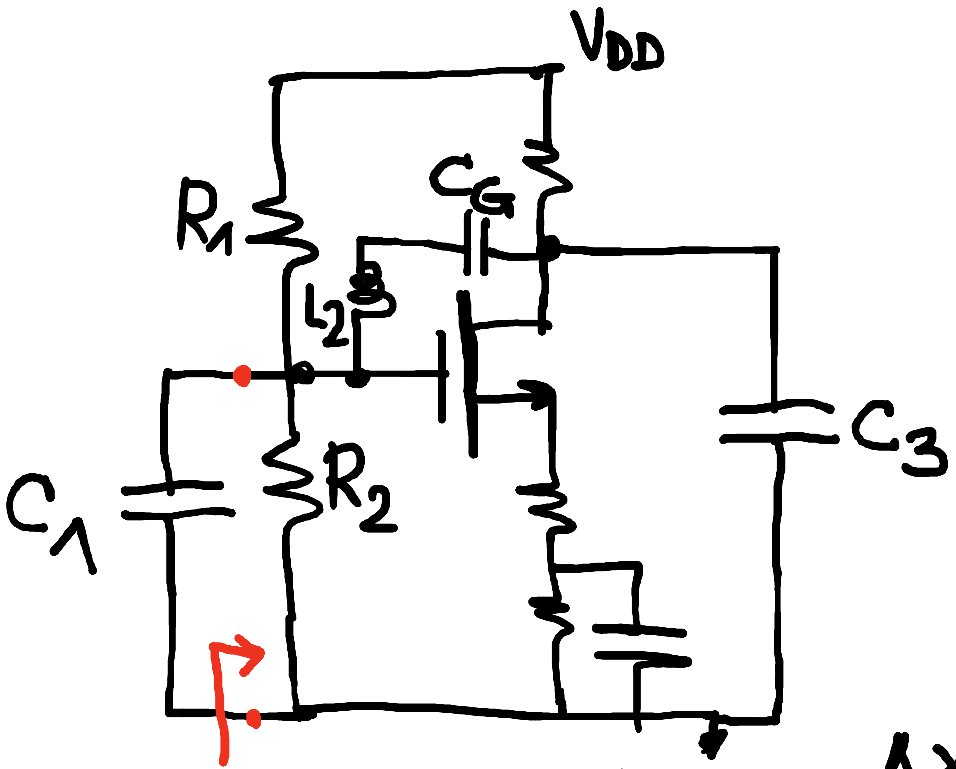

$$X_1+X_2+X_3=0$$

$$-\frac{1}{\omega C_1}+\omega L_2-\frac{1}{\omega C_3}=0$$

$$-C_3+\omega^2 L_2 C_1 C_3-C_1=0$$

$$\omega_0=\sqrt{\frac{C_1+C_3}{L_2 C_1 C_3}}$$

$$R_{in}=R_1 /\!/ R_2$$

$$\beta A(j\omega_0)=\frac{AX_1}{X_3}>1 \Rightarrow \frac{AC_3}{C_1}>1$$

$$Z_1=\frac{1}{j\omega C_1} /\!/ R_{in} \approx \frac{1}{j\omega C_1} \text{ se } \left|\frac{1}{\omega C_1}\right| \ll R_{in}$$

Oscillatori al quarzo

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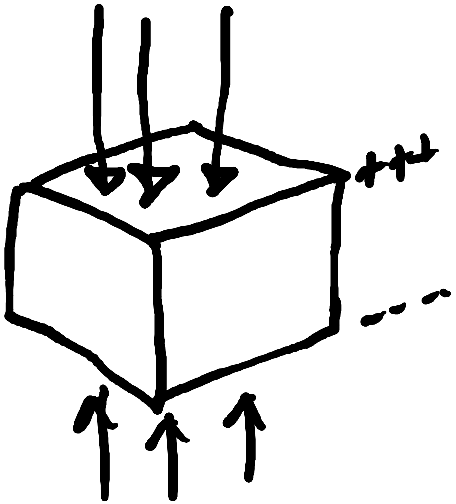
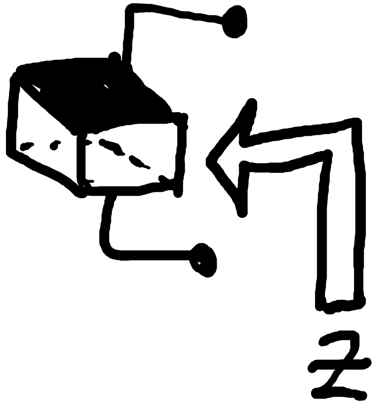
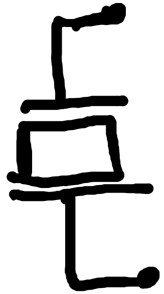
↳ SiO_2 cristallino.

↳ materiale PIEZOELETTRICO



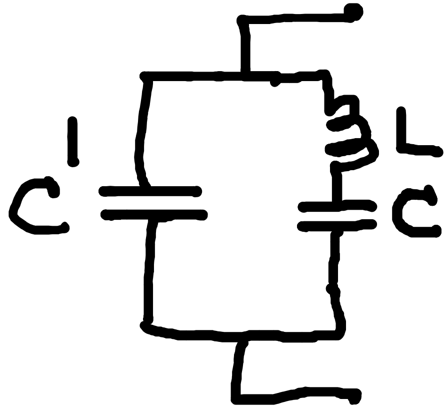




XTAL

Simbolo

Circuito equivalente



$$Z = \frac{1}{j\omega C'} \parallel \left[j\omega L + \frac{1}{j\omega C} \right]$$

Oscillatore al quarzo

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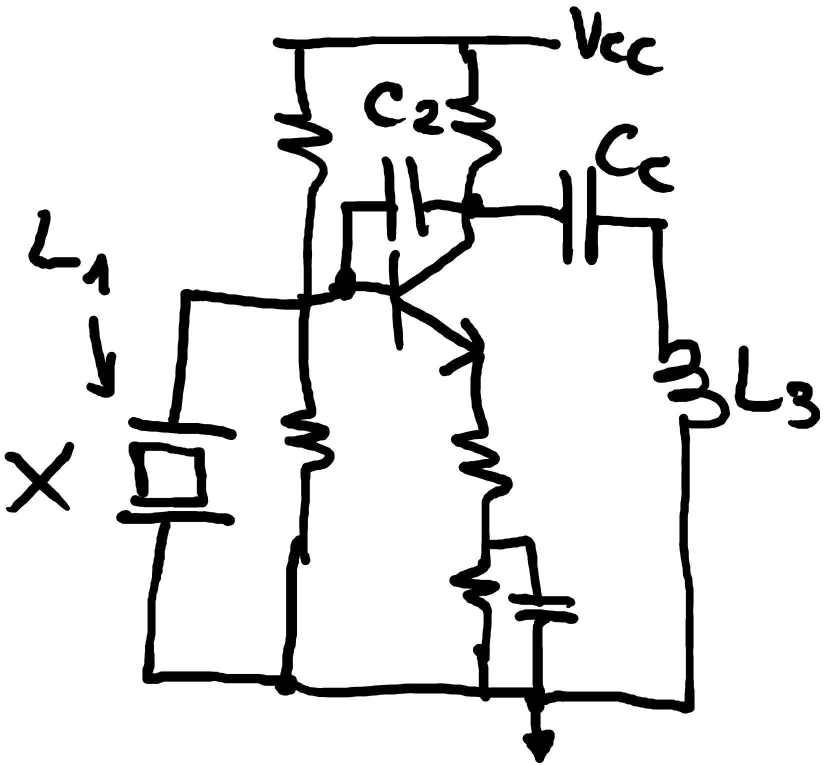
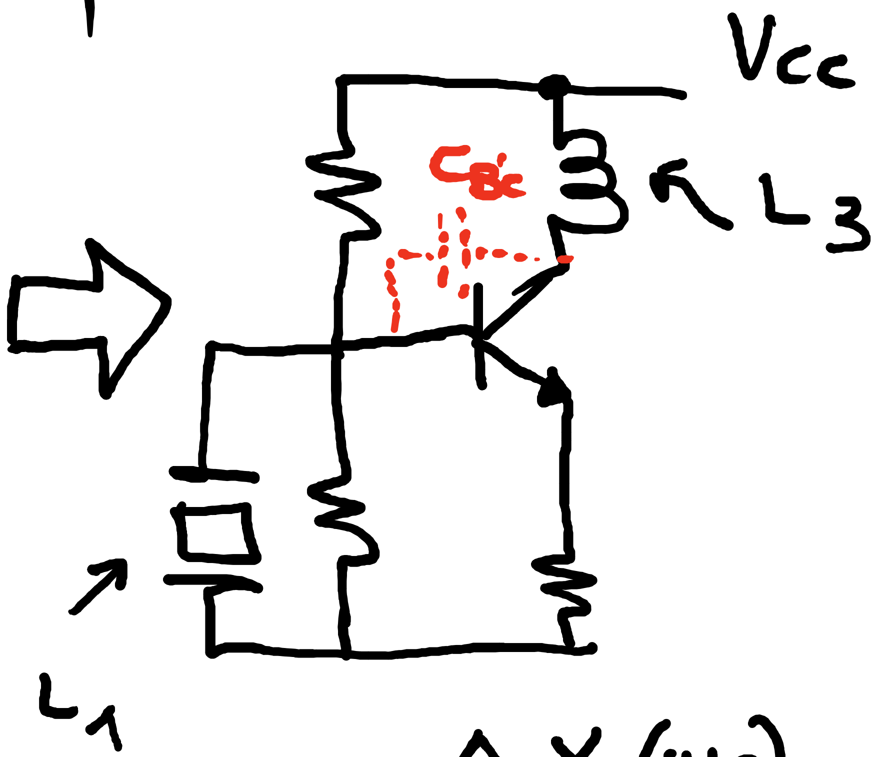
↳ oscillatore di Hartley





$$A \frac{X_1(\omega_p)}{\omega_p L_3} > 1$$

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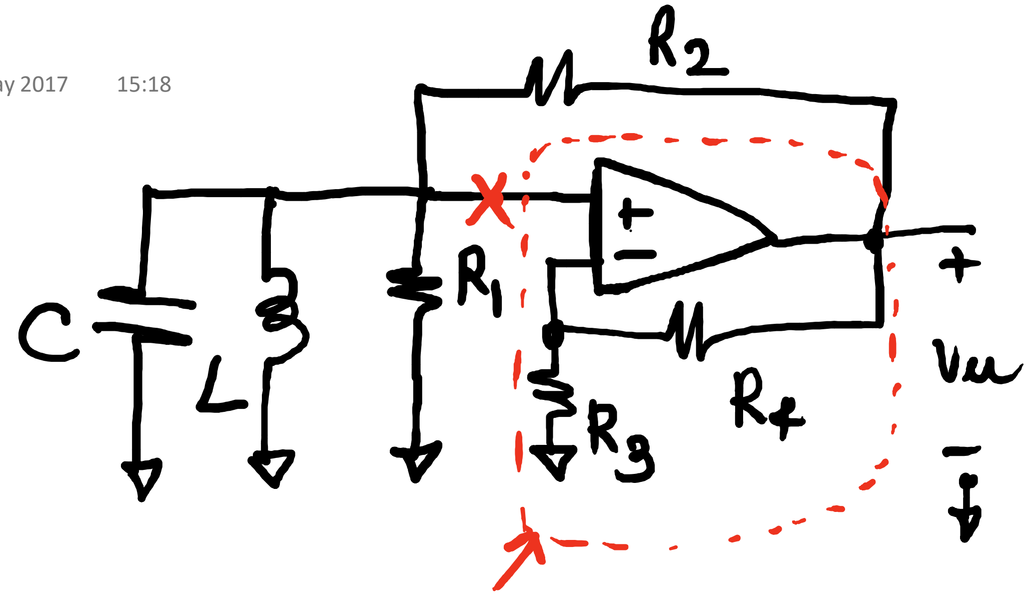


Amplificatore NON invertente

$R_1 = R_2 = 10\,k\Omega$

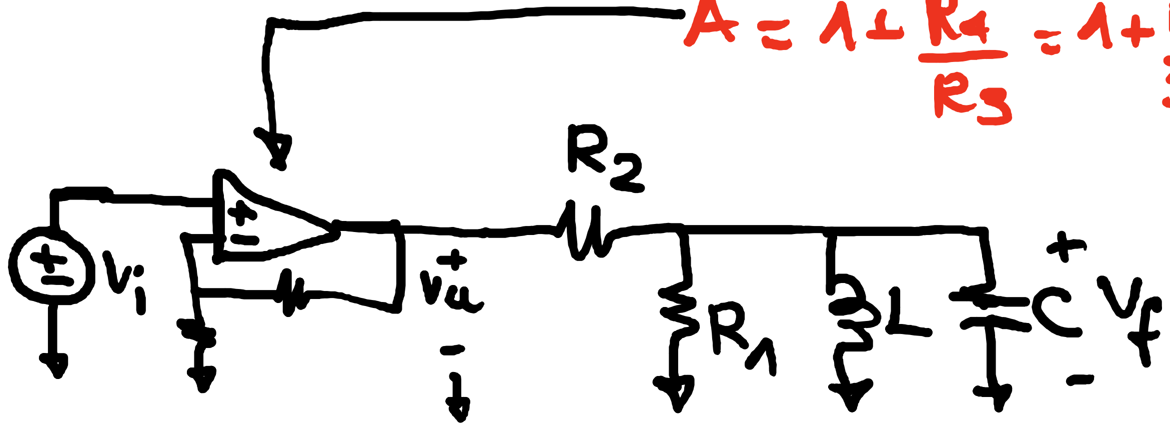
$R_3 = 3\,k\Omega$

$R_4 = 5\,k\Omega$

$L = 50\,\mu H$

$C = 4.7\,\mu F$

$$A = 1 + \frac{R_4}{R_3} = 1 + \frac{5}{3} = 2.67$$



$$\beta = \frac{V_f}{V_u} = \frac{R_1 /\!/ j\omega L /\!/ \frac{1}{j\omega C}}{R_2 + R_1 /\!/ j\omega L /\!/ \frac{1}{j\omega C}}$$

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$$R_1 /\!/ j\omega L /\!/ \frac{1}{j\omega C} = \left[\frac{1}{R_1} + \frac{1}{j\omega L} + j\omega C\right]^{-1} = \left[\frac{j\omega L + R_1 - R_1\omega^2 LC}{j\omega L R_1}\right]^{-1}$$

$$= \frac{j\omega L R_1}{R_1(1-\omega^2 LC) + j\omega L}$$

$$\beta A(j\omega) = A\,\frac{j\omega L R_1}{R_2\left[R_1(1-\omega^2 LC) + j\omega L\right] + j\omega L R_1} =$$

$$= \frac{A\, j\omega L R_1}{R_2 R_1(1-\omega^2 LC) + j\omega L(R_1+R_2)}$$

$$\angle \beta A(j\omega_0) = 0 \Rightarrow \omega_0 = \frac{1}{\sqrt{LC}}$$

$$\beta A(j\omega_0) = A\,\frac{R_1}{R_1+R_2} > 1$$

Devo verificare $|\beta A(j\omega_0)| > 1$

$$\left(1+\frac{R_4}{R_3}\right)\frac{R_1}{R_1+R_2} > 1$$

$$\left(1+\frac{5}{3}\right)\frac{10}{20} > 1$$

$$\frac{8}{3}\cdot\frac{10}{20} = \frac{4}{3} = 1.33 > 1 \quad \text{ok}$$

- L'oscillazione si innesca a frequenza $f_0 = \frac{1}{2\pi}\frac{1}{\sqrt{LC}} = \underline{\underline{10.4\ kHz}}$

ESERCIZIO CON SPICE

Tuesday, 9 May 2017 15:33

Realizzare un oscillatore a ponte di WIEN con frequenza di oscillazione 24 KHz e ampiezza picco-picco > 1V.

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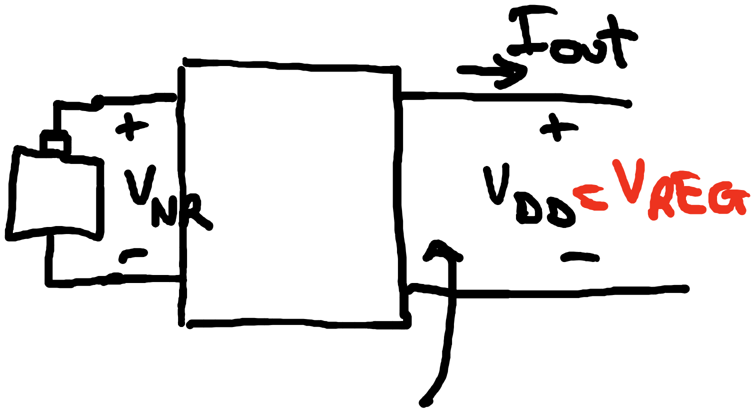
Regolatore di Tensione ← circuito di potenza



la tensione di uscita deve essere costante rispetto a variazioni

- DELLA TENSIONE DI INGRESSO
- DELLA TEMPERATURA
- DELLA CORRENTE DI USCITA

$$\Delta V_{REG} = \left[\frac{\partial V_{REG}}{\partial V_{NR}}\right]\Delta V_{NR} + \left[\frac{\partial V_{REG}}{\partial T}\right]\Delta T + \left[\frac{\partial V_{REG}}{\partial I_{out}}\right]\Delta I_{OUT}$$

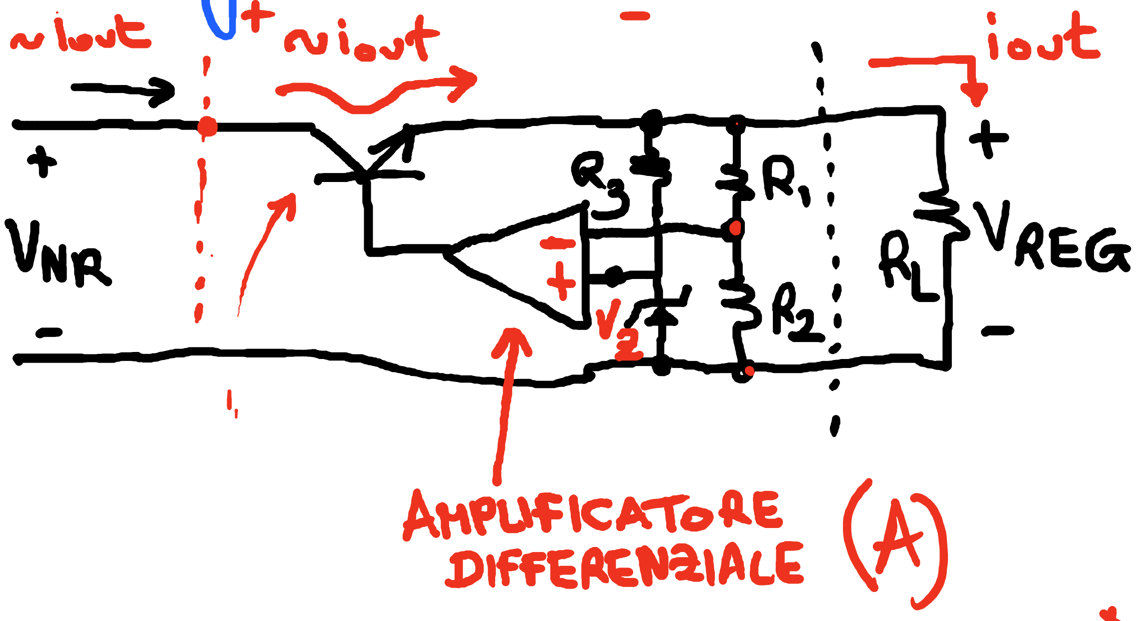
$\frac{\partial V_{REG}}{\partial V_{NR}} = S_V$ FATTORE DI REGOLAZIONE DI TENSIONE

$\frac{\partial V_{REG}}{\partial T} = S_T = TC$ COEFFICIENTE DI TEMPERATURA [V/°C]

$\frac{\partial V_{REG}}{\partial I_{out}} = R_{out}$ RESISTENZA DI USCITA

Regolatore di tensione LINEARE (serie)

Tuesday, 9 May 2017 15:54



se A ≫ 1 e l'amplificatore funziona in zona lineare → POSSIAMO APPLICARE L'APPROSSIMAZIONE DI C.C.V.

$$V_Z = V_{REG} \cdot \frac{R_2}{R_1+R_2}$$

$$\Rightarrow V_{REG} = V_Z \left(\frac{R_1+R_2}{R_1}\right)$$

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LA POTENZA DISSIPATA NEL TRANSISTORE DI PASSO

$$P_D \cong I_{out}\left[V_{NR} - V_{REG}\right]$$

POTENZA EROGATA IN USCITA: $P_{out} = V_{REG} I_{out}$

POTENZA EROGATA DAL GENERATORE NON REGOLATO:

$$P_{IN} = P_{NR} = V_{NR} I_{out}$$

$$P_{IN} \cong P_{out} + P_D$$

EFFICIENZA DI CONVERSIONE $\eta = \dfrac{P_{out}}{P_{IN}} \sim \dfrac{V_{REG}}{V_{NR}}$

PUÒ ESSERE PICCOLA

ES. $V_{REG} = 5\,V$

$V_{NR} = 12\,V$

$\eta = \frac{5}{12} \simeq 42\%$

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$$Z = jX = \frac{1}{j\omega C'} \parallel \left[\frac{-\omega^2 LC + 1}{j\omega C}\right] = \frac{1-\omega^2 LC}{(1-\omega^2 LC)\, j\omega C' + j\omega C} =$$

$$Z = jX = \frac{1}{j\omega (C+C')} \cdot \frac{1-\omega^2 LC}{1 - \frac{\omega^2 LCC'}{(C+C')}}$$

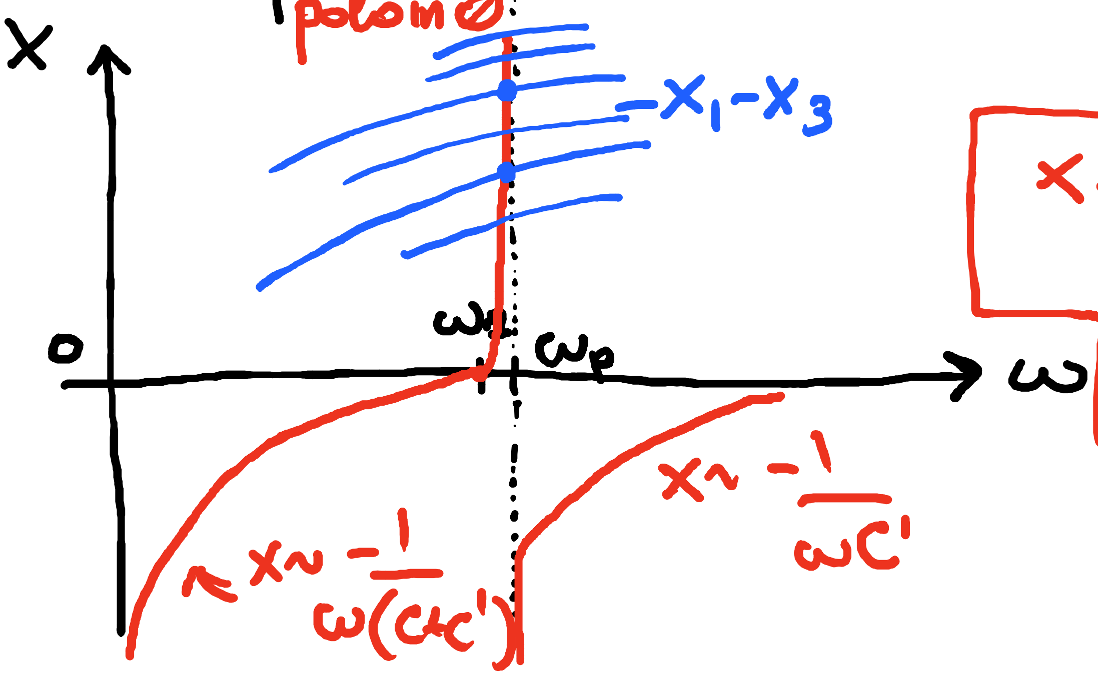
← due zeri immaginari $\omega_z = \frac{1}{\sqrt{LC}}$

↖ due poli immaginari

$$\omega_p = \sqrt{\frac{C+C'}{LCC'}} \gtrsim \omega_z$$

↑ perché $C' \gg C$

↑ polo in 0



X è positivo solo $\omega_z < \omega < \omega_p$

$$X_1 + X_2 + X_3 = 0$$

$$X = -X_1 - X_3$$