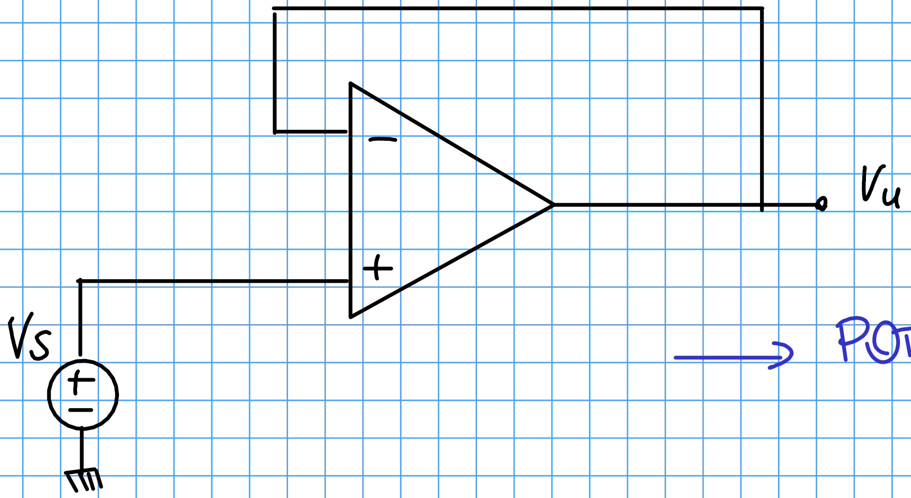
inizio carrellata di filtri

1 DIC

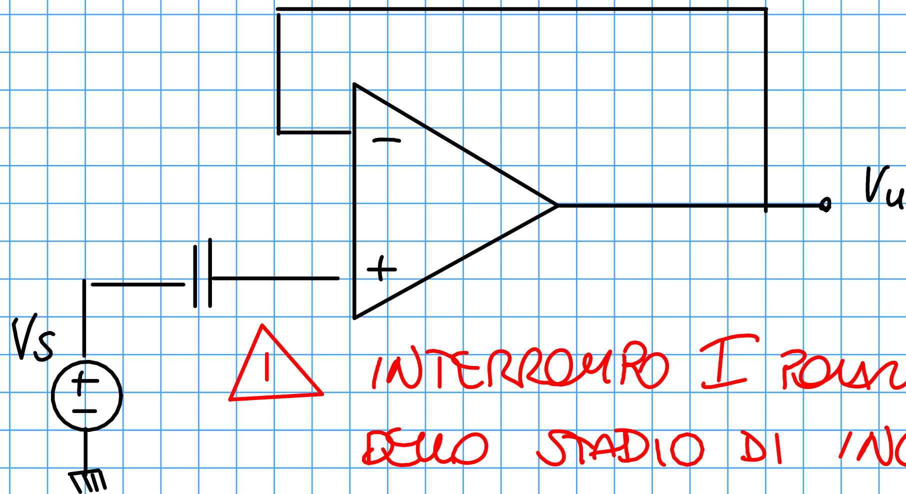
INSEGUITORE DI TENSIONE IN AC

→ FORNISCE IMPEDENZA INDUTTIVA SENZA UTILIZZARE INDUTTANZA (IN CAMPO AUDIO SONO INGOMBRANTI)



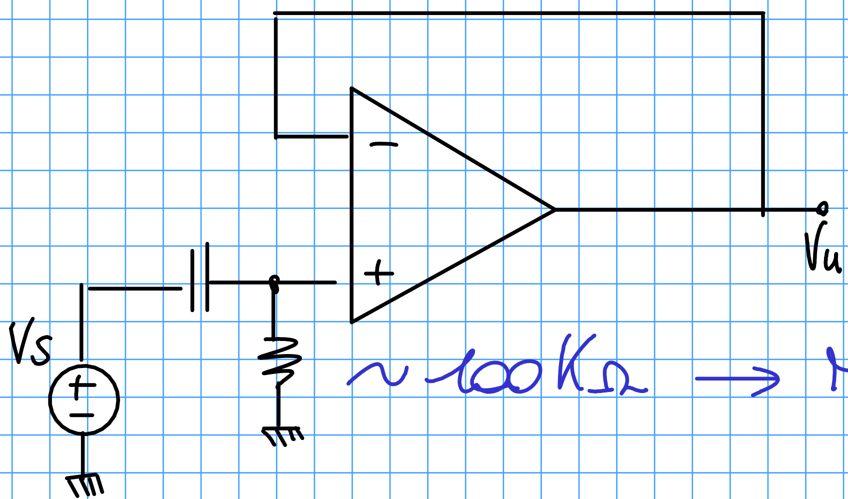
VOGLIO INSEGUIRE AC, MA COMPONENTE CONTINUA MANDA IN SATURAZIONE L'OPAMP

→ POTREI INSERIRE CAPACITÀ PER FILTRARE CONTINUA



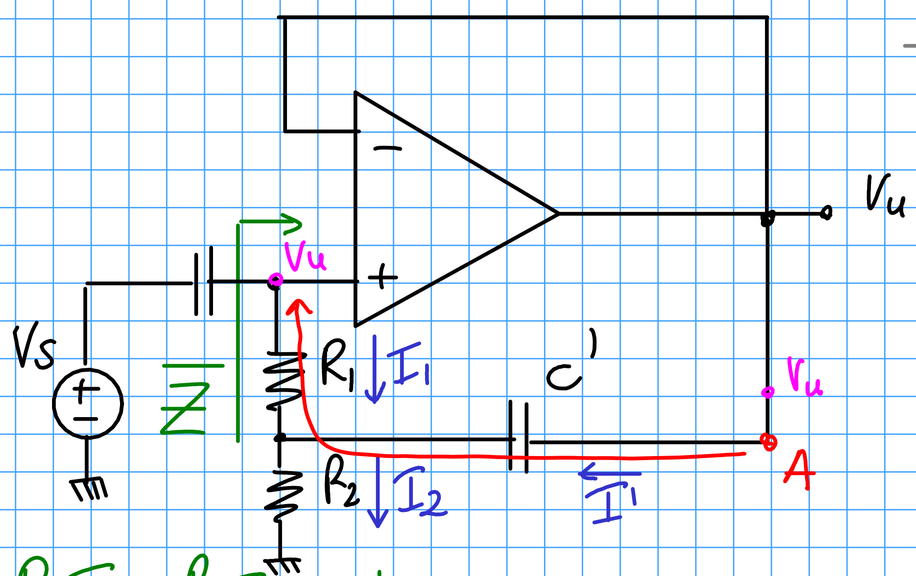
⚠ INTERROMPO I POLARIZZAZIONE DELLO STADIO DI INGRESSO

"APRO" VIA A I POLARIZZAZIONE



~ 100 KΩ → MA RIDUCO R_{IN} (IN CONTINUA ~ $R_{IS} = 400\,M\Omega$)

TECNICA BOOTSTRAP



→ IN CONTINUA TENSIONE SU R NULLA, DA V_s VEDO R_{IN} ELEVATA

→ IN FREQUENZA C' È UN CORTOCIRCUITO

$$v^+ = R_1 I_1 + R_2 I_2$$

$$I_2 = I_1 + I'$$

$$v^+ = R_1 I_1 + R_2 (I_1 + I')$$

NULLA PERCHÉ INSEGUITORE DI TENSIONE

DA A → $-I' j\omega C_1 + I_1 R_1 = \emptyset$

$$I_1 = \frac{j\omega C_1}{R_1} I'$$

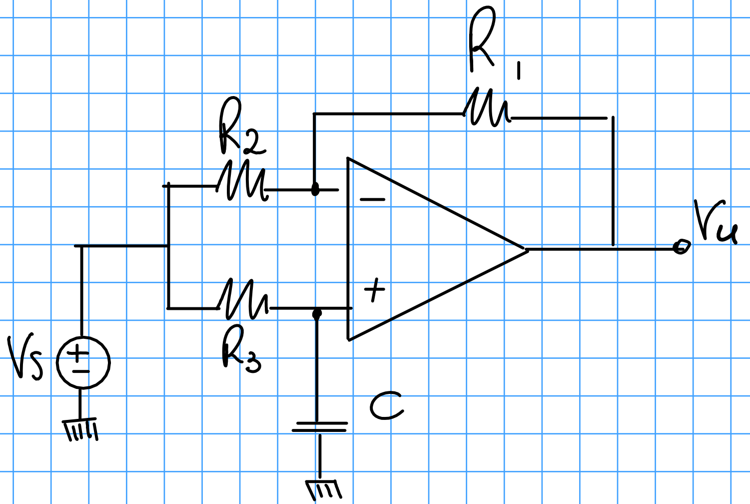
$$v^+ = (R_1 + R_2 + R_1 R_2 j\omega C') I_1$$

$$\bar{Z} = \frac{v^+}{I_1} = R_1 + R_2 + R_1 R_2 j\omega C' = R_1 + R_2 + j\omega L'$$

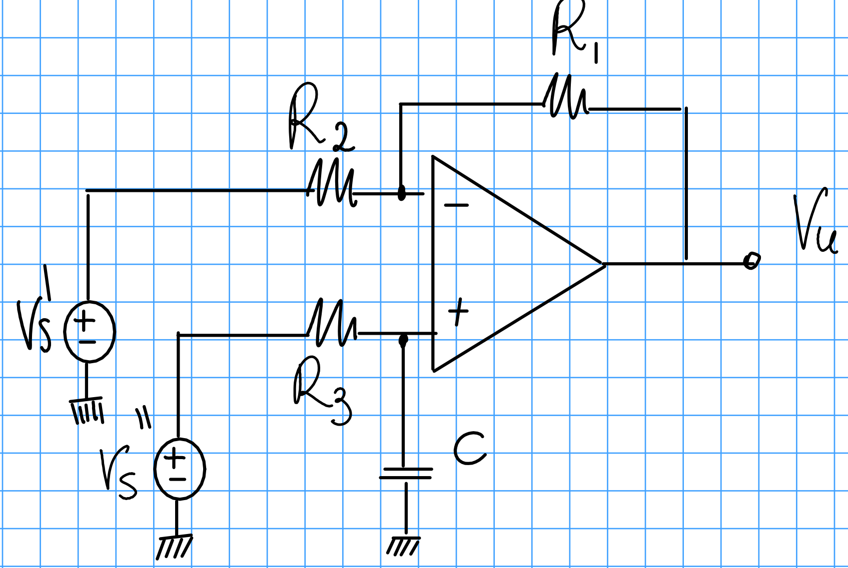
CON $L' = R_1 R_2 C'$

VEDO COMPONENTE INDUTTIVA SENZA INDUTTANZA

FILTRO PASSA TUTTO



separo ingressi per utilizzare sovrapp. degli effetti



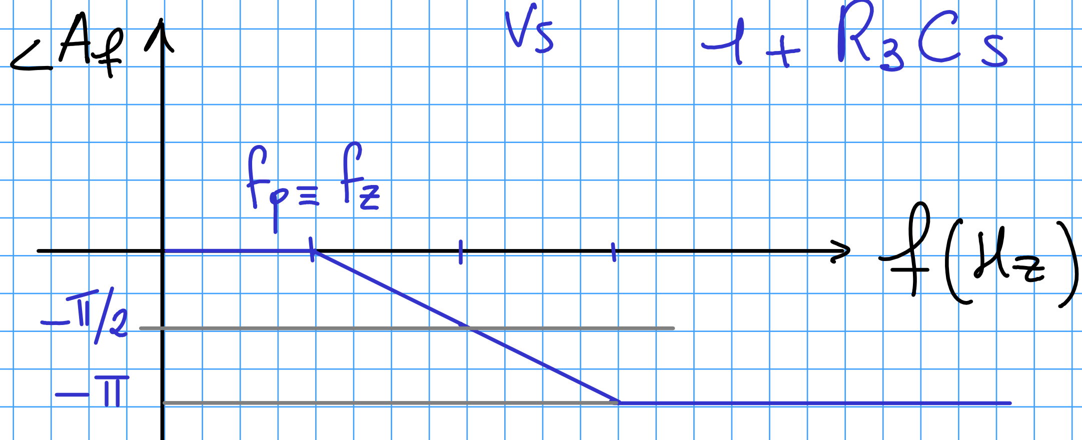
SOVRAPPOSIZIONE EFFETTI

1) $V_u' = -\dfrac{R_1}{R_2} V_s'$

2) $v^+ = \dfrac{1}{1+R_3Cs} V_s'' \longrightarrow V_u'' = \left(1+\dfrac{R_1}{R_2}\right)\dfrac{1}{1+R_3Cs}$

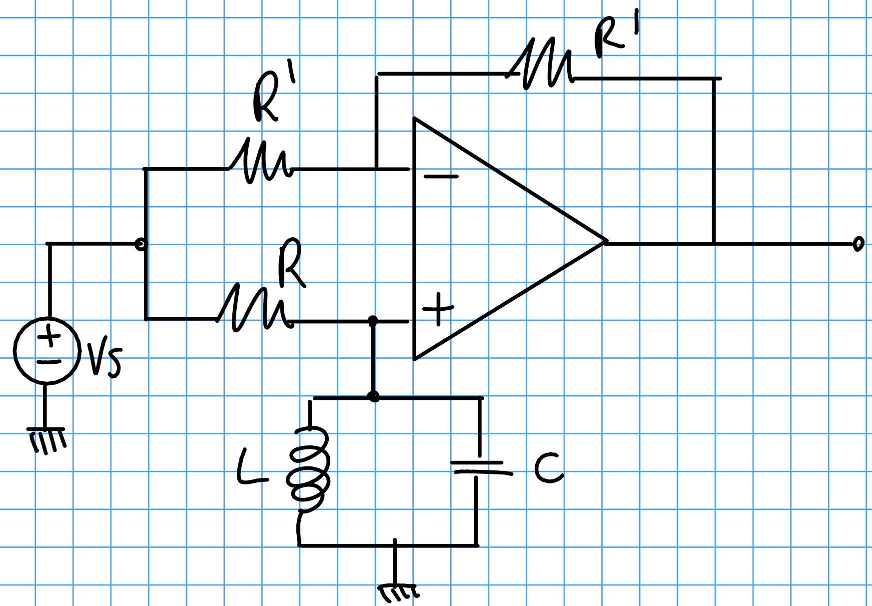
$$\boxed{\frac{V_u}{V_s} = \frac{1 - \frac{R_2}{R_1} R_3Cs}{1+R_3Cs}}$$

CON $R_1 = R_2 \longrightarrow \dfrac{V_u}{V_s} = \dfrac{1 - R_3Cs}{1+R_3Cs}$



FILTRO PASSA TUTTO 2° ORDINE

3 DIC



1) $\dfrac{V_u'}{V_s'} = -\dfrac{R'}{R'} = -1$

2) COME PRIMA, VARIA v^+

$$\frac{V_u''}{v^+} = 1 + \frac{R'}{R'} = 2$$

$$\frac{v^+}{V_s''} = \frac{\dfrac{Ls\,1/Cs}{Ls + 1/Cs}}{R + \dfrac{Ls\,1/Cs}{Ls + 1/Cs}} = \frac{Ls}{RLCs^2 + Ls + R} = \frac{L/R \cdot s}{LCs^2 + \dfrac{L}{R}s + 1}$$

$$= \frac{\dfrac{s}{Q\omega_0}}{\dfrac{s^2}{\omega_0^2} + \dfrac{s}{Q\omega_0} + 1}$$

CON:

$\omega_0 \triangleq \dfrac{1}{\sqrt{LC}}$

$Q \triangleq \dfrac{R}{L\omega_0}$

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$$\frac{V_u''}{V_s''} = \frac{v^+}{V_s''} \cdot \frac{V_u''}{v^+} = 2 \cdot \frac{\frac{s}{Q\omega_0}}{\frac{s^2}{\omega_0^2} + \frac{s}{Q\omega_0} + 1}$$

$$\frac{V_u}{V_s} = 2\,\frac{s/Q\omega_0}{\frac{s^2}{\omega_0^2} + \frac{s}{Q\omega_0} + 1} - 1 = \frac{\cancel{2}\,s/Q\omega_0 - s^2/\omega_0^2 - \cancel{s/Q\omega_0} - 1}{\frac{s^2}{\omega_0^2} + \frac{s}{Q\omega_0} + 1}$$

$$\boxed{\frac{V_u}{V_s} = -\,\frac{\frac{s^2}{\omega_0^2} - \frac{s}{Q\omega_0} + 1}{\frac{s^2}{\omega_0^2} + \frac{s}{Q\omega_0} + 1}}$$

$$s_{p_{1,2}} = \frac{-\frac{1}{Q\omega_0} \pm \sqrt{\frac{1}{Q^2\omega_0^2} - \frac{4}{\omega_0^2}}}{2/\omega_0^2}$$

$$s_{z_{1,2}} = \frac{\frac{1}{Q\omega_0} \pm \sqrt{\frac{1}{Q^2\omega_0^2} - \frac{4}{\omega_0^2}}}{2/\omega_0^2}$$

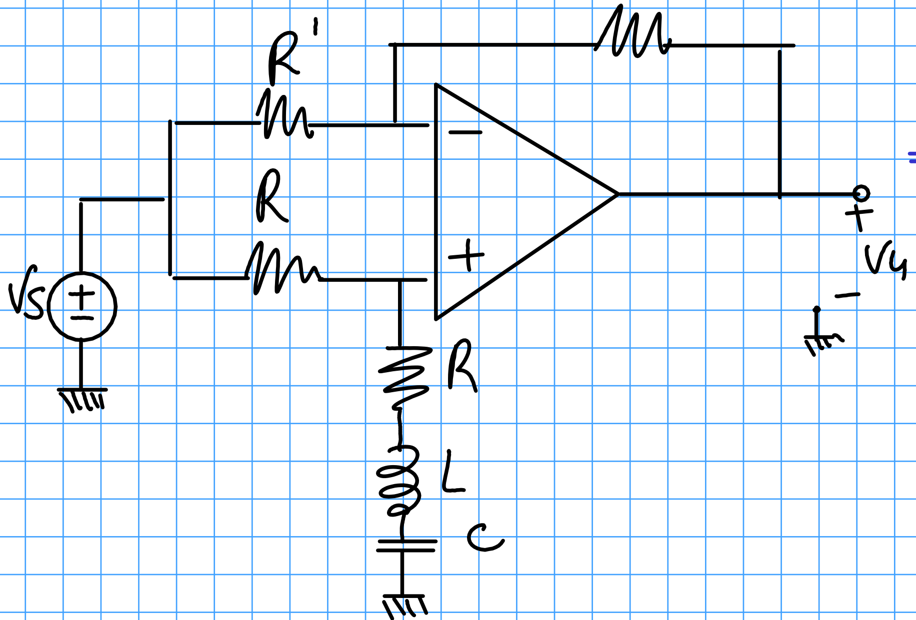
CON $\Delta < 0 \Longrightarrow$ MODULO AMPIEZZA COSTANTE (CONTRIBUTO POLI E ZERI COMPLESSI SI ANNULLANO)

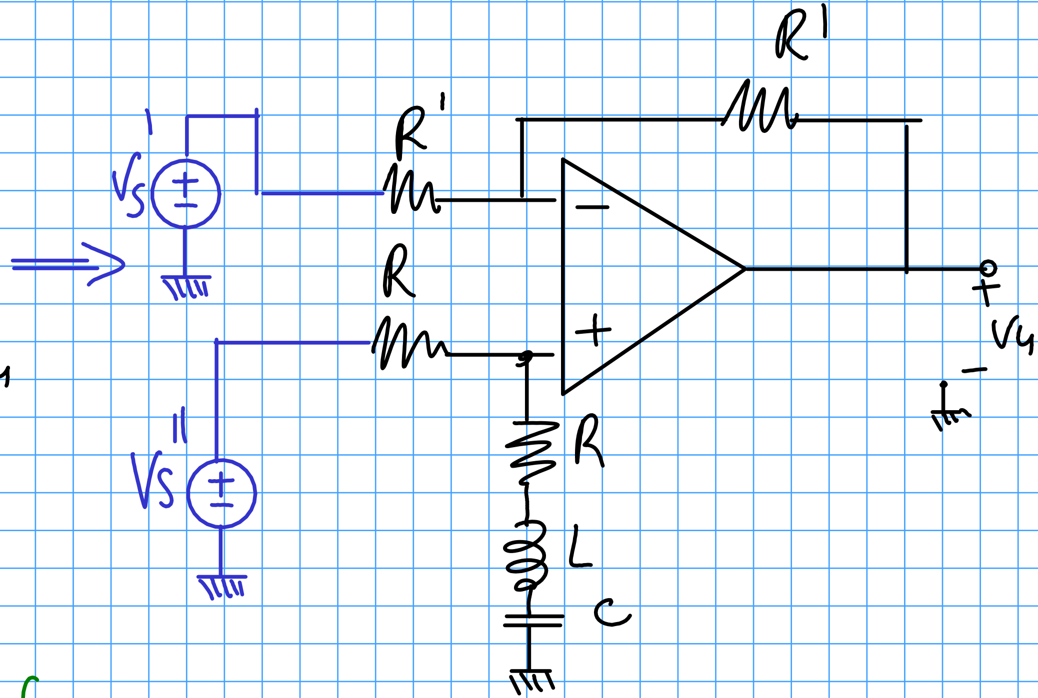
CON $\Delta \geq 0 \Longrightarrow$ POLI REALI DISTINTI, SITUAZIONE NON CI INTERESSA

$$\frac{1}{Q^2\cancel{\omega_0^2}} - \frac{4}{\cancel{\omega_0^2}} < 0 \longrightarrow \boxed{Q > 1/2}$$

POLI COMPLESSI CONIUGATI

FILTRO NOTCH





AVRÀ 2 POLI, 2 ZERI IMMAGINARI PURI (A ZERO CON ω REALE)

$$\begin{cases} \text{CONTANO DA } \omega_0 \longrightarrow \dfrac{V_s}{V_u} = 1 \\ \text{IN } \omega = \omega_0 \longrightarrow \dfrac{V_s}{V_u} = \emptyset \end{cases}$$

$$\frac{V_u'}{V_s'} = 1$$

$$\frac{v^+}{V_s''} = \frac{R + Ls + 1/Cs}{2R + Ls + 1/Cs} = \frac{RCs + LCs^2}{2RCs + LCs^2 + 1}$$

$$RC \triangleq \frac{1}{2}\,\frac{1}{\omega_0 Q}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$\frac{v^+}{V_S''} = \frac{\frac{s^2}{\omega_0^2} + \frac{s}{2Q\omega_0} + 1}{\frac{s^2}{\omega_0^2} + \frac{s}{\omega_0 Q} + 1}$$

$$\frac{V_u''}{V_S''} = 2\,\frac{\frac{s^2}{\omega_0^2} + \frac{s}{2Q\omega_0} + 1}{\frac{s^2}{\omega_0^2} + \frac{s}{\omega_0 Q} + 1}$$

MOLTIPLICO PER GUADAGNO OPERAZIONALE NON INVERTENTE

UNISCO CALCOLI:

$$\frac{V_u}{V_S} = 2\,\frac{\frac{s^2}{\omega_0^2} + \frac{s}{2Q\omega_0} + 1}{\frac{s^2}{\omega_0^2} + \frac{s}{\omega_0 Q} + 1} - 1 = \frac{\cancel{2}\frac{s^2}{\omega_0^2} + \cancel{\frac{s}{Q\omega_0}} + 2 - \cancel{\frac{s^2}{\omega_0^2}} - \cancel{\frac{s}{\omega_0 Q}} - 1}{\frac{s^2}{\omega_0^2} + \frac{s}{\omega_0 Q} + 1}$$

$$\boxed{\frac{V_u}{V_S} = \frac{\frac{s^2}{\omega_0^2} + 1}{\frac{s^2}{\omega_0^2} + \frac{s}{\omega_0 Q} + 1}}$$

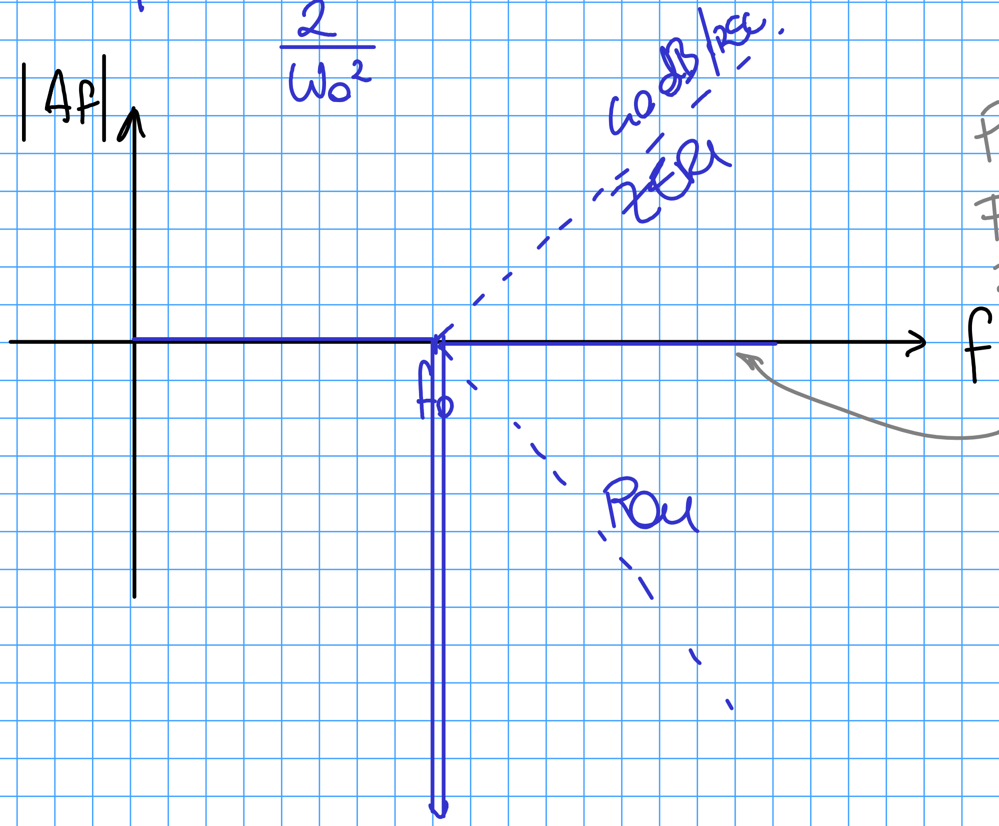
$$s_{p_{1,2}} = \frac{-\frac{1}{Q\omega_0} \pm \sqrt{\frac{1}{Q^2\omega_0^2} - \frac{4}{\omega_0^2}}}{2/\omega_0^2}$$

CON $Q > 1/2$, $\Delta < 0$, POLI COMPLESSI CONIUGATI

CALCOLO MODULO QUADRO NUMERATORE

$$\cancel{\frac{1}{Q^2\omega_0^2}} + \frac{4}{\omega_0^2} - \cancel{\frac{1}{\omega_0^2 Q^2}} = N \cdot \bar{N} = |N|^2 \longrightarrow$$

$$|S_p| = \frac{\frac{2}{\omega_0}}{\frac{2}{\omega_0^2}} = \omega_0$$

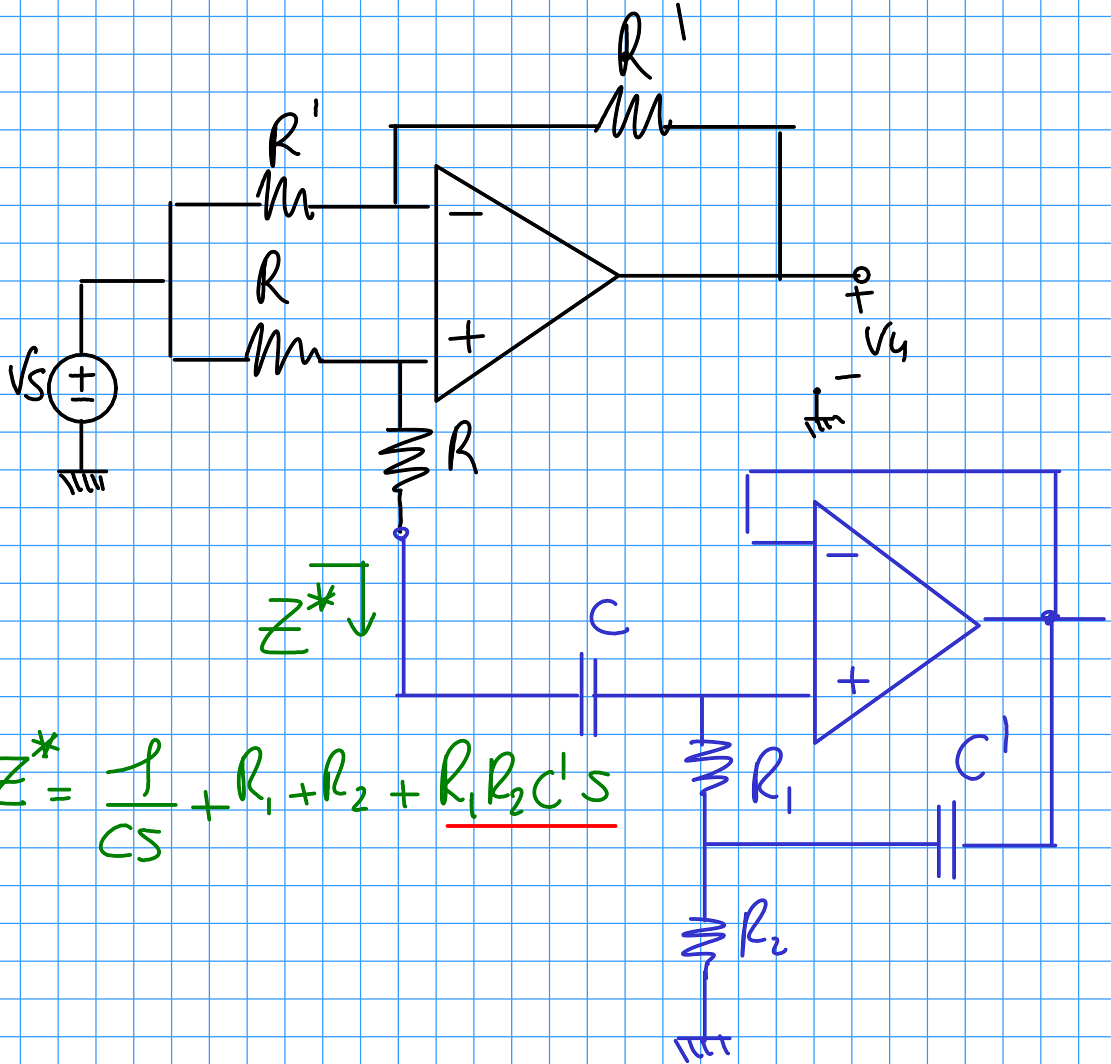


PRESENTA ZERI IMMAGINARI PURI MI FORNISCE PICCO DI RISONANZA VERSO $-\infty$

POLI SOLITO CONTRIBUTO POLI STABILITÀ

A ZERO dB IL MODULO

POSSO SOSTITUIRE L ? ⟶ INSEGUITORE IN AC



$$Z^* = \frac{1}{Cs} + R_1 + R_2 + R_1 R_2 C' s$$