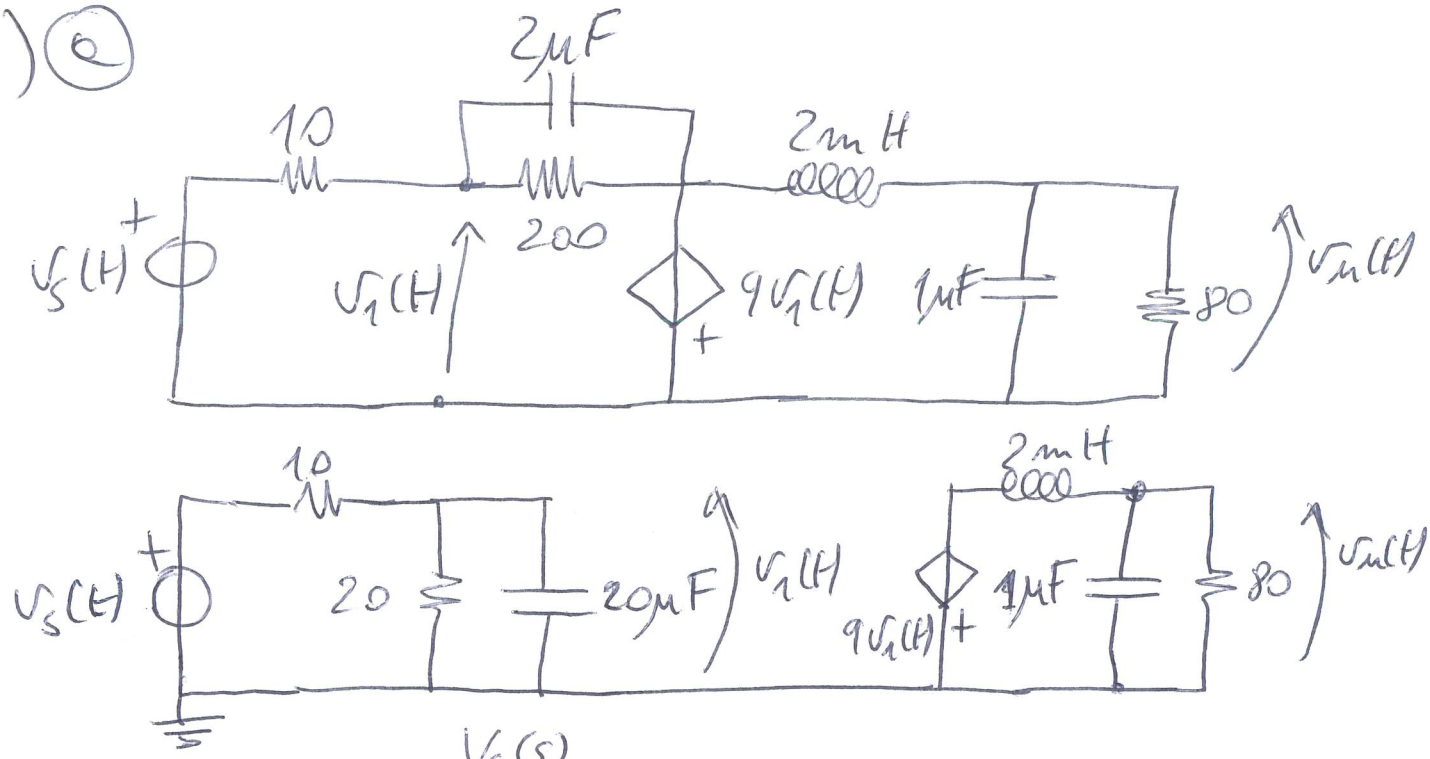
FUNZIONI DI RETE

1) (a)



$$V_1(s) = \frac{\frac{V_s(s)}{10}}{\frac{1}{10} + \frac{1}{20} + sC_1} = \frac{2}{3}\,\frac{V_s(s)}{1 + sC_1\frac{20}{3}}$$

$$V_u(s) = \frac{\frac{-9V_1(s)}{sL}}{\frac{1}{sL} + \frac{1}{80} + sC_2} =$$

$$= \frac{-9V_1(s)\cdot 80}{80 + sL + s^2 80C_2L} =$$

$$V_u(s) = \frac{-9\,V_1(s)}{1 + s\frac{L}{80} + s^2LC_2}$$

$$H(s) = \frac{V_u(s)}{V_s(s)} = \frac{V_u(s)}{V_1(s)} \cdot \frac{V_1(s)}{V_s(s)}$$

FUNZIONI DI RETE

1) (e)

$$H(s) = -9\,\frac{2}{3}\,\frac{1}{1+sC_1\frac{20}{3}}\,\frac{1}{1+s\frac{L}{80}+s^2L_2C}$$

$$H(s) = -6\,\frac{1}{1+s\,\frac{4}{3}10^{-4}}\,\frac{1}{1+s\,\frac{10^{-4}}{4}+s^2\,2\times10^{-9}}$$

$H(0) = -6$

$\lim_{|s|\to+\infty} |H(s)| = 0$

$\begin{cases} n = 3 \\ m = 0 \end{cases}$

$\begin{cases} 3 \text{ ZERI } \infty \\ p_1 = -7500 \\ p_{1,2} = -6250 \pm j\,1250\sqrt{295} \end{cases}$

$\begin{cases} \omega_0^2 = 5\times10^8 \\ \omega_0 q = 4\times10^4 \end{cases}$ $\quad \omega_0 = \sqrt{5}\times10^4$ rad/s

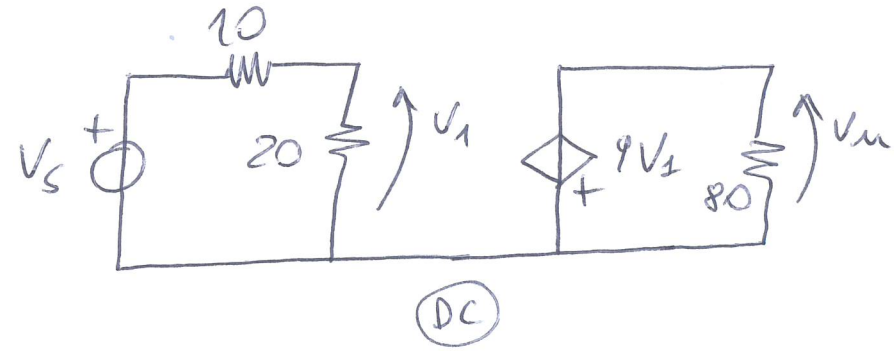
$q = \frac{4\times10^4}{\sqrt{5}\times10^4} = \frac{4}{\sqrt{5}} = 1.79$

CIRCUITO STABILE

$$H(j\omega) = -6\,\frac{1}{1+j\omega\,\frac{4}{3}\times10^{-4}}\,\frac{1}{1+j\omega\,\frac{10^{-4}}{4}+(j\omega)^2\,2\times10^{-9}}$$

$\lim_{\omega\to\infty} |H(j\omega)| = 0$

$|H(j0)| = -6$



(DC)

FUNZIONI DI RETE

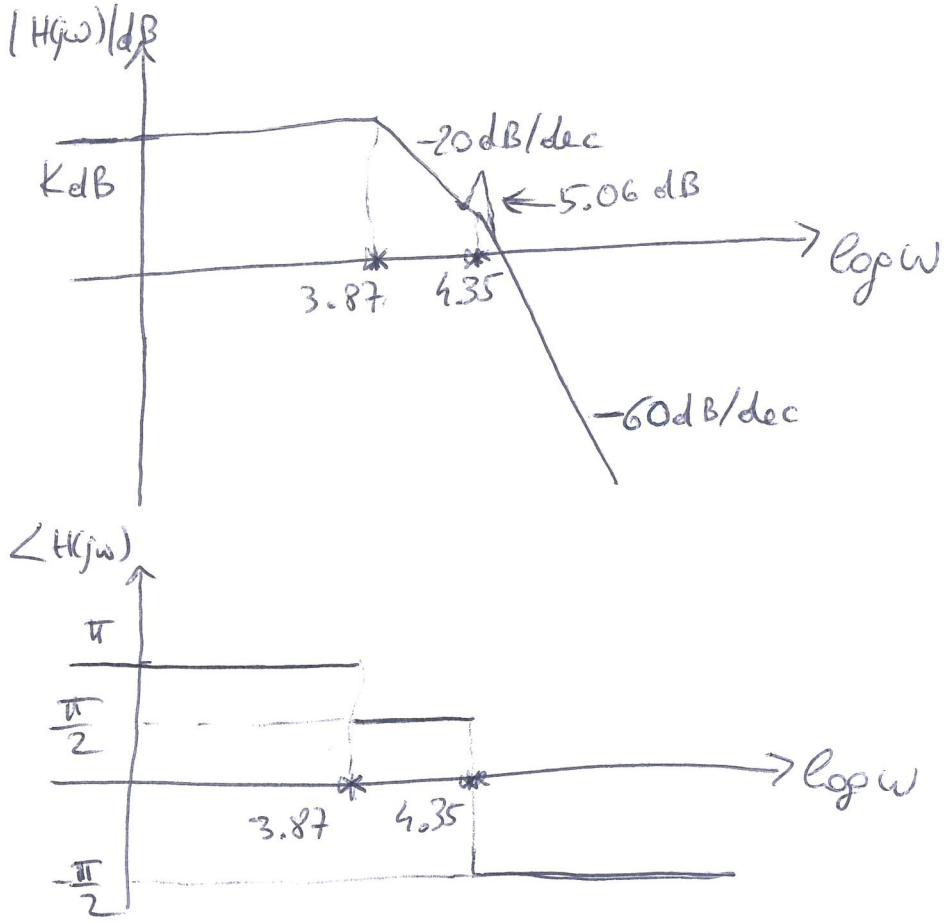
1) (c)

DIAGRAMMI DI BODE

$K_{dB} = 20 \log 6 = 15.56\ dB$

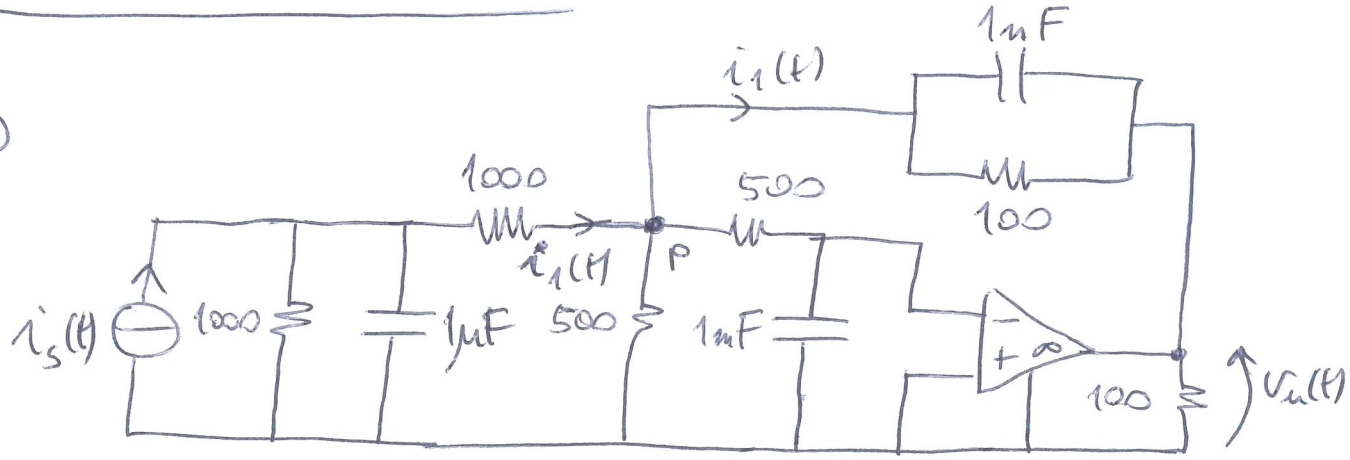
$\log |p_1| = 3.87$

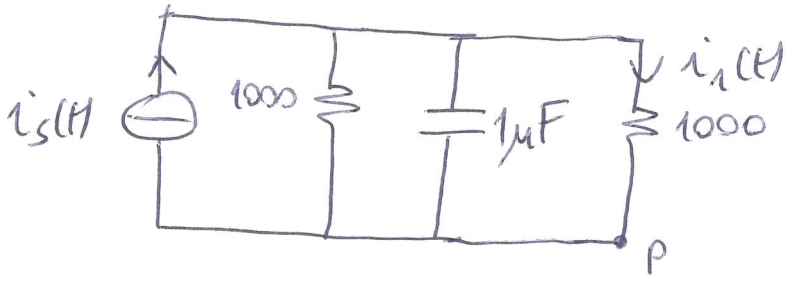
$\log \omega_0 = 4.35 \quad 20 \log q = 5.06\ dB$



FUNZIONI DI RETE

2) (a)





$V_p = 0$ V

(MASSA VIRTUALE)

$$I_1(s) = \frac{\frac{1}{1000}}{\frac{1}{1000} + sC_1 + \frac{1}{1000}} I_s(s) =$$

$$= \frac{1}{2 + sC_1 1000} I_s(s) = \frac{1}{2} \frac{1}{1 + sC_1 500} I_s(s)$$

$$V_u(s) = -I_1(s)\, Z_p(s)$$

$$Z_p(s) = \frac{100}{1 + sC_2 100}$$

$$H(s) = \frac{V_u(s)}{I_s(s)} = \frac{V_u(s)}{I_1(s)} \cdot \frac{I_1(s)}{I_s(s)} = -50 \frac{1}{1 + sC_1 500} \frac{1}{1 + sC_2 100}$$

$$H(s) = -50 \frac{1}{1 + s5 \times 10^{-4}} \frac{1}{1 + s10^{-7}}$$

$(n = 2, m = 0)$

FUNZIONI DI RETE

2) (f) $H(0) = -50$

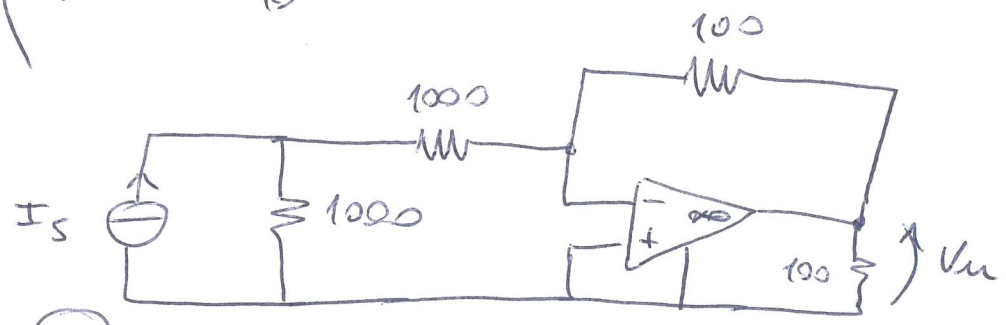
$\lim_{|s| \to \infty} |H(s)| = 0$

2 POLI, 2 ZERI ∞

$p_1 = -\frac{1}{5} 10^4 = -2000$

$p_2 = -\frac{1}{10^{-7}} = -10^7$

CIRCUITO STABILE



(DC)

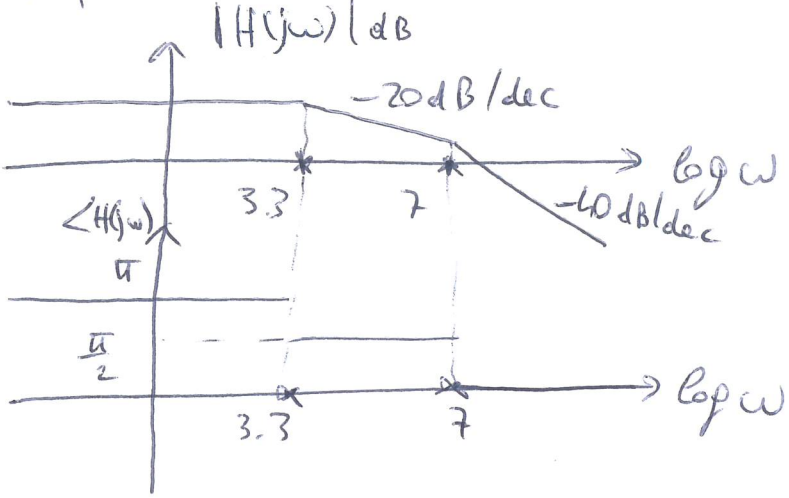
$$\frac{V_u}{1000\, I_S} = \frac{-100}{2000} \Rightarrow \frac{V_u}{I_S} = -50$$

$$H(j\omega) = -50 \; \frac{1}{1 + j\omega\, 5 \times 10^{-4}} \; \frac{1}{1 + j\omega\, 10^{-7}}$$

$20 \log|K| = K_{dB} = 33.98\ dB$

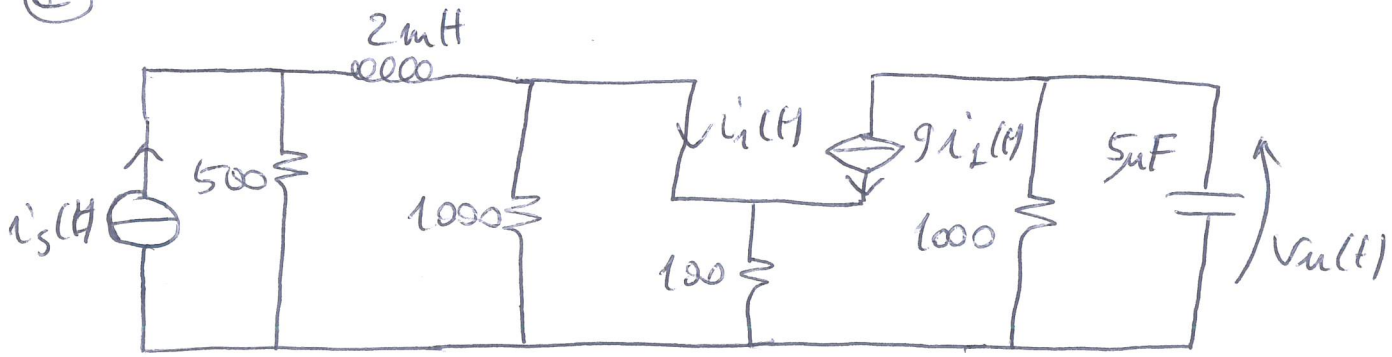
$\log|p_1| = 3.3$

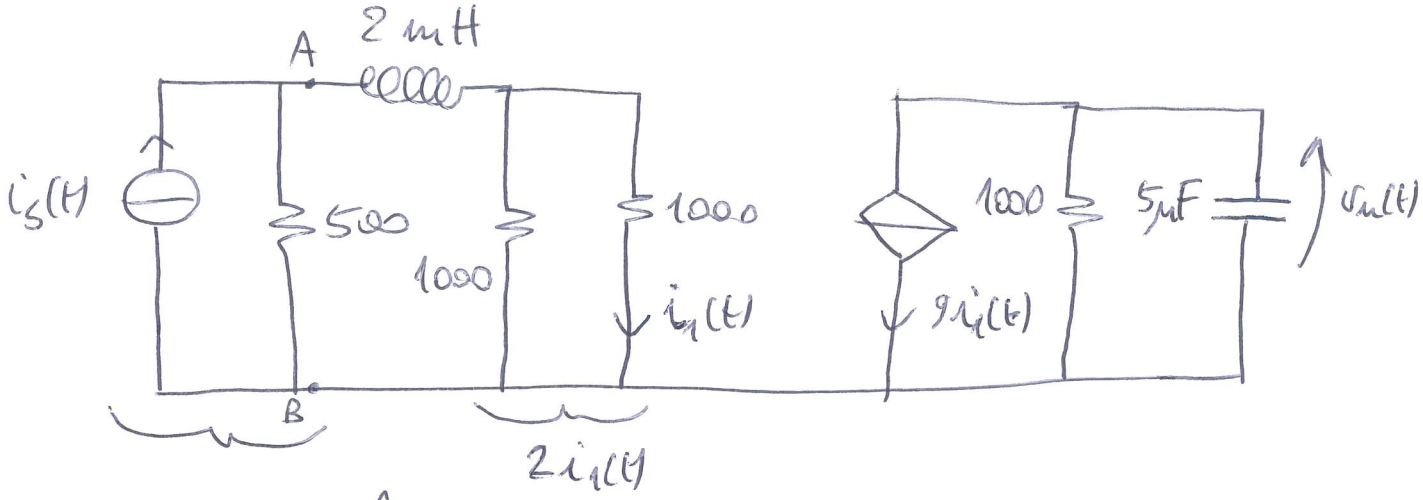
$\log|p_2| = 7$

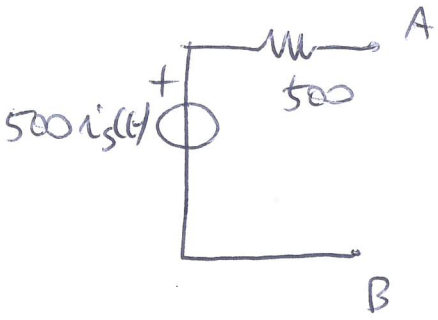


FUNZIONI DI RETE

4) (e)







$$I_1(S) = \frac{1}{2} \cdot \frac{500 I_S(S)}{1000 + SL} =$$

$$= \frac{1}{4} \frac{1}{1 + SL/1000} I_S(S)$$

$$V_u(S) = - \frac{1000}{1 + SC1000} g I_1(S)$$

$$H(S) = \frac{V_u(S)}{I_S(S)} = -2250 \frac{1}{(1 + SL/1000)(1 + SC1000)}$$

$$H(S) = -2250 \frac{1}{(1 + S2 \cdot 10^{-6})(1 + S\,5 \times 10^{-3})}$$

$(n = 2, m = 0)$

FUNZIONI DI RETE

4) (E)

$$H(0) = -2250$$

$$\lim_{|s| \to \infty} |H(s)| = 0$$

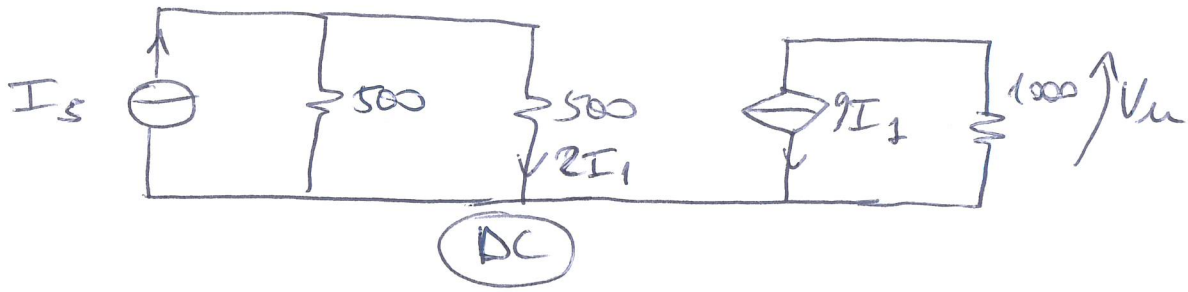
2 ZERI ∞

$$p_1 = -\frac{1}{5\times10^{-3}} = -200$$

$$p_2 = -\frac{1}{2\times10^{-6}} = -5\times10^{5}$$

CIRCUITO STABILE

$$H(j\omega) = -2250 \frac{1}{1+j\omega\, 2\times10^{-6}} \frac{1}{1+j\omega\, 5\times10^{-3}}$$



$$I_1 = \frac{I_s}{4} \qquad V_u = -9I_1 \times 1000 = -2250\, I_s$$

$$\lim_{\omega \to \infty} |H(j\omega)| = 0$$

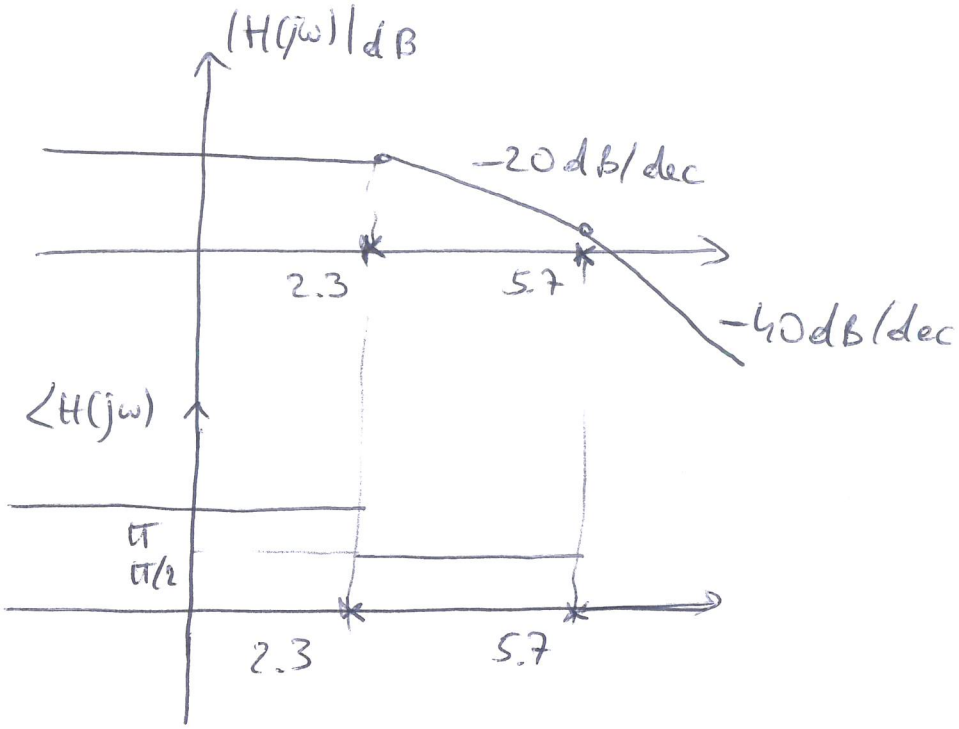
$$20 \log |K| = 67\ dB$$

$$\log |p_1| = 2.3$$

$$\log |p_2| = 5.7$$

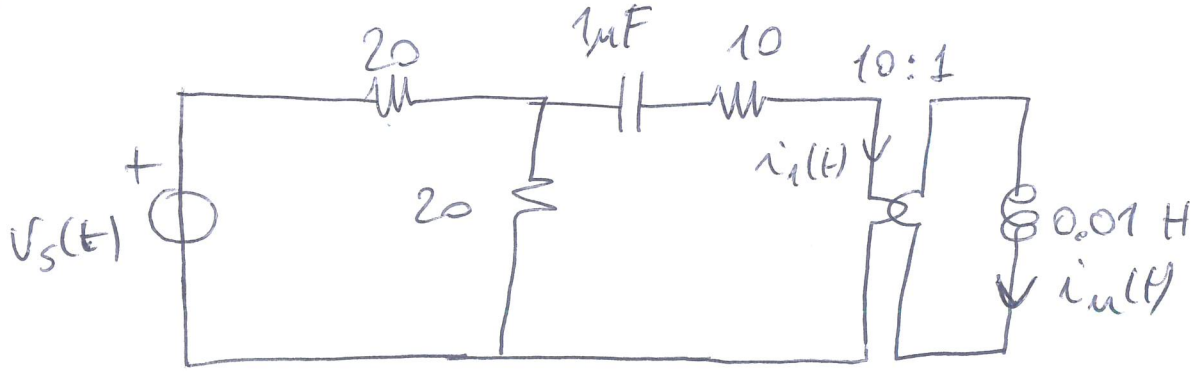
FUNZIONI DI RETE

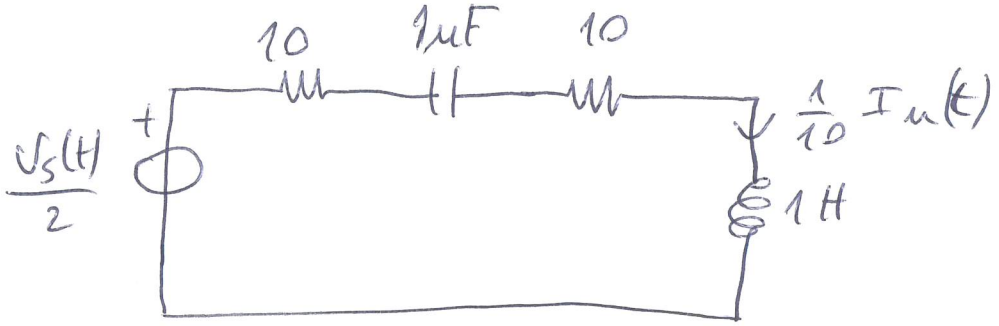
4) (C)



FUNZIONI DI RETE

6) (a)





$$Z_1 = n^2 Z_L = n^2 sL = s$$

$$\begin{cases} v_1(t) = n v_2(t) \\ i_1(t) = -\frac{1}{n} i_2(t) = \frac{1}{n} i_m(t) \end{cases}$$

$$\frac{1}{10} I_m(s) = \frac{\frac{V_s(s)}{2}}{20 + \frac{1}{sc} + sL} = \frac{1}{2} \frac{sc}{1 + 20sc + s^2 LC} V_s(s)$$

$$H(s) = \frac{I_m(s)}{V_s(s)} = 5c \frac{s}{1 + 20sc + s^2 LC}$$

$$H(s) = 5 \times 10^{-6} \frac{s}{1 + s \times 2 \times 10^{-5} + s^2 10^{-6}}$$

$(n = 2, m = 1)$

FUNZIONI DI RETE

6) (F)

$H(0) = 0$

$\lim_{|s| \to \infty} |H(s)| = 0$

1 ZERO ORIGINE

1 ZERO ∞

CIRCUITO STABILE

$p_2 = -10 \pm 1000j$

$\omega_0^2 = 10^6 \qquad \omega_0 = 1000 \text{ rad/s}$

$q\omega_0 = \frac{1}{2 \times 10^{-5}} \qquad q = \frac{10^5}{2} \frac{1}{1000} = 50$

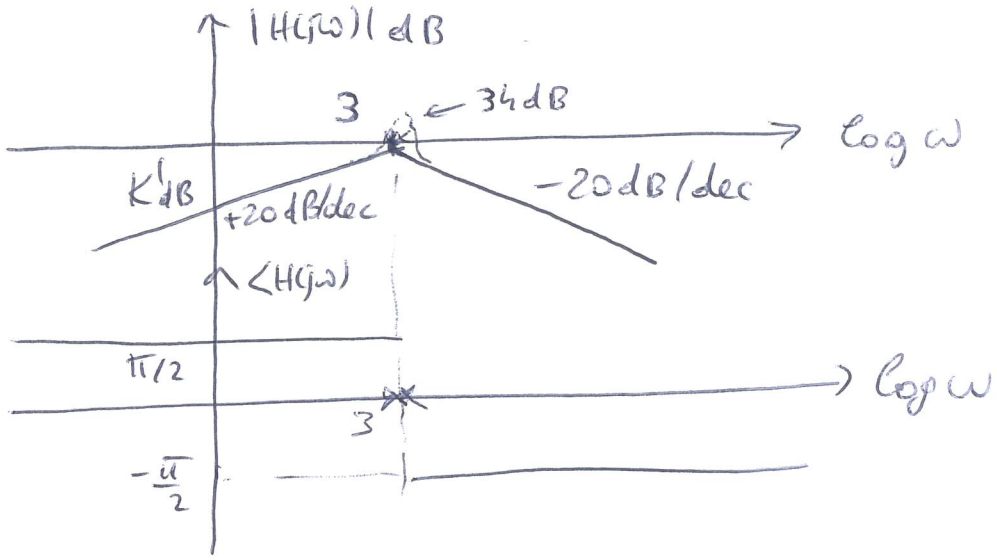
$$H(j\omega) = 5 \times 10^{-6} \frac{j\omega}{1 + j\omega 2 \times 10^{-5} + (j\omega)^2 10^{-6}}$$

$H(j0) = 0 \qquad \lim_{\omega \to \infty} |H(j\omega)| = 0$

$20 \log K' = K'_{dB} = -106 \text{ dB}$

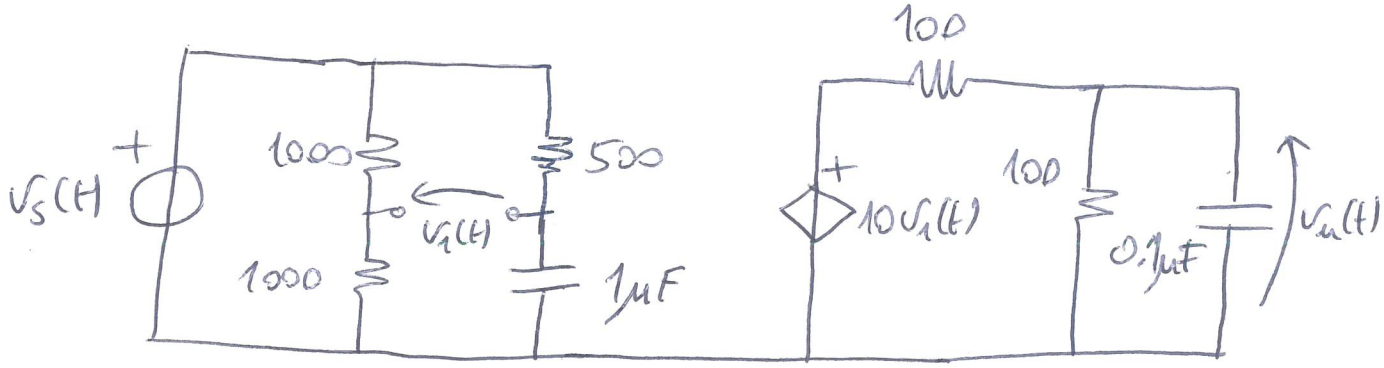
$\log \omega_0 = 3$

$20 \log q = 34 \text{ dB}$



FUNZIONI DI RETE

7) (a)



$$V_1(s) = \frac{1000}{1000+1000} V_s(s) - \frac{\frac{1}{sC_1}}{\frac{1}{sC_1} + 500} V_s(s)$$

$$\frac{V_1(s)}{V_s(s)} = -\frac{1}{2} \frac{1 - sC_1 500}{1 + sC_1 500} = -\frac{1}{2} \frac{1 - s\,5\times10^{-4}}{1 + s\,5\times10^{-4}}$$

$$V_u(s) = \frac{\frac{10V_1(s)}{100}}{\frac{1}{100} + \frac{1}{100} + sC_2} = \frac{5V_1(s)}{1 + s\,C_2\,50} =$$

$$= \frac{5V_1(s)}{1 + s\,5\times10^{-6}}$$

$$H(s) = \frac{V_u(s)}{V_s(s)} = -\frac{5}{2} \frac{1 - s\,5\times10^{-4}}{1 + s\,5\times10^{-4}} \frac{1}{1 + s\,5\times10^{-6}}$$

$$(M = 2\,,\ m = 1)$$

$$\lim_{|s|\to\infty} |H(s)| = 0 \qquad H(0) = -\frac{5}{2}$$

FUNZIONI DI RETE

7) (B)

1 ZERO ∞

$z_1 = \frac{1}{5\times10^{-4}} = 2000$

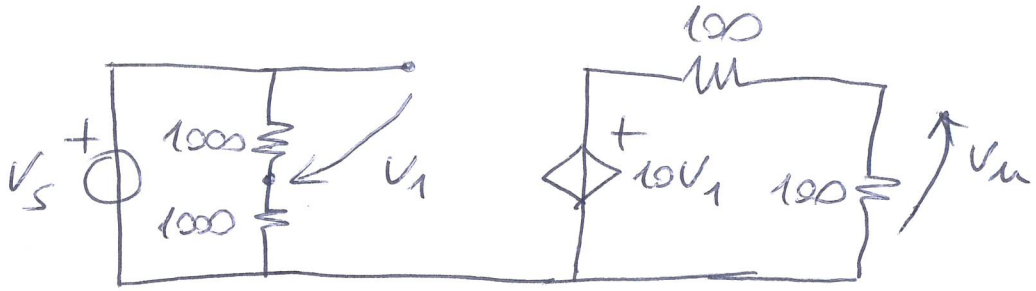
$p_1 = -\frac{1}{5\times10^{-4}} = -2000$

$p_2 = -\frac{1}{5\times10^{-6}} = -2\times10^5$

CIRCUITO STABILE

$$H(j\omega) = -\frac{5}{2}\,\frac{1-j\omega\,5\times10^{-4}}{1+j\omega\,5\times10^{-4}}\,\frac{1}{1+j\omega\,5\times10^{-6}}$$

$$|H(j0)| = -\frac{5}{2} \qquad \lim_{\omega\to\infty} |H(\omega)| = 0$$



$$V_1 = -\frac{1}{2}V_s \qquad V_u = \frac{10V_1}{2} = -\frac{5}{2}V_s$$

$K_{dB} = 20\log|K| = 7.96\ dB$

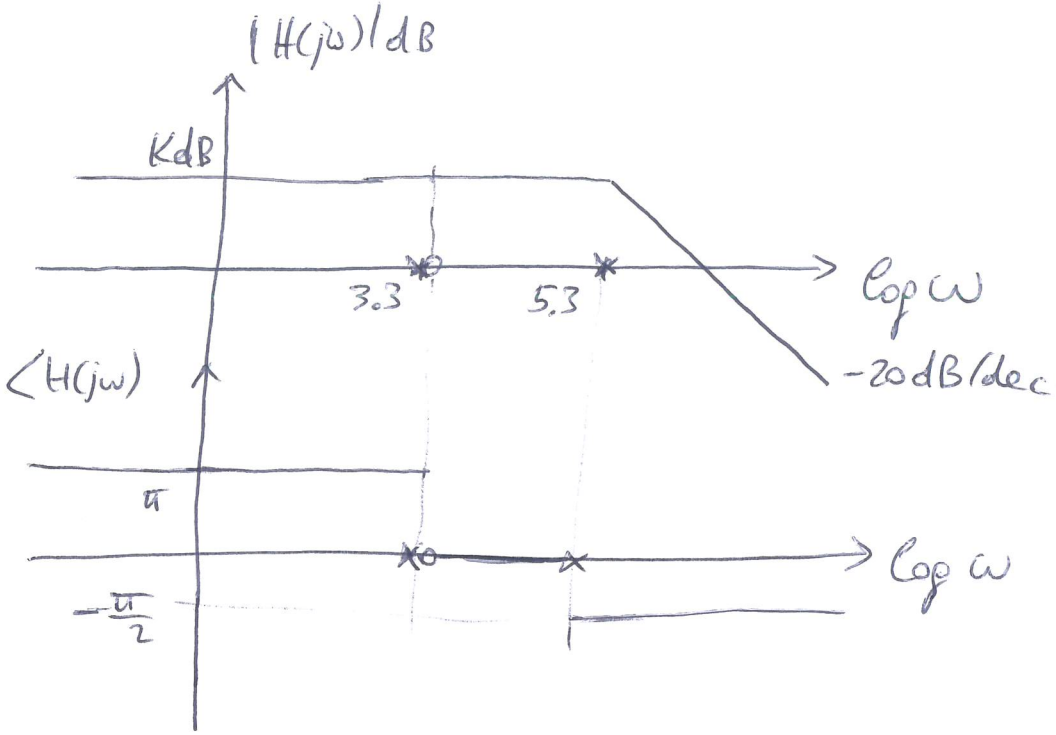
$\log z_1 = 3.3$

$\log|p_1| = 3.3$

$\log|p_2| = 5.3$

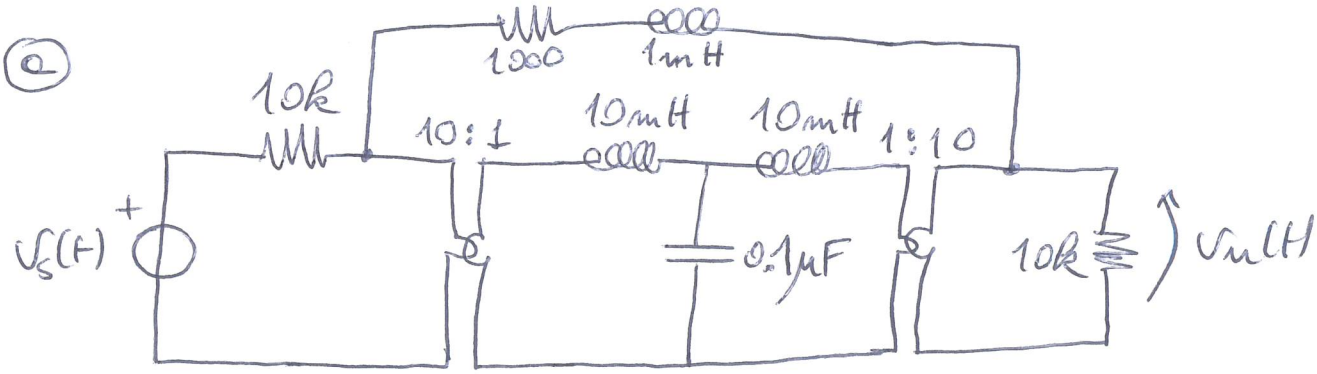
FUNZIONI DI RETE

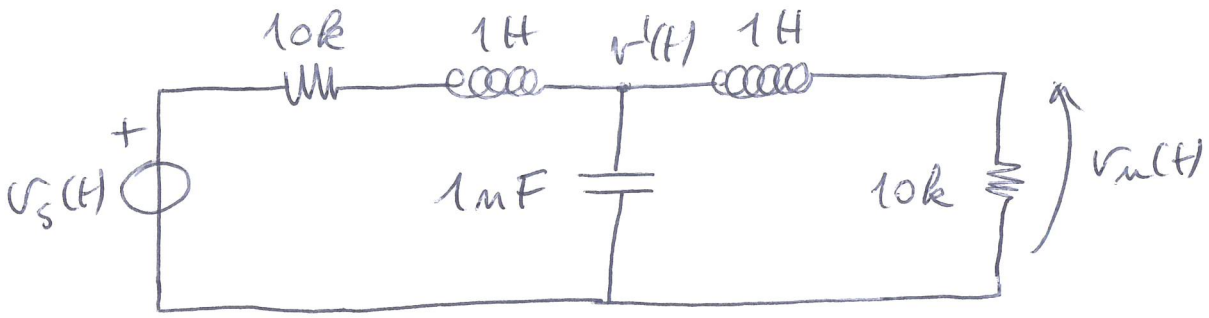
7) (C)



FUNZIONI DI RETE

9) (a)





$$V'(s) = \frac{\frac{V_s(s)}{10^4+s}}{\frac{1}{10^4+s} + sC + \frac{1}{10^4+s}} =$$

$$= \frac{V_s(s)}{2 + sC(10^4+s)} =$$

$$= \frac{V_s(s)}{2 + s10^{-5} + s^2 10^{-9}}$$

$$V_u(s) = \frac{10^4}{10^4+s} V'(s) = \frac{1}{1+s/10^4} V'(s)$$

$$H(s) = \frac{V_u(s)}{V_s(s)} = \frac{1}{2} \frac{1}{1+s10^{-4}} \frac{1}{1 + s\,0.5\times10^{-5} + s^2 0.5\,10^{-9}}$$

$(n=3, m=0)$

$$\begin{cases} H(0) = \frac{1}{2} \\ \lim_{|s|\to\infty} |H(s)| = 0 \end{cases}$$

FUNZIONI DI RETE

9) (e)

3 ZERI ∞

$p_1 = -10^4$

$p_{2,3} = -5000 \pm j\,44441$

CIRCUITO STABILE

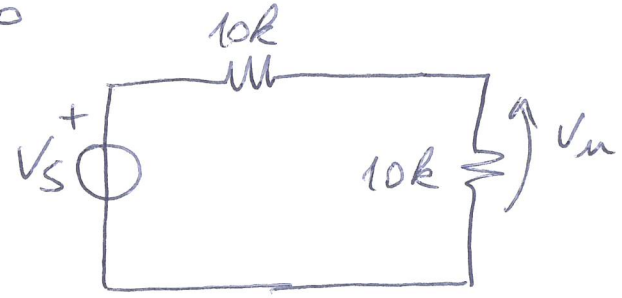
$\omega_0^2 = 2 \times 10^9 \qquad \omega_0 = \sqrt{20}\,10^4$ rad/s

$q\omega_0 = 2 \times 10^5 \qquad q = \sqrt{20}$

$$H(j\omega) = \frac{1}{2}\,\frac{1}{1+j\omega 10^{-4}}\,\frac{1}{1+j\omega\frac{10^5}{2}+(j\omega)^2\frac{10^{-9}}{2}}$$

$$|H(j0)| = \frac{1}{2}$$

$$\lim_{\omega\to\infty} |H(j\omega)| = 0$$



$$V_u = \frac{1}{2} V_S$$

FUNZIONI DI RETE

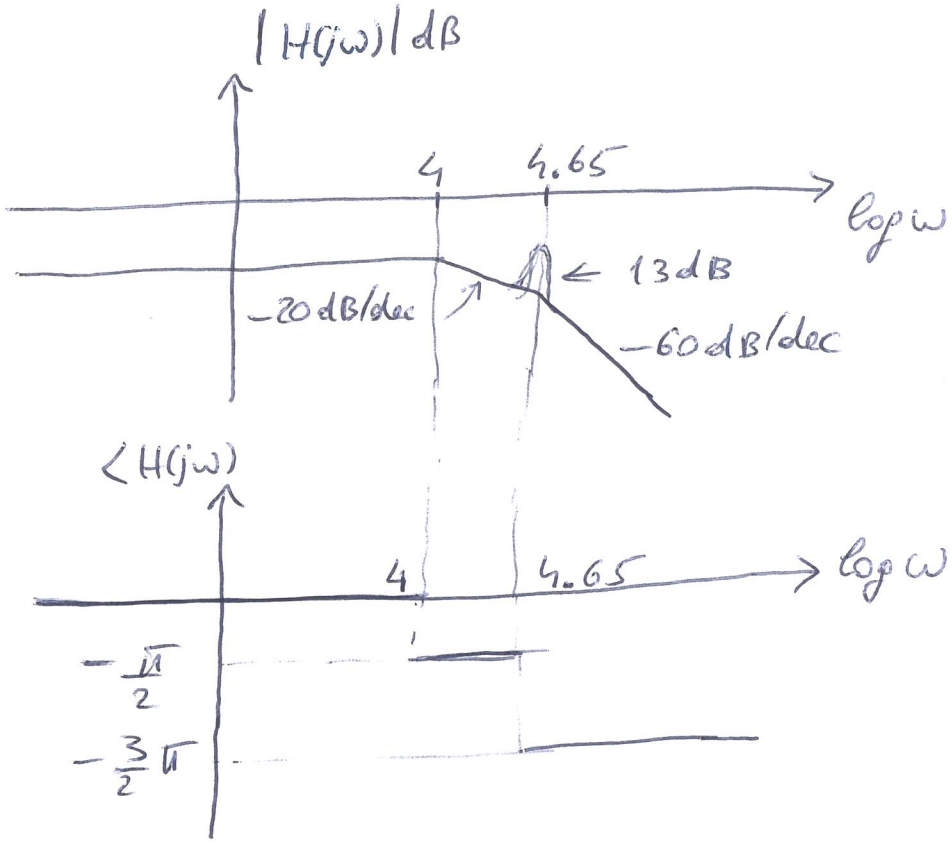
9) (c)

DIAGRAMMI DI BODE

$K_{dB} = 20 \log K = -6\,dB$

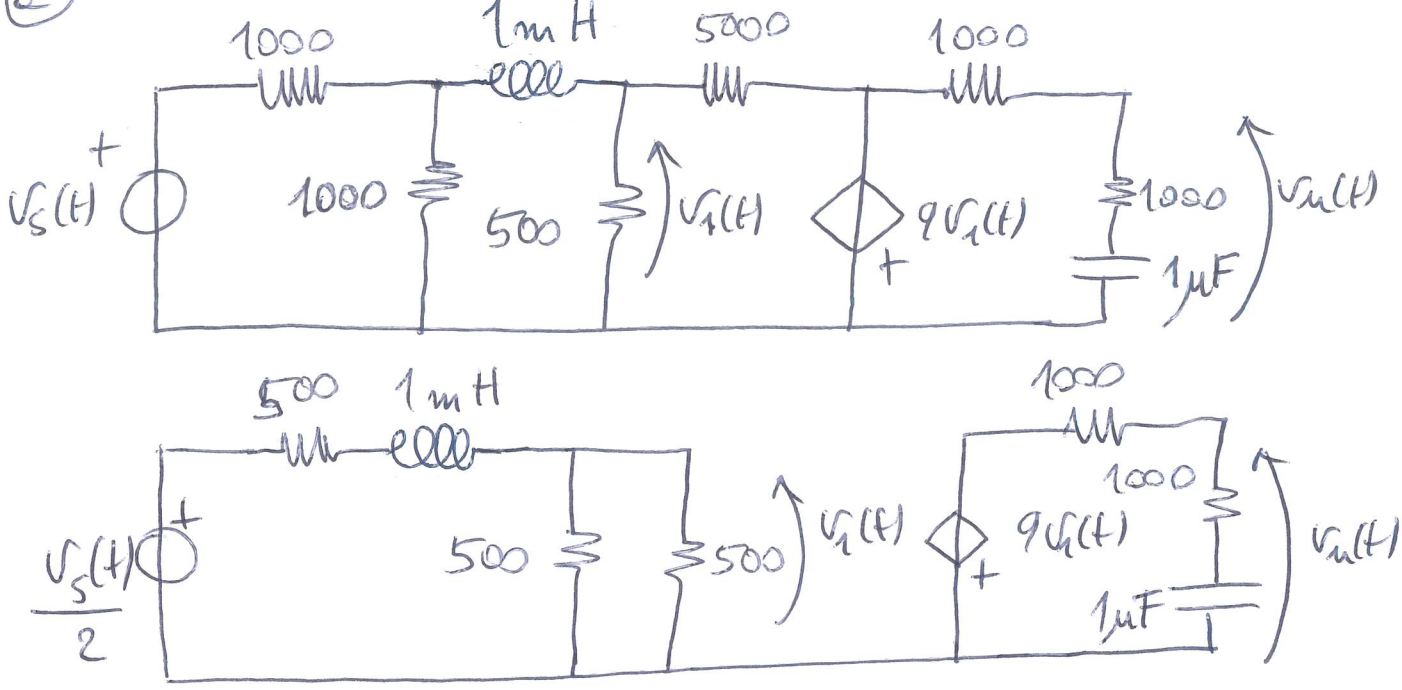
$\log |k_1| = 4$

$\log \omega_0 = 4.65 \qquad 20 \log q = 13\,dB$



FUNZIONI DI RETE

10) (a)



$$V_1(s) = \frac{250}{250+500+sL}\,\frac{V_s(s)}{2} = \frac{125}{750}\,\frac{1}{1+s\frac{L}{750}}\,V_s(s)$$

$$\frac{V_1(s)}{V_s(s)} = \frac{1}{6}\,\frac{1}{1+s\frac{4}{3}10^{-6}}$$

$$V_u(s) = \frac{1000+\frac{1}{sC}}{2000+\frac{1}{sC}}\left[-9\,V_1(s)\right] = \frac{1+sC1000}{1+sC\,2000}(-9)V_1(s)$$

$$\frac{V_u(s)}{V_1(s)} = -9\,\frac{1+s\,10^{-3}}{1+s\,210^{-3}}$$

$$H(s) = \frac{V_u(s)}{V_s(s)} = -\frac{3}{2}\,\frac{1}{1+s\frac{4}{3}10^{-6}}\,\frac{1+s\,10^{-3}}{1+s\,2\cdot10^{-3}}$$

$$(n=2,\ m=1)$$

$$H(0) = -\frac{3}{2} \qquad \lim_{|s|\to\infty}|H(s)| = 0$$

FUNZIONI DI RETE

10) (E)

1 ZERO ∞

$z_1 = -\frac{1}{10^{-3}} = -1000$

$p_1 = -\frac{1}{\frac{4}{3}10^{-6}} = -\frac{3}{4}\times 10^6$

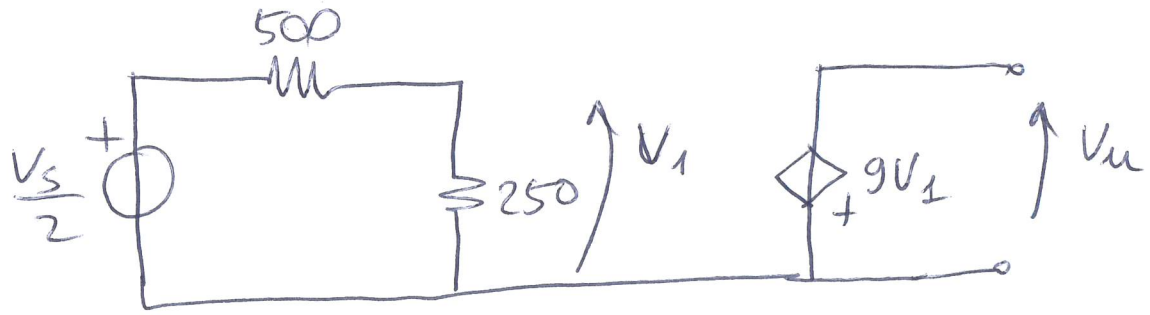
$p_2 = -\frac{1}{2\times 10^{-3}} = -500$

CIRCUITO STABILE

$$H(j\omega) = -\frac{3}{2}\,\frac{1}{1+j\omega\,\frac{4}{3}10^{-6}}\,\frac{1+j\omega\,10^{-3}}{1+j\omega\,2\,10^{-3}}$$

$\lim_{\omega\to\infty} |H(j\omega)| = 0$

$H(j0) = -\frac{3}{2}$



$V_1 = \frac{250}{250+750}\,\frac{V_s}{2} = \frac{V_s}{6}$ $\quad V_u = -9V_1 = -\frac{3}{2}V_s$

FUNZIONI DI RETE

10) ©

DIAGRAMMI DI BODE

$\log|z_1| = 3$

$\log|p_1| = 5.875$

$\log|p_2| = 2.7$

$20\log|K| = K_{dB} = 3.5$