Comportamento in frequenza degli amplificatori

Wednesday, March 29, 2017 2:00 PM

⇒ dobbiamo tenere conto dell'effetto di C e L

CENTROBANDA: l'intervallo di frequenza in cui $|H(f)|$ NON DIPENDE DALLA FREQUENZA

[$H(f)$ è RESISTIVA]

BASSA FREQUENZA	CENTROBANDA	ALTA FREQUENZA
$\{C_{L_i}\}$	$\{C_{L_i}\} \sim cc$ →	cc
ca ←	$\{C_{H_i}\} \sim ca$	$\{C_{H_i}\}$

Es.

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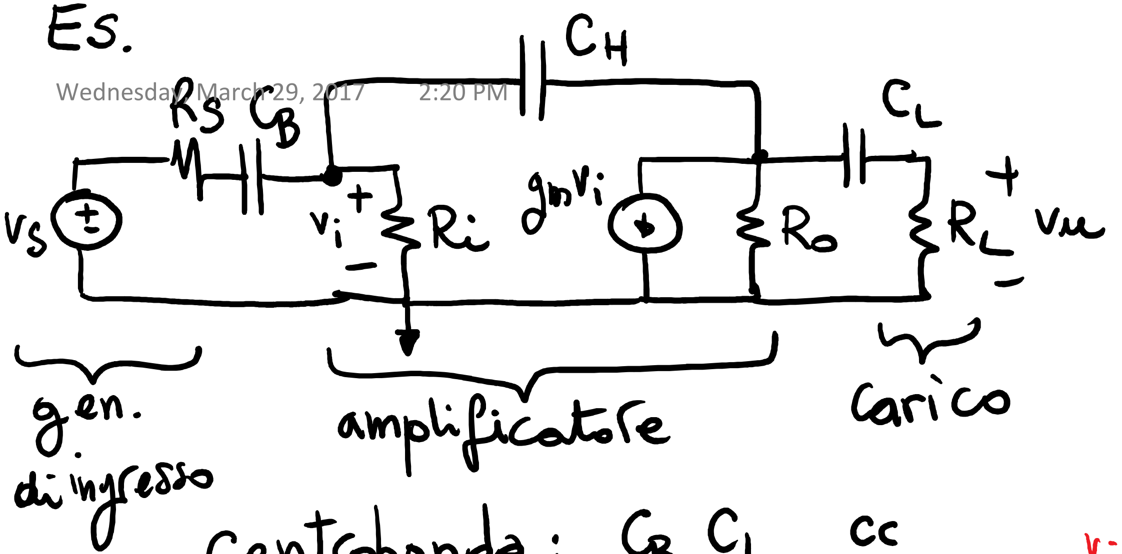
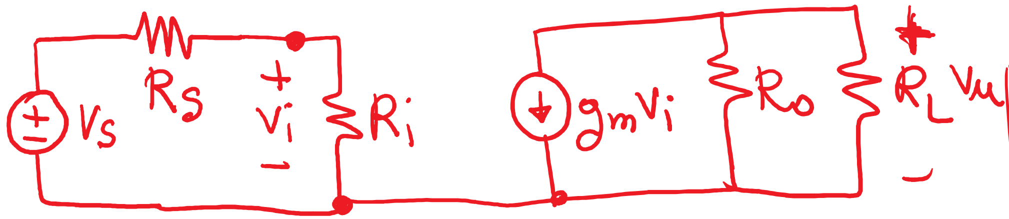


Centrobanda: C_B, C_L cc
C_H ca

Centrobanda



$$v_i = v_S \frac{R_i}{R_i + R_S}$$

$$v_u = -g_m v_i (R_o \| R_L)$$

$$\boxed{A_{CB} = \frac{v_u}{v_S} = \frac{-g_m (R_o \| R_L) R_i}{R_i + R_S}}$$

ALTA FREQUENZA

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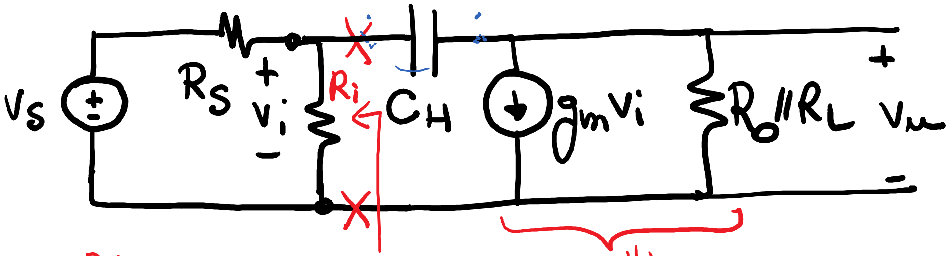
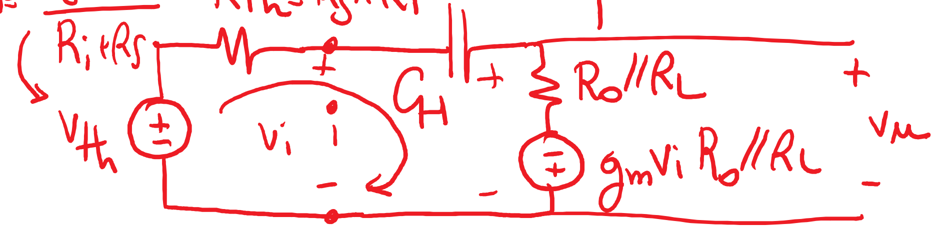
$\boxed{C_H}$, C_L, C_B sono cc



$V_{th} = \dfrac{V_S R_i}{R_i + R_S}$ $R_{th} = R_S // R_i$



eq. maglia : $V_{th} + g_m V_i R_o // R_L = i\left[R_{th} + R_o // R_L + \dfrac{1}{C_H s}\right]$

$V_i = V_{th} - R_{th}\, i$

$V_u = R_o // R_L\, i - g_m V_i R_o // R_L$

$$\begin{cases} v_{th} + \overbrace{g_m}^{R_o \parallel R_L}\left(v_{th} - R_{th}\, i\right) = i\left[R_{th} + R_o \parallel R_L + \dfrac{1}{C_M s}\right] \\ v_u = R_o \parallel R_L\, i - g_m R_o \parallel R_L \left(v_{th} - R_{th}\, i\right) \end{cases}$$

$$\begin{cases} v_{th}\left(1 + g_m R_o \parallel R_L\right) = i\left[\overbrace{R_{th} + g_m (R_o \parallel R_L) R_{th} + R_o \parallel R_L}^{R_M} + \dfrac{1}{C_M s}\right] \\ v_u = -g_m R_o \parallel R_L\, v_{th} + i\left[R_o \parallel R_L + g_m (R_o \parallel R_L) R_{th}\right] \end{cases}$$

$$\frac{v_u}{v_{th}} = \underline{-g_m R_o \parallel R_L} + \left[\frac{\left(1 + g_m R_o \parallel R_L\right)}{R_M + \dfrac{1}{C_M \underline{s}}}\right]\left[R_o \parallel R_L + g_m (R_o \parallel R_L) R_{th}\right]$$

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$$A_H = \frac{V_u}{V_S} = \frac{V_u}{V_{th}} \cdot \frac{V_{th}}{V_S} = A_{H0} \frac{\left(1 - s/s_z\right)}{\left(1 - s/s_{p1}\right)}$$

FdT in ALTA FREQUENZA

$$A_{H0} = \lim_{s \to 0} A_H = \boxed{-g_m R_o // R_L \left(\frac{R_i}{R_i + R_S}\right)} = \underline{A_{CB}}$$

$$\underline{s_{p1}} : \quad R_H + \frac{1}{C_H s_{p1}} = 0 \Rightarrow \boxed{s_{p1} = -\frac{1}{R_H C_H}}$$

$$\lim_{s \to \infty} A_H = A_{H\infty} = A_{H0} \frac{s_{p1}}{s_{z1}} \Rightarrow \boxed{s_{z1} = \frac{A_{H0}\, s_{p1}}{A_{H\infty}}}$$

Diagramma di BODE di ampiezza

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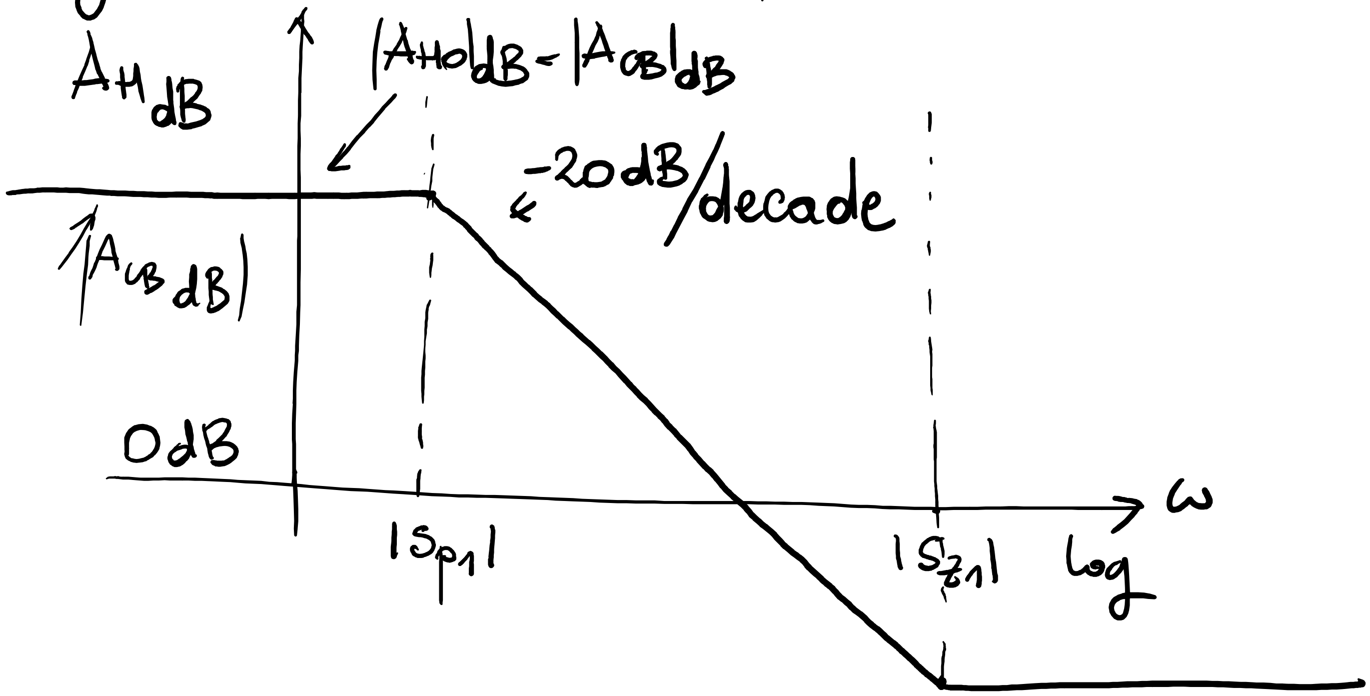

BASSA FREQUENZA

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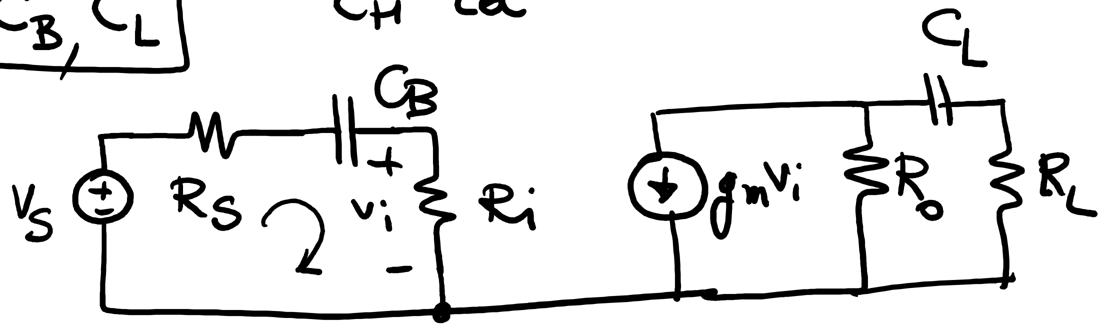
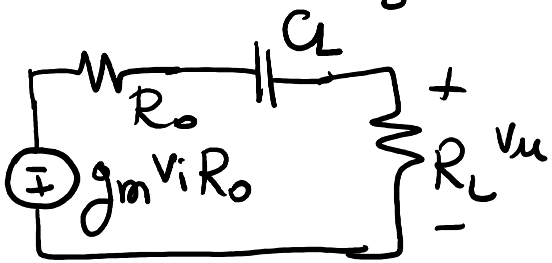
$\boxed{C_B, C_L}$ C_H ca



$$\frac{v_i}{v_S} = \frac{R_i}{R_i + R_S + \frac{1}{C_B s}} = \frac{R_i C_B s}{1 + (R_i + R_S) C_B s}$$



$$v_u = -g_m v_i R_o \frac{R_L}{R_L + R_o + \frac{1}{C_L s}}$$

$$\frac{v_u}{v_i} = \frac{-g_m R_o R_L C_L s}{(R_L + R_o) C_L s + 1}$$

$$A_L = \frac{v_u}{v_S} = \frac{v_u}{v_i} \cdot \frac{v_i}{v_S} = \frac{-g_m R_L R_o C_L s}{1 + (R_L + R_o) C_L s} \cdot \frac{R_i C_B s}{1 + (R_i + R_S) C_B s}$$

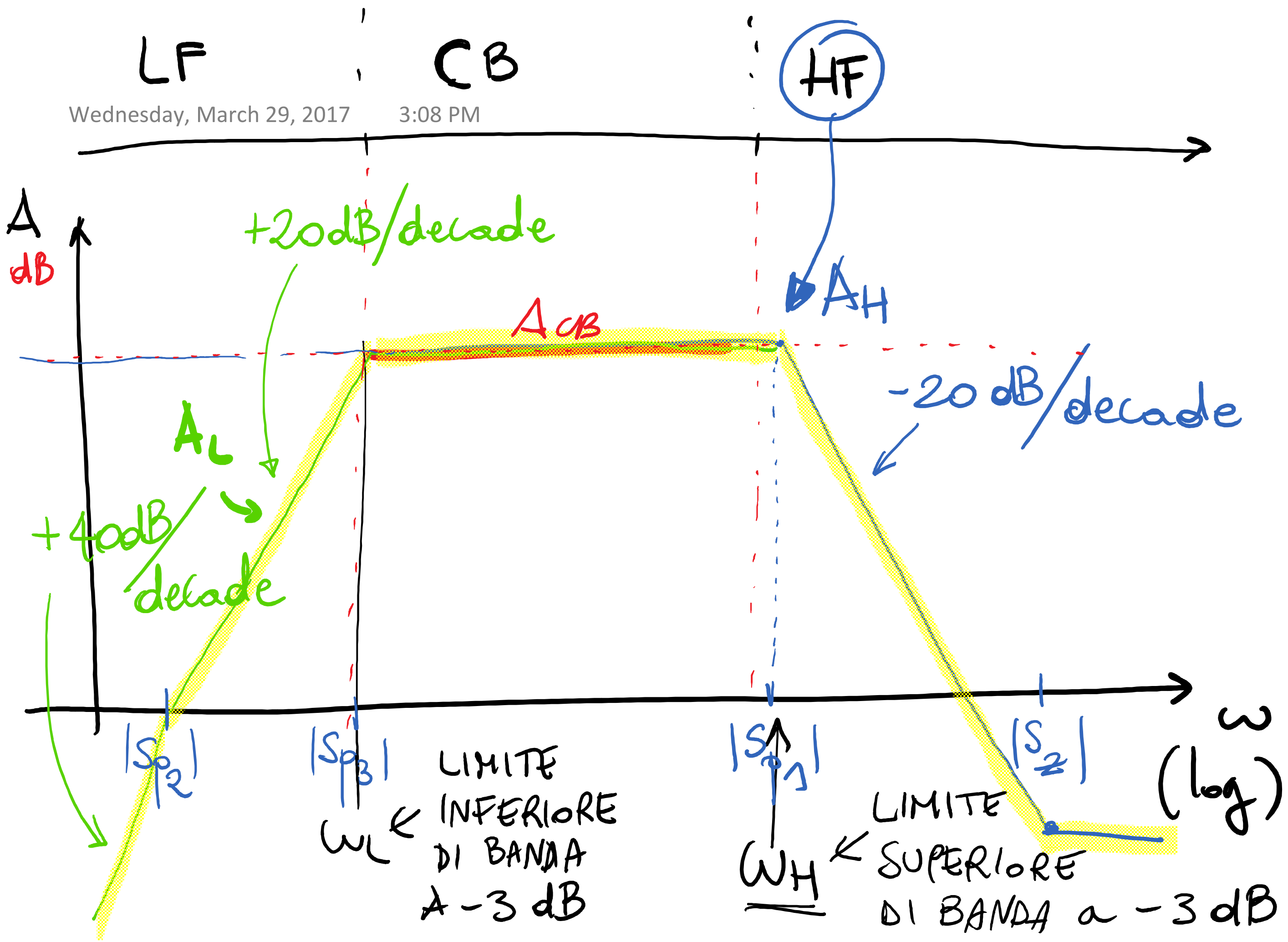
2 poli reali NEGATIVI $\rightarrow$

$$s_{p2} = \frac{-1}{(R_L + R_o) C_L}$$

$$s_{p3} = \frac{-1}{(R_i + R_S) C_B}$$

2 zeri nell'origine

$$\lim_{s \to \infty} (A_L) = -g_m \overbrace{\left(\frac{R_L \cdot R_o}{R_L + R_o}\right)}^{R_L /\!/ R_o} \frac{R_i}{R_i + R_S} = A_{CB}$$


LF
CB
HF
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3:08 PM
A
dB
+20dB/decade
A CB
A H
A L
+40dB/decade
-20 dB/decade
ω
(log)
|Sp2|
|Sp3|
|Sp1|
|S2|
ωL
ωH
LIMITE INFERIORE DI BANDA A -3 dB
LIMITE SUPERIORE DI BANDA a -3 dB

METODO DI COCHRUN-GRABEL

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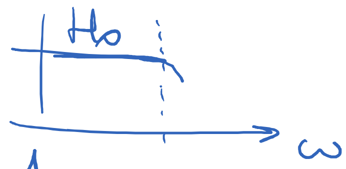
× CALCOLARE TUTTI I COEFFICIENTI DELLA FUNZIONE DI TRASFERIMENTO DI UN CIRCUITO CON R, C, generatori controllati in funzione delle capacità e di alcune resistenze viste

$$H(s) = H_0 \frac{1 + b_1 s + b_2 s^2 + \dots + b_n s^n}{1 + a_1 s + a_2 s^2 + \dots + a_n s^n}$$

← Espressione Passa BASSO

Espansione al 1° ORDINE IN S



$$\lim_{s \to 0} H(s) = H_0 \qquad H(s) = H_0 \frac{1 + b_1 s}{1 + a_1 s} \sim H_0 \frac{1}{1 + a_1 s}$$

LIMITE SUPERIORE DI BANDA A -3dB

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$\omega_H \hookrightarrow \left|H(j\omega_H)\right| = \frac{H_0}{\sqrt{2}}$

$$\left|\frac{H_0}{1+ja_1\omega_H}\right| = \frac{H_0}{\sqrt{2}} \rightarrow a_1\omega_H = 1$$

$$\boxed{\omega_H = \frac{1}{a_1}}$$

dal METODO di Cochrun · GRABEL

$$a_1 = \sum_{i=1} R_i^0 C_i$$

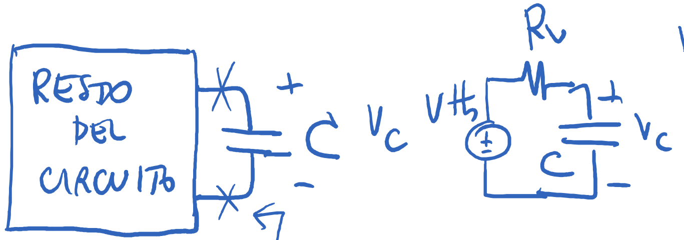
corre su tutte le capacità

RESISTENZA VISTA DA C_i QUANDO TUTTE LE ALTRE CAPACITÀ SONO UN CIRCUITO APERTO

NEL CASO PARTICOLARE DI UNA SOLA CAPACITÀ

$$a_1 = R_V C \rightarrow \underbrace{\omega_H = \frac{1}{R_V C}} = |S_p|$$

Resistenza VISTA da C



Thevenin

$$V_C = V_{th} \cdot \frac{\frac{1}{Cs}}{\frac{1}{Cs} + R_V} \Rightarrow \frac{V_c}{V_{th}} = \frac{1}{1 + R_V C s}$$

$$\boxed{S_p = -\frac{1}{R_V C}}$$

ord

FdT scritta in modo passa alto

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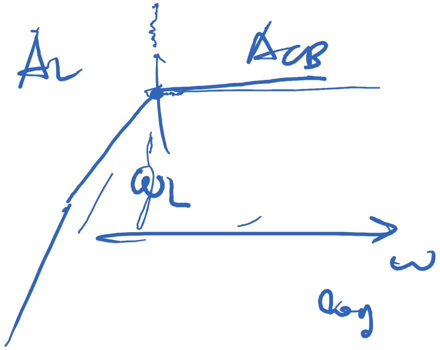
$$H(s) = H_\infty \frac{s^n + d_{n-1}s^{n-1} + d_{n-2}s^{n-2} + \dots + d_0}{s^n + c_{n-1}s^{n-1} + c_{n-2}s^{n-2} + \dots + c_0}$$

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



ESPANSIONE AL 1° ORDINE $\left(\frac{1}{s}\right)$

$$H(s) = H_\infty \frac{1 + d_{n-1}/s}{1 + c_{n-1}/s} \sim \underbrace{H_\infty \frac{1}{1+c_{n-1}/s}}$$

LIMITE INFERIORE DI BANDA

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A -3dB

$$\omega_L \rightarrow |H(j\omega_L)| = \frac{|H_\infty|}{\sqrt{2}}$$

$$\left| H_\infty \frac{1}{1 + \frac{c_{n-1}}{j\omega_L}} \right| = \frac{|H_\infty|}{\sqrt{2}}$$

$$\frac{c_{n-1}}{\omega_L} = 1 \Rightarrow \boxed{\omega_L = c_{n-1}}$$

dal

METODO COCHRUN GRABEL

$$\omega_L = c_{n-1} = \sum_i \left(\frac{1}{R_i^{\infty} C_i} \right)$$

RESISTENZA VISTA DA C_i QUANDO TUTTE LE CAPACITÀ SONO IN CC

NELL'ESEMPIO DI PRIMA

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$$c_{n-1} = c_1 = \underbrace{\frac{1}{C_B(R_S+R_i)} + \frac{1}{C_L(R_L+R_o)}}_{} \simeq \omega_L$$

Casi tipici di RESISTENZE VISTE

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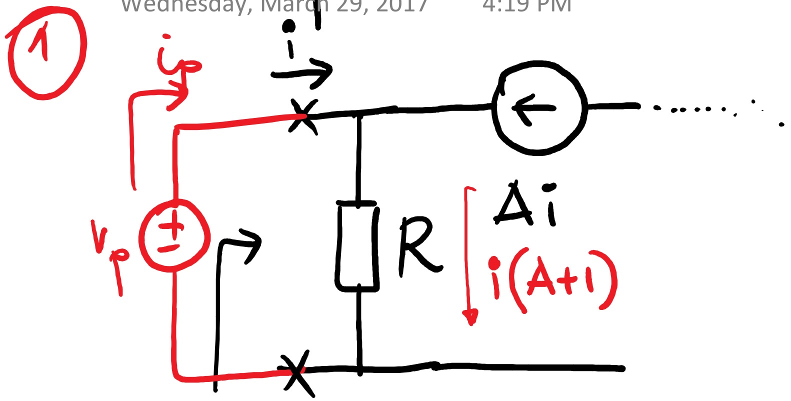
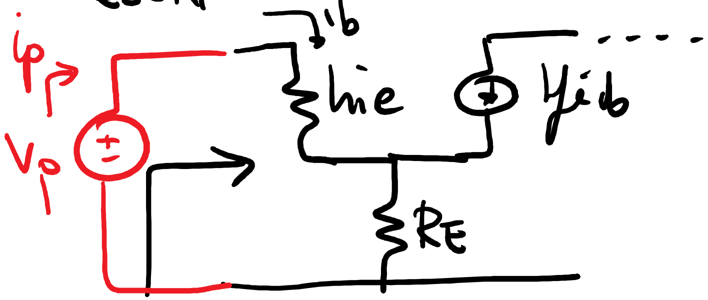


$$i_p = i$$

$$V_p = Ri(A+1)$$

$$R_V = \frac{V_p}{i_p} = R(A+1)$$

ESEMPIO



$$R_V = h_{ie} + R_E(h_{fe}+1)$$

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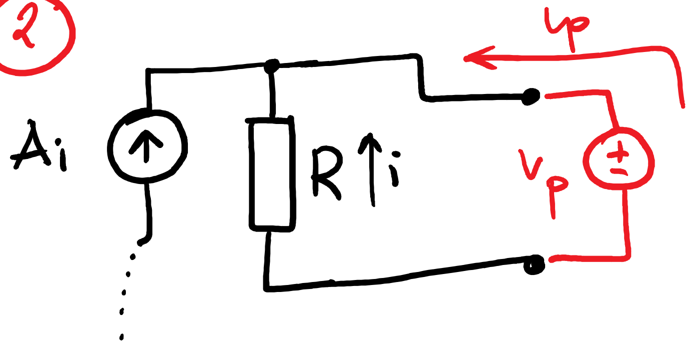
2

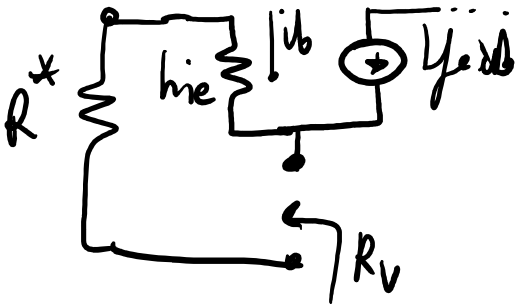


$$v_p = -Ri$$

$$i_p = -i - Ai$$

$$R_V = \frac{v_p}{i_p} = \frac{R}{A+1}$$

ESEMPIO



$$R_V = \frac{h_{ie} + R^*}{h_{fe} + 1}$$

Limite inferiore di banda

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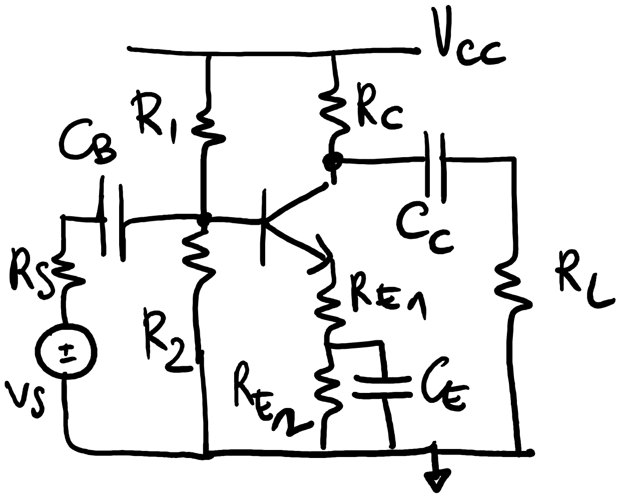
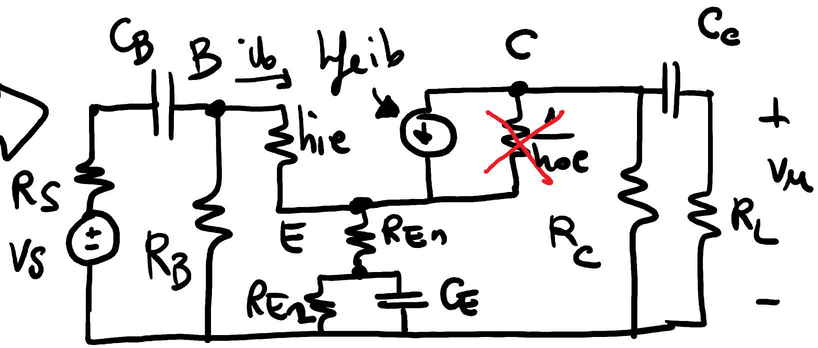


circuito di piccolo segnale
IN BASSA FREQUENZA



$R_B = R_1 \parallel R_2$

$$\boxed{\omega_L = \frac{1}{R_B^{\infty} C_B} + \frac{1}{R_E^{\infty} C_E} + \frac{1}{R_C^{\infty} C_C}}$$

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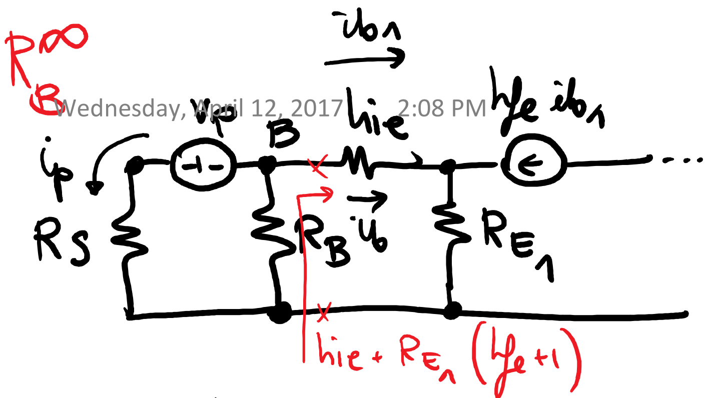
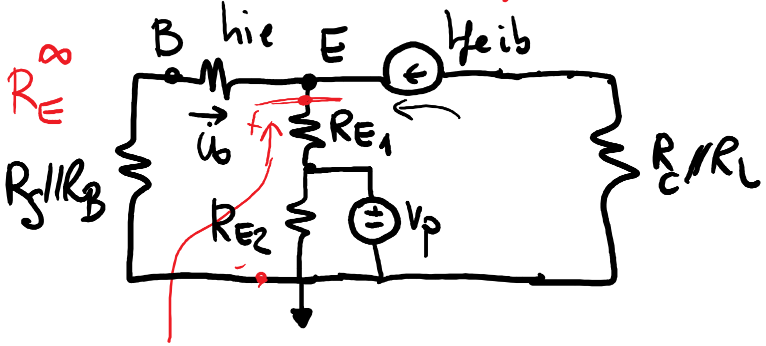
R_B^∞



$$R_B^\infty = \left[h_{ie} + R_{E_1}(h_{fe}+1)\right] // R_B + R_S$$

R_E^∞



$$\frac{h_{ie} + R_S // R_B}{h_{fe}+1}$$

$$R_E^\infty = \left\{ \underbrace{\left[\frac{h_{ie} + R_S // R_B}{h_{fe}+1}\right]} + R_{E_1} \right\} // R_{E2}$$

R_C^{∞}

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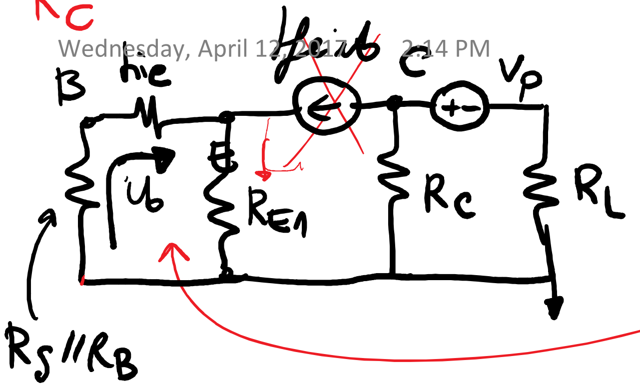

$$\left[R_S // R_B + h_{ie}\right] i_b + R_{E_1} i_b \left(y_{fe}+1\right) = 0$$

$\hookrightarrow i_b = 0$

$$\boxed{R_C^{\infty} = R_C + R_L}$$