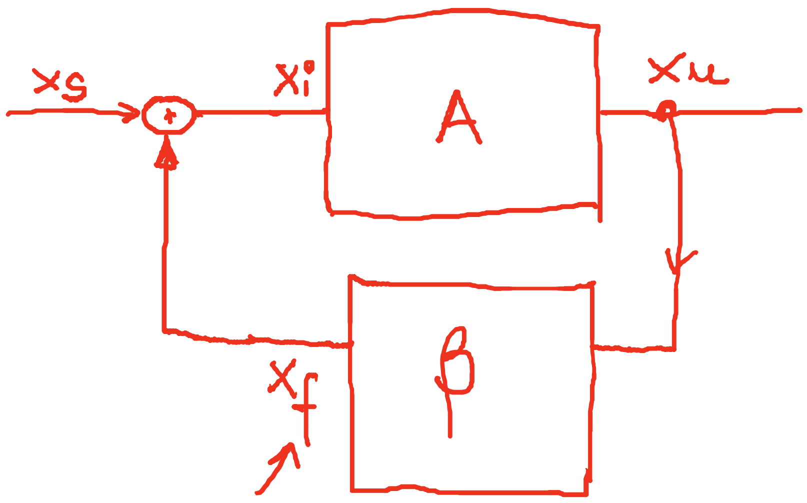
Circuiti in reazione

Thursday, 27 April 2017 09:14



Feedback

βA guadagno di anello

$1-\beta A$ fattore di reazione

$$x_i = x_s + x_f$$

$$x_u = A x_i$$

$$x_f = \beta x_u$$

$$\frac{x_u}{A} = x_s + \beta x_u$$

$$x_u(1-\beta A) = x_s A$$

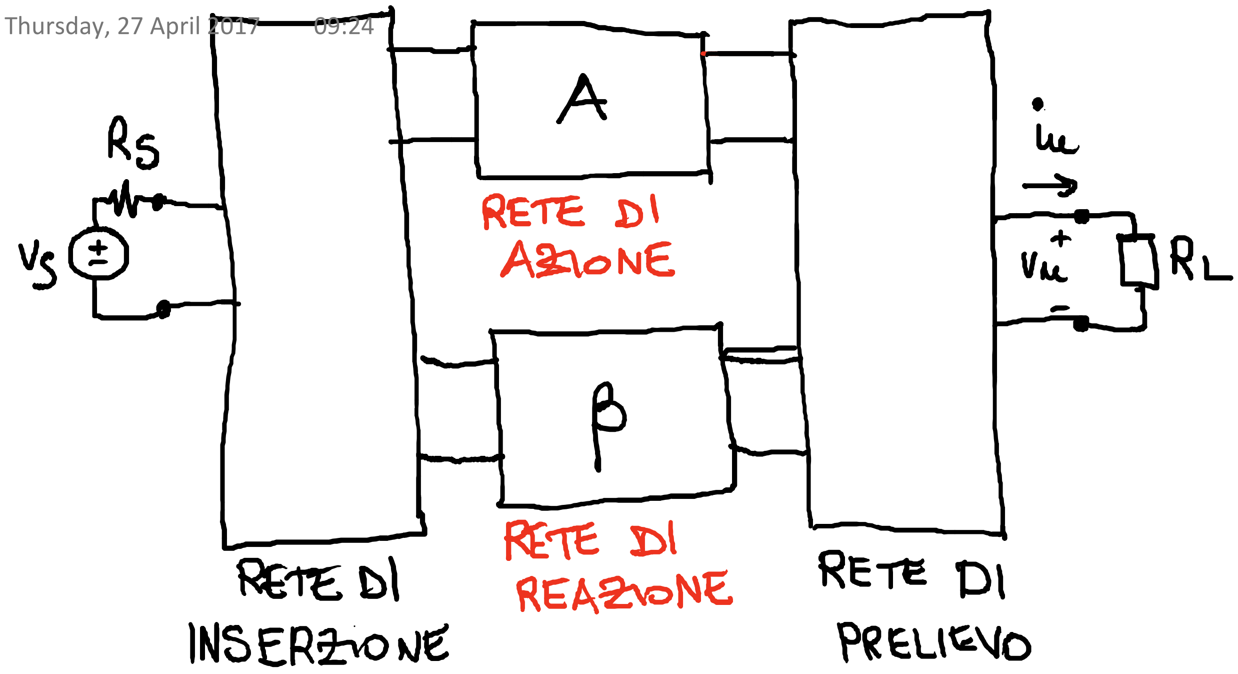
$$A_F = \frac{x_u}{x_s} = \frac{A}{1-\beta A}$$

se $|\beta A| \gg 1$

$$A_F \approx -\frac{1}{\beta}$$

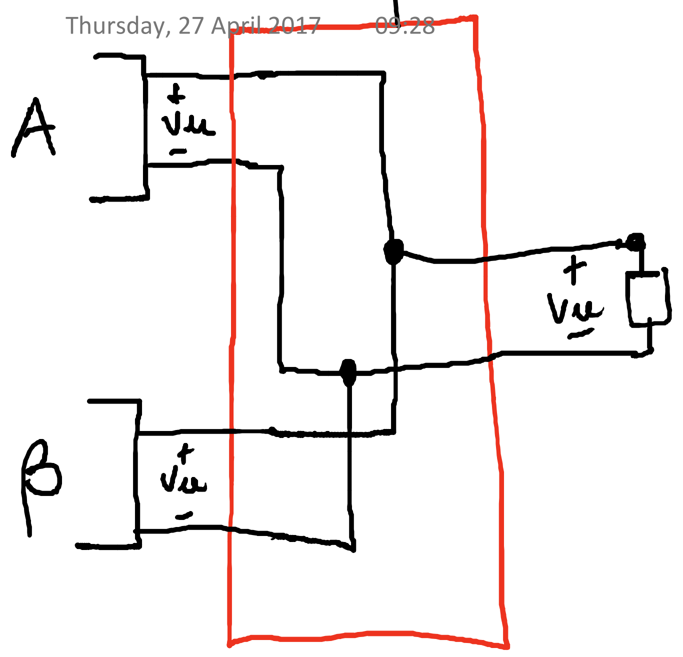
Circuiti elettrici in reazione

Thursday, 27 April 2017 09:24

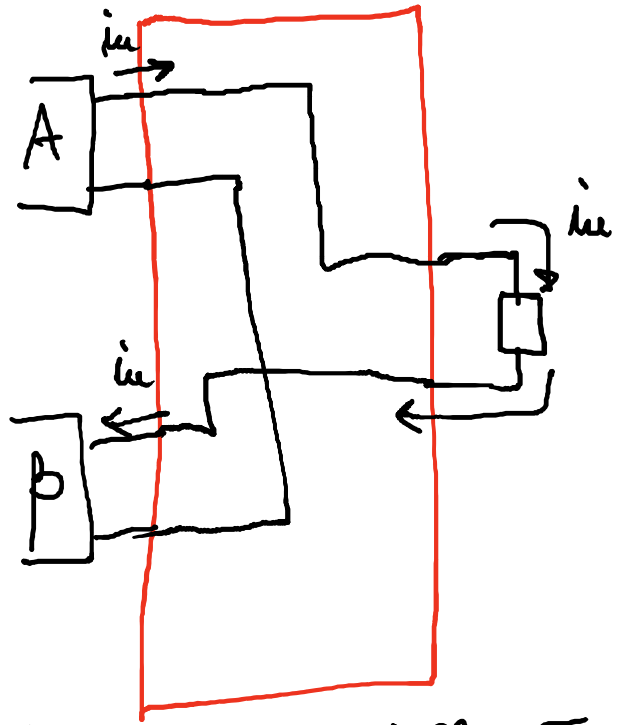


Rete di prelievo

Thursday, 27 April 2017 09:28



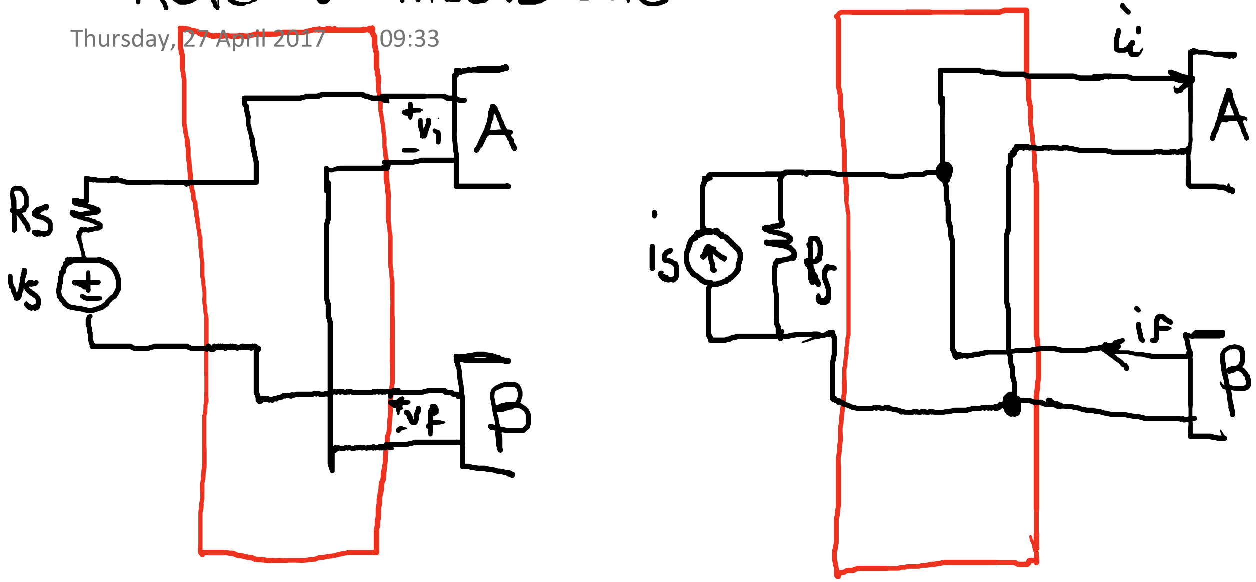
PRELIEVO DI TENSIONE
(PARALLELO)



PRELIEVO DI CORRENTE
(SERIE)

Rete di inserzione

Thursday, 27 April 2017 09:33

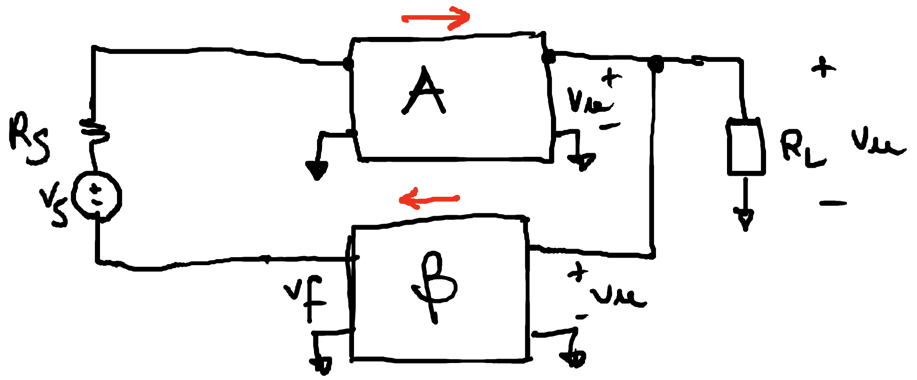


INSERZIONE DI TENSIONE (SERIE)

INSERZIONE DI CORRENTE (PARALLELO)

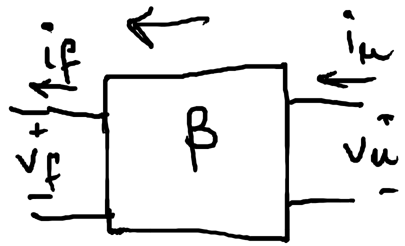
Prelievo di tensione, inserzione di tensione

Thursday, 27 April 2017 09:40



$x_u \Rightarrow v_u$

$x_s, x_i, x_f \Rightarrow v_s, v_i, v_f$

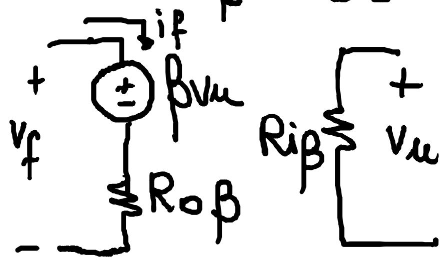


$$\beta = \left.\frac{v_f}{v_u}\right|_{i_f=0} \qquad R_{o\beta} = \left.\frac{v_f}{i_f}\right|_{v_u=0}$$

$$R_{i\beta} = \left.\frac{v_u}{i_u}\right|_{i_f=0} \qquad \cancel{K} = \left.\frac{i_u}{i_f}\right|_{v_u=0}$$

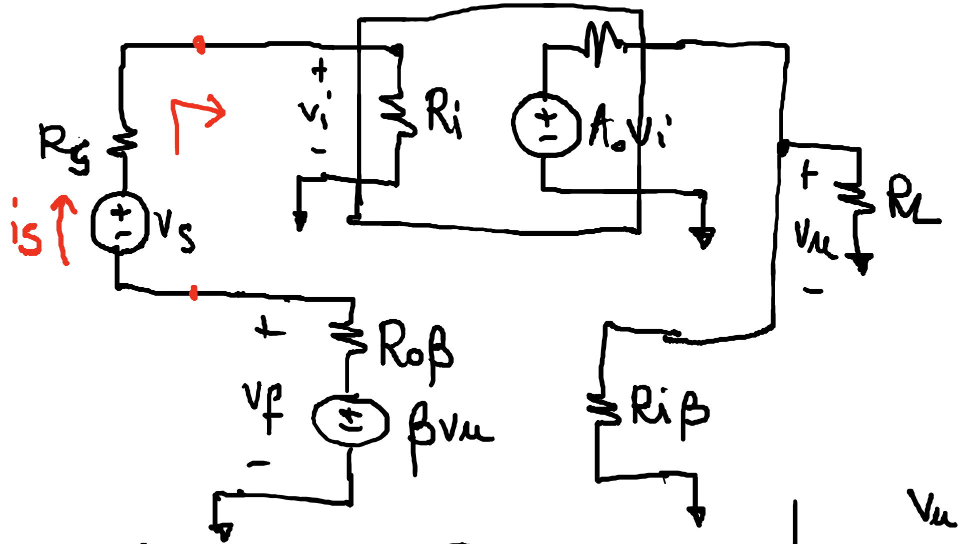
consideriamo β unidirezionale

$$\begin{bmatrix} v_f \\ i_u \end{bmatrix} = \begin{bmatrix} \beta & R_{o\beta} \\ \frac{1}{R_{i\beta}} & \cancel{K} \end{bmatrix} \begin{bmatrix} v_u \\ i_f \end{bmatrix}$$



Ae

Thursday, 27 April 2017 09:54



$$A_e = \left.\frac{v_u}{v_s}\right|_{\beta=0}$$

se $\beta = 0$

$$v_u = A_e v_s$$

se $\beta \neq 0$

$$v_u = A_e\left[v_s + \beta v_u\right]$$

$$v_u(1 - \beta A_e) = A_e v_s$$

$$A_F = \frac{v_u}{v_s} = \frac{A_e}{1 - \beta A_e}$$

$$v_u = A_o v_i \frac{R_L /\!/ R_{i\beta}}{R_L /\!/ R_{i\beta} + R_{out}} \qquad v_i = v_s \frac{R_i}{R_i + R_s + R_{o\beta}}$$

$$A_e = \left.\frac{v_u}{v_s}\right|_{\beta=0} = A_o \frac{R_L /\!/ R_{i\beta}}{R_L /\!/ R_{i\beta} + R_{out}} \cdot \frac{R_i}{R_i + R_s + R_{o\beta}}$$

Impedenza di uscita

Thursday, 27 April 2017 10:14

$$R_{oF} = \frac{v_{uo}}{i_{ucc}} = \frac{A_F \big|_{R_L \to \infty} \cancel{v_s}}{\lim\limits_{R_L \to 0} \left(\frac{A_F}{R_L}\right) \cancel{v_s}} = \frac{\dfrac{A_e|_{R_L \to \infty}}{1 - \beta A_e|_{R_L \to \infty}}}{\dfrac{(A_e/R_L)_{R_L \to 0}}{1 - \cancel{\beta A_e}|_{R_L \to 0}}}$$

$$i_u = \frac{v_u}{R_L}$$

$$i_{ucc} = \lim_{R_L \to 0} \left(\frac{v_u}{R_L}\right) = \lim_{R_L \to 0} \left(\frac{A_F}{R_L}\right) v_s$$

$$R_{oF} = \frac{1}{1 - \beta A_e|_{R_L \to \infty}} \cdot \frac{\lim\limits_{R_L \to \infty} A_e}{\lim\limits_{R_L \to 0} \left(\frac{A_e}{R_L}\right)} =$$

Impedenza di ingresso

Thursday, 27 April 2017 10:05

$\boxed{R_S = 0}$

$$v_s + \beta v_u = (R_i + R_{o\beta})\, i_s$$

$$v_u = \frac{A_e}{1-\beta A_e} v_s$$

$$v_s\left[1 + \frac{\beta A_e}{1-\beta A_e}\right] = v_s \frac{1}{1-\beta A_e} = (R_i + R_{o\beta})\, i_s$$

$$R_{iF} = (R_i + R_{o\beta})(1-\beta A_e)\Big|_{R_S=0}$$

del sistema in reazione

se il fattore di reazione ha modulo $\gg 1$ si può ottenere $R_{iF} \gg R_i$

Thursday, 27 April 2017 10:27

$$R_{OF} = \frac{1}{1-\beta A_e\big|_{R_L\to\infty}} \cdot \frac{R_{i\beta}}{R_{i\beta}+R_{out}} \frac{1}{\lim\limits_{R_L\to\infty}\left[\frac{\cancel{R_L} R_{i\beta}}{(\cancel{R_L}+\cancel{R_{i\beta}})R_{out}\cancel{R_L}}\right]}$$

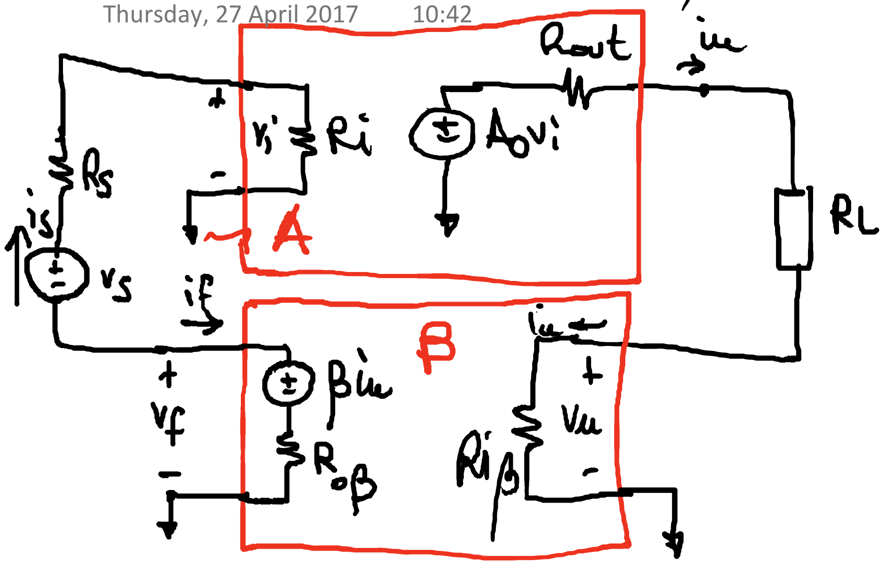
$$R_{OF} = \frac{1}{1-\beta A_e\big|_{R_L\to\infty}}\left(R_{i\beta} /\!/ R_{out}\right)$$

se $\left|1-\beta A_e\right|_{R_L\to\infty} \gg 1$

allora $\boxed{R_{OF} \ll R_{out}}$

Prelievo di corrente, inserzione di Tensione

Thursday, 27 April 2017 10:42



$x_u \to i_u$

$x_s, x_f, x_i \to v_s, v_f, v_i$

$$\begin{bmatrix} v_f \\ v_u \end{bmatrix} = \begin{bmatrix} \beta & R_{o\beta} \\ R_{i\beta} & \times \end{bmatrix} \begin{bmatrix} i_u \\ i_f \end{bmatrix}$$

$$\beta = \left.\frac{v_f}{i_u}\right|_{i_f=0}$$

$$R_{o\beta} = \left.\frac{v_f}{i_f}\right|_{i_u=0}$$

$$R_{i\beta} = \left.\frac{v_u}{i_u}\right|_{i_f=0}$$

A_e

Thursday, 27 April 2017 10:50

$$A_e = \left.\frac{i_u}{V_s}\right|_{\beta=0}$$

se $\beta = 0$ $\quad i_u = A_e V_s$

se $\beta \neq 0$ $\quad i_u = A_e (V_s + \beta i_u)$

$$i_u (1 - \beta A_e) = A_e V_s$$

$$A_F = \frac{i_u}{V_s} = \frac{A_e}{1 - \beta A_e}$$

$$v_i = v_s \frac{R_i}{R_i + R_s + R_o \beta}$$

$$i_u = \frac{A_o v_i}{R_{out} + R_L + R_i \beta} \Rightarrow A_e = \frac{A_o}{R_{out} + R_L + R_i \beta} \cdot \frac{R_i}{R_i + R_s + R_o \beta}$$

R_{iF}

Thursday, 27 April 2017 10:55

$$i_s = \frac{v_s + \beta i_u}{R_i + R_{o\beta}} = \frac{v_s + \frac{\beta A_e v_s}{1-\beta A_e}}{R_i + R_{o\beta}}$$

$$i_s = \frac{v_s}{(1-\beta A_e)(R_i + R_{o\beta})} \Rightarrow R_{iF} = \frac{v_s}{i_s} = (R_i + R_{o\beta})(1-\beta A_e|_{R_s=0})$$

$$R_{oF} = \frac{v_{uo}}{i_{ucc}} = \frac{\lim_{R_L\to\infty}(R_L i_u)}{\lim_{R_L\to 0}(i_u)} = \frac{\lim_{R_L\to\infty}\left[R_L \cdot \frac{A_e}{1-\cancel{\beta A_e}}\right]\cancel{v_s}}{\lim_{R_L\to 0}\left(\frac{A_e}{1-\beta A_e}\right)\cancel{v_s}} = (1-\beta A_e|_{R_L=0})\frac{\lim_{R_L\to\infty}(R_L A_e)}{A_e|_{R_L=0}}$$

$$R_{oF} = (1-\beta A_e|_{R_L=0})(R_{out} + R_{i\beta})$$

SE $(1-\beta A_e|_{R_L=0}) \gg 1$

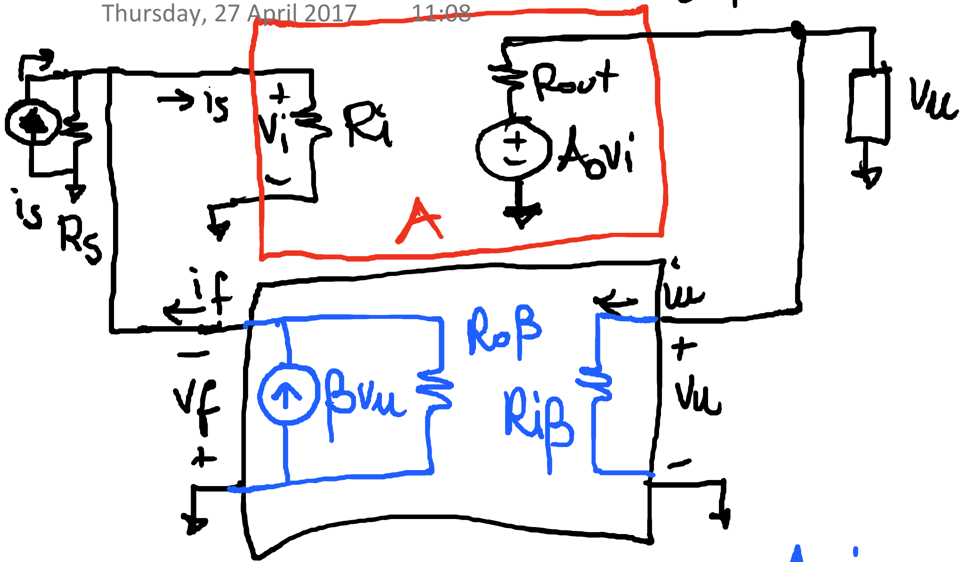
ALLORA $R_{oF} \gg R_{out}$

Inserzione di corrente, prelievo di Tensione $x_u \to v_u$

Thursday, 27 April 2017 11:08

$x_i, x_s, x_f \to i_i, i_s, i_f$

$\boxed{\beta}$



$$\begin{bmatrix} i_f \\ i_u \end{bmatrix} = \begin{bmatrix} \beta & \frac{1}{R_{o\beta}} \\ \frac{1}{R_{i\beta}} & \times \end{bmatrix} \begin{bmatrix} v_u \\ v_f \end{bmatrix}$$

$$\beta \triangleq \left.\frac{i_f}{v_u}\right|_{v_f=0}$$

$$R_{o\beta} \triangleq \left.\frac{v_f}{i_f}\right|_{v_u=0}$$

$$R_{i\beta} \triangleq v_u/i_u\big|_{v_f=0}$$

$$A_e \triangleq \left.\frac{v_u}{i_s}\right|_{\beta=0} \Rightarrow \begin{array}{l} \text{se } \beta=0 \quad v_u = A_e i_s \\ \text{se } \beta\neq 0 \quad v_u = A_e(i_s + \beta v_u) \end{array}$$

$$v_u(1-\beta A_e) = A_e i_s$$

$$\boxed{A_F \triangleq \frac{v_u}{i_s} = \frac{A_e}{1-\beta A_e}}$$

A_e

Thursday, 27 April 2017 11:17

$$v_i = i_S\, R_S // R_i // R_o\beta \qquad v_u = A_o v_i \frac{R_L // R_i\beta}{R_L // R_i\beta + R_{out}}$$

$$A_e = \left.\frac{v_u}{i_S}\right|_{\beta=0} = A_o \frac{R_L // R_i\beta}{R_L // R_i\beta + R_{out}} \cdot \frac{1}{R_S // R_i // R_o\beta}$$

$$\boxed{R_{iF}} = \left.\frac{v_S}{i_S}\right|_{R_S \to \infty}$$

$$v_S = v_i = \left(i_S + \beta v_u\right)\left(R_i // R_o\beta\right)$$

$$= \left(i_S + \frac{\beta A_e}{1-\beta A_e} i_S\right)\left(R_i // R_{ou}\beta\right)$$

$$\boxed{R_{iF} = \frac{R_i // R_o\beta}{1-\beta A_e|_{R_S\to\infty}}}$$

SE $|1-\beta A_e| \gg 1$

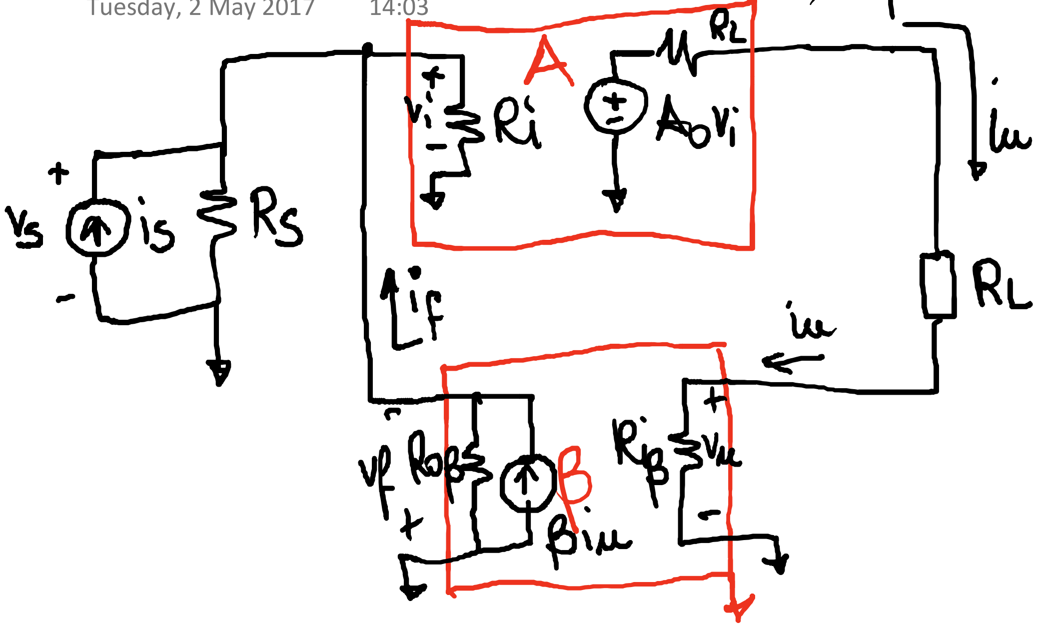
ALLORA $\underline{\underline{R_{iF}}} \ll \underline{\underline{R_i}}$

$$\boxed{R_{oF}}$$

$$\boxed{R_{oF} = \frac{R_{out} // R_i\beta}{1-\beta A|_{R_L\to\infty}}}$$

Inserzione di corrente, prelievo di corrente

Tuesday, 2 May 2017 14:03



$$\begin{bmatrix} i_f \\ v_u \end{bmatrix} = \begin{bmatrix} \beta & \frac{1}{R_{o\beta}} \\ R_{i\beta} & \times \end{bmatrix} \begin{bmatrix} i_u \\ v_f \end{bmatrix}$$

$$\beta \triangleq \left. \frac{i_f}{i_u} \right|_{v_f=0}$$

$$R_{o\beta} \triangleq \left. \frac{v_f}{i_f} \right|_{i_u=0}$$

$$R_{i\beta} \triangleq \left. \frac{v_u}{i_u} \right|_{v_f=0}$$

Ae

Tuesday, 2 May 2017 14:09

$$A_e = \left.\frac{i_u}{i_s}\right|_{\beta=0} \Rightarrow \begin{array}{l} \text{se } \beta=0 : \; i_u = A_e i_s \\ \text{se } \beta\neq 0 : \; i_u = A_e(i_s + \beta i_u) \end{array}$$

$$i_u(1-\beta A_e) = A_e i_s$$

$$A_F \triangleq \frac{i_u}{i_s} = \boxed{\frac{A_e}{1-\beta A_e}}$$

$$R_{iF} \triangleq \left.\frac{v_s}{i_s}\right|_{R_S\to\infty} \qquad v_s = (i_s + \beta i_u)(R_i /\!/ R_{o\beta}) = \left[i_s + \frac{\beta A_e}{1-\beta A_e} i_s\right] R_i /\!/ R_{o\beta}$$

$$R_{iF} = \frac{v_s}{i_s} = \left.\frac{R_i /\!/ R_{o\beta}}{1-\beta A_e}\right|_{R_S\to\infty}$$

← come nel caso di inserzione di corrente, prelievo di tensione

Tuesday, 2 May 2017 14:16

$$\underline{R_{oF}} = \frac{v_{uo}}{i_{ucc}} = \frac{\lim\limits_{R_L\to\infty}[R_L i_u]}{\lim\limits_{R_L\to 0} i_u} = \frac{\lim\limits_{R_L\to\infty}[R_L A_F]}{\lim\limits_{R_L\to 0}[A_F]} =$$

$$= \frac{\lim\limits_{R_L\to\infty}\left[\frac{R_L A_e}{1-\beta A_e}\right]}{\lim\limits_{R_L\to 0}\left[\frac{A_e}{1-\beta A_e}\right]} = \frac{\lim\limits_{R_L\to\infty}[R_L A_e]}{\lim\limits_{R_L\to 0}[A_e]} \cdot \left(1-\beta A_e\Big|_{R_L=0}\right) =$$

$$\to R_{oF} = (R_{out}+R_i\beta)\left(1-\beta A_e\Big|_{R_L=0}\right)$$

$$A_e = \frac{i_u}{i_S}\Big|_{\beta=0} = \frac{[R_i // R_S // R_o\beta]A_o}{R_{out}+R_L+R_i\beta}$$

Se $|1-\beta A_e| \gg 1$

$R_{oF} \gg R_{out}$

Tuesday, 2 May 2017 14:25

Inserzione	Prelievo	A_F (def)	A_F	R_{iF}	R_{oF}
S	P	$A_F \triangleq \frac{v_u}{v_s}$	$A_F = \frac{A_e}{1-\beta A_e}$	$(R_i + R_{o\beta})(1-\beta A_e\|_{R_S=0})$	$\frac{R_{out} // R_{i\beta}}{1-\beta A_e\|_{R_L\to\infty}}$
S	S	$A_F \triangleq \frac{i_u}{v_s}$			$(R_{out}+R_{i\beta})(1-\beta A_e\|_{R_L\to 0})$
P	P	$A_F \triangleq \frac{v_u}{i_s}$		$\frac{R_i // R_{o\beta}}{(1-\beta A_e\|_{R_S\to 0})}$	$\frac{R_{out} // R_{i\beta}}{1-\beta A_e\|_{R_L\to\infty}}$
P	S	$A_F \triangleq \frac{i_u}{i_s}$			$(R_{out}+R_{i\beta})(1-\beta A_e\|_{R_L\to 0})$

EFFETTO DELLA REAZIONE SUI POLI

Tuesday, 2 May 2017 14:37

$$A_F = \frac{A_e}{1-\beta A_e}$$

- gli ZERI di A_e sono ZERI di A_F
- gli zeri di $(1-\beta A_e)$ sono i POLI di A_F

1) $A_e = \dfrac{A_{e0}}{1-S/S_p}$; β cost. $\Rightarrow A_F = \dfrac{A_{e0}}{1-S/S_p - \beta A_{e0}} =$

$$A_F = \frac{\overbrace{\dfrac{A_{e0}}{1-\beta A_{e0}}}^{A_{F0}}}{1-\dfrac{S}{\underbrace{S_p(1-\beta A_{e0})}_{S_H}}} = \frac{A_{F0}}{1-S/S_H} \Rightarrow A_{F0} = \frac{A_{e0}}{1-\beta A_{e0}}$$

$$S_H = S_p(1-\beta A_{e0})$$

$A_{F0} S_H = A_{e0} S_p$ PRODOTTO GUADAGNO BANDA COSTANTE

Tuesday, 2 May 2017 14:46

2) $A_e = \left[\dfrac{-s/s_p}{1-s/s_p}\right] A_{e\infty}$ 1 zero nell'origine
1 polo reale

β costante

$$A_F = \frac{A_e}{1-\beta A_e} = \frac{-s/s_p\, A_{e\infty}}{1-s/s_p+\beta\, s/s_p\, A_{e\infty}} = \left[\frac{-\dfrac{s(1-\beta A_{e\infty})}{s_p}}{1-\dfrac{s(1-\beta A_{e\infty})}{s_p}}\right] \underbrace{\frac{A_{e\infty}}{(1-\beta A_{e\infty})}}_{A_{F\infty}}$$

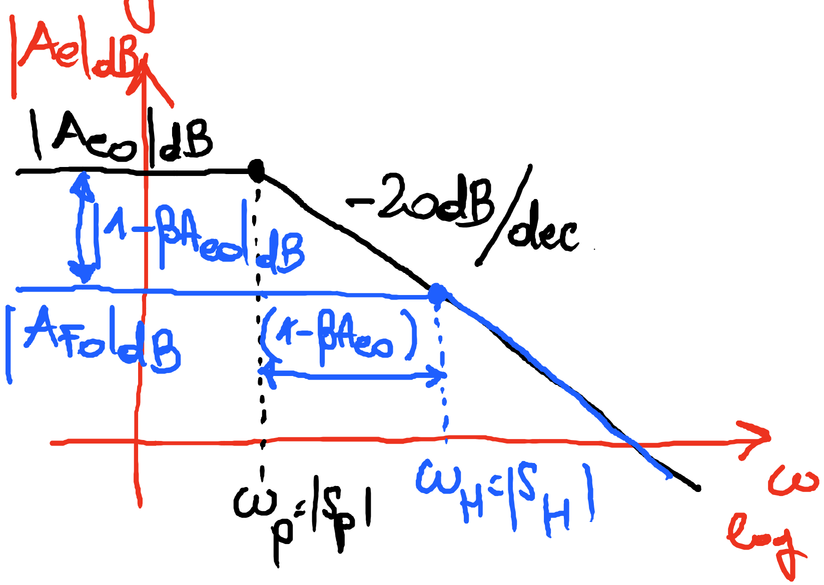
$$A_{F\infty} = \frac{A_{e\infty}}{1-\beta A_{e\infty}} \;;\; s_L = \frac{s_p}{1-\beta A_{e\infty}} \Rightarrow A_F = \left[\frac{-s/s_L}{1-s/s_L}\right] A_{F\infty}$$

1 zero nell'origine   1 polo $s_L = s_p / 1-\beta A_{e\infty}$

Tuesday, 2 May 2017 14:54

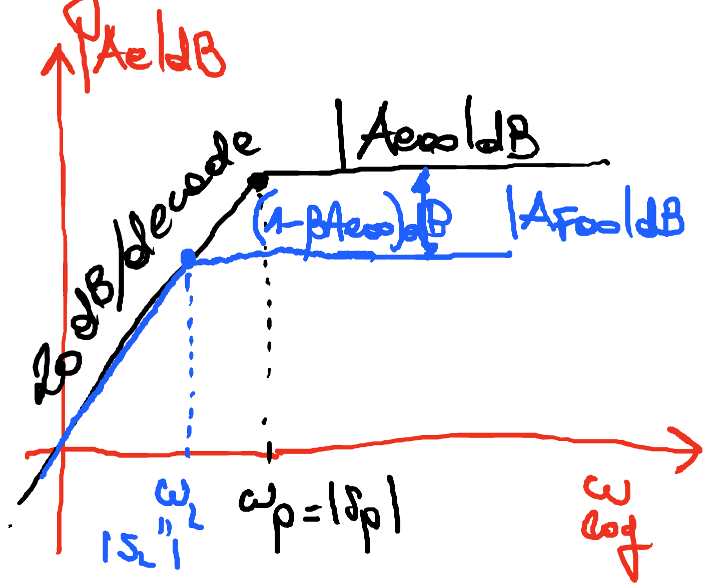
1)

diagramma di Bode



2)

diagramma di Bode

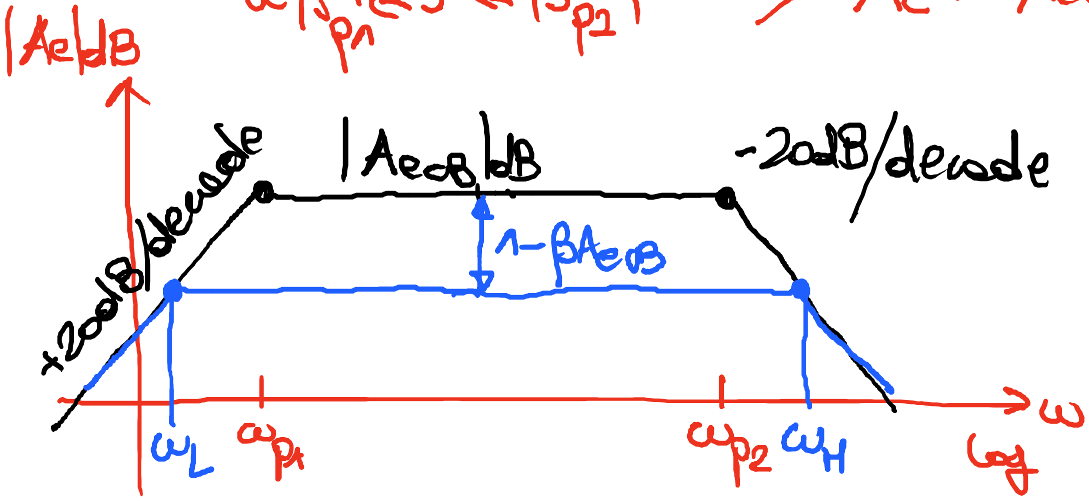


Tuesday, 2 May 2017 15:01

3) $$A_e = \frac{s\,A_{eCB}}{\left(1 - s/s_{p_2}\right)\left(s - s_{p_1}\right)}$$

$|s_{p_1}| \ll |s_{p_2}|$

se $|s_{p_1}| \ll s \ll |s_{p_2}|$ $\rightarrow$ $A_e \cong A_{eCB}$



β cost

Tuesday, 2 May 2017 15:05

$$A_F = \frac{A_e}{1-\beta A_e} = \frac{s\, A_{eCB}}{(1-s/s_{p2})(s-s_{p1}) - \beta s A_{eCB}}$$

$$A_F = \frac{s\, A_{eCB}}{\left(s - s_{p1} - \frac{s^2}{s_{p2}} + \cancel{\frac{s\, s_{p1}}{s_{p2}}} - \beta A_{eCB}\, s\right)} = \frac{s\,\frac{A_{eCB}}{1-\beta A_{eCB}}}{s - \frac{s_{p1}}{1-\beta A_{eCB}} - \frac{s^2}{s_{p2}(1-\beta A_{eCB})}}$$

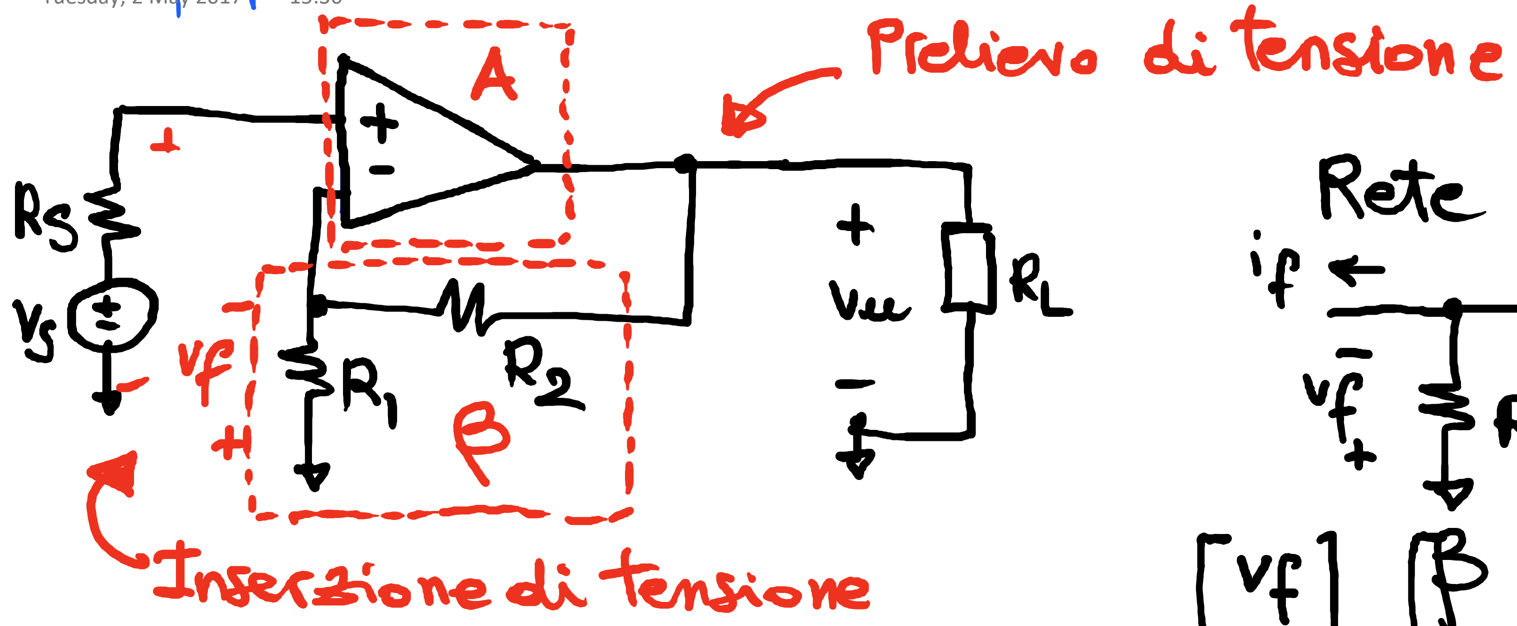
$$A_F = \frac{s A_{FCB}}{(1-s/s_H)(s-s_L)} = \frac{s A_{FCB}}{s - s_L - \frac{s^2}{s_H} + \cancel{\frac{s s_L}{s_H}}}$$

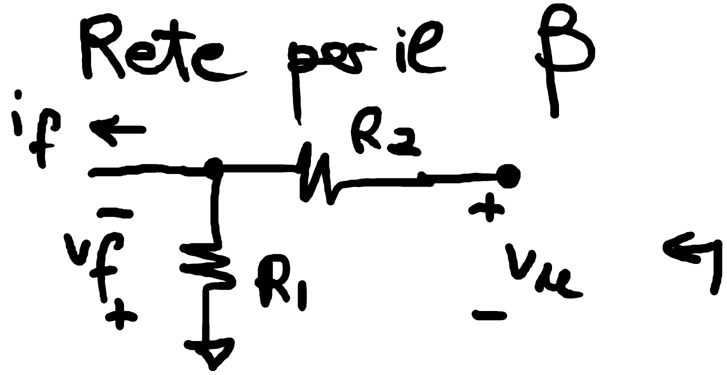
$$s_L = \frac{s_{p1}}{(1-\beta A_{eCB})}$$

$$s_H = s_{p2}\,(1-\beta A_{eCB})$$

Amplificatore non invertente

Tuesday, 2 May 2017 15:30





$$\begin{bmatrix} v_f \\ i_u \end{bmatrix} = \begin{bmatrix} \beta & R_{o\beta} \\ \frac{1}{R_{i\beta}} & \times \end{bmatrix} \begin{bmatrix} v_u \\ i_f \end{bmatrix}$$

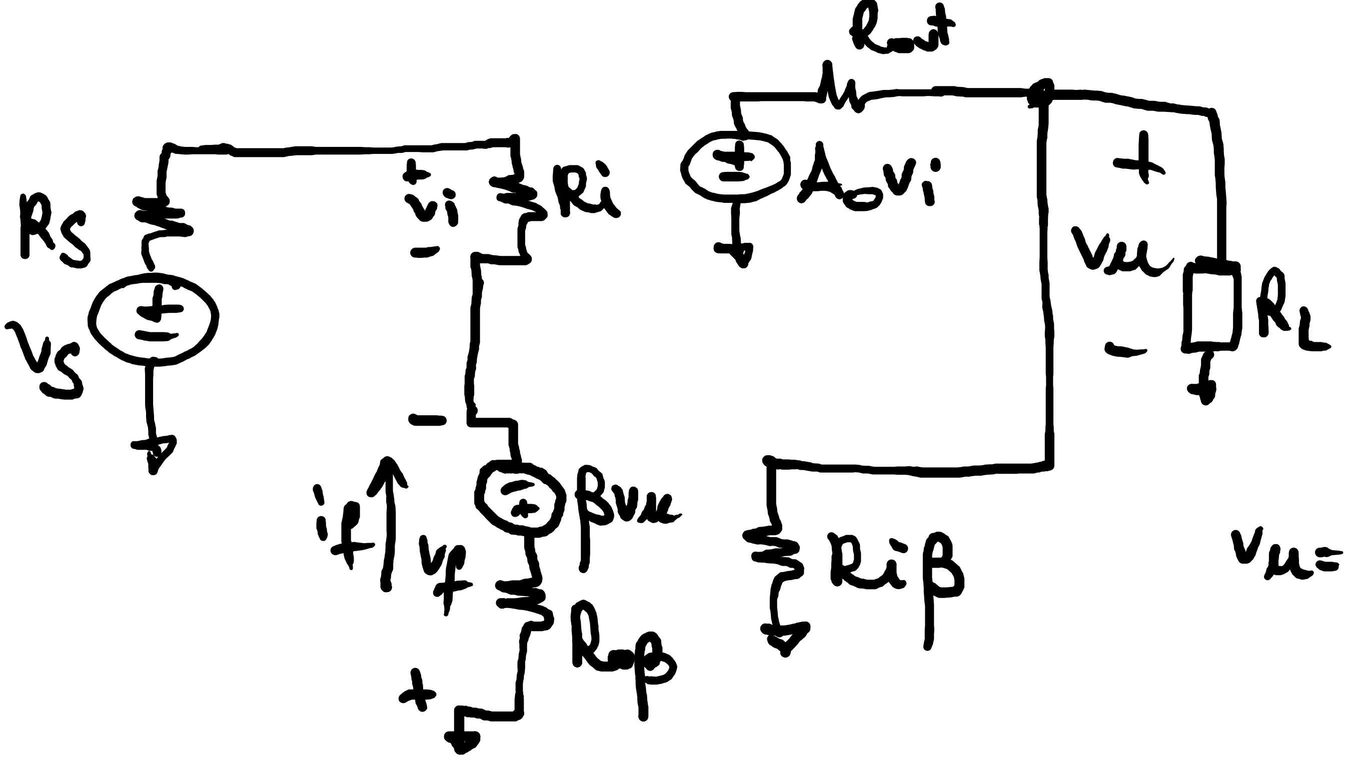
$$\beta \triangleq \left.\frac{v_f}{v_u}\right|_{i_f=0} = \frac{R_1}{R_1+R_2}$$

$$R_{o\beta} \triangleq \left.\frac{v_f}{i_f}\right|_{v_u=0} = R_1 /\!/ R_2$$

$$R_{i\beta} \triangleq \left.\frac{v_u}{i_u}\right|_{i_f=0} = R_2 + R_1$$

Calcolo di Ae

Tuesday, 2 May 2017 15:43



$$A_e = \left.\frac{v_u}{v_S}\right|_{\beta=0}$$

$$v_i = v_S \frac{R_i}{R_i + R_S + R_{o\beta}}$$

$$v_u = A_o v_i \frac{R_L /\!/ R_i}{R_{out} + R_L /\!/ R_i}$$

$$A_e = \left.\frac{v_u}{v_S}\right|_{\beta=0} = A_o \frac{R_L /\!/ R_i}{R_{out} + R_L /\!/ R_i} \cdot \frac{R_i}{R_i + R_S + R_{o\beta}}$$

Tuesday, 2 May 2017 15:47

$$A_F = \frac{A_e}{1-\beta A_e} = \frac{v_u}{v_s} \underset{\text{se}\,|\beta A_e| \gg 1}{=} \qquad A_F \simeq -\frac{1}{\beta} = \underline{\underline{\frac{R_1+R_2}{R_1}}}$$

coincide con l'approx di c.c.v.

se A_e ha un polo (è il polo di A_o)
allora A_F ha un polo : $\omega_H = \omega_p(1-\beta A_{e0})$

$$\boxed{\omega_H = \frac{\omega_p A_{e0}}{A_{F0}}}$$

se $|1-\beta A_e| \gg 1$
$R_{iF} \to \infty$
$\underline{\underline{R_{oF} \to 0}}$

$$R_{iF} = (R_i + R_{o\beta})(1-\beta A_e|_{R_S=0}) \qquad R_{oF} = \frac{(R_{out} /\!/ R_{i\beta})}{(1-\beta A_e|_{R_L\to\infty})}$$

$A_{vo} = 1000$

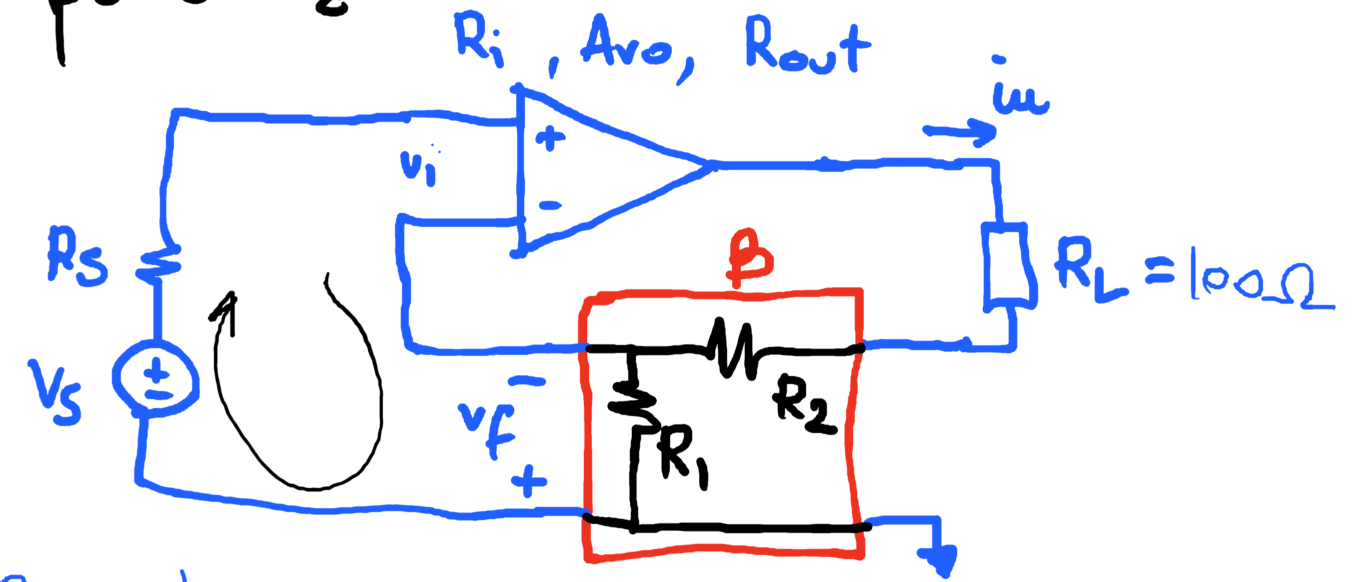
$R_i = 100\ k\Omega$

$R_{out} = 100\ \Omega$

$\omega_p = 100\ Hz$

$R_{IF} = 1-2\ M\Omega \Rightarrow R_{IF} > R_i$ INSERZIONE DI TENSIONE

$R_{OF} > 100\ k\Omega \Rightarrow R_{OF} > R_{out}$ PRELIEVO DI CORRENTE



$R_S = 2\ k\Omega$

Rete del β

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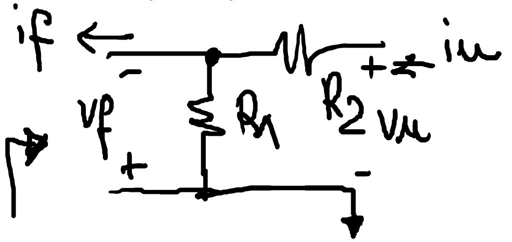
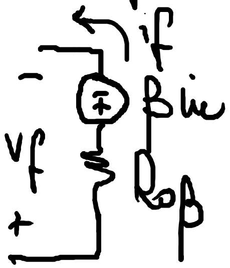
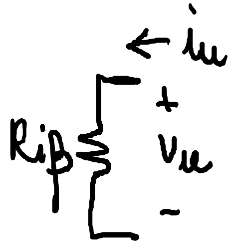


$$\begin{bmatrix} v_f \\ v_u \end{bmatrix} = \begin{bmatrix} \beta & R_{o\beta} \\ R_{i\beta} & 0 \end{bmatrix} \begin{bmatrix} i_u \\ i_f \end{bmatrix}$$

$$\beta \triangleq \left.\frac{v_f}{i_u}\right|_{i_f=0} = -R_1 \;; \quad R_{o\beta} \triangleq \left.\frac{v_f}{i_f}\right|_{i_u=0} = R_1 \;; \quad R_{i\beta} \triangleq \left.\frac{v_u}{i_u}\right|_{i_f=0} = R_1 + R_2$$





$$A_e = i_o / v_s \big|_{\beta=0}$$

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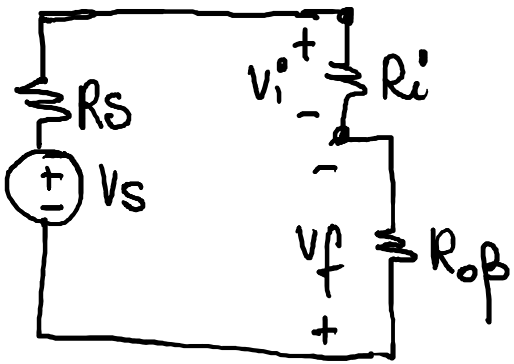

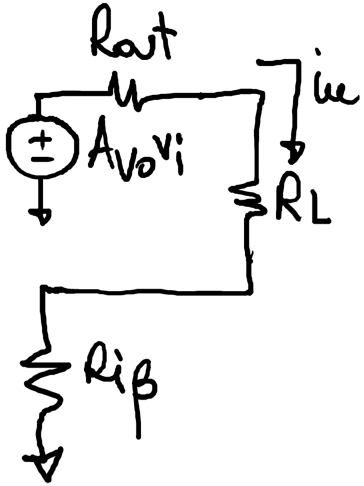

$$v_i = v_s \frac{R_i}{R_i + R_s + R_{o\beta}}$$

$$i_o = \frac{A_{vo} v_i}{R_{out} + R_L + R_{i\beta}}$$

$$A_e = \frac{A_{vo}}{R_{out} + R_L + R_{i\beta}} \cdot \frac{R_i}{R_i + R_s + R_{o\beta}}$$

$$R_{IF} = (\underset{100\,k\Omega}{R_i} + \underset{R_1}{R_{o\beta}})\left(1 - \beta \underset{-R_1}{A_e}\Big|_{R_S=0}\right) \qquad 1M\Omega < R_{iF} < 2M\Omega$$

$$R_{oF} = (\underset{100\,\Omega}{R_{out}} + \underset{R_1+R_2}{R_{i\beta}})\left(1 - \beta A_e\Big|_{R_L=0}\right) \qquad R_{oF} > 100\,k\Omega$$

$[R_1, R_2]$

$$1 - \underset{-10}{\beta A_e} = 1 + R_1 \frac{\overset{1000}{A_{vo}}}{\underset{100\,\Omega}{R_L} + \underset{100\,\Omega}{R_{out}} + R_1 + R_2} \cdot \frac{\overset{100\,k\Omega}{R_i}}{R_i + \underset{2\,k\Omega}{R_S} + R_1} = 11$$

$R_1 = 1k\Omega$

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$\beta A_e\Big|_{R_S=0} = -10 \rightarrow \underbrace{\beta A_e}_{-10} = \underbrace{-R_1}_{1} \frac{\overbrace{A_{vo}}^{1000}}{R_L + R_{out} + R_1 + R_2} \cdot \frac{R_i}{R_i + \cancel{R_S} + R_1}$

$\frac{100}{101}$

$\underbrace{R_L}_{200} + R_{out} + \underbrace{R_1}_{1k} + R_2 \cong 100k \rightarrow R_2 = 100k\Omega$

$$\beta A_e\Big|_{R_S=0} = -R_1 \frac{A_{vo}}{R_L + R_{out} + R_1 + R_2} \cdot \frac{R_i}{R_i + R_1} = \frac{-1000}{101.2} \cdot \frac{100}{101} = 9{,}8$$

$$\beta A_e\Big|_{R_L=0} \quad \frac{-1000}{101{,}1} \cdot \frac{100}{103} = 0{,}96$$

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OK

$$R_{IF} = (R_i + R_o\beta)\left(1 - \beta A_e\big|_{R_f=0}\right) = 101 \cdot (1+9.8) = 101.10.8 = \boxed{1.09\,M\Omega}$$

$$R_{OF} = (R_{out} + R_i\beta)\left(1 - \beta A_e\big|_{R_L=0}\right) = 101.1\,(1+9.6) = 101.1.10.6 =$$

$$= \boxed{1.07\,M\Omega}$$

OK