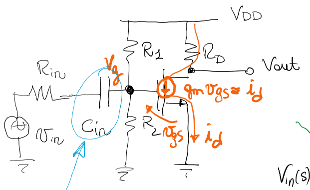
Nel dominio di Laplace l'impedenza di un condensatore è $Z(s) = 1/sC$

DIMENSIONAMENTO CAPACITÀ DI DISACCOPPIAMENTO IN INGRESSO

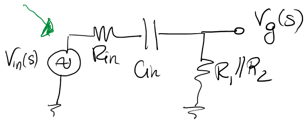


capacità di disaccoppiamento in ingresso

FUNZIONE DI TRASFERIMENTO

$$T(s) \triangleq \frac{V_{out}(s)}{V_{in}(s)} =$$

Tensione di segnale al nodo di gate



$$V_g(s) = \frac{R_1 // R_2}{R_{in} + 1/sC_{in} + R_1//R_2} V_{in}(s) =$$

$$= \frac{sC_{in} R_1//R_2}{1 + \underbrace{sC_{in}(R_{in} + R_1//R_2)}_{\tau = C_{in}(R_{in}+R_1//R_2)}} V_{in}(s)$$

$$V_{out}(s) = -g_m V_g(s) R_D =$$

$$= -g_m R_D \frac{sC_{in} R_1//R_2}{1 + sC_{in}(R_{in} + R_1//R_2)} V_{in}(s)$$

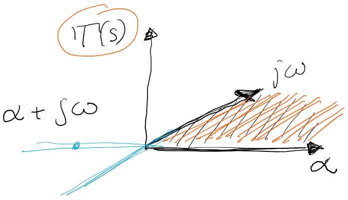
zero nell'origine

$$T(s) = - \frac{s C_{in} R_1//R_2}{1 + s C_{in}(R_{in} + R_1//R_2)} \cdot g_m R_D$$

stadio invertente

$$s = -\frac{1}{C_{in}(R_{in} + R_1//R_2)}$$

polo con costante di tempo $\tau_p = C_{in}(R_{in} + R_1//R_2)$



$s = \alpha + j\omega$

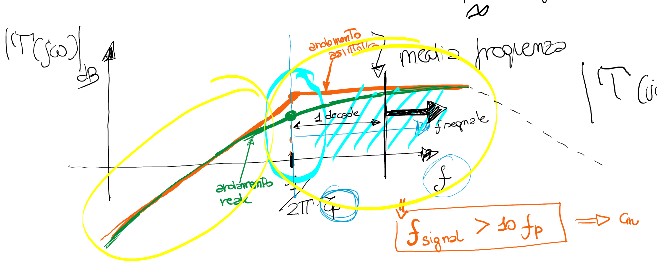
$$T_{MF} = -\frac{R_1 // R_2}{R_{in} + R_1 // R_2} g_m R_D$$

MEDIA FREQUENZA

$$|T(j\omega)| = \left| -g_m R_D \frac{j\omega C_{in} R_1//R_2}{1 + j\omega C_{in}(R_{in} + R_1//R_2)} \right| =$$

$$= g_m R_D \frac{\omega C_{in} R_1//R_2}{\sqrt{1 + \omega^2 \tau_p^2}} \qquad \tau_p = C_{in}(R_{in} + R_1//R_2)$$

$$\omega \to \infty \qquad |T(j\omega)|_\infty = g_m R_D \frac{\cancel{C_{in}} R_1//R_2}{\cancel{C_{in}}(R_{in} + R_1//R_2)}$$

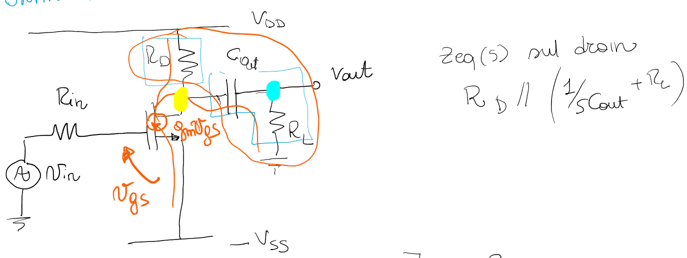


$f_{signal} > 10 f_p \Rightarrow C_{in}$

bassa frequenza

$$|T(j\omega)|_{dB} = 20 \log_{10} |T(j\omega)|$$

DIMENSIONAMENTO DELLA CAPACITÀ DI DISACCOPPIAMENTO IN USCITA



$Z_{eq}(s)$ sul drain

$$R_D // \left(1/sC_{out} + R_L \right)$$

$$T(s) \triangleq \frac{V_{out}(s)}{V_{in}(s)} = -g_m \left[R_D // \left(R_L + \frac{1}{sC_{out}} \right) \right] \cdot \frac{R_L}{R_L + 1/sC_{out}} =$$

$$= -g_m \frac{R_D \cancel{(R_L + 1/sC_{out})}}{R_D + R_L + 1/sC_{out}} \cdot \frac{R_L}{\cancel{R_L + 1/sC_{out}}} =$$

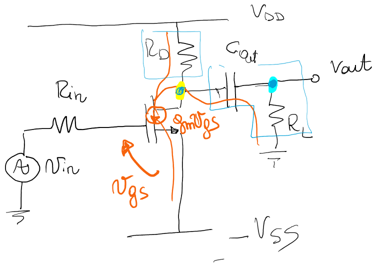
$$= -g_m \frac{R_D R_L (sC_{out})}{1 + sC_{out}(R_D + R_L)} \cdot \frac{(R_D + R_L)}{(R_D + R_L)}$$

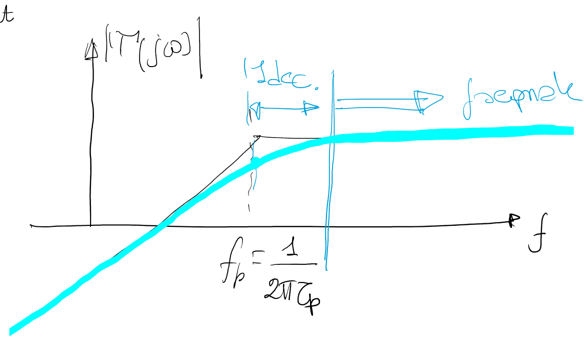
$$= -g_m \frac{R_D R_L \, (s C_{out})}{1 + s C_{out}(R_D + R_L)} \cdot \frac{(R_D+R_L)}{(R_D+R_L)}$$

zero nell'origine

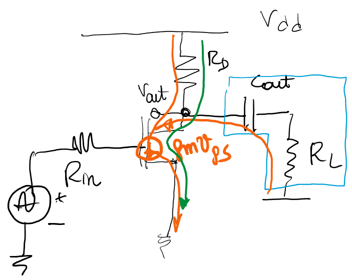
$$= -g_m \underbrace{\frac{R_D R_L}{R_D + R_L}}_{R_D /\!/ R_L} \cdot \frac{s C_{out}(R_D+R_L)}{1 + s C_{out}(R_D+R_L)}$$

polo con $\tau_p = C_{out}(R_D+R_L)$





$\omega = 2\pi f$



BASSA FREQ.
C_{out} aperto
$|T(j\omega)|_{LF} = g_m R_D$

MEDIA (o ALTA) FREQUENZA
C_{out} corto circuito
$|T(j\omega)|_{MF} = g_m R_L /\!/ R_D$

FdT

$$T(s) \triangleq \frac{V_{out}(s)}{V_{in}(s)} = -g_m \, Z_{eq}(s) =$$

$$Z_{eq}(s) = R_D /\!/ \left(R_L + \tfrac{1}{sC_{out}}\right) =$$

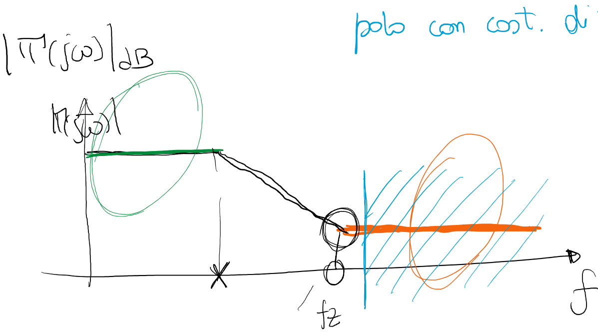
$$= \frac{R_D\left(R_L + \tfrac{1}{sC_{out}}\right)}{R_D + R_L + \tfrac{1}{sC_{out}}} =$$

zero con costante di tempo $\tau_z = C_{out} R_L$

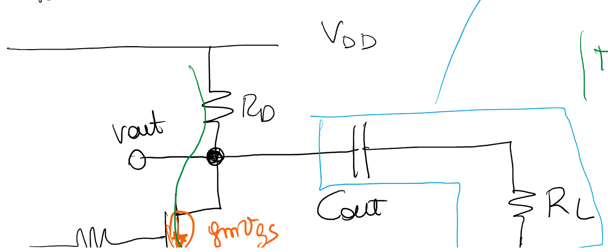
$$= \frac{R_D\,(1 + s C_{out} R_L)}{1 + s C_{out}(R_D + R_L)} =$$

$$= -g_m R_D \frac{1 + s C_{out} R_L}{1 + s\, C_{out}(R_D + R_L)}$$

polo con cost. di tempo $\tau_p = C_{out}(R_D + R_L)$

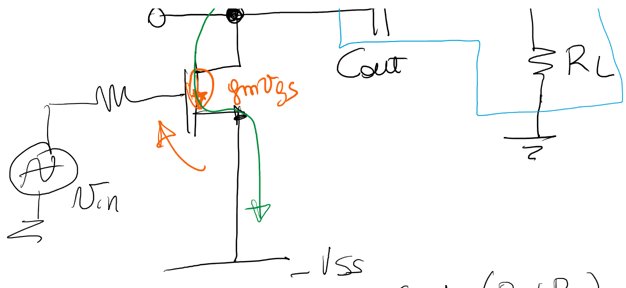


$$Z_L(s) = \frac{1}{s C_{out}} + R_L = 0 \qquad \tau_z = C_{out} R_L$$



$|T_{LF}|$ BASSA FREQ. LOW FREQ. C_{out} circ. aperto

$$\left.\frac{V_{out}}{V_{in}}\right|_{LF} = -g_m R_D$$



$$\left.\frac{v_{out}}{v_{in}}\right|_{LF} = -g_m R_D$$

$|T_{MF}|$ MEDIA FREQUENZA

Cout "già intervenuta"

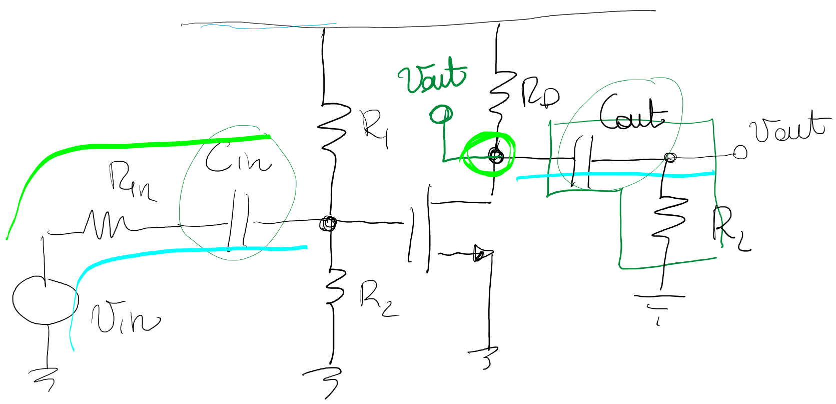
Cout c.c.

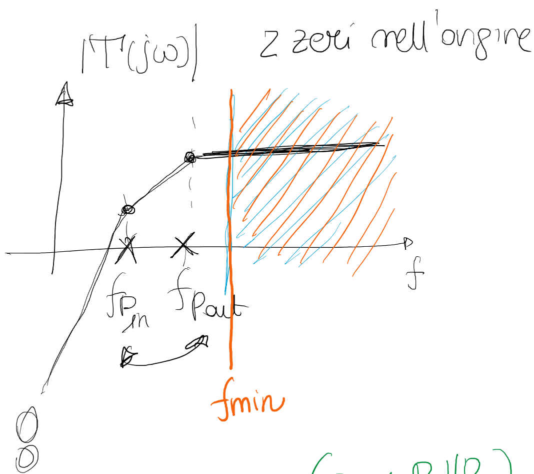
singolarità: • polo $\tau_p = C_{out}(R_D + R_L)$ $\quad |T_{MF}| = |-g_m(R_D // R_L)|$

• zero ?

Avere uno zero nella funzione di trasferimento, significa che

$\exists\ \bar{s}$ t.c. $\forall\ V_{in}(\bar{s}) \neq 0 \Rightarrow V_{out}(\bar{s}) = 0$





$\tau_{pin} = C_{in}(R_{in} + R_1 // R_2)$

$\tau_{pout} = C_{out}(R_L + R_D)$

segnale audio $\quad f \in [20\,Hz, 20\,kHz]$

fmin $\quad$ fmax

$\Downarrow$

$f_{min} \geq 10 \max(f_{pin}; f_{pout})$

$|T(j\omega)|$ 1 zero nell'origine di Cin

1 zero con $\tau_z = C_{out} R_L$