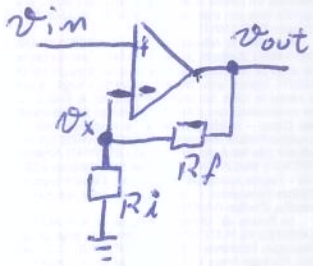
Aula 12 A

✱ Largura de banda finita

- Revisão

+ Amplificador não inversor

- $A_{0_{MA}} = \infty$ (Amplificador ideal) $\Rightarrow v_x = v_{in}$



$$\Rightarrow \frac{v_x}{R_i} = \frac{v_{out}}{R_A+R_i} \Rightarrow v_{out} = v_x\left(\frac{R_A+R_i}{R_i}\right)$$

$$\Rightarrow \frac{v_{out}}{v_{in}} \Rightarrow \boxed{A_{v_{id}} = 1+\frac{R_A}{R_i}}$$

- $A_0 < \infty$ (Amplificador não ideal)

$$\Rightarrow v_{out} = (v_{in} - v_x)\cdot A_0 = \left(v_{in} - \frac{v_{out}}{R_A+R_i}\cdot R_i\right)\cdot A_0$$

$$v_{out} = A_0 v_{in} - A_0 v_{out}\frac{R_i}{R_A+R_i}$$

$$v_{out}\left(1 + A_0\frac{R_i}{R_A+R_i}\right) = A_0 v_{in}$$

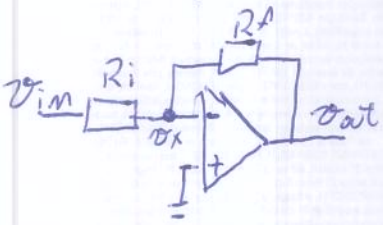
$$\frac{v_{out}}{v_{in}} = \frac{A_0}{1+A_0\frac{R_i}{R_A+R_i}}\cdot\left(R_i/\!/(R_A+R_i)\right)^{-1} = \frac{A_0\left(\frac{R_A+R_i}{R_A}\right)}{\frac{R_A+R_i}{R_A}+A_0}$$

$$\frac{v_{out}}{v_{in}} = \frac{A_0\left(\frac{R_i}{R_A}+1\right)}{\left(\frac{R_i}{R_f}+1\right)+A_0} = \frac{A_0 A_{v_{id}}\cdot A_0^{-1}}{A_{v_{id}}+A_0\cdot A_0^{-1}}$$

$$\Rightarrow \boxed{A_{v_{nid}} = \frac{A_{v_{id}}}{\frac{A_{v_{id}}}{A_0}+1}}$$

+ Amplificador inversor

- $A_o = \infty$



$v_x = 0$

$$\frac{v_{in}}{R_i} = -\frac{v_{out}}{R_f} \Rightarrow \frac{v_{out}}{v_{in}} = \frac{-R_f}{R_i} \Rightarrow \boxed{A_{vid} = \frac{-R_f}{R_i}}$$

- $A_o < \infty$

$$\begin{cases} \dfrac{v_{in} - v_x}{R_i} = -\dfrac{(v_{out} - v_x)}{R_f} \\ v_{out} = -v_x \cdot A_o \end{cases}$$

$$\frac{v_{in} - v_x}{R_i} = -\frac{(-v_x A_o - v_x)}{R_f} \Rightarrow \frac{v_{in} - v_x}{R_i} = \frac{v_x (A_o + 1)}{R_f}$$

$$v_{in} = \frac{v_x R_i}{R_f} \cdot (A_o + 1) + v_x \Rightarrow v_{in} = v_x \left[\frac{R_i}{R_f}(A_o + 1) + 1\right]$$

$$\frac{v_{out}}{v_{in}} = \frac{-A_o}{\frac{R_i}{R_f}\cdot(A_o+1)+1} = \frac{-A_o}{-A_{vid}\cdot(A_o+1)+1} \cdot \frac{-A_{vid}}{-A_{vid}} = \frac{A_o A_{vid}}{A_o + 1 - A_{vid}} \cdot \frac{A_o^{-1}}{A_o^{-1}}$$

$$\frac{v_{out}}{v_{in}} = \frac{A_{vid}}{1 + \frac{1}{A_o}\cdot(1 - A_{vid})} \Rightarrow \boxed{A_{v_{mid}} = \frac{A_{vid}}{1 + \frac{1}{A_o}\cdot(1 - A_{vid})}}$$

=> Considerando a largura de banda finita

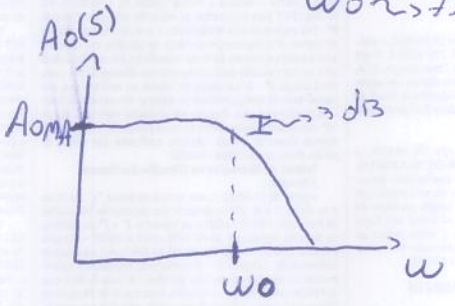
-> O ganho de malha aberta varia com a frequência:

$$A_o(s) = \frac{A_{oMA}}{1 + \frac{s}{\omega_o}}$$

A_{oMA} -> ganho de malha aberta c.c.

=> filtro passa baixa

ω_o -> freq. de corte de malha aberta



=> Amplificador não inversor

$$A_{onid} = \frac{A_{oid}}{\frac{A_{oid}}{A_o} + 1} = \frac{A_{oid}}{\frac{\frac{A_{oid}}{A_{oMA}} + 1}{1 + \frac{s}{\omega_o}}} = \frac{A_{oid}}{\frac{A_{oid}}{A_{oMA}} \cdot \left(1 + \frac{s}{\omega_o}\right) + 1} \cdot \left(\frac{A_{oMA}}{A_{oid}}\right)$$

$$\boxed{A_{onid}(s) = \frac{A_{oMA}}{1 + \frac{s}{\omega_o} + \frac{A_{oMA}}{A_{oid}}}} = \frac{A_{oMA}}{\left(1 + \frac{A_{oMA}}{A_{oid}}\right)\left(1 + \frac{s}{\omega_o \left(1 + \frac{A_{oMA}}{A_{oid}}\right)}\right)}$$

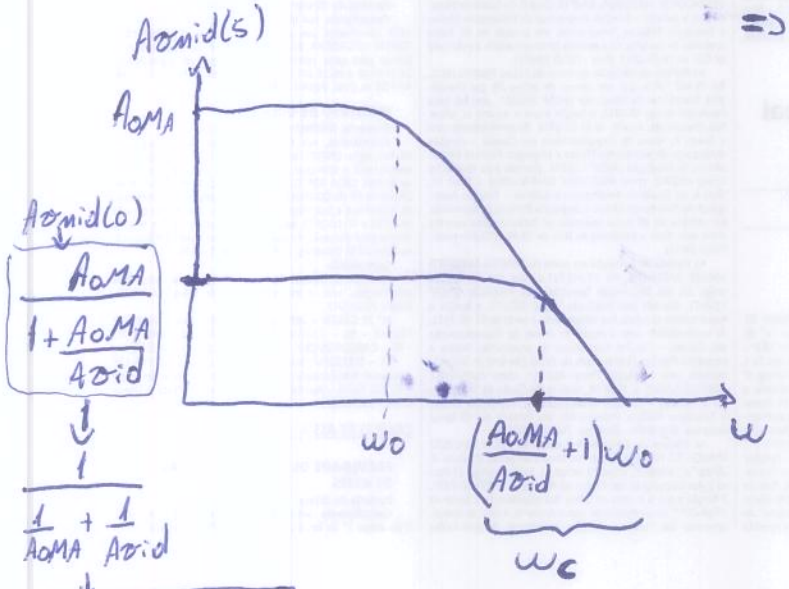
$$\boxed{s_p = -\left(\frac{A_{oMA}}{A_{oid}} + 1\right)\omega_o}$$

=> $\omega_c \cdot A_{onid}(\emptyset) = A_{oMA} \cdot \omega_o$ -> ganho para $s = \emptyset$

$$\boxed{\omega_c \cdot A_{oid} \cong A_{oMA} \cdot \omega_o} \quad \left(\frac{|R_f|}{|R_i|} + 1\right)$$

-> para Ao alto ($\gg A_{oid}$)

-> produto ganho . largura de banda é constante



=> Amplificador inversor

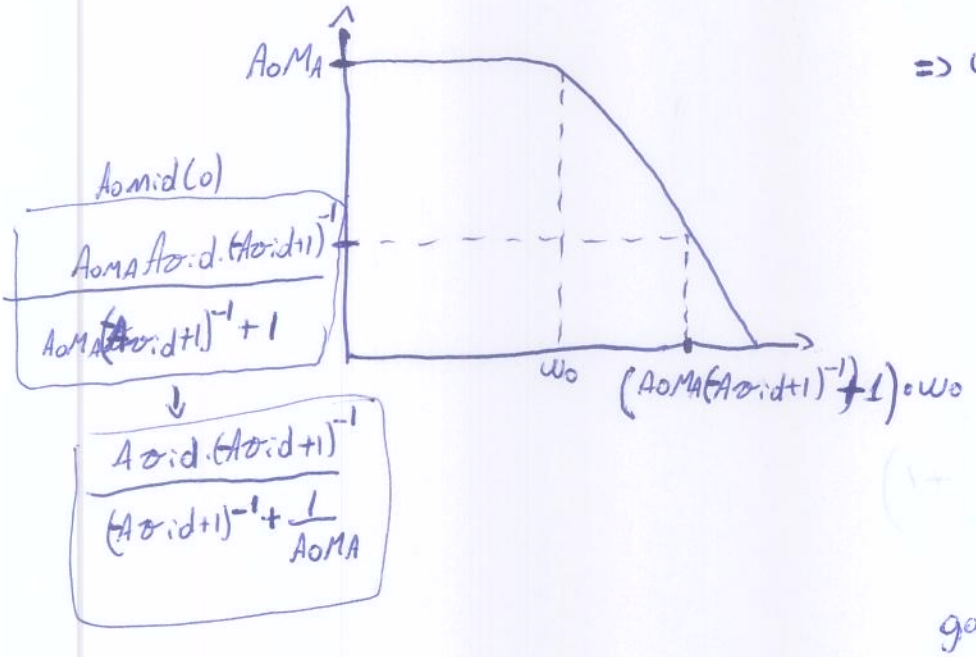
$$A_{Vnid} = \frac{A_{Vid}}{1 + \frac{1}{A_{OMA}} \cdot (1 - A_{Vid})}$$

$$A_{Vnid}(s) = \frac{A_{Vid}}{1 + \frac{1}{A_{OMA}\left(1 + \frac{s}{\omega_0}\right)^{-1}} \cdot (1 - A_{Vid})} = \frac{A_{Vid}}{1 + \frac{(1 + \frac{s}{\omega_0})}{A_{OMA}} \cdot (1 - A_{Vid})} \cdot A_{OMA}$$

$$A_{Vnid}(s) = \frac{A_{Vid}\, A_{OMA}}{A_{OMA} + \left(1 + \frac{s}{\omega_0}\right) \cdot (1 - A_{Vid})} = \frac{A_{Vid} \cdot A_{OMA}}{A_{OMA} + (1 - A_{Vid}) + \frac{s}{\omega_0}(1 - A_{Vid}) - (1 - A_{Vid})} \cdot (1 - A_{Vid})^{-1}$$

$$\boxed{A_{Vnid}(s) = \frac{A_{OMA} \cdot A_{Vid} \cdot (-A_{Vid} + 1)^{-1}}{A_{OMA}(-A_{Vid} + 1)^{-1} + 1 + \frac{s}{\omega_0}}}$$

$$s_p = -\left(A_{OMA}(-A_{Vid} + 1)^{-1} + 1\right) \cdot \omega_0$$



$$\frac{A_{Vid} \cdot (-A_{Vid} + 1)^{-1}}{(-A_{Vid} + 1)^{-1} + \frac{1}{A_{OMA}}}$$

$$\Rightarrow \omega_c \cdot A_{Vnid}(0) = A_{OMA} \cdot A_{Vid} \cdot (-A_{Vid} + 1)^{-1} \cdot \omega_0$$

$$\Downarrow \; p/\, A_{Vid} >> 1 \rightsquigarrow -\frac{R_f}{R_i}$$

$$\boxed{\omega_c A_{Vnid}(0) = A_{OMA} \cdot \omega_0}$$

$$\Downarrow \; A_0 \text{ alto} (>> 1)$$

$$\boxed{\omega_c A_{Vid} = A_{OMA} \cdot \omega_0}$$

produto = cte

ganho x largura de banda = cte

obs: Quanto maior o ganho, menor ω_c, ou seja, o aumento da banda de passagem é a custa da queda do ganho.