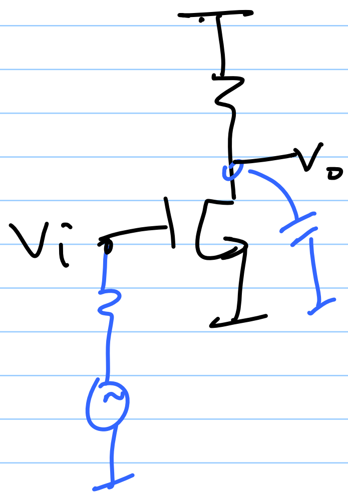
31-10-12

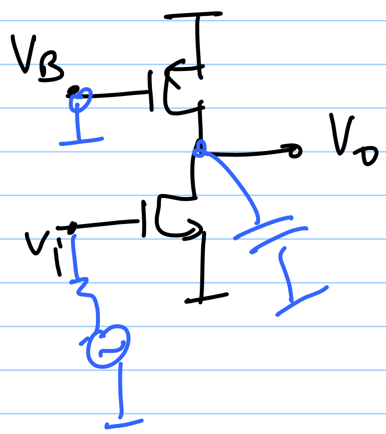
Lec 39

Amplifier

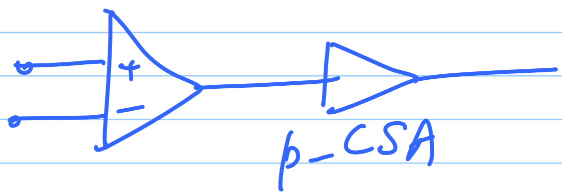
* Every node of the amp. has a parasitic cap associated with it
  ⇒ pole associated with the cap @ each node

* More gain ⇒ cascade of amplifiers
  ⇒ more # nodes ⇒ more # poles

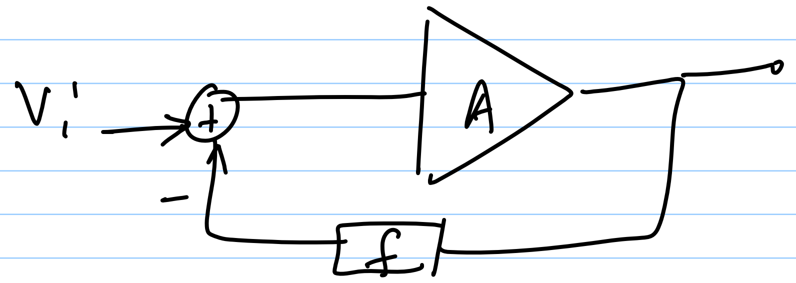




2-pole system



more nodes
⇒ more poles



$$\frac{V_o}{V_i} = \frac{1}{f}\,\frac{Af}{1+Af}$$

$$\sim \frac{1}{f} \text{ if } Af \text{ is large}$$

$$A = A(s)$$

$$\Rightarrow \quad CLG = \frac{1}{f} \cdot \frac{A(s)\cdot f}{1 + A(s)\cdot f} = CLG(s)$$

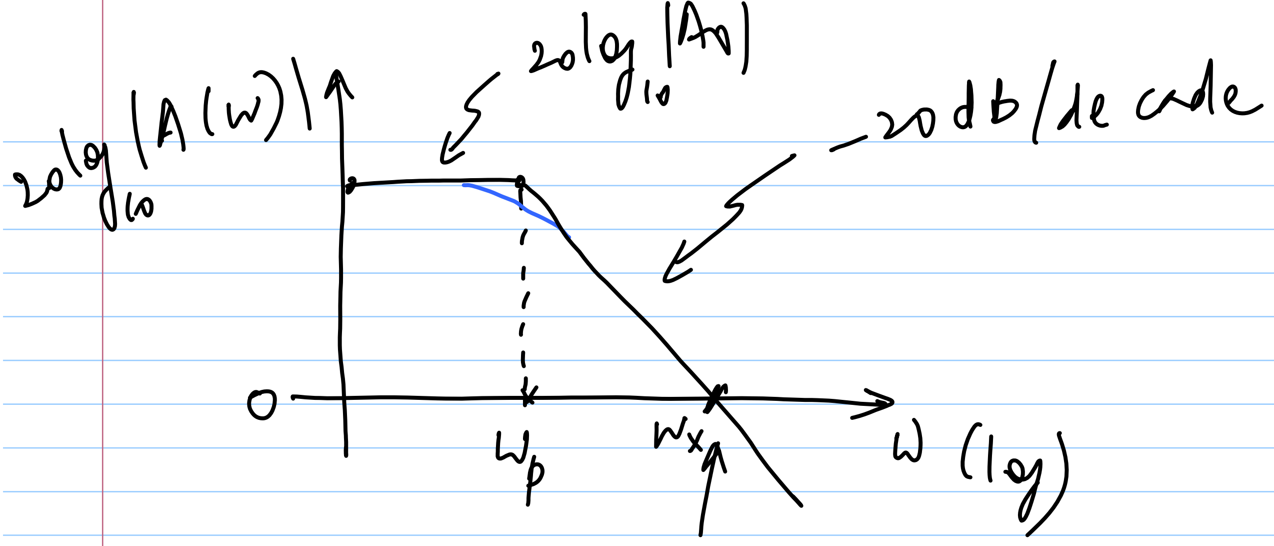
$$A(s) = \frac{A_0}{1 + s/\omega_p} \quad \leftarrow \text{single pole amp.}$$

@ low freq., $A(s) \approx A_0$

$LG \approx A_0 f$

$CLG \approx \dfrac{1}{f}$

* $\omega \uparrow \Rightarrow |A(\omega)|$ starts reducing @ ω_p
  but CLG stays close to $1/f$
  till $|A(\omega)\cdot f| \sim 1$



$A_0 f = 10000$

CLG

$$w_x = w_p \cdot A_0$$

$$CLG(s) = \frac{1}{f} \cdot \frac{A(s)\cdot f}{1 + A(s)\cdot f}$$

$$= \frac{1}{f} \cdot \frac{A_0 f}{1 + s/w_p} \cdot \cancel{f \left[1 + \left(\frac{A_0 f}{1 + s/w_p}\right)\right]}$$

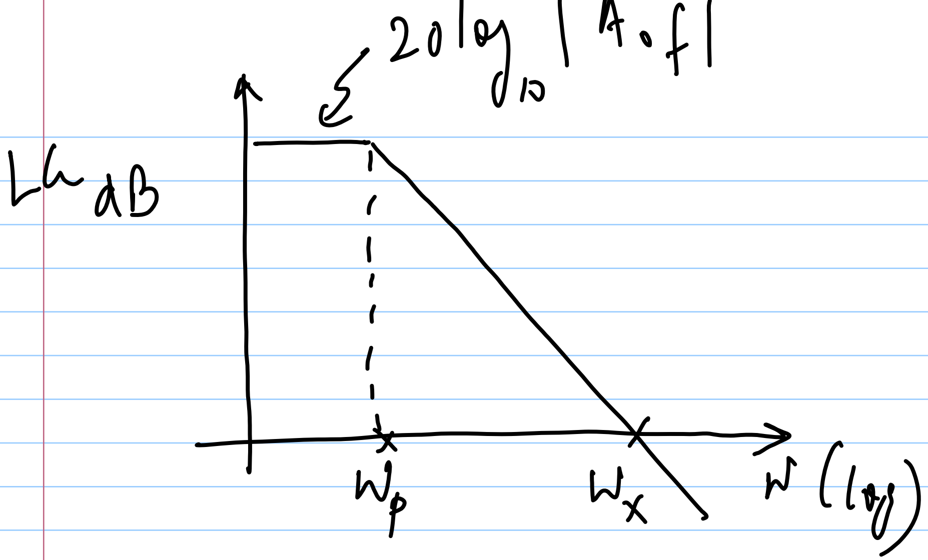
$$= \frac{1}{f} \cdot \frac{A_0 f}{1 + \frac{s}{w_p} + A_0 f}$$

$$CLG(s) = \frac{1}{f} \cdot \frac{A_0 f}{1 + A_0 f} \cdot \frac{1}{1 + \frac{s}{w_p(1 + A_0 f)}}$$

$$CLG(s) = \frac{1}{f} \cdot \frac{A_0 f}{1 + A_0 f} \cdot \frac{1}{1 + \frac{s}{w_p(1 + A_0 f)}}$$

fwd amp BW $= w_p$

CLG BW $= w_p(1 + A_0 f) \approx w_p A_0 f$



$$w_x = A_0 f \cdot w_p$$

* Stability — 1) poles in LHP ✓

2) Unconditionally stable

2-pole system

$$A(s) = \frac{A_o}{(1 + s/\omega_p)^2}$$

$$CL(s) = \frac{1}{f} \cdot \frac{A_o f}{1 + A_o f} \cdot \frac{1}{\underbrace{1 + \frac{2s}{A_o f \cdot \omega_p} + \frac{s^2}{\omega_p^2 \cdot A_o f}}}$$

* Stability — 1) LHP poles ✓

2) Unconditionally stable

general 2nd order

$$\left(1 + \frac{s}{\omega_o \cdot Q} + \frac{s^2}{\omega_o^2}\right) \leftarrow \text{Dr.}$$ ✓

Quality factor

$$s^2 + 2\zeta\omega_n s + \omega_n^2$$

$$\frac{s}{\omega_o} = \frac{-1}{2Q} \pm j\sqrt{1 - \frac{1}{4Q^2}}$$ ✓

Small $-Q \Rightarrow$ 2 real poles in LHP

$Q = \frac{1}{2} \Rightarrow$ 2 equal poles

$Q > \frac{1}{2} \Rightarrow$ complex conjugate poles

$Q = \infty \Rightarrow$ poles on jw axis