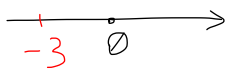
* Right-hand and Left-hand Zero :

$x+3=0 \Rightarrow x=-3$ (LH)



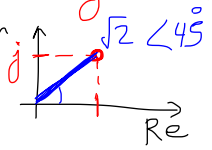
$$\frac{V_{out}(jw)}{V_{in}(jw)} = \frac{A_{v0}\left(1 \pm j\frac{w}{w_z}\right)}{\left(1+j\frac{w}{w_{p1}}\right)\left(1+j\frac{w}{w_{p2}}\right)}$$

$w_{p1} \ll (w_z, w_{p2})$

w_{p2} ? w_z

	w_z	w_{p1}	w_{p2}
(Worst) C.S	RHZ	LHP	LHP
C.G	—	LHP	LHP
(Best) C.D	LHZ	LHP	LHP

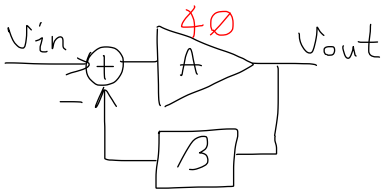
inherently stable



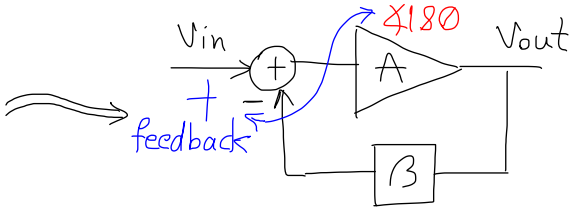
*Assume : $w_{p1} < w_{p2} < w_z$

- $w=0 \Rightarrow \left|\frac{V_{out}}{V_{in}}\right| = A_{v0}$, $\angle V_{out} - \angle V_{in} = 0$
- $w = w_{p1} \Rightarrow \frac{V_{out}}{V_{in}} = \frac{A_{v0}(1+j0)}{(1+j)(1+j0)}$
- $w_{p1} < w < w_{p2} \Rightarrow \frac{V_{out}}{V_{in}} = \frac{A_{v0}(1+j0)}{j\frac{w}{w_{p1}}(1+j0)} = -j\frac{A_{v0}.w_{p1}}{w}$
- $w = w_{p2} \Rightarrow \frac{V_{out}}{V_{in}} = \frac{A_{v0}(1+j0)}{j\frac{w}{w_{p1}}(1+j)}$
- $w_{p2} < w < w_z \Rightarrow \frac{V_{out}}{V_{in}} = \frac{A_{v0}(1+j0)}{j\frac{w}{w_{p1}} \cdot j\frac{w}{w_{p2}}} = -\frac{A_{v0}.w_{p1}.w_{p2}}{w^2}$

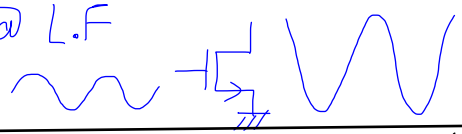
(negative feedback stable amplifier)



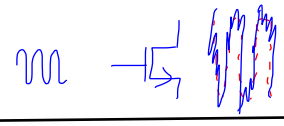
(positive feedback unstable amplifier)



@ L.F



@ H.F



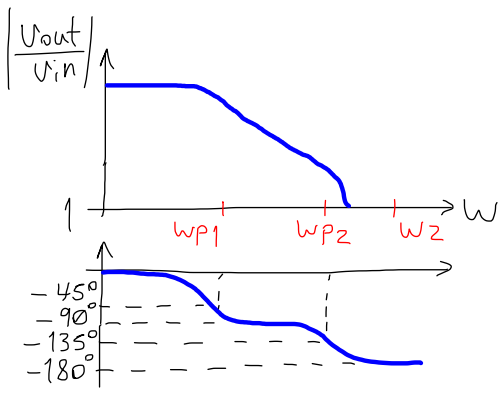
Example : $\frac{V_{out}}{V_{in}} = \frac{A_{v0}\left(1-j\frac{w}{w_z}\right)}{\left(1+j\frac{w}{w_{p1}}\right)\left(1+j\frac{w}{w_{p2}}\right)} \Rightarrow \angle V_{out} - \angle V_{in} = -45° - (45° + 45°) = -135°$

$\frac{V_{out}}{V_{in}} = \frac{A_{v0}\left(1+j\frac{w}{w_z}\right)}{\left(1+j\frac{w}{w_{p1}}\right)\left(1+j\frac{w}{w_{p2}}\right)} \Rightarrow \angle V_{out} - \angle V_{in} = 45° - (45° + 45°) = -45°$

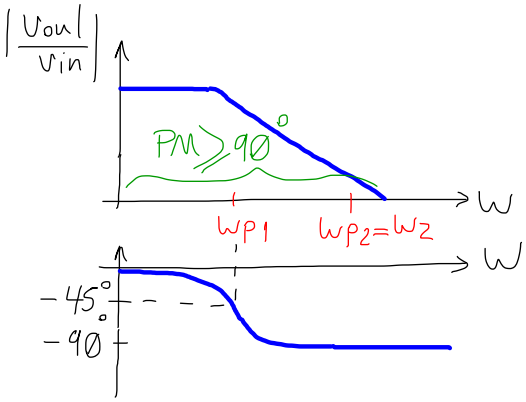
* How to choose the value of w_z in a Common Drain amplifier:

$$\frac{V_{out}(jw)}{V_{in}(jw)} = \frac{A_{v0}\left(1+j\frac{w}{w_z}\right)}{\left(1+j\frac{w}{w_{p1}}\right)\left(1+j\frac{w}{w_{p2}}\right)}$$

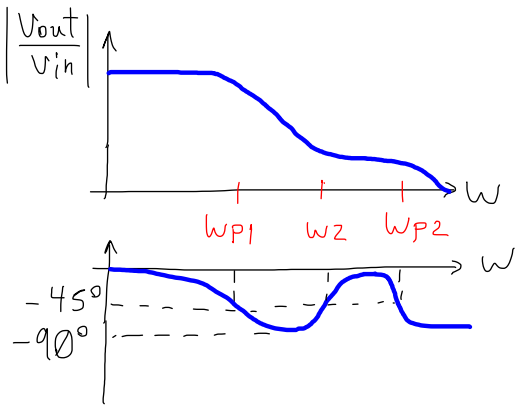
$w_{p1} < w_{p2} < w_z$

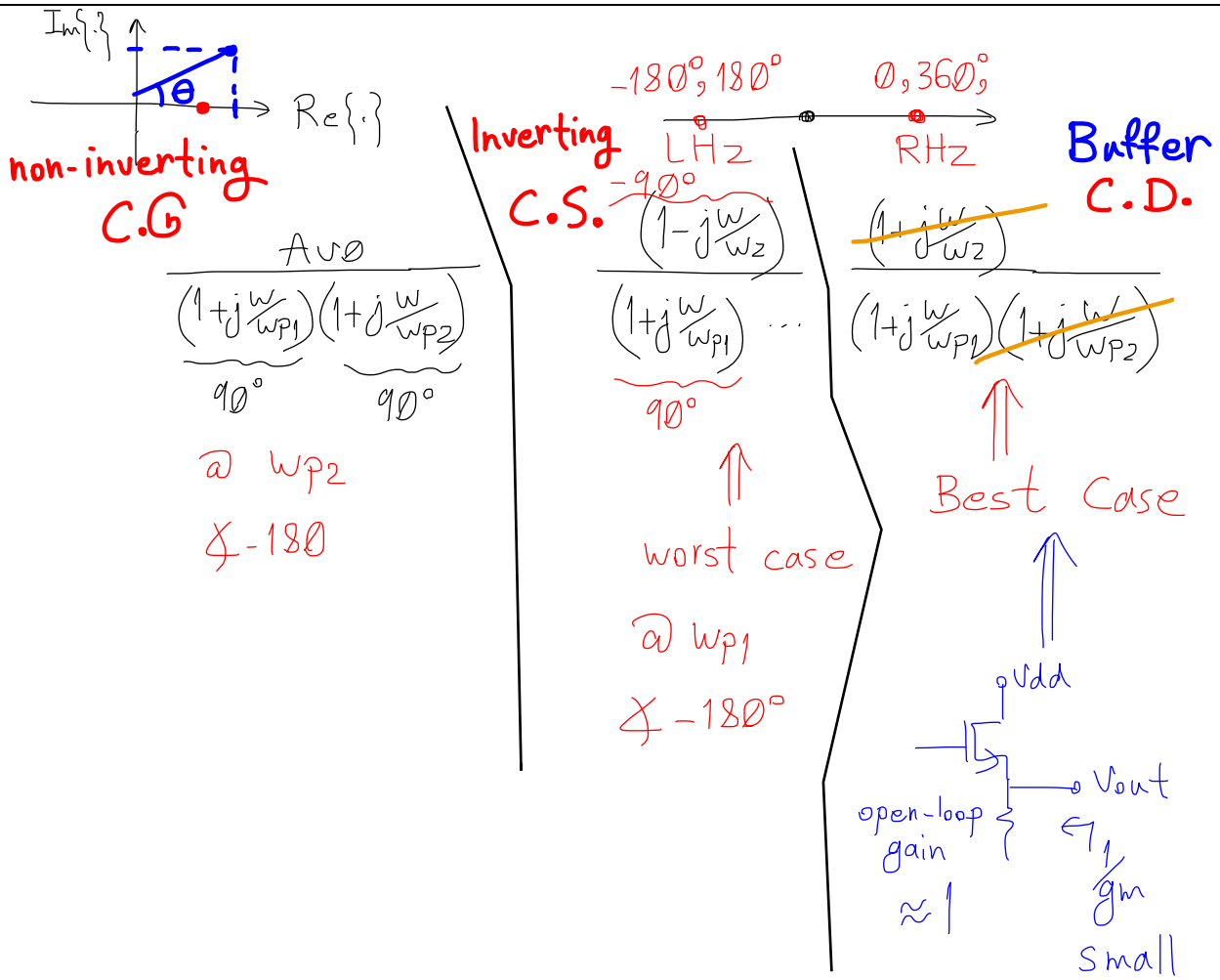


$w_{p1} < (w_z = w_{p2})$



$w_{p1} < w_z < w_{p2}$




Im{.}
θ
Re{.}
non-inverting
C.G
Inverting
C.S.
-180°, 180°
0, 360°
LHz
RHz
Buffer
C.D.
-90°
Avo
(1+jw/wp1)(1+jw/wp2)
90°
90°
@ wp2
∠-180
(1-jw/wz)
(1+jw/wp1)
90°
worst case
@ wp1
∠-180°
(1+jw/wz)
(1+jw/wp1)(1+jw/wp2)
Best Case
Vdd
Vout
open-loop gain
≈1
1/gm
Small