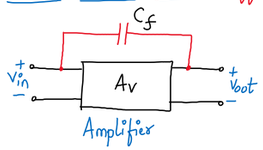
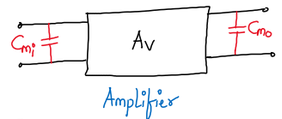
AEC 9E.3 28/2/22

✳ Miller theorem (Miller effect) :



C_{mi} – Miller input capacitance
C_{mo} – Miller output

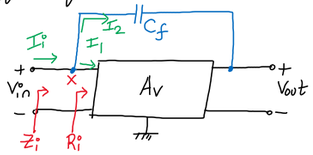


Conditions :
① Inverting amplifier
→ Gain A_v is negative

→ $C_{mi} = C_f(1-A_v)$

→ $C_{mo} = C_f\left(1-\frac{1}{A_v}\right)$

I] Effect of C_f on the input:



→ KCL at node X, $I_i = I_1 + I_2$

i.e $\frac{V_{in}}{Z_i} = \frac{V_{in}}{R_i} + \frac{V_{in}-V_{out}}{X_{cf}}$ $\quad V_{out} = A_V V_{in}$

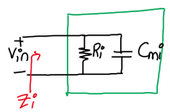
i.e $\frac{V_{in}}{Z_i} = \frac{V_{in}}{R_i} + \frac{V_{in}(1-A_v)}{X_{cf}}$

Divide by V_{in},

i.e $\frac{1}{Z_i} = \frac{1}{R_i} + \frac{1}{X_{cf}/(1-A_v)}$

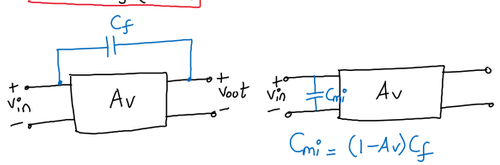
i.e $\frac{1}{Z_i} = \frac{1}{R_i} + \frac{1}{X_{C_{mi}}}$ .... (1)

→ $X_{C_{mi}} = \frac{X_{cf}}{1-A_v}$

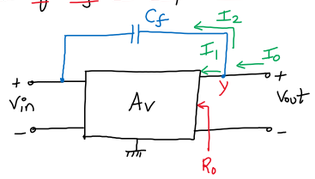


i.e $\frac{1}{2\pi f C_{mi}} = \frac{1}{2\pi f C_f(1-A_v)}$ $\quad X_C = \frac{1}{2\pi f C}$

→ $C_{mi} = C_f(1-A_v)$ .... (2)



II] Effect of C_f on Output side:



→ KCL at node Y, $I_o = I_1 + I_2$

i.e $I_o = \frac{V_{out}}{R_o} + \frac{V_{out}-V_{in}}{X_{cf}}$

R_o is usually large → $\frac{V_{out}}{R_o} \approx 0$

i.e $I_o \approx \frac{V_{out}-V_{in}}{X_{cf}}$ $\quad A_v = \frac{V_{out}}{V_{in}}$

$V_{in} = \frac{V_{out}}{A_v}$

i.e $I_o \approx \frac{V_{out}-\frac{V_{out}}{A_v}}{X_{cf}}$

i.e $I_o \approx \frac{\left(1-\frac{1}{A_v}\right)V_{out}}{X_{cf}}$

i.e $\frac{I_o}{V_{out}} \approx \frac{\left(1-\frac{1}{A_v}\right)}{X_{cf}}$ $\quad X_C = \frac{1}{2\pi f C}$

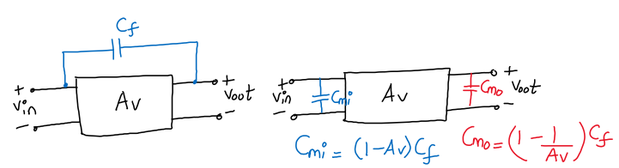
i.e $\frac{V_{out}}{I_o} \approx \frac{X_{cf}}{\left(1-\frac{1}{A_v}\right)} \approx \frac{1}{2\pi f\left(1-\frac{1}{A_v}\right)C_f} \approx \frac{1}{2\pi f C_{mo}}$

$X_{cf}\left(1-\frac{1}{A_v}\right) = X_{C_{mo}}$

→ $\frac{1}{2\pi f\left(1-\frac{1}{A_v}\right)C_f} = \frac{1}{2\pi f C_{mo}}$

→ $C_{mo} = C_f\left(1-\frac{1}{A_v}\right)$ .... (3)

If $A_v \gg 1$ → $C_{mo} \approx C_f$



→ Inverting amplifier (CE amplifier, CS amplifier)

$A_v \gg 1$; $C_{mi} \gg C_f$

$C_{mo} \approx C_f$

Miller effect : Increase in the capacitance at the input is called "Miller effect"

—x—