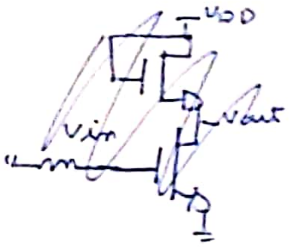
Bicmos

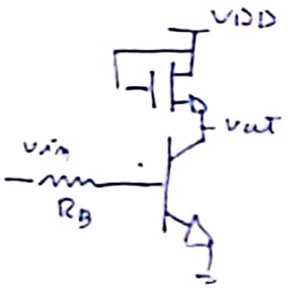
CE



same Thing as a resistive CE stage

But $R_D = R_{eq} = \dfrac{1}{g_{m2} + g_{mb2} + \frac{1}{r_{o2}}}$

AV=



$A_V = \dfrac{-g_{m1} r_{\pi 1} R_{eq} r_{o1}}{(R_B + r_{\pi 1})(R_{eq} + r_{o1})}$

Input Impedance = R_B

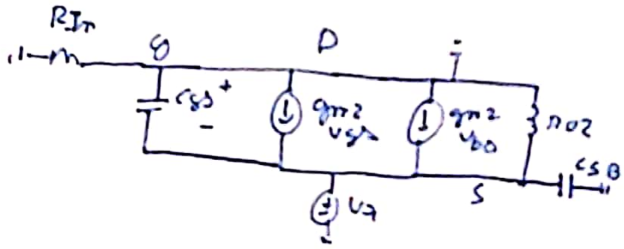
$g_m = g_m \dfrac{r_{\pi 1}}{R_B + r_{\pi 1}}$

$r_{out} = r_{o1} \,||\, R_{eq2}$

DC
not a great circuit

In high Frequency
gain, Input output Impedance
just switch

with
Zeq=

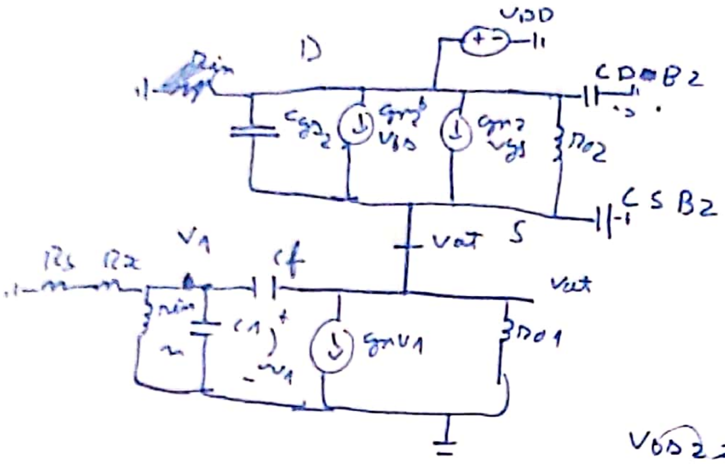


$V_x \left(\dfrac{1}{r_{o2} \,||\, \frac{1}{C_{gs} s} \,||\, \frac{1}{C_{sb} s}} + g_{m2} + g_{m2b} \right) = I_x$

$R\ Z_{eq} = \dfrac{1}{g_{m2} + g_{mb2} + \frac{1}{r_{o2}} + C_{gs2} s + C_{sb2} s}$

Just substitute Zeq and RD with this

A+



$$\frac{R_{in}}{R_{in}C_1 s + 1}$$

$$Z_{eq1} = r_{in} \,//\, \frac{1}{C_1 s}$$

$$Z_{eq2} = Z_{eq1} \,//\, (R_S + R_X)$$

$$Z_{eq2} = \frac{Z_{eq1}(R_S + R_X)}{Z_{eq1} + (R_S + R_X)}$$

$V_{GS2} = \cancel{V_{gs2} = -V_{out}}$ $V_{DD} - V_{out}$

$V_{GD} = -V_{out}$

$V_{gs2} = V_{DD} - V_{out}$

$$V_1 = V_{out} \times \frac{\frac{1}{C_f s}}{\frac{1}{C_f s} + Z_{eq2}}$$

$\cancel{Z_{eq3} \approx R_{in}}$

$$Z_{eq3} = r_{o2} \,//\, \frac{1}{C_{gs2}}$$

$V_1 \to$ decreases with frequency

sum of currents at V_{out}

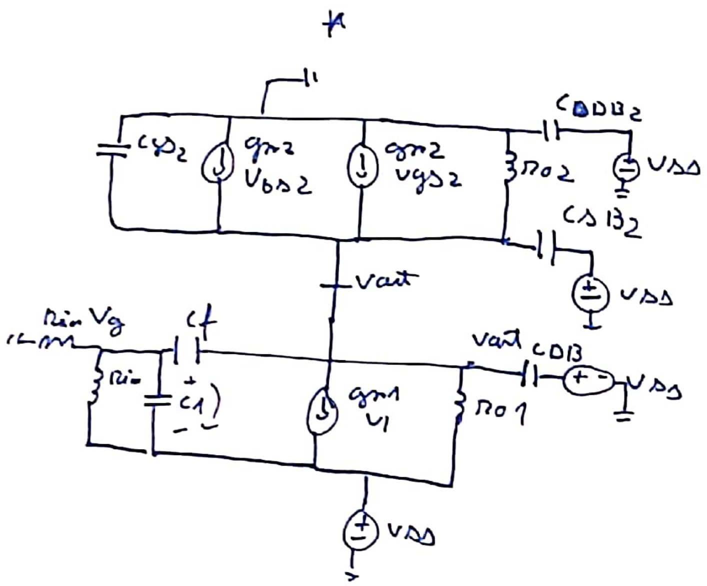
$$V_{out} C_{SB2} + \frac{V_{out}}{r_{o1}} + g_m V_1 + (V_{out} - V_1) C_f s - g_{m2b} V_{BS} - g_{m2} v_{gs} + \frac{V_{out} - V_{DD}}{Z_{eq3}} = 0$$

$$V_{out}\left(C_{SB2} + \frac{1}{r_{o1}} + g_m C_f s + g_{m2} + g_{m2b} + \frac{1}{Z_{eq3}} + \frac{\frac{1}{C_f s}}{\frac{1}{C_f s} + Z_{eq2}} \to \right.$$

$$\to \left. \left(g_{m1} - C_f s \right) \right) - V_{DD}\left(g_{m2} + \frac{1}{Z_{eq3}} \right) = 0$$

$$\frac{V_{out}}{V_{DD}} = A^+ = \frac{g_{m2} + \frac{1}{Z_{eq3}}}{\left(C_{SB2} + \frac{1}{r_{o1}} + C_f s + g_{m2} + g_{m2b} + \frac{1}{Z_{eq3}} + \ldots\ldots \right.}$$

A -



$Zeq1 = \frac{1}{C_{SB2}s} \,||\, \frac{1}{C_{DB1}s}$

$V_1 = v_g - v_{SS}$

$v_{bs} = v_{gs} = -v_{out}$

$Zeq2 = Rin \,||\, \frac{1}{C_1 s}$

$Zeq3 = \frac{1}{C_{gs2}s} \,||\, r_{o2}$

sum of currents at vg

$$\frac{v_g}{Rin} + \frac{v_g - v_{SS}}{Zeq2} + (v_g - v_{out})\, C_f s = 0$$

$$v_g\left(\frac{1}{Rin} + \frac{1}{Zeq2} + C_f s\right) = \frac{V_{DD}}{Zeq2} + v_{out} C_f s$$

$$v_g = \frac{\frac{V_{DD}}{Zeq2} + v_{out} C_f s}{\left(\frac{1}{Rin} + \frac{1}{Zeq2} + C_f s\right)}$$

sum of currents at vout

$$\frac{v_{out} - v_{SS}}{Zeq1} - g_{m2}(-v_{out}) - g_{m2b}(-v_{out}) + \frac{v_{out}}{Zeq3} + (v_{out} - v_g)\, C_f s + g_m V_1 + \frac{v_{out} - v_{SS}}{r_{o1}}$$

$$v_{out}\left(\frac{1}{Zeq1} + g_{m2} + g_{m2b} + \frac{1}{Zeq3} + C_f s + \frac{1}{r_{o1}} + \frac{C_f s}{\left(\frac{1}{Rin} + \frac{1}{Zeq2} + C_f s\right)}\left(g_m - C_f s\right)\right)$$

$$- v_{SS}\left(\frac{1}{r_{o1}} + \frac{1}{Zeq1} + \frac{\frac{1}{Zeq2}}{\frac{1}{Rin} + \frac{1}{Zeq2} + C_f s}\left(g_{m1} - C_f s\right)\right)$$

$$\frac{V_{out}}{V_{ss}} = A^- = \cancel{\left(\frac{1}{Z_{eq1}} + g_{m2} + g_{m2b} + \frac{1}{Z_{eq3}} + cfs + \right)}$$

$$A^- = \frac{\frac{1}{r_{o1}} + \frac{1}{Z_{eq1}} + \frac{\frac{1}{Z_{eq2}}}{\frac{1}{R_{in}} + \frac{1}{Z_{eq2}} + cfs}\left(g_{m1} - cfs\right)}{\frac{1}{Z_{eq1}} + g_{m2} + g_{m2b} + \frac{1}{Z_{eq3}} + cfs + \frac{1}{r_{o1}} + \frac{cfs}{\frac{1}{R_{in}} + \frac{1}{Z_{eq2}} + cfs}\left(g_{m1} - cfs\right)}$$