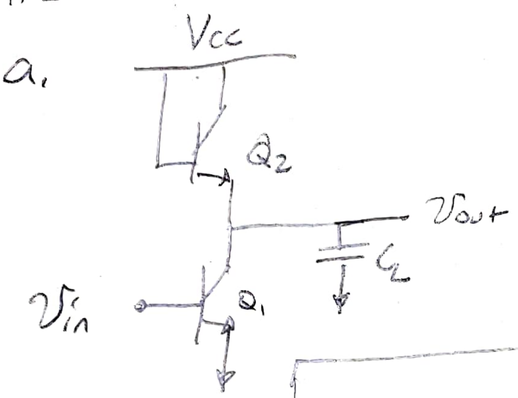
11.3

a.

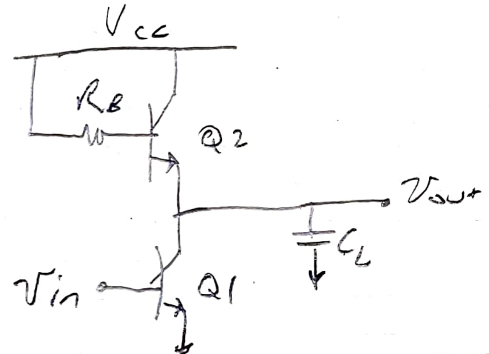


$$\omega_{3dB} = \frac{1}{R_{out} C_L}$$

$$R_{out} = r_{e2}$$

$$\boxed{\omega_{3dB} = \frac{1}{r_{e2} C_L} \approx \frac{g_{m2}}{C_L}}$$

b.

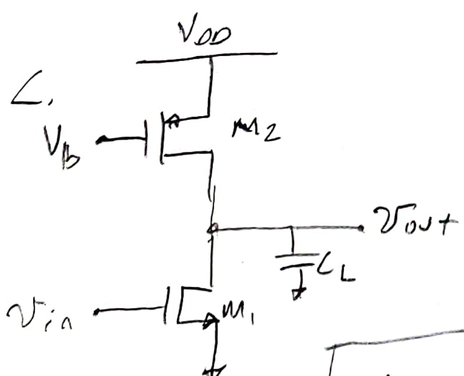


$$\omega_{3dB} = \frac{1}{R_{out} C_L}$$

$$R_{out} = r_{e2} + \frac{R_B}{\beta+1}$$

$$\boxed{\omega_{3dB} = \frac{1}{\left(r_{e2} + \frac{R_B}{\beta+1}\right) C_L} = \frac{g_{m2}(\beta+1)}{\beta + g_{m2} R_B}}$$

c.

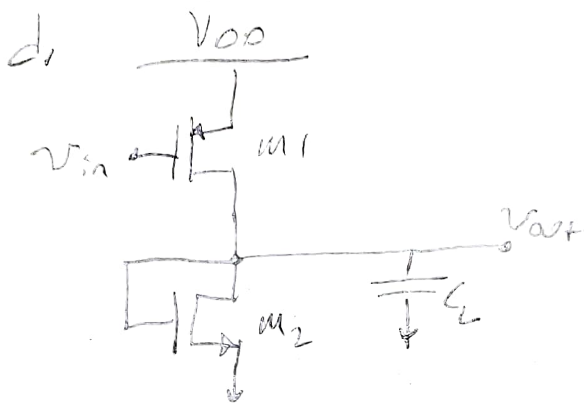


$$\omega_{3dB} = \frac{1}{R_{out} C_L}$$

$$R_{out} = r_{o1} || r_{o2}$$

$$\boxed{\omega_{3dB} = \frac{1}{(r_{o1} || r_{o2}) C_L} = \frac{g_{o1} + g_{o2}}{C_L}}$$

d)

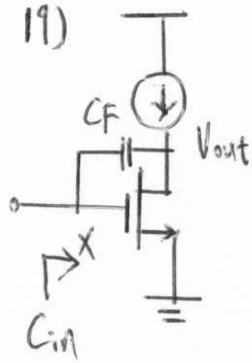


$$\omega_{3dB} = \frac{1}{R_{out} C_L}$$

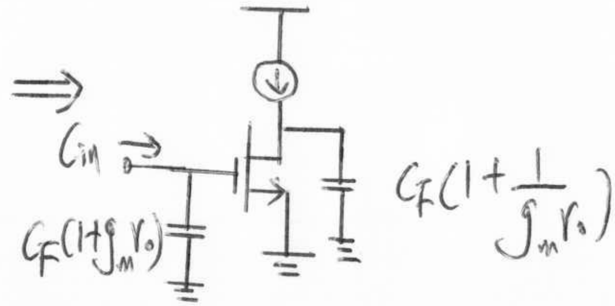
$$R_{out} = r_{o1} \| r_{o2} \| \frac{1}{g_{m2}}$$

$$\boxed{\omega_{3dB} = \frac{1}{\left(r_{o1} \| r_{o2} \| \frac{1}{g_{m2}}\right) C_L} = \frac{g_{o1} + g_{o2} + g_{m2}}{C_L} \approx \frac{g_{m2}}{C_L}}$$

19)



$\lambda > 0$, DC gain $= -g_m r_o$

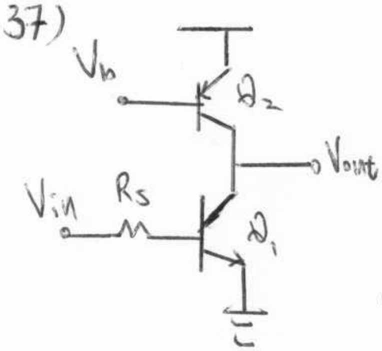


$C_{in} = C_F(1 + g_m r_o)$, neglecting other caps.

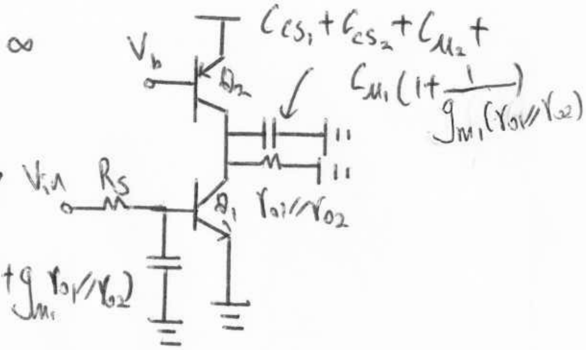
As $\lambda \to 0$, $r_o \to \infty$, DC gain $\to \infty$,

$C_{in} \to \infty$, this bandwidth will $\to 0$.

37)



$V_A < \infty$ $\Longrightarrow$



$$\omega_{pin} = \frac{1}{(R_S//r_{\pi_1})\left[C_{\pi_1}+C_\mu(1+g_{m_1}(r_{o1}//r_{o2})\right]}$$

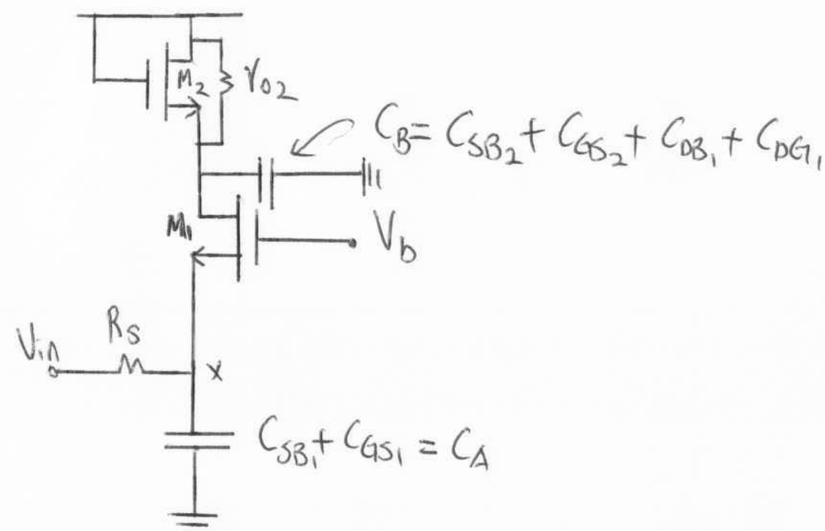
$$\omega_{pout} = \frac{1}{(r_{o1}//r_{o2})\left[C_{CS_1}+C_{CS_2}+C_{\mu_2}+C_{\mu_1}(1+1/(g_{m_1}r_{o1}//r_{o2})\right]}$$

$$g_m r_o \gg 1$$

$$H(s) = \frac{g_m(r_{o1}//r_{o2})(r_\pi/r_\pi+R_s)}{(1+R_s[C_{\pi_1}+C_\mu(g_m(r_{o1}//r_{o2}))]s)(1+(r_{o1}//r_{o2})[C_{CS1}+C_{CS2}+C_{\mu_2}+C_{\mu_1}]s)}$$

46)

a)



$$V_{out} = -(0 - V_x) g_{m_1}\left[\frac{1}{g_{m_2}} \parallel \frac{1}{C_B s}\right] = V_x g_{m_1}\left[\frac{1}{g_{m_2}} \parallel \frac{1}{C_B s}\right]$$

Node equation at X, $\dfrac{V_x - V_{in}}{R_s} + V_x C_A s - g_m(0 - V_x) = 0$

$$V_x\left(\frac{1}{R_s} + C_A s + g_m\right) = \frac{V_{in}}{R_s} \Rightarrow V_x = \frac{V_{in}}{(1 + R_s C_A s + R_s g_m)}$$

subsitute in V_x and solving for V_{out}/V_{in} $\Rightarrow$

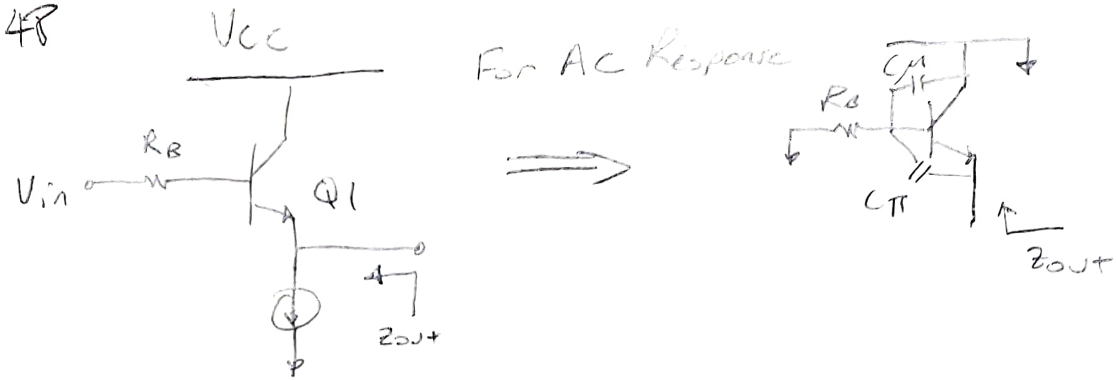
$$\frac{V_{out}}{V_{in}} = \frac{g_{m_1}\left[1/g_{m_2} \parallel \frac{1}{C_B s}\right]}{(1 + R_s C_A s + R_s g_m)}$$

$$\frac{V_{out}}{V_{in}} = \frac{g_{m_1}(1/g_{m_2})}{(C_B(1/g_{m_2})s + 1)(1 + R_s C_A s + R_s g_{m_1})}$$

Where $C_B = C_{SB_2} + C_{GS_2} + C_{DB_1} + C_{DG_1}$

$C_A = C_{SB_1} + C_{GS_1}$

11.48



This is the same circuit in Lecture 6, Slide 62, but now we are including C_μ.

We can start with the same transfer function and substitue

$$R_B \rightarrow R_B \,\|\, \frac{1}{sC_\mu} = \frac{R_B}{1+sR_BC_\mu}$$

$$Z_{out} = \frac{\left(\frac{R_B}{1+sR_BC_\mu}\right) r_\pi C_\pi s + r_\pi + \frac{R_B}{1+sR_BC_\mu}}{r_\pi C_\pi s + \beta + 1}$$

$$= \frac{R_B r_\pi C_\pi s + r_\pi(1+sR_BC_\mu) + R_B}{(r_\pi C_\pi s + \beta+1)(1+sR_BC_\mu)}$$

$$\boxed{Z_{out} = \frac{sR_B r_\pi (C_\pi + C_\mu) + r_\pi + R_B}{(r_\pi C_\pi s + \beta+1)(1+sR_BC_\mu)}}$$