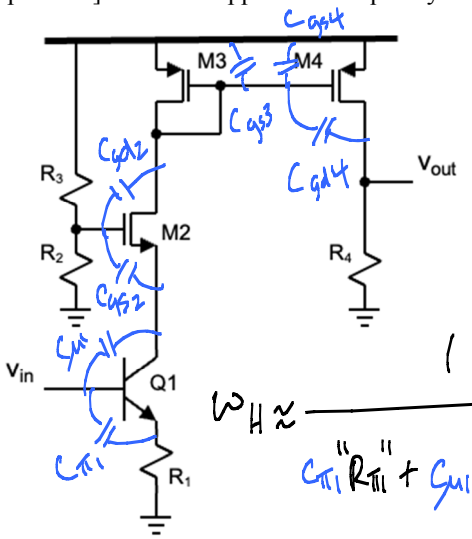
1. [10 pts total] Find the "upper 3dB frequency" ω_H considering intrinsic capacitances.



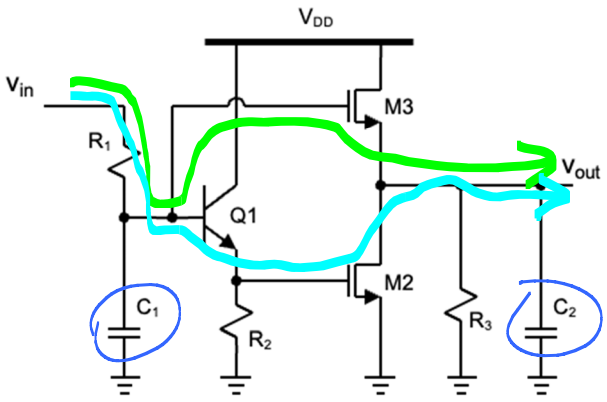
$$\omega_H \approx \frac{1}{C_{\pi 1}{}''R_{\pi 1}{}''+C_{\mu 1}{}''R_{\mu 1}{}''+C_{gs2}{}''R_{gs2}{}''+C_{gd2}{}''R_{gd2}{}''+(C_{gs3}+C_{gs4})\,{}''R_{gs3}{}''+C_{gd4}{}''R_{gd4}{}''}$$

$$''R_{\pi 1}{}'' = R_1 \left\| \frac{r_{\pi 1}}{1+\beta_1} \right. \qquad ''R_{\mu 1}{}'' = \frac{1}{g_{m2}} \qquad ''R_{gs2}{}'' = \frac{(R_2 \| R_3)+\infty}{1+g_{m2}\infty} = \frac{1}{g_{m2}}$$

$$''R_{gd2}{}'' = (R_2 \| R_3)(1-0)+\frac{1}{g_{m3}} = (R_2 \| R_3)+\frac{1}{g_{m3}}$$

$$''R_{gs3}{}'' = \frac{1}{g_{m3}} \qquad ''R_{gd4}{}'' = \frac{1}{g_{m3}}\left(1+g_{m4}R_4\right)+R_4$$

2. [10 pts total] Find the input to output (small-signal gain) transfer function H(s). Ignore intrinsic capacitances.

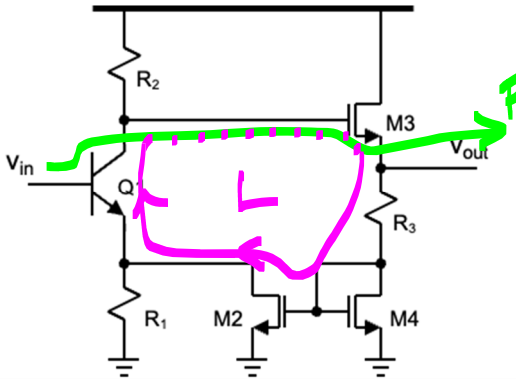


$$H(s) = \frac{r_{\pi_1} + R_2(1+\beta_1)}{R_1 + r_{\pi_1} + R_2(1+\beta_1)} \left(\frac{R_3}{\frac{1}{g_{m3}} + R_3} - \frac{R_2(1+\beta_1)}{r_{\pi_1} + R_2(1+\beta_1)} g_{m2} \left[\frac{1}{g_{m3}} \| R_3 \right] \right) \frac{1}{(1+sC_1''R_1'')(1+sC_2''R_2'')}$$

$$R_1'' = R_1 \| \left(r_{\pi_1} + R_2[1+\beta_1] \right)$$

$$R_2'' = R_3 \| \frac{1}{g_{m3}}$$

3. [10 pts total] Find the input to output small-signal gain.



$$\text{Gain} = \frac{F.P.}{1 - L}$$

$$F.P. = -\frac{r_{\pi 1}}{r_{\pi 1} + R_1(1+\beta_1)} g_{m1} R_2 \frac{R_3 + \frac{1}{g_{m4}}}{\frac{1}{g_{m3}} + R_3 + \frac{1}{g_{m4}}}$$

$$L = -g_{m2}\left(R_1 \| \frac{r_{\pi 1}}{1+\beta_1}\right) g_{m1} R_2 \frac{\frac{1}{g_{m4}}}{\frac{1}{g_{m3}} + R_3 + \frac{1}{g_{m4}}}$$