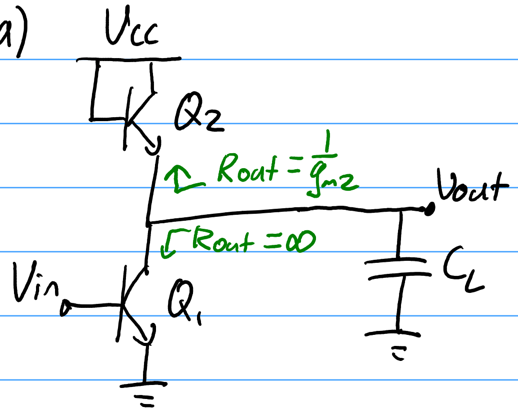
**11.3** (a)

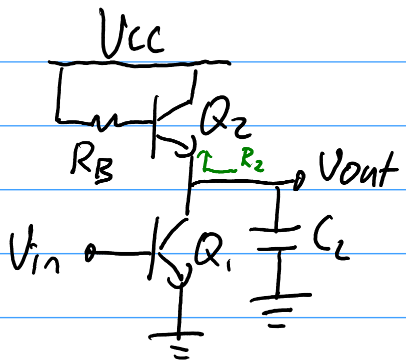



Looking into $Q_2$ emitter, $R_{out} = \frac{1}{g_{m2}}$

Looking into $Q_1$ collector, $R_{out} = \infty$ because $V_A = \infty$.

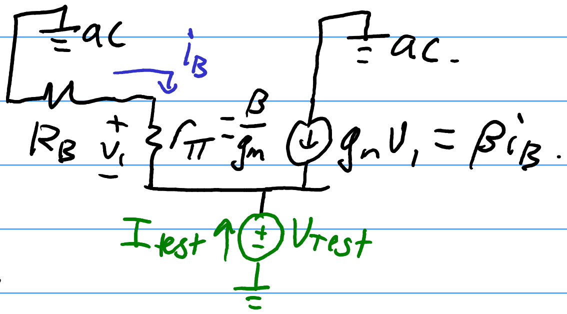
$\therefore$ Only one pole, the −3 dB point is $f = \dfrac{1}{2\pi \frac{1}{g_{m2}} C_L} = \dfrac{g_{m2}}{2\pi C_L}$

(b)




Need to find the impedance seen looking into $Q_2$'s emitter.

Consider small signal model.




By KCL, $i_B + I_{Test} + \beta i_B = 0$

$\therefore (1+\beta) i_B + I_{Test} = 0.$

By Ohm's law, $i_B = \dfrac{0 - V_{Test}}{R_B + r_\pi}$

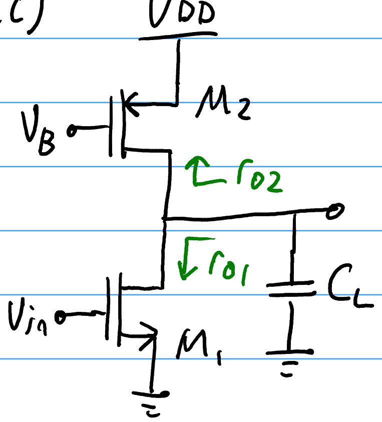
$\therefore (1+\beta)\left(\dfrac{-V_{Test}}{R_B + r_\pi}\right) + I_{Test} = 0.$

$$(1+\beta) V_{Test} = (R_B + r_\pi) I_{Test} = \left(R_B + \frac{\beta}{g_m}\right) I_{Test}$$

$$\frac{V_{Test}}{I_{Test}} = \frac{R_B + \frac{\beta}{g_m}}{1+\beta} \approx \frac{R_B + \frac{\beta}{g_m}}{\beta} = \frac{1}{g_m} + \frac{R_B}{\beta}.$$

$\therefore$ −3dB point is $\dfrac{1}{2\pi C_L \left(\frac{1}{g_m} + \frac{R_B}{\beta}\right)}$

(c)



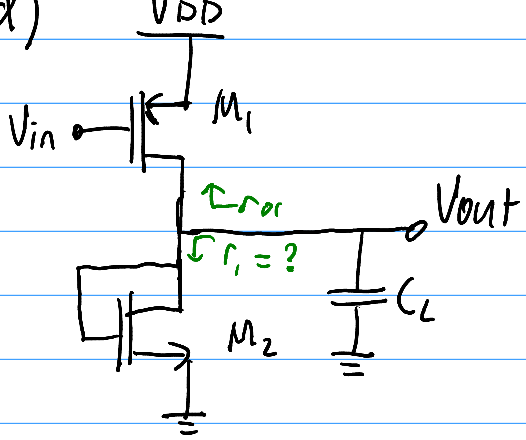

Notice $M_2$ is PMOS

∴ we are looking into the drain of both devices.

∴ Resistances are the $r_o$ of each transistor.

∴ $-3\,dB$ point is $\frac{1}{2\pi(r_{o1} \| r_{o2})C_L}$.

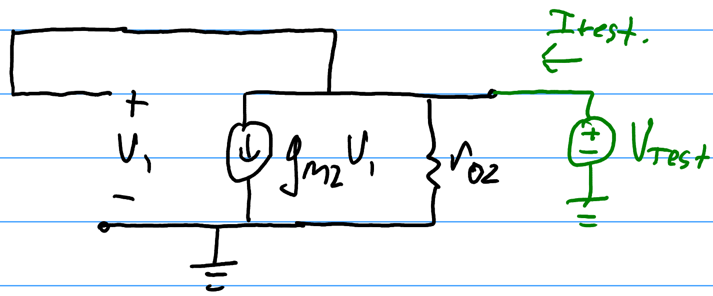
(d)




- See $r_{o1}$ looking into $M_1$
- Looking into $M_2$, notice that $V_{out} = V_{GS}$

∴ Current is controlled.

Need to check small signal model.




$V_1 = V_{Test}$

By KCL: $I_{Test} = g_m V_{Test} + \frac{V_{Test}}{r_{o1}} = \left(g_m + \frac{1}{r_{o1}}\right) V_{Test}$

$$\frac{V_{Test}}{I_{Test}} = \frac{1}{g_m + \frac{1}{r_{o1}}} = \frac{1}{g_m} \| r_{o1}.$$

∴ $-3\,dB$ point is $\frac{1}{2\pi C_L\left(\frac{1}{g_{m2}} \| r_{o1} \| r_{o2}\right)}$