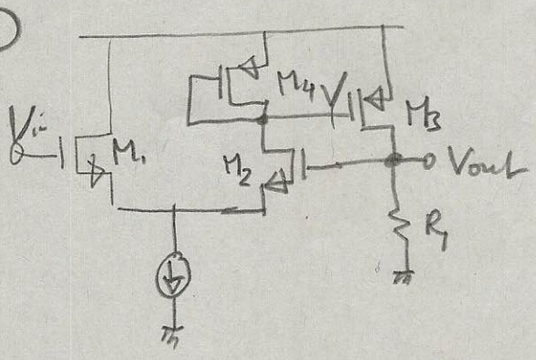
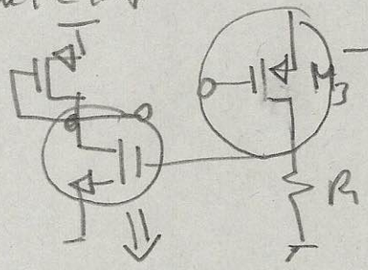
EHB 335E HW#4 Solutions:

①



Break the loop

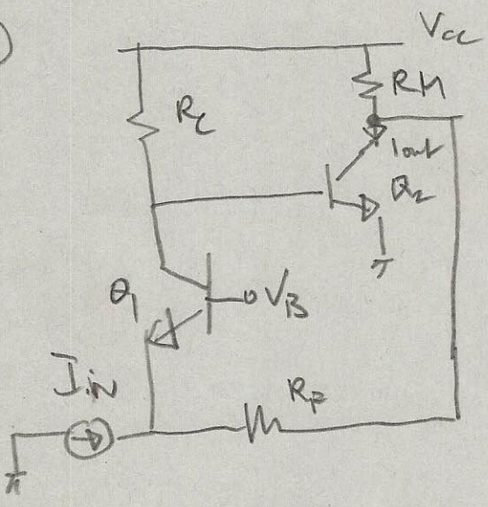


→ Common source (-) polarity

Common source (-) polarity

⇒ (-) × (-) = (+) ⇒ Positive feedback

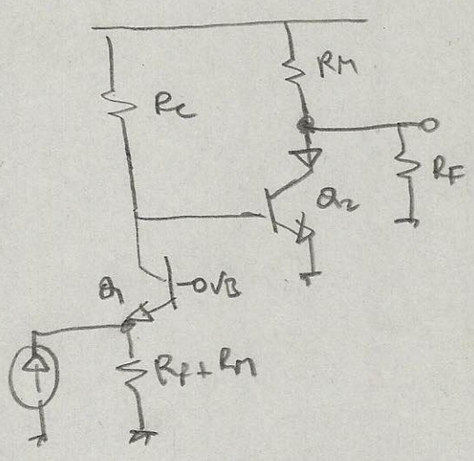
②



current-current amplifier

⇒ shunt-series feedback

⇒



$$A_{i,0} = \frac{(R_F + R_M)}{R_F + R_M + \frac{1}{g_{m1}}} \times (R_C \| r_{o2}) \times g_{m2}$$

$$R_{out,OL} = R_M \| R_F$$

$$R_{IN,OL} = \left(\frac{1}{g_m}\right) \| (R_F + R_M)$$

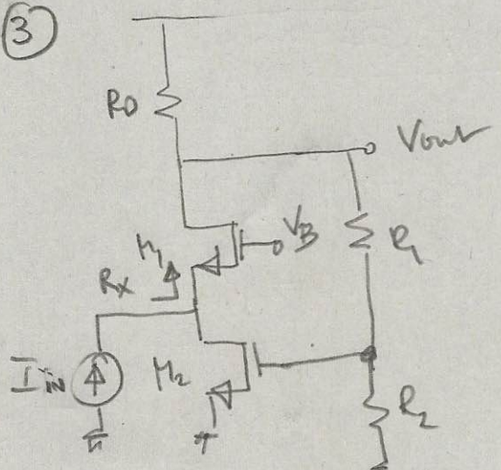
To find K, note that: $V_{out} = -i_F \cdot R_F \quad \& \quad i_{out} + \frac{V_{out}}{R_M} = i_F$

$$i_{out} = i_F \left(1 + \frac{R_F}{R_M}\right) \Rightarrow K = \frac{i_F}{i_{out}} = \frac{R_M}{R_M + R_F}$$

$$A_{i,CL} = \frac{A_{i,OL}}{1 + K \cdot A_{i,OL}} \; ; \; R_{IN,OL} = \frac{R_{IN,OL}}{1 + K A_{i,OL}} \; ;$$

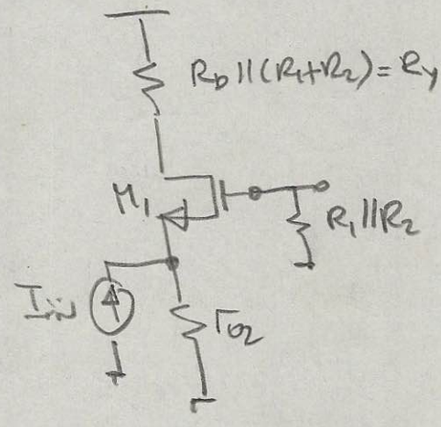
$$R_{out,CL} = R_{out,OL}(1 + K \cdot A_{i,OL})$$

(3)



shunt-shunt feedback

Current-Voltage Amplifier (Transresistance Amplifier)

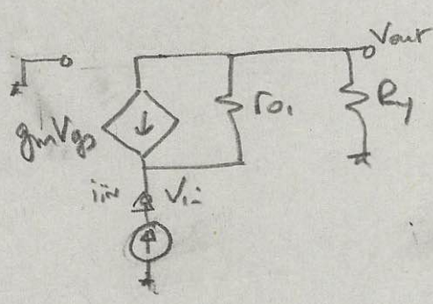


$$K = \frac{i_f}{V_{out}} = \frac{R_2}{R_1+R_2} \cdot g_{m2}$$

$$R_{in,OL} = R_x \,||\, r_{o2}$$

$$R_{out,OL} = R_D \,||\, (R_1+R_2) \,||\, \left(r_{o1} + r_{o2} + g_{m1} r_{o1} r_{o2}\right)$$

$A_{R,a} =$



$$i_{IN} + g_m(0 - V_{in}) = \frac{V_{in} - V_{out}}{r_{o1}}$$

$$V_{out} = i_{IN} \cdot R_y$$

$$i_{IN}\left(1 + \frac{R_y}{r_{o1}}\right) = \left(\frac{1}{r_{o1}} + g_{m1}\right) V_{in}$$

$$R_{in,OL} = \frac{V_{in}}{i_{IN}} = \frac{1 + \frac{R_y}{r_{o1}}}{\frac{1}{r_{o1}} + g_{m1}} \qquad \tilde{A}_{R,OL} = \frac{V_{out}}{i_{IN}} = \frac{i_{IN} \cdot R_y}{i_{IN}} = R_y$$

$$A_{R,OL} = R_y \cdot \frac{r_{o2}}{r_{o2} + \frac{1}{g_{m1}}} \quad ; \quad R_{IN,CL} = \frac{R_{in,OL}}{1 + K \cdot A_{R,OL}} \quad ; \quad R_{out,CL} = \frac{R_{out,CL}}{1 + K A_{R,OL}}$$

$$A_{R,CL} = \frac{A_{R,OL}}{1 + K A_{R,OL}}$$