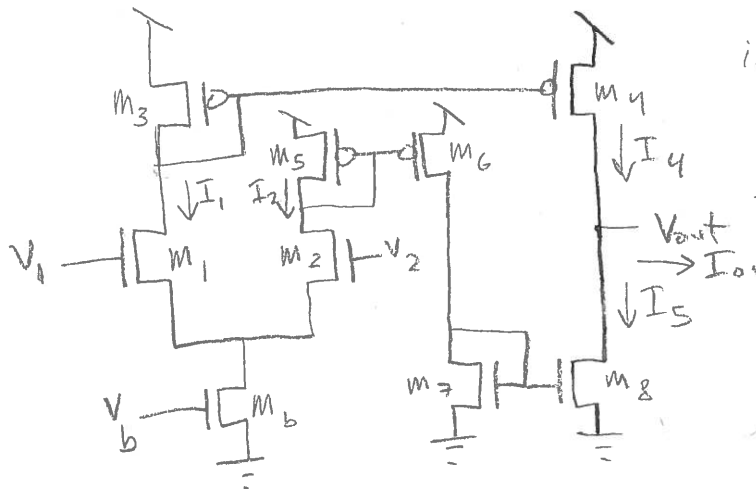
Prelab 9

Ruby Spring

(1)



if $V_1 \uparrow$, $I_4 \uparrow$ so I_5 must increase by increasing V_{out}. so V_1 is the noninverting input.

if $V_2 \uparrow$, $I_5 \uparrow$ so I_4 must increase by decreasing V_{out}, so V_2 is the inverting input.

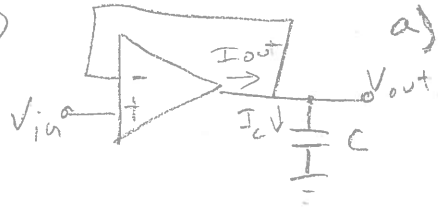
(2) $I_1 = I_2 + I_{out}$ b/c $I_4 = I_1$ and $I_5 = I_2$ due to the current mirrors.

(3) if $V_1 \approx V_2$, $I_{out} = V_{dm} G_m$ where G_m is the incremental transconductance gain of the circuit

if $V_1 << V_2$, $I_{out} \approx -I_2 = -I_b$

if $V_1 >> V_2$, $I_{out} \approx I_1 = I_b$

(4)



a) after a long time, $V_{out} = V_{in}$

b) for a small increase in V_{in}:

$$I_{out} = C\frac{dV_{out}}{dt} = G_m V_{dm}$$
$$= G_m(V_{in} - V_{out})$$
$$V_{out} = \frac{C}{G_m}\frac{dV_{out}}{dt} + V_{in}$$

$$V_{out} = K_1 e^{-\frac{tG_m}{C}} + V_{in} \quad (K_1 \text{ is a constant})$$

so after only a short time, $V_{out} = V_{in}$ plus a small amount, but after more time passes V_{out} eventually converges to V_{in}.

c) for a large increase in V_{in}

$$I_{out} = C\frac{dV_{out}}{dt} = I_b$$

$$V_{out} = K_2 + \frac{I_b t}{C}$$

so V_{out} rails at V_{dd}