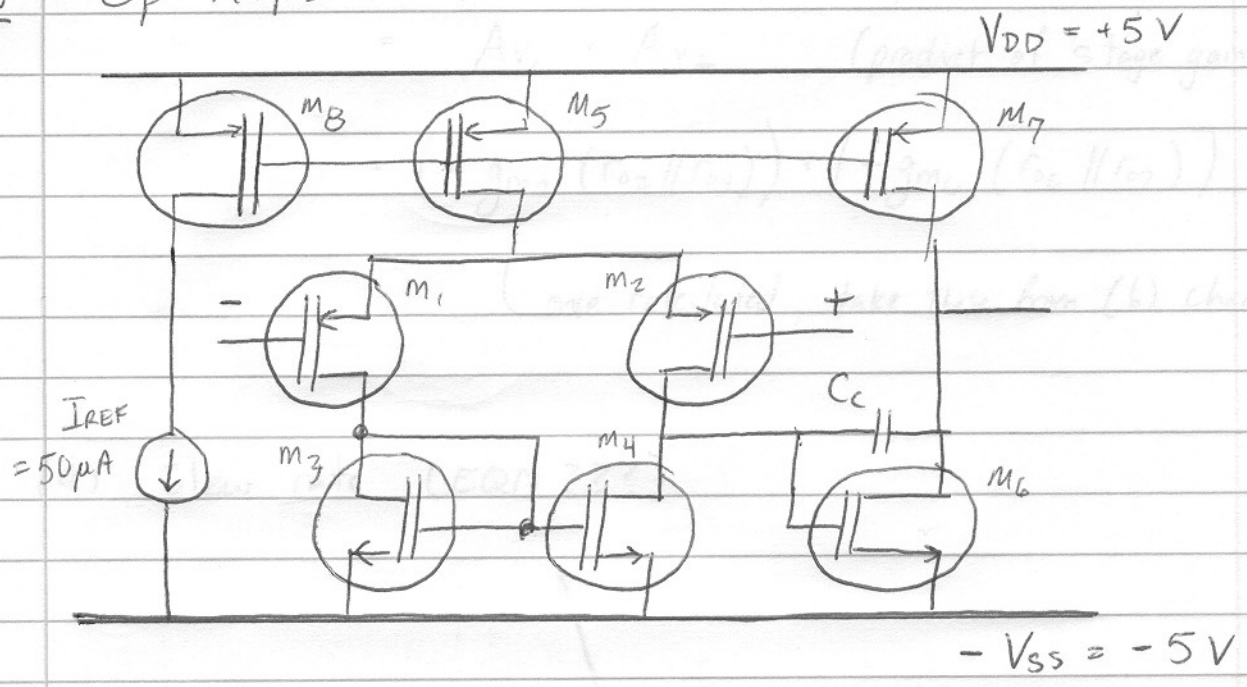
UE3003 SPR 2006 9/8/06

Q6 Op-Amp.



(a) Choose value W_7 such that cct does not exhibit a systematic offset voltage. ??? what does this mean → how to calc?

satisfy $\frac{(W/L)_6}{(W/L)_4} = 2\frac{(W/L)_7}{(W/L)_5}$

(b)

	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8
$\frac{W}{L}$	$\frac{120}{8}$	$\frac{120}{8}$	$\frac{50}{10}$	$\frac{50}{10}$	$\frac{150}{10}$	$\frac{100}{10}$	$\frac{\quad}{10}$	$\frac{300}{10}$
~~I_D~~	25μ	25μ	25μ	25μ	50μ	50μ	50μ	50μ
V_{GS}	1.41	1.41	~~1.582~~	~~1.582~~	1.58	2	~~2~~	1.41
$\frac{2I_D}{V_{GS}-V_t} = g_m$	122	122	50	50				
$\frac{V_A}{I_D} = r_o$	~~100k~~ 1M	~~100k~~ 1M	~~100k~~ 1M	~~100k~~ 1M	500k	500k	500k	500k

$$V_{GS} = V_t + \sqrt{\frac{2I_D}{\mu C_{ox}(W/L)}} \; ; \quad I_D = \frac{1}{2}\mu C_{ox}\left(\frac{W}{L}\right)\left(|V_{GS}| - |V_t|\right)^2$$

$$\boxed{A_{v_1} = -g_{m_2}(r_{o_2} \parallel r_{o_4})} \; ; \quad \boxed{A_{v_2} = -g_{m_6}(r_{o_6} \parallel r_{o_7})}$$

(c) $A_{V(total)}$ = Stage ① GAIN · Stage ② GAIN

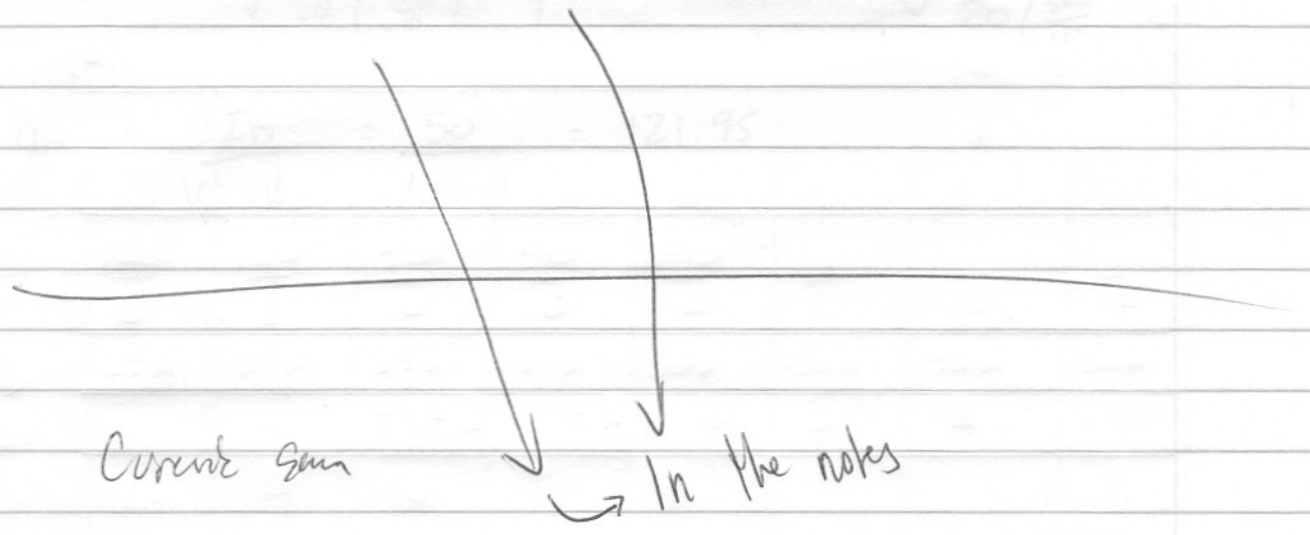
= $A_{V_1} \cdot A_{V_2}$ (product of stage gains)

= $\left(-g_{m_2}\left(r_{o_2} \| r_{o_4}\right)\right) \cdot \left(-g_{m_6}\left(r_{o_6} \| r_{o_7}\right)\right)$

↑ once calculated, take these from (b) chart

(d) Slew rate (EQN ???)

(e) -3 dB frequency (EQN for cutoff frequency ???)



Q $\mu_n C_{ox} = 20\mu \quad \mu_p C_{ox} = 10\mu$

$$V_{OS_1} = V_t + \sqrt{\frac{2I_D}{\mu C_{ox}\left(\frac{W}{L}\right)}} = 1 + \sqrt{\frac{50\mu}{20\mu\left(\frac{120}{8}\right)}} = 1.41$$

$$V_{OS_3} = (1) + \sqrt{\frac{50}{10\left(\frac{120}{8}\right)}} = 1.58$$

$$V_{OS_6} = (1) + \sqrt{\frac{100}{10\left(\frac{100}{10}\right)}} =$$

$$V_{OS_3} = 1 + \sqrt{\frac{50}{10\left(\frac{50}{10}\right)}}$$

$$V_{OS_5} = 1 + \sqrt{\frac{100}{20\left(\frac{150}{10}\right)}} \qquad V_{OS_8} = 1 + \sqrt{\frac{100}{20\left(\frac{300}{10}\right)}}$$

$$g_{m_1} = \frac{2I_D}{V_{OS} - V_t} = \frac{50}{1.41 - 1} = 121.95$$

50

μ