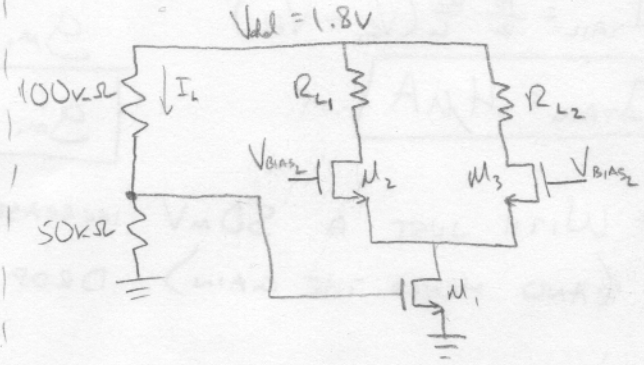
Problem Set 3

Miles Sherman

1)

$\beta = 320 \frac{\mu A}{V^2}$

$I_{DS} = \frac{\beta}{2} \frac{W}{L} (V_{GS} - V_{th})^2$, $V_{th} = 500mV$



Part 1 (Fig 1)

$1.8V - (150k\Omega) I_L = 0$

$I_L = 12\mu A$

$1.8 - (12\mu A)(100k\Omega) = V_{G_1}$

$V_{G_1} = 0.6V$

$I_{DS_1} = I_{TAIL} = \frac{\beta}{2} \frac{W}{L} (V_{G_1} - V_{th})^2$

$\boxed{I_{TAIL} = 16\mu A}$

$g_{m_1} = g_{m_2} = \sqrt{2\left(\frac{I_{TAIL}}{2}\right)\beta \frac{W}{L}}$

$\boxed{g_{m_1} = g_{m_2} = 0.16mS}$

For max gain & still in saturation:

$1.8 - (R_{L_1})\left(\frac{I_{TAIL}}{2}\right) - V_{OV_{2,3}} - V_{OV_1} = 0$

$-R_{L_1} = \left(V_{OV_{2,3}} + V_{OV_1} - 1.8\right) / \left(I_{TAIL}/2\right)$

$\boxed{R_{L_1} = R_{L_2} = 200k\Omega}$

$\frac{I_{TAIL}}{2} = \frac{\beta}{2} \frac{W}{L} (V_{OV_{2,3}})^2$ for M_2 & M_3

$V_{OV_{2,3}} = 0.1V$

$V_{OV_1} = 0.1V$

* The gain of the diff-amp increases with R_{L_1} & R_{L_2} (assuming their values are equal. However, if the voltage drop across the resistors is too high, M_2 will fall out of saturation.