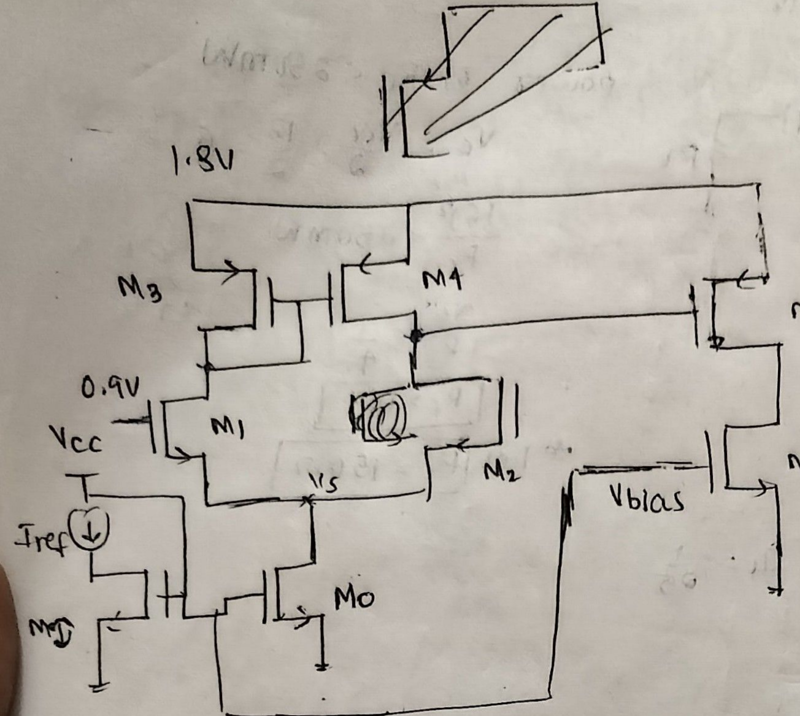
$\mu_n C_{ox} = 230\mu$ $V_{th} = 0.37$

$\mu_p C_{ox} = 100\mu$ $V_{tp} = 0.39$



M_o.

$I_{tail} = 20\mu A$

$(I_D)_o = 20\mu A$.

$20\mu A = \mu_n C_{ox} \left(\frac{W}{2L}\right)_o (V_{gs} - V_{th})^2$

$\cancel{20}\mu A = \frac{(23\cancel{0}\mu)}{2} \left(\frac{W}{L}\right)_o (0.2)^2$

$\frac{4}{23\,(0.2)^2} = \left(\frac{W}{L}\right)_o$

$\left(\frac{W}{L}\right)_o = 4.3478$

$I_{ref} = 2\mu A$.

$\frac{I_{ref}}{\left(\frac{W}{L}\right)_I} = \frac{I_{tail}}{\left(\frac{W}{L}\right)_o} \Rightarrow \frac{2\mu}{\left(\frac{W}{L}\right)_I} = \frac{\overset{10}{\cancel{20\mu}}}{\left(\frac{W}{L}\right)_o}$

$\left(\frac{W}{L}\right)_I = \frac{4.3478}{10} = 0.435$

$(V_{gs})_{M_1} > 0.37$

$0.9 - V_s > 0.37$

$V_s - 0.9 < -0.37$

$V_s < 0.9 - 0.37$

$V_s < 0.53$

For M_o to be in saturation

$V_s > (0.2)$
V_{Drain}

say $V_s = 0.45$

$I_{M_1} = 10\mu$

$(I_D)_{M_1} = (230\mu) \left(\frac{W}{2L}\right)_1 (V_{gs} - V_{th})^2$

$1\cancel{0}\mu = \frac{23\cancel{0}\mu}{2} \left(\frac{W}{L}\right)_1 (0.9 - 0.45 - 0.37)^2$

$\frac{2}{23\,(0.08)^2} = \left(\frac{W}{L}\right)_1$

$\boxed{\left(\frac{W}{L}\right)_1 = 13.587}$ — ①

If $(V_{gs} - V_{th} = 0.2)$ M_1

$\Rightarrow$ $V_s = 0.33$ ~~still in satu~~ (ON)

$\Rightarrow \boxed{\left(\frac{W}{L}\right)_1 = 2.174}$ — ②

① is better for better gain.

$\therefore \boxed{\left(\frac{W}{L}\right)_1 \text{ and } \left(\frac{W}{L}\right)_2 = 13.587}$

V_D of M_1.

$V_{DS} > V_{gs} - V_{th}$ (saturation)

$V_D - 0.45 > 0.9 - 0.45 - 0.37$

$V_D > 0.53$.

say $(V_D)_3 = 0.6 \Rightarrow (V_G)_3 = 0.6$.

$$16\mu = \frac{\cancel{100}^{5}\mu}{\cancel{2}} \left(\frac{W}{L}\right)_3 (V_{SG} - V_{tp})^2 \Rightarrow \frac{1}{5} = \left(\frac{W}{L}\right)_3 (1.8 - 0.6 - 0.39)^2$$

$$\frac{1}{5(0.81)^2} = \left(\frac{W}{L}\right)_3 \Rightarrow \left(\frac{W}{L}\right)_3 = 0.305$$

If $V_{sg} - V_{tp} = 0.2V$

$\Rightarrow \boxed{\left(\frac{W}{L}\right)_3 = 5}$ we prefer higher $\frac{W}{L}$

$\therefore 1.8 - (V_G)_3 - 0.39 = 0.2$

$\boxed{(V_G)_3 = 1.21}$

$\therefore \boxed{\left(\frac{W}{L}\right)_{3 \& 4} = 5}$.

then $(V_D)_3 = 1.21 = (V_G)_4$

~~Gain of stage~~

$(V_D)_4 = (V_D)_{M_3} = 1.21$

$(V_G)_5 = 1.21$

Let I is S-11 ⇒ 50μ

$\underline{M_5}$ → $50\mu = 100\mu \left(\frac{W}{L}\right)_5 (\overset{V_S}{1.8} - \overset{V_G}{1.21} - \overset{V_{tp}}{0.39})^2$; $\underbrace{1.8-1.21-0.39}_{0.2}$

$\left(\frac{W}{L}\right)_5 = 25$

$50\mu = \frac{230\mu}{2} \left(\frac{W}{L}\right)_6 (0.57-0.37)^2$

$(V_g)_{M_6} = (V_g)_{M_0}$

$\Rightarrow (V_{gs}-V_{th})_{M_0} = 0.2$

$V_g = 0.2+0.37$

$V_g = 0.57$

$\left(\frac{W}{L}\right)_6 = 10.87$.

Lmin = 0.18μ for simulation six times ⇒ 0.9μ

$W_0 = 3.913\mu$ · $W_I = 0.391$ $W_{1\&2} \Rightarrow 12.23$ $W_{3\&4} = 4.5$

~~$W_5 = 22.5$~~

~~$W_6 = 9.783$~~

use L = 0.18μ for S-11.

⇒ $W_5 = 25 \times 0.18\mu = 4.5\mu$

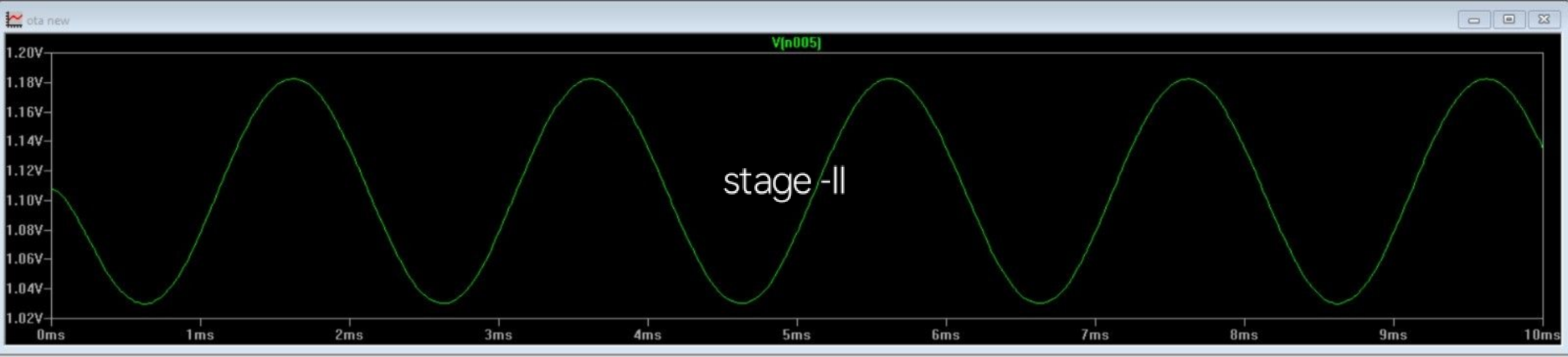
⇒ $W_6 = 1.9566\mu$.

S1 → simulation ⇒ Gain ⇒ 44.861 dB Gain = 175

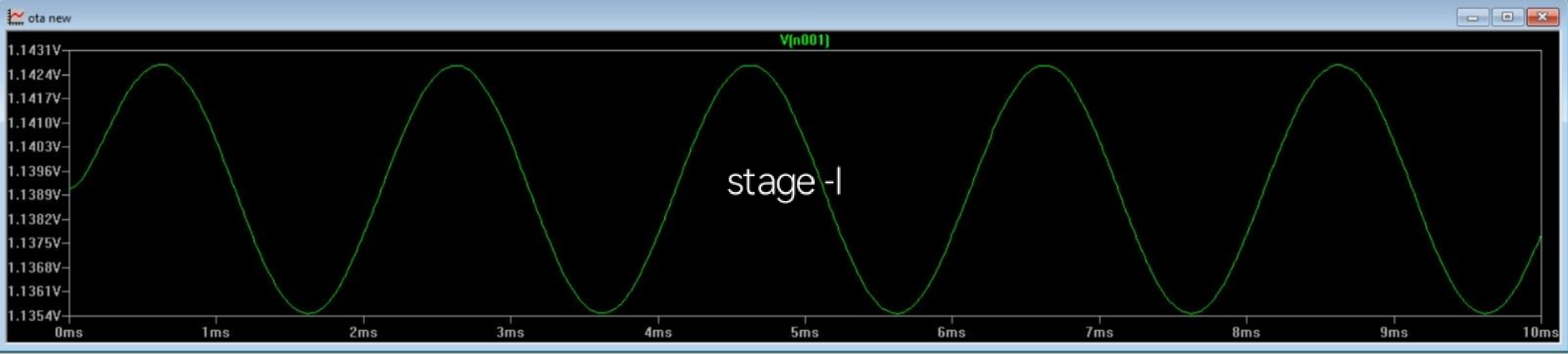
S-11 ⇒ ⇒ Gain = 71.5671dB Gain = 3787.5

Final values DC gain.

	M_0	M_I	M_2	M_3	M_4	M_5	M_6	M_I
$\frac{W}{L}$	4.3478	13.587	13.587	5	5	25	10.87	0.435
g_m	2×10^{-4}	~~2×10^{-5}~~ 250×10^{-6}	~~2×10^{-5}~~ 250×10^{-6}	24.69×10^{-6}	24.69×10^{-6}	5×10^{-4}	5×10^{-4}	2×10^{-5}
r_o	5×10^{5}	10^6	10^6	10^6	10^6	2×10^5	2×10^5	5×10^6
$V_{GS}-V_T$	0.2	0.08	0.08	0.81	0.81	0.2	0.2	0.2
I_D	20μ	10μ	10μ	10μ	10μ	50μ	50μ	2μ.



ota new
V(n005)
stage -II
1.20V
1.18V
1.16V
1.14V
1.12V
1.10V
1.08V
1.06V
1.04V
1.02V
0ms
1ms
2ms
3ms
4ms
5ms
6ms
7ms
8ms
9ms
10ms


ota new
V(n001)
1.1431V
1.1424V
1.1417V
1.1410V
1.1403V
1.1396V
1.1389V
1.1382V
1.1375V
1.1368V
1.1361V
1.1354V
0ms
1ms
2ms
3ms
4ms
5ms
6ms
7ms
8ms
9ms
10ms
stage -I