Choose tail current $75\,\mu A$

$\therefore$ Current through diff part : $37.5\,\mu A$

To start with

Take $(V_{gs}-V_{tn})_{M4} = 0.1\ V.$

$\therefore \quad V_{tn} = 0.37$

$V_g = 0.9\ V.$

$$I_D = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_4 \cdot (V_{gs}-V_{tn})^2$$

$$37.5 = \frac{1}{2} \times 230 \cdot \left(\frac{W}{L}\right)_4 \times (0.1)^2$$

$$\boxed{\left(\frac{W}{L}\right)_4 = 32.}$$

for pmos,

$$37.5 = \frac{1}{2} \times 100 \cdot \left(\frac{W}{L}\right)_2 \times (0.1)^2$$

$$\boxed{\left(\frac{W}{L}\right)_2 = 75}$$ (Later changed to 55 to maintain decent gain in 2nd Stage)

Current through $M6 = \frac{75}{10} = 7.5\,\mu A$

$\therefore$ Choose $\boxed{\left(\frac{W}{L}\right)_6 = 4.}$

$\therefore \quad \boxed{\left(\frac{W}{L}\right)_5 = 40.}$

Gain Calculation, (Theoretical,

$V_{gs} - V_{th} = 0.1$

$\therefore g_m = \frac{2 I_D}{0.1}$ (λ's of both are equal (from DC log file))

$R_{out} = r_{ON} \parallel r_{op} = \frac{1}{2\lambda I_D}$.

Taking $\lambda \approx 0.1$ (from DC_log file).

$A_v = g_m \cdot R_{out} \approx 100$.

Simulated gain (stage 1) in LTspice

80.

for pmos M2, $V_{sg} = 0.1 + V_{tp}$

$1.8 - V_g = 0.1 + V_{tp}$.

$V_g = 1.7 - 0.39$

$V_g \approx 1.31$

V_{d1}

2nd Stage design

Choose $I_D = 30\,\mu A$

$(V_{gs} - V_{tp}) = 0.1\,V$

$\therefore \boxed{\left(\frac{W}{L}\right)_7 = 60}$

$\therefore \left(\frac{W}{L}\right)_8 = \frac{4}{7.5} \times 30$

$\boxed{\left(\frac{W}{L}\right)_8 = 16}$

→ Taken as 19 to get decent gain

Note: Due to variation in V_{tp} in simulation it is changed to 0.8 to get decent gain,

in simulation actual $V_{tp} \approx 0.5\,V$.

~~Calculated~~ bias data,

	M_1	M_2	M_3	M_4	M_5	M_6	M_7	M_8
$\lvert V_{gs}-V_{th}\rvert$ (V)	0.14	0.14	0.08	0.08	0.12	0.12	0.052	0.053
g_m (μAV^{-1})	442	442	612	612	1030	108	415	406
r_o (MΩ)	0.29	0.29	0.26	0.26	10	0.01	7.7	0.11
I_D (μA)	35	35	35	35	70	7.5	23	23
W	55	55	32	32	40	4	16	3.5
L (μ)	1	1	1	1	1	1	0.18	0.18