

1st stage

$$A_{v1} = g_m (r_{o2} // r_{o4})$$

$$g_m = 2\sqrt{K_n I_D}$$

$$r_o = \frac{1}{\lambda I_D}$$

$$r_{o2} = r_{o4}$$

$$A_{v1} = g_m \frac{r_o}{2} = 2\sqrt{K_n I_D} \left(\frac{1}{2\lambda I_D} \right)$$

$$A_{v1} = \frac{1}{\lambda} \frac{\sqrt{K_n I_D}}{I_D} = \frac{1}{\lambda} \sqrt{\frac{K_n}{I_D}}$$

$$\frac{K_n}{I_D} = (\lambda A_{v1})^2 \quad \text{where } K_n = \frac{k'_n}{2} \frac{W}{L}$$

Example: Design for $A_{v1} = 50$

$$\frac{K_n}{I_D} = (\lambda A_{v1})^2 = [(0.01)(50)]^2 = 0.25$$

$$\frac{50\mu \left(\frac{W}{L}\right)_n}{I_D} = 0.25$$

$$25\mu \left(\frac{W}{L}\right)_n = 0.25 I_D$$

$$\left(\frac{W}{L}\right)_n = \frac{0.25}{25\mu} I_D = 0.01(10)^6 I_D$$

$$I_{DQ} = 100\mu A$$

$$\left(\frac{W}{L}\right)_n = 1$$

$$\left(\frac{W}{L}\right)_p = 2$$

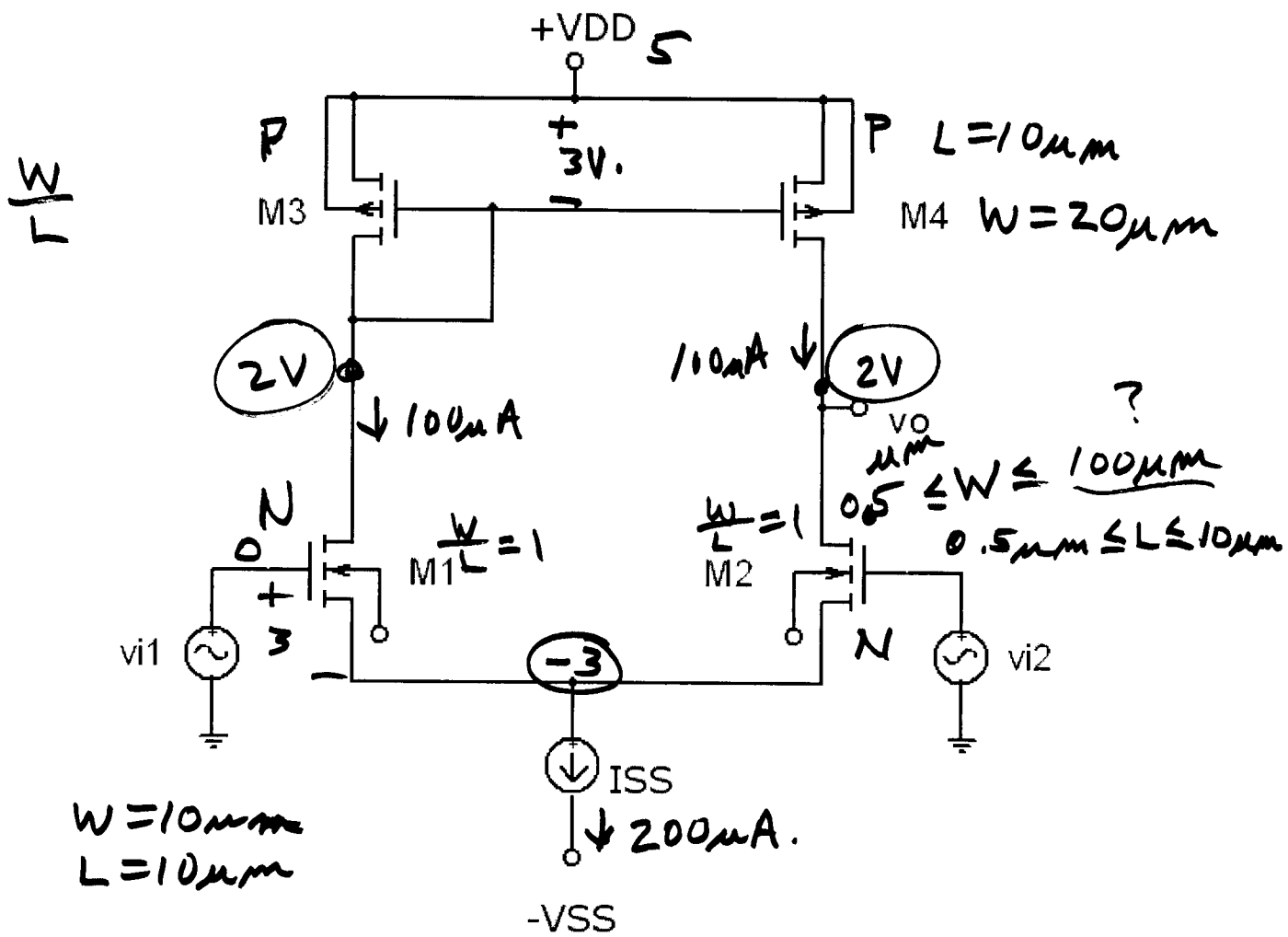
$$\lambda = 0.01$$

$$k'_n = 50\mu A/V^2$$

$$k'_p = 25\mu A/V^2$$

$$V_{TN} = 1$$

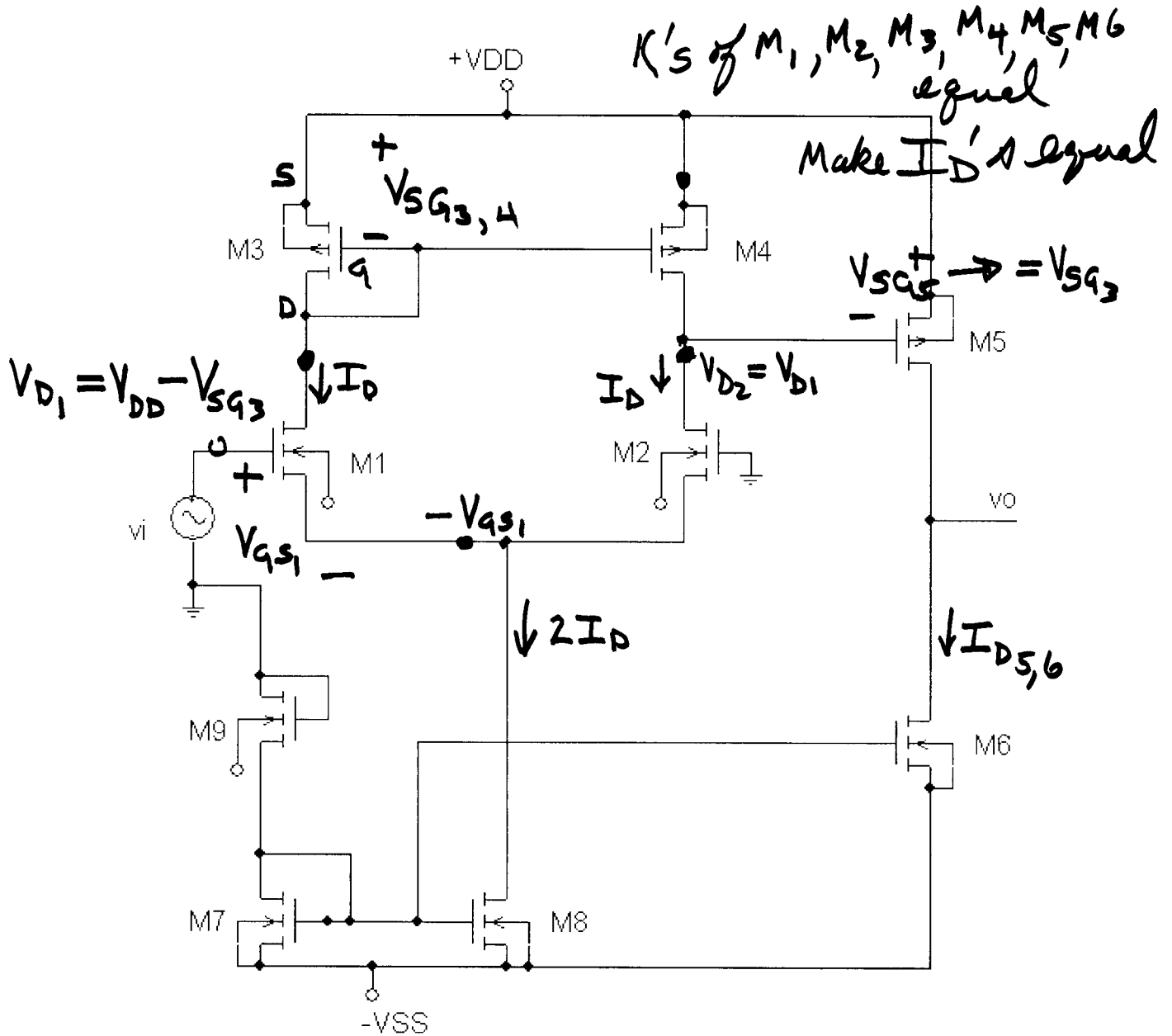
$$V_{TP} = -1$$



$$V_{GS} = \sqrt{\frac{I_D}{K}} + V_{TN}$$

$$V_{GS} = \sqrt{\frac{100\mu A}{25\mu}} + 1 = 3V.$$

STAGES 1 AND 2 TOGETHER



$$V_{GS1} = \sqrt{\frac{I_D}{K_n}} + V_{TN}$$

P-CH: $I_D = K_P (V_{SG} + V_{TP})^2$ $V_{TP} < 0$

N-CH: $I_D = K_n (V_{GS} - V_{TN})^2$

$$I_D = K_P (V_{SG} - |V_{TP}|)^2$$