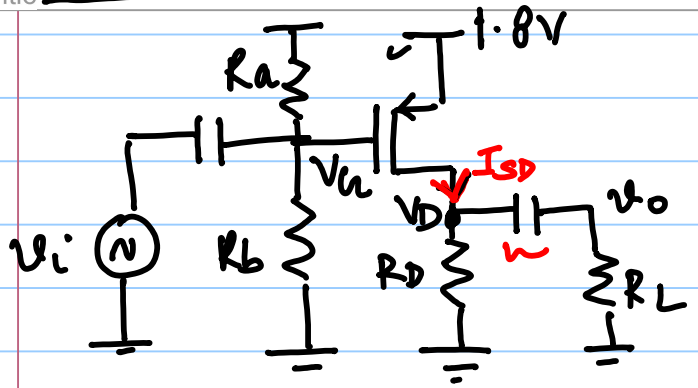
Tutorial #3

Note Title 24-09-2021



$-\left(\frac{W}{L}\right) = 20$, $V_{thp} = -0.7$, $\mu_p C_{ox} = 50\ \mu A/V^2$

- $R_D = 8K$ ✓ , $R_L = 8K$, $\frac{R_b}{R_b + R_a} \times 1.8V = 0.6V = V_G$

$R_D = 12K$

$$I_{SD} = \frac{\mu_p C_{ox}}{2}\left(\frac{W}{L}\right)\left(V_{SG} - |V_{thp}|\right)^2$$ ✓

$$= \frac{50 \times 10^{-6}}{2} \times 10 \left(1.8 - 0.6 - 0.7\right)^2$$

$$= 5 \times 10^{-4} \times 0.5^2$$

$$= \frac{5}{4} \times 10^{-4} = 125\ \mu A$$

$V_D = 125\ \mu A \times 8K = 0.125\ mA \times 8\ K = 1V$

$V_D = 125\ \mu A \times 12K$

$= 1.5\ V$

$1.5 \not< 0.6 + 0.7$

- $V_{SG} > |V_{thp}|$, $V_{SD} \geq V_{SG} - |V_{thp}|$ ✓

Transistor is in cut-off. ✗

$\Rightarrow V_S - V_D \geq V_S - V_G - |V_{thp}|$

$\Rightarrow V_D \leq V_G + |V_{thp}|$ ✓

$1V \qquad 0.6 + 0.7 = 1.3$

$$I_{SD} = \mu_p C_{ox} \left(\frac{W}{L}\right) \left((V_{SG} - |V_{THP}|) V_{SD} - \frac{V_{SD}^2}{2} \right) = \frac{V_D}{R_D}$$

$$\cancel{50}\ \mu A/V^2 \quad \cancel{20} \quad (1000\ \mu A/V^2 \left((1.2 - 0.7)(1.8 - V_D) - \frac{(1.8 - V_D)^2}{2} \right) = \frac{V_D}{12K}$$

$$12 \left(0.5(1.8 - V_D) - \frac{(1.8 - V_D)^2}{2} \right) = V_D \qquad 1.8^2$$

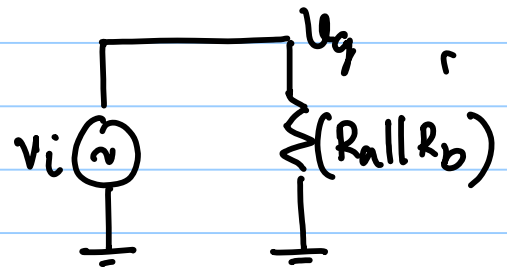
$$12 \left(0.9 - 0.5 V_D - \left(\frac{3.24 + V_D^2 - 3.6 V_D}{2} \right) \right) = V_D$$

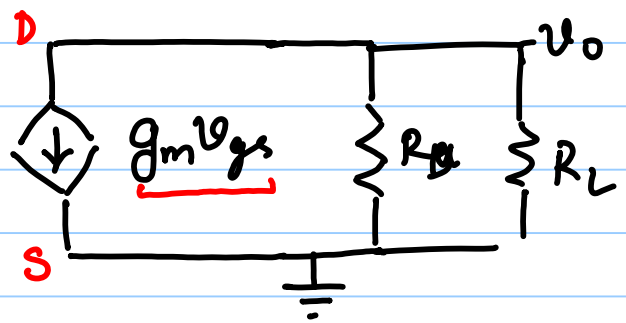
$$12 \left(1.3 V_D - 0.5 V_D^2 - 0.72 \right) = V_D$$

$I_{SD} = 125\,\mu A$, $\frac{W}{L} = 20$, $\mu_p C_{ox} = 50\,\mu A/V^2$, $V_{thp} = -0.7\,V$

$$g_m = \frac{2I_{SD}}{V_{SG} - |V_{thp}|} = \frac{2 \times 0.125\ mA}{1.8 - 0.6 - 0.7} = \frac{0.25}{0.5}\frac{mA}{V} = 0.5\ mA/V$$

$$r_{ds} = 1/\frac{\partial I_{DS}}{\partial V_{DS}} = \infty$$

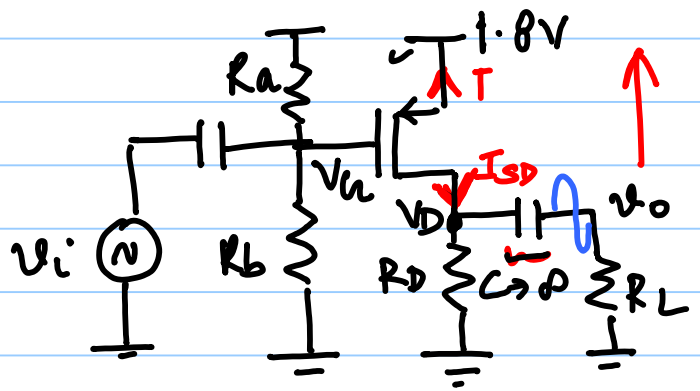




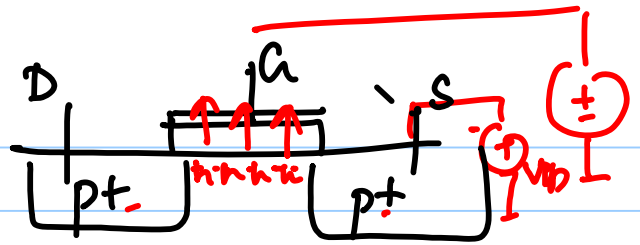
$$\frac{v_o}{v_i} = -g_m(R_D \| R_L)$$

$$= -0.5\ mA/V \times 4K$$

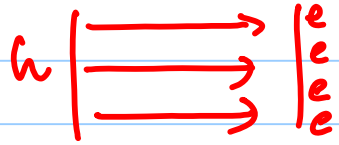
$$A = -2\ V/V$$



- $V_{SG} - |V_{thp}| > 0$ ✓
- $V_{SD} \geq V_{SG} - |V_{thp}|$ ✓
- $V_D \leq V_G + |V_{thp}|$

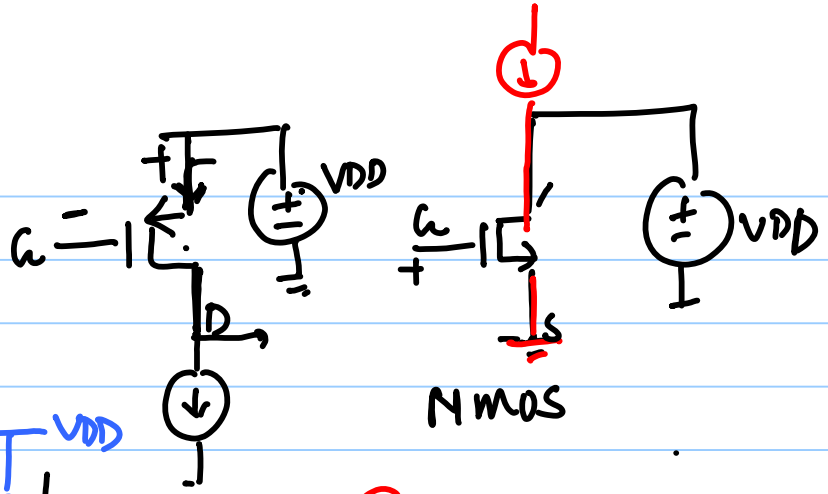


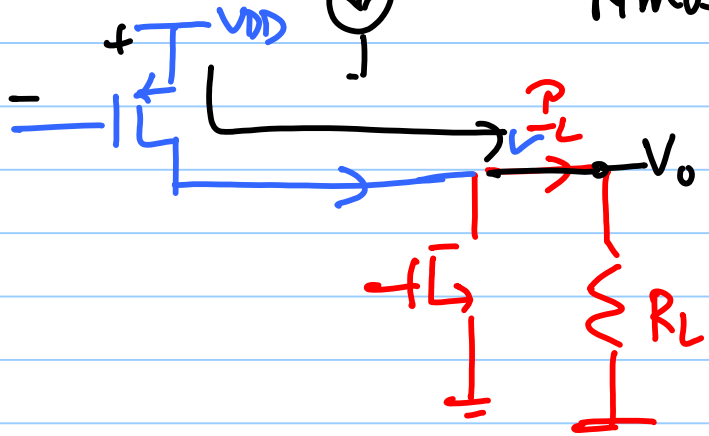
n-type

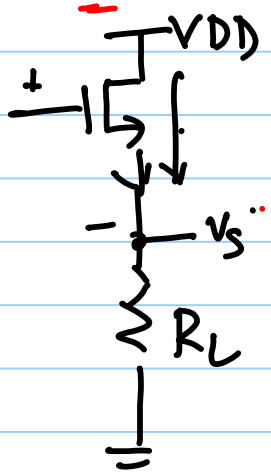


p-type

$V_{GS} < V_{thp}$







- $V_{SG} - |V_{tmp}| > 0$

- $V_{SD} \geq V_{SG} - |V_{tmp}|$

$V_D \leq V_G + |V_{tmp}|$

- $I_{SD} - g_m v_i \geq 0$

I_{SD}

$i = g_m v_i$

$1.0V - 2V/V \times v_i \leq 0.6 + v_i + 0.7$

$-0.3 \leq 3v_i$

$-0.1V \leq v_i$

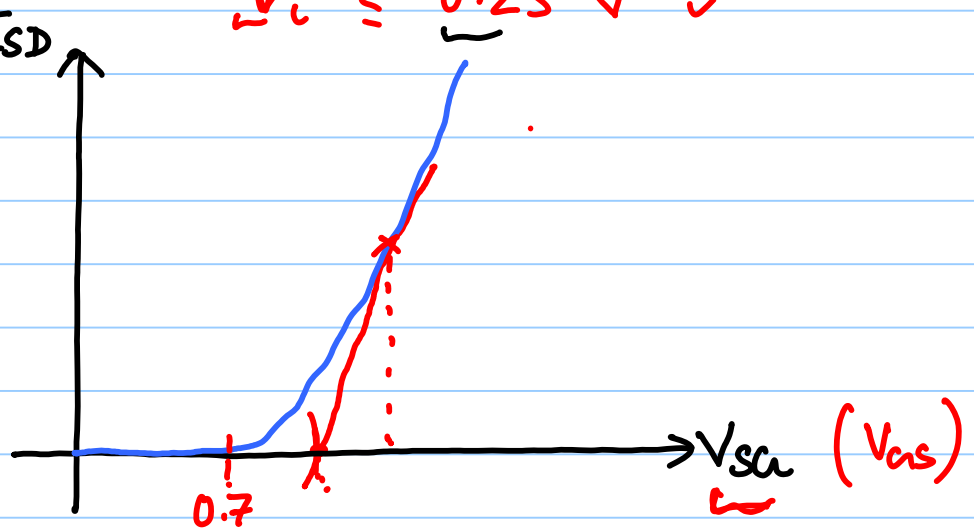
- $1.8 - (0.6 + v_i) - 0.7 > 0$

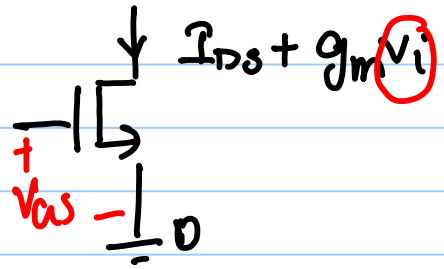
$v_i < 0.5$

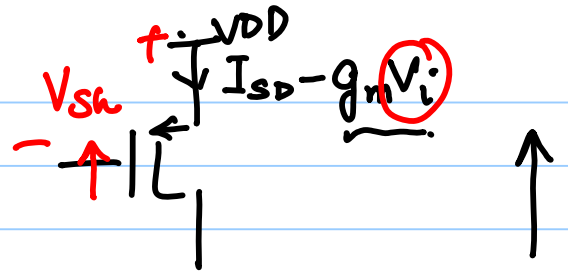
- $0.125\,mA - \frac{0.5\,mA}{V} v_i \geq 0$

$v_i \leq \frac{0.125}{0.5}$

$v_i \leq 0.25\,V$







$$-0.1V \leq v_i \leq 0.25V$$

$$-0.5V \leq v_o \leq 0.2V$$

$$1 - 0.5 \leq 1.0 + v_o \leq 1 + 0.2$$

$$0.5 \leq V_D \leq 1.2$$