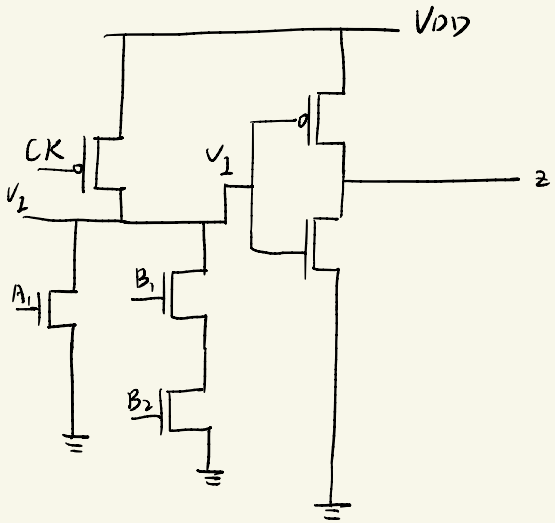
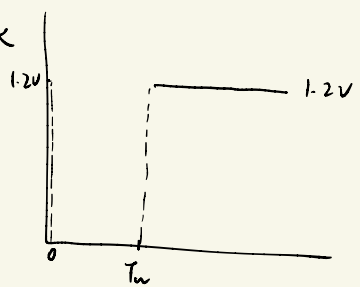
7.1 (a)



(b)



相多于对称出的从反相

长沟道：

计算pmos： $V_{GS}-V_{Tp}=V_{CK}-V_{DD}-V_{Tp}=0-1.2+0.5|=-0.69=V_{OV}$

$V_{DS}=V_2-V_{DD}=V_2-1.2$

线性区条件： $V_{OD}<V_{DS}$

$-0.69<V_2-1.2$

$V_2>0.5|V$.

饱和区条件： $V_2<0.5|V$

$$T_w=C_L\left(\int_0^{0.5|}\frac{dV_2}{I_{Dsat}}+\int_{0.5|}^{0.6}\frac{dV_2}{I_{D.Lin}}\right)$$

$$I_{Dsat}=\frac{1}{2}\mu_p C_{ox}\frac{W_p}{L_p}(V_{GS}-V_{Tp})^2=1.314mA$$

$$I_{D,lin} = \frac{1}{2}\mu_p C_{ox}\frac{W_p}{L_p}\left(2(V_{GS}-V_{Tp})V_{DS}-V_{DS}^2\right)$$

$L_p = L_p = 40 - 2\times 10 = 20nm$

暂令 $V_2 = 0.6V$.

可求 $I_{D,lin} = 1.2917\ mA$

$$T_w = 0.1\times10^{-12}\times\left(\frac{1}{1.314\times10^{-3}}\times 0.5 + (0.6-0.5)\cdot\frac{1}{1.2917\times10^{-3}}\right)$$

$$= 45.78\ ps$$

短沟道

线性区条件

$$V_{DS} > \frac{(V_{GS}-V_{Tp})E_{cp}L_p}{(V_{GS}-V_{Tp})+E_{cp}L_p}$$

$$V_2 - 1.2 > \frac{-0.69\times 1.8}{1.8-0.69}$$

$$V_1 > 0.7239\ V$$

饱和区条件: $V_2 < 0.7239V$

$$I_{Dsat} = \frac{1}{2}\mu_p C_{ox}\frac{W_p}{L_p}\cdot\frac{1}{1+\frac{(V_{GS}-V_{Tp})^2}{E_{cp}L_p}}\cdot(V_{GS}-V_{Tp})^2$$

$$= 1.039\ mA$$

$$I_{D,sat} = \frac{1}{2}\mu_p C_{ox}\frac{W_p}{L_p}\frac{1}{1+\frac{(V_{GS}-V_{TP})^2}{E_{sat}L_p}}\left(2(V_{GS}-V_{TP})V_{DS}-V_{DS}^2\right)$$

$(V_2 = 0.6V)$

$$= 1.0215\,mA$$

$$T_W = C_L\left(\int_0^{0.6}\frac{dV_2}{I_{D,sat}}\right)$$

$$= 0.1\times 10^{-12}\times 0.6\times\frac{1}{1.039\times 10^{-3}}$$

$$= 57.75\,ps$$

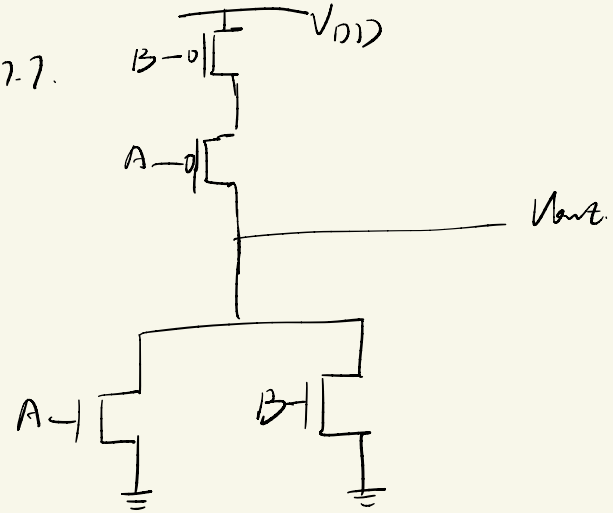
16. $F = AB + AC + BC + ABC = AB + AC + BC$

$$= \overline{\overline{AB}\cdot\overline{AC}\cdot\overline{BC}} \quad (NAND)$$

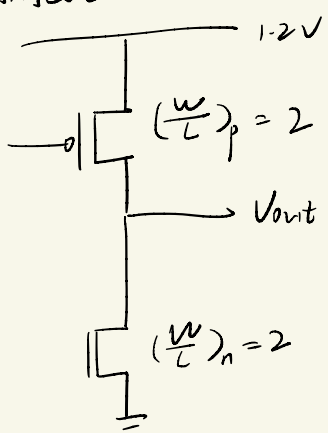
$$= (A+B)(A+C)(B+C)$$

$$= \overline{\overline{A+B}\cdot\overline{A+C}\cdot\overline{B+C}} \quad (或非)$$

7.7.



A.13 同时变化



$V_{Tn} = 0.53V$ $V_{Tp} = -0.51V$. $\mu_n C_{ox} = 98.2\ \mu A/V^2$. $\mu_p C_{ox} = 46\ \mu A/V^2$

$V_{OL} = 0V$

$V_{OH} = 1.2V$

V_{2L};

$$V_{out} = \frac{1}{2}\left(\left(\frac{k_n}{k_p}+1\right)V_{2L} - \frac{k_n}{k_p}V_{Tn} - V_{Tp} + V_{DD}\right)$$

$$\frac{k_n}{2}(V_{2L}-V_{tn})^2 = k_p\left(V_{3L}-V_{DD}-V_{tp}-\frac{V_{out}-V_{DD}}{2}\right)(V_{out}-V_{DD})$$

解得：$V_{2L} = 0.2072V$ 或 $0.5708V$

$V_{out} = \begin{pmatrix} \text{舍去} \\ \text{或} \end{pmatrix}$ ↓ $1.184V$

V_{2H}：

$$V_{out} = \frac{1}{2}\left(\left(\frac{k_n}{k_p}+1\right)V_{2H} - V_{tn} - \frac{k_p}{k_n}(V_{DD}+V_{tp})\right)$$

$$k_n\left(V_{2H}-V_{tn}-\frac{V_{out}}{2}\right)V_{out} = \frac{k_p}{2}(V_{2H}-V_{DD}-V_{tp})^2$$

$V_{2H} = 0.6102V$

$NM_L = 0.5708V$

$NM_H = 1.2 - 0.6102 = 0.5898V$

A.13 只有一个变化

$\left(\frac{W}{L}\right)_p = 2$ $\left(\frac{W}{L}\right)_n = 1$ (只有一条路)

其余计算均一致

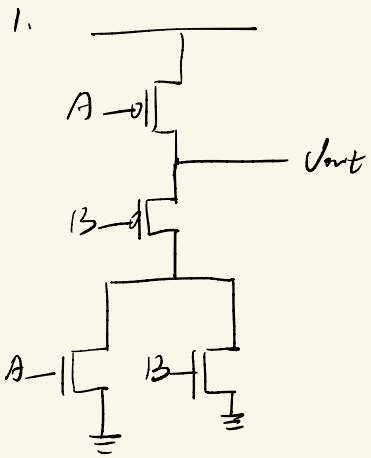
$V_{2L} = 0.5885V$

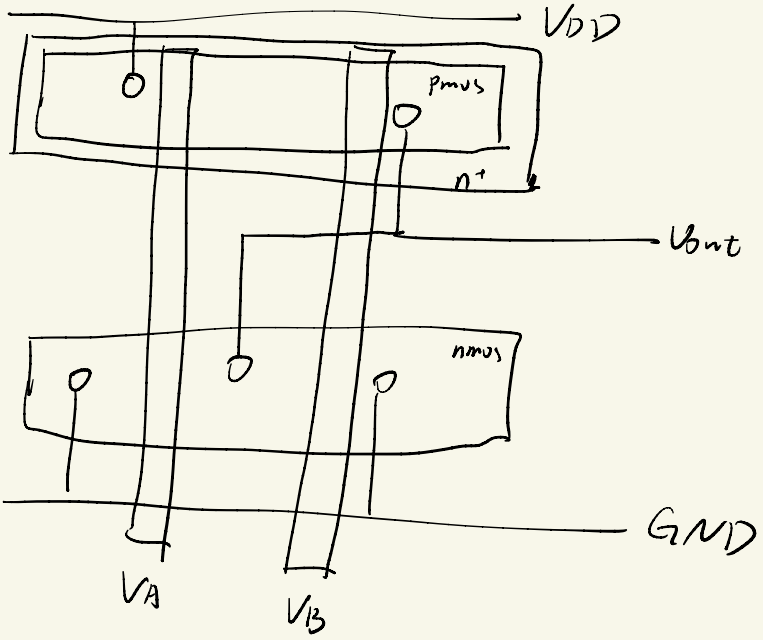
$V_{2H} = 0.6283V$

$NM_L = 0.5885V$

$NM_H = 1.2 - 0.6283 = 0.5717V$

1.





2.