HW-2

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Q1

If I insist that V_{T0} can never be reached as terminal B is grounded, the whole question becomes a deadlock. Thus I can only assume that the minimum value of V_{Th} is V_{T0}. Thus

$$\begin{aligned} V_{Th} &= \frac{1}{2}(V_{T,max} + V_{T0}) \\ &= V_{T0} + \frac{1}{2}\gamma(\sqrt{|(-2)\phi_F + V_{OH,max}|} - \sqrt{|2\phi_F|}) \end{aligned} \tag{1}$$

a

As $V_{GS} = V_{DD} - V_{OH}$ and only when $V_{OH} \leq V_{DD} - V_{Th}$ could guarentee the transistor is turned on. And the maximum value is the output voltage before t = 0.

$$\begin{aligned} V_{OH,max} &= V_{DD} - V_{Th} \\ &= V_{DD} - V_{T0} - \frac{1}{2}\gamma(\sqrt{|(-2)\phi_F + V_{OH,max}|} - \sqrt{|2\phi_F|}) \\ &= \end{aligned} \tag{2}$$

Q2

In this question, it is evidently $V_{sg} = V_X - V_{in}$. Thus $V_{sd} = V_X = V_{DD} - IR_1$. When $V_X = V_x - V_{in} + V_T$, $V_{in} = -0.4(V)$, and obviously $V_{in} \geq 0(V)$, so the transistor is always in saturation mode. Thus,

$$\begin{aligned} V_X &= V_{DD} - IR_1 \\ &= V_{DD} + \frac{1}{2}R_1\kappa\frac{W}{L}(V_X - V_{in} + V_T)^2(1 + \lambda V_X) \\ &= \end{aligned} \tag{3}$$

a

b

$$\begin{aligned} \frac{W}{L} &= 2 \times \frac{V_X - V_{DD}}{R_1\kappa(V_X - V_{in} + V_T)^2(1 + \lambda V_X)} \\ &= 6.48 \end{aligned} \tag{4}$$