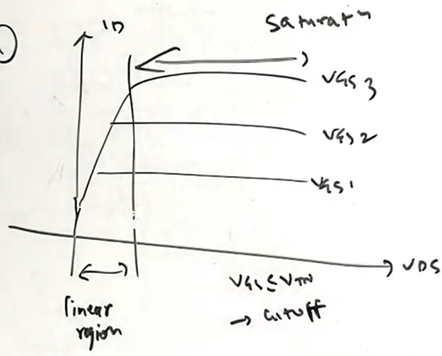
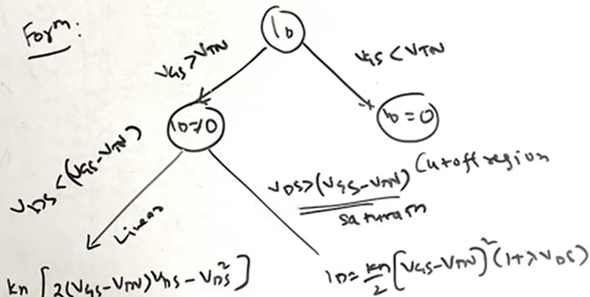
Drain current

(1) Graph (2) Form (3) Sums

(1)



(2) Form:



$$I_D = \frac{k_n}{2}\left[2(V_{GS}-V_{TN})V_{DS} - V_{DS}^2\right]$$

$$I_D = \frac{k_n}{2}\left[V_{GS}-V_{TN}\right]^2(1+\lambda V_{DS})$$

(1) NMOS: $V_T = 0.8$, $\lambda = 0.04V^{-1}$, $k_n' = 20\mu$, $\frac{W}{L} = 20\mu$, $V_D = 4$, $V_G = 5$, $V_S = 2$

$k_n = k_n' \cdot \frac{W}{L}$

$I_D = ?$

1) V_{GS}, V_{DS} → $V_{GS} = V_G - V_S = 3$, $V_{DS} = V_D - V_S = 2$

2) $V_{GS} > V_{TN}$ → ON

$(V_{GS} - V_{TN}) = 2.2$ $\quad V_{DS} = 2 < 2.2$

$V_{DS} < (V_{GS} - V_{TN})$

linear eqn

3) $I_D = \frac{k_n}{2}\left[2(V_{GS}-V_{TN})V_{DS} - V_{DS}^2\right]$

$= 0.16\ mA$ 10^{-3}

(1) NMOS: $\frac{W}{L} = \frac{10}{0.55}$, $k_n' = 110\ \mu A/V^2$

$I_D = ?$ $\quad V_{GS} = 2V$, $V_{DS} = 2V$, $V_{TN} = 0.7V$

Sol^n:

1) $V_{GS} - V_{TN} = 1.3V$

2) $V_{DS} = 2V$ $\quad V_{DS} > (V_{GS} - V_{TN})$ → saturatn

3) $I_D = \frac{k_n}{2}\left[V_{GS} - V_{TN}\right]^2$

4) $\lambda = 0$, $k_n = k_n' \cdot \frac{W}{L}$

5) $I_D = 110 \times 10^{-6} \times \frac{10}{0.55}(1.3)^2$

$= 3.3\mu A$

QUESTION 3:

$V_{TN} = 0.8V$, $\lambda = 0.05V^{-1}$, $\mu_n C_{ox} = 20\mu A/V^2$

$V_G = 2.8V$, $V_D = 5V$, $V_S = 1V$

$I_D = 0.24\ mA$

To find: $\frac{W}{L}$

L & S

V_{ov} & V_{DS}

Sol^n:

1] $V_{GS} = V_G - V_S = 1.8V$

$V_{DS} = V_D - V_S = 4V$

2] $V_{ov} = V_{GS} - V_{TN} = 1.8 - 0.8 = 1V$

$V_{DS} > V_{GS} - V_{TN}$ → SATURATION region

3] $I_D = \frac{k_n}{2}[V_{GS} - V_{TN}]^2 (1 + \lambda V_{DS})$

$\therefore 0.24 \times 10^{-3} = \frac{(\mu_n C_{ox}) \cdot W/L}{2}[1]^2[1 + 0.05 \times 4]$

Given: $\mu_n C_{ox} = 20 \times 10^{-6}$

$k_n = k_n' \cdot \frac{W}{L}$

$= (\mu_n C_{ox}) \cdot \frac{W}{L}$

$\therefore \frac{W}{L} = 20$