

5.8 NMOS $V_{GS} = 0, 1, 2, 3$ $V_{DS} = 0.3V$ $W = 6\mu m$

$L = 0.5\mu m$ $V_{TN} = 0.75V$ $K'_N = 200\mu A/V^2$ $K_N = ?$ $I_D = ?$

$V_{GS} = 0: I_D = 0$

$V_{GS} = 1: I_D = \frac{K_N}{2} (V_{GS} - V_{TN})^2 (1 + \lambda V_{DS}) = 0.52\mu A$

$V_{GS} = 2: I_D = K_N \left((V_{GS} - V_{TN}) - \frac{V_{DS}}{2} \right) \cdot V_{DS} = 5.5\mu A$

$V_{GS} = 3: I_D = K_N \left((V_{GS} - V_{TN}) - \frac{V_{DS}}{2} \right) \cdot V_{DS} = 10.5\mu A$

$K_N = K'_N \frac{L}{W} = 16.67\mu A/V^2$

5.20 NMOS $V_{GS} = 0, 1, 2, 3$ $V_{DS} = 3.3V$ $W = 5\mu m$

$L = 0.5\mu m$ $V_{TN} = 1V$ $K'_N = 375\mu A/V^2$ $K_N = ?$ $I_D = ?$

$V_{GS} = 0: I_D = 0$

$V_{GS} = 1: I_D = 0$

$V_{GS} = 2: I_D = \frac{K_N}{2} (V_{GS} - V_{TN})^2 = 18.75\mu A$ $3.3 \geq 2 - 1 \checkmark$

$V_{GS} = 3: I_D = \frac{K_N}{2} (V_{GS} - V_{TN})^2 = 75\mu A$ $3.3 \geq 3 - 1 \checkmark$

$K_N = K'_N \frac{L}{W} = 37.5\mu A/V^2$

5.24 NMOS $\mu_n = 400 \mu\text{A/V}^2$ $V_{TN} = 0.7\text{V}$

a) $V_{GS} = 3.3\text{V}$ $V_{DS} = 3.3\text{V}$

$V_{GS} > V_{TN} \checkmark$ $V_{DS} \leq V_{GS} - V_{TN} \times$ Saturation

b) $V_{GS} = 0\text{V}$ $V_{DS} = 3.3\text{V}$

$V_{GS} > V_{TN} \times$ Cutoff

c) $V_{GS} = 2\text{V}$ $V_{DS} = 2\text{V}$

$V_{GS} > V_{TN} \checkmark$ $V_{DS} \leq V_{GS} - V_{TN} \times$ Saturation

d) $V_{GS} = 1.5\text{V}$ $V_{DS} = 0.5\text{V}$

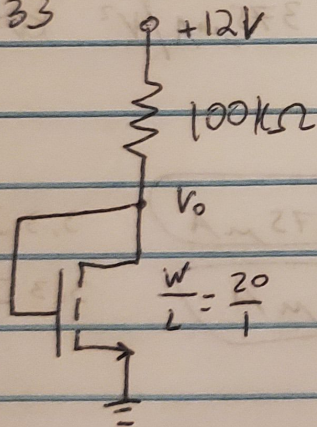
$V_{GS} > V_{TN} \checkmark$ $V_{DS} \leq V_{GS} - V_{TN} \checkmark$ Triode

e) $V_{GS} = 2\text{V}$ $V_{DS} = -0.5\text{V}$

$V_{GS} > V_{TN} \checkmark$ $V_{DS} \leq V_{GS} - V_{TN} \checkmark$ Triode

f) $V_{GS} = 3\text{V}$ $V_{DS} = -3\text{V}$ $V_{GS} > V_{TN} \checkmark$ $V_{DS} \leq V_{GS} - V_{TN} \checkmark$ Triode

5.33



a) $I_D = ?$ $\lambda = 0$ $V_{GS} = V_D = V_{DS}$

$$I_D = \frac{\mu_n}{2} \cdot (V_{GS} - V_{TN})^2$$

$$\frac{12 - V_D}{100\text{k}} = \frac{\mu_n}{2} \cdot (V_D - V_{TN})^2$$

$$K_n = \mu_n \cdot C_{ox} \cdot \frac{W}{L} = 20$$

$$I_D = 10(12 - 100I_D)^2$$

$I_D = 329 \mu\text{A}$

b) $\lambda = 0.025 \text{ V}^{-1}$ $I_D = 5(12 - 100I_D)^2(1 + 0.025V_{DS})$

$$= 5(12 - 100I_D)^2(1.3 + 2.5I_D)$$

$I_D = 121 \mu\text{A}$

5,35

a) ~~$I_D = ?$~~ $I_D = ?$ $\lambda = 0$

