FET HW 1

[1] $I_{d(sat)} = \frac{1}{2} k_p (V_{SS} - V_{TO})^2 \times \frac{W}{4}$

$= \frac{1}{2} \times 15 \times 10^{-6} \times (3 - 0.5)^2 \times \frac{2}{1}$

$I_{d(sat)} = 0.3125\,mA$

$V_{d\,sat} = V_{GS} - V_{TO} = 3 - 0.5 = 2.5V$

[2]

$I_d = \frac{1}{2} \times 25 \times 10^{-6} \times (-3 - (-0.5))^2 \times \frac{2}{1}$

$25 \times 10^{-6} \times 39.0625 \times 2$

$I_{d\,sat} = 0.3125\,mA$

$V_{d\,sat} = V_{GS} - V_{TO} = -3 + 0.5 = -2.5V$

[3]

a) $R_{on} = \frac{1}{K_n' \frac{W}{L} (V_{GS} - V_{tn})} = \frac{W}{4} = \frac{1}{\left(\frac{100\mu A}{V^2}\right)(500\Omega)(5V - 0.75V)}$

$= 4.705\,\Omega$

b) $= \frac{1}{\left(\frac{100\mu A}{V^2}\right)(500\Omega)(3.3 - 0.75)} = \frac{1 \times 10^6}{\left(\frac{100A}{V^2}\right)(1275\Omega V)} = 7.843 = \frac{W}{L}$

4

$$R_{on} = \frac{V_{DS}}{I_D} = \frac{0.1V}{10A} = 0.01\,\Omega = 10m\Omega$$

$V_S = 0$

$V_{GS} = V_G - V_S = 5 - 0 = \underline{5V}$

$$I_D = k_n\left(V_{GS} - V_{Tn} - \frac{V_{DS}}{2}\right)V_{DS}$$

$$k_n = \frac{10A}{\left[5V - 2V - \left(\frac{0.1}{2}\right)\right]0.1V} = \underline{33.9\,A/V^2}$$

5

$V_{GS} - V_{tn} = 2V - 0.75 = 1.25V$

$I_D = \frac{k_n'}{2}\left(\frac{W}{L}\right)(V_{GS} - V_{Tn})^2$ $V_{DS} > V_{GS} - V_{Tn}$ Sat region

$$i_D = \frac{200mA/V^2}{2}\left(\frac{10}{1}\right)(2V - 0.75)^2 = \underline{1562.5mA}$$

$V_{DS} < V_{GS} - V_{Tn}$ Triod region

$$i_d = 200mA/V^2\left(\frac{10}{1}\right)\left(2V - 0.75 - \frac{0.2}{2}\right)0.2 = \underline{460mA}$$

$V_{GS} < V_{Tn}$ Cutoff

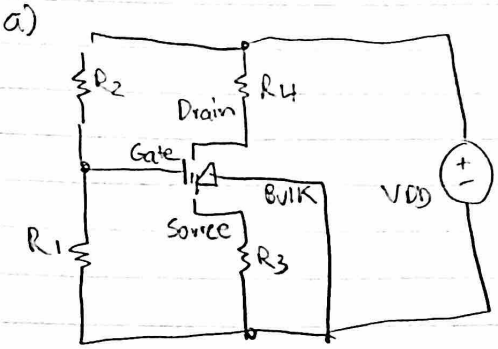
drain current = 0

$$i_D = \frac{300mA/V^2}{2}\left(\frac{10}{1}\right)(2V - 0.750)^2 = 2,343.75mA$$

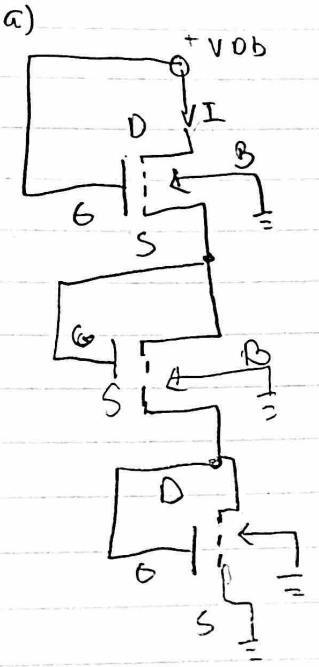
$$i_D = 308\left(\frac{10}{1}\right)(2 - 0.75 - \frac{.2}{2}).2 = 690mA$$

drain values = $\underline{2343.75, 690, 0}$

6 a)


R2
Drain
R4
Gate
BULK
VDD
Source
R1
R3

7 a)


+VDD
D
VI
B
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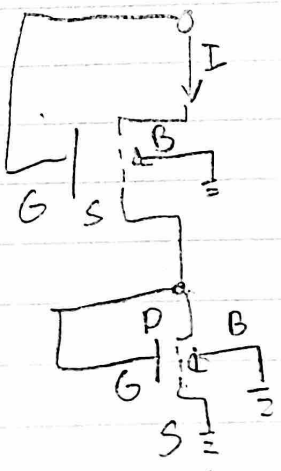
S
G
B
S
D
G
S

b)


I
B
G
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D
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