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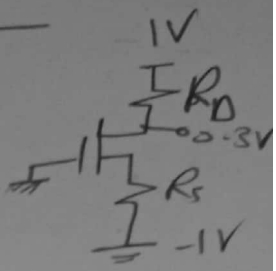
Assignment #7



Question ①:

$R_D = \frac{1-0.3}{0.1} = 7k\Omega$

$R_S = 3k\Omega$

$R_D = 7k\Omega$

$\because V_D > V_G - V_{th} \rightarrow \therefore$ Sat

$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS}-V_{th})^2$

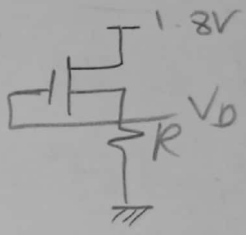
$0.1\times10^{-3} = \frac{1}{2} * 400 * 10^{-6} * \frac{5}{0.4}(-V_S-0.5)^2$

$V_S = -0.3V$ ✗

$V_S = -0.7V$ ✓

$R_S = \frac{-0.7-(-1)}{0.1} = 3k\Omega$

Question ②:



$V_{DS} > V_{GS} - V_{th}$ ∴ Sat

$I_{SD} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{SG}-|V_{th}|^2)(1+\lambda V_{DS})$

$180\times10^{-6} = \frac{1}{2}\times400\times10^{-6}\times\frac{W}{0.18\times10^{-6}}((1.8-1)-0.5)^2$

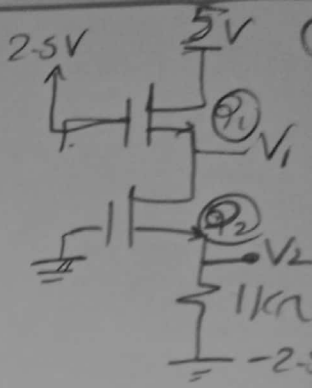
$\therefore W = 7.2\mu m = 40L$

$\therefore W = 7.2\mu m$

$V_D = 1V$ $R = \frac{V_D}{I_D} = 5.56k\Omega$

$R = 5.56k\Omega$

Question ③:



$V_{DS_1} > V_{GS_1} - V_{th}$ ∴ Q_1 in Sat

$I_{DS} = \frac{1}{2} K_n' \frac{W}{L} (V_{GS_1} - V_{th_1})^2$

$= \frac{1}{2} * 1.5 * 10^{-3} (2.5 - V_{S_1} - 0.9)^2$

$2.5 - V_{S_1} > 0.9$ ∴ $V_{S_1} < 1.6$ (I)

For Q_2: $V_{GS_2} = -V_{S_2}$

$V_{GS_2} > V_{th}$

∴ $V_{S_2} < -0.9$ (II)

From (I) & (II): $V_{D_2} > V_G - V_{th}$

$V_{D_2} > -0.9$

Q_2 in Sat → $I_{D_2} = \frac{1}{2} K_n' \frac{W}{L} (V_{GS_2} - V_{th})^2$

$= \frac{1}{2} * 1.5 * 10^{-3} (-V_{S_2} - 0.9)^2$

$I_{D_1} = I_{D_2}$

$(V_{S_1} - 1.6)^2 = (V_{S_2} + 0.9)^2$

$V_{S_1} = V_{S_2} + 2.5$

∴ $V_{S_1} = 0.66V$ ✓

$V_{S_1} = -V_{S_2} + 0.7 = 2.54$ X

$I_{D_S} = \frac{V_{S_2} - (-2.5)}{1} = 0.75 * 10^{-3} (V_{S_2} + 0.9)^2$

$V_{S_2} = 1.37$ X

$V_{S_2} = -1.84$ ✓

∴ $V_{S_1} = 0.66V$ $V_{S_2} = -1.84V$ $I_{D_S} = 0.66mA$ //