

CSCE 5730: Digital CMOS VLSI Design

Assignment 3, Assigned Date: 14th Mar 2007 (Wed), Due Date: 26th Mar 2007 (Wed)
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- Determine the mode of operation (saturation, linear, or cutoff) and drain current I_D for each of the biasing configurations given below. Use the following transistor data: NMOS: $k'_n = 115 \mu\text{A}/\text{V}^2$, $V_{T0} = 0.43 \text{ V}$, $\lambda = 0.06 \text{ V}^{-1}$, PMOS: $k'_p = 30 \mu\text{A}/\text{V}^2$, $V_{T0} = -0.4 \text{ V}$, $\lambda = -0.1 \text{ V}^{-1}$. Assume $(W/L) = 1$.
 - NMOS: $V_{GS} = 2.5 \text{ V}$, $V_{DS} = 2.5 \text{ V}$. PMOS: $V_{GS} = -0.5 \text{ V}$, $V_{DS} = -1.25 \text{ V}$.
 - NMOS: $V_{GS} = 3.3 \text{ V}$, $V_{DS} = 2.2 \text{ V}$. PMOS: $V_{GS} = -2.5 \text{ V}$, $V_{DS} = -1.8 \text{ V}$.
 - NMOS: $V_{GS} = 0.6 \text{ V}$, $V_{DS} = 0.1 \text{ V}$. PMOS: $V_{GS} = -2.5 \text{ V}$, $V_{DS} = -0.7 \text{ V}$.
- Consider an NMOS with the following parameters: $t_{ox} = 5 \text{ nm}$, $L = 0.2 \mu\text{m}$, $W = 0.4 \mu\text{m}$, $L_D = L_S = 0.5 \mu\text{m}$, $C_O = 3 \times 10^{-10} \text{ F/m}$, $C_{j0} = 2 \times 10^{-3} \text{ F/m}^2$, and $C_{jsw0} = 2.75 \times 10^{-10} \text{ F/m}$. Determine the zero-bias value of all the relevant capacitances.
- Given the data in Table 0.1 below for a short channel NMOS transistor with $V_{DSAT} = 0.6 \text{ V}$ and $k' = 100 \mu\text{A}/\text{V}^2$, calculate V_{T0} , γ , λ , $2|\phi_f|$, and W/L :

0.1 Measured NMOS transistor data

	V_{GS}	V_{DS}	V_{BS}	$I_D (\mu\text{A})$
1	2.5	1.8	0	1812
2	2	1.8	0	1297
3	2	2.5	0	1361
4	2	1.8	-1	1146
5	2	1.8	-2	1039