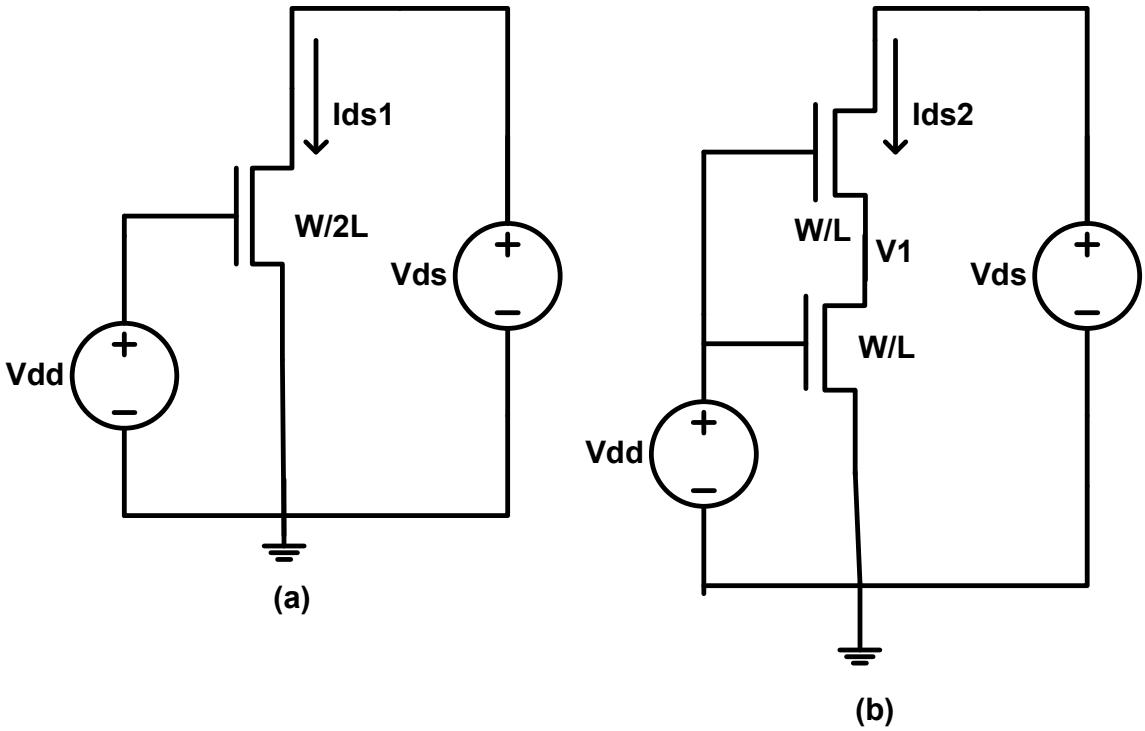
EE466: Homework 1

Due Sept 18, 2009

10 points for each question

1. Show that the current through two transistors in series is equal to the current through a single transistor of twice the length if the transistors are well described by the Chockley model. Specifically, show that $I_{DS1} = I_{DS2}$ in Fig. 1 when the transistors are in their linear region: $V_{DS} < V_{DD}-V_t$, $V_{DD} > V_t$ (this is also true in saturation).



2. A 90 nm long transistor has a gate oxide thickness of 16 A. What is the gate capacitance per micron of width?
3. Consider the nMOS transistor in a 0.6 um process with gate oxide thickness of 100 A. The doping level is $N_A = 2.10^{-3}$ cm^{-3} and the nominal threshold voltage is is 0.7 V. The body effect is tied to ground with a substrate contact. How much does the threshold change at room temperature if the source is at 4 V instead of 0?
4. Find the threshold leakage current of an inverter at room temperature if the input A = 0. Let $\beta n = 2\ \beta p = 1 mA/V^2$, n = 1.0, and $V_t = 0.4$ V. Assume the body effect and DIBL coefficients are $\gamma = \eta = 0$.
5. An nMOS transistor has a threshold voltage of 0.4 V and a supply voltage of VDD = 1.2 V. A circuit designer is evaluating a proposal to reduce Vt by 100 mV to obtain faster transistors.
    a) By what factor would the saturation current increase (at $V_{gs} = V_{ds} = V_{DD}$) if the transistors were ideal?

b) By what factor would the subthreshold leakage current increase at room temperature at $V_{gs} = 0$? Assume n = 1.4.
c) By what factor would the subthreshold leakage current increase at 120 C? Assume the threshold voltage is independent of temperature.