

UNIVERSITY OF CALIFORNIA AT BERKELEY
College of Engineering
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Homework #4
(Due 9/24/03)

EECS 140
Fall 2003

.model nmos

+ **nmos level=1 tox=2.6n vt0=0.3 gamma=0.2 phi=0.6 u0=250 ld=0.025u**
 + **capop=0 acm=3 ldif=0 hdif=0.2u cj=8e-4 cjsw=8e-12 cjgate=8e-11**
 + **lambda=0.2**

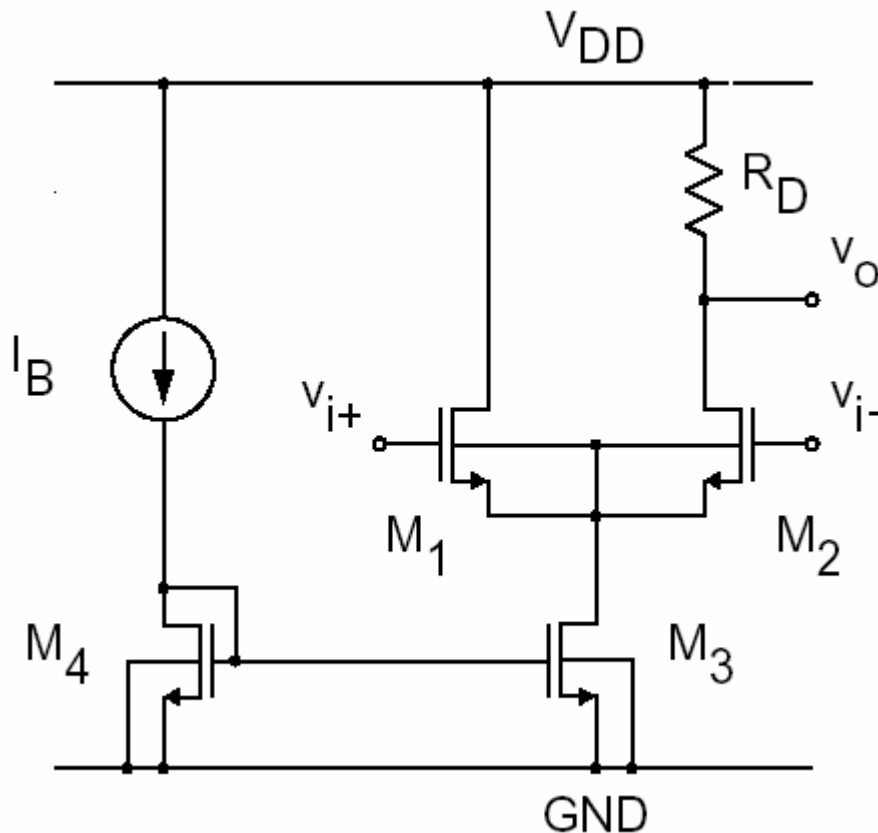
.model pmos

+ **pmos level=1 tox=2.6n vt0=-0.3 gamma=0.2 phi=0.6 u0=100 ld=0.025u**
 + **capop=0 acm=3 ldif=0 hdif=0.2u cj=8e-4 cjsw=8e-12 cjgate=8e-11**
 + **lambda=0.15**

When using the above models, remember to use W/L_{eff} in your calculations, where $L_{eff}=L-2*L_d$ and $L_d=0.025\mu m$. You can calculate k' directly from the SPICE model parameters u_0 and tox .

1. For the circuit shown below, assume $V_{DD}=1.2V$, $W=4\mu m$, $L=0.13\mu m$, $R_D=1K\Omega$, $I_B=600\mu A$.

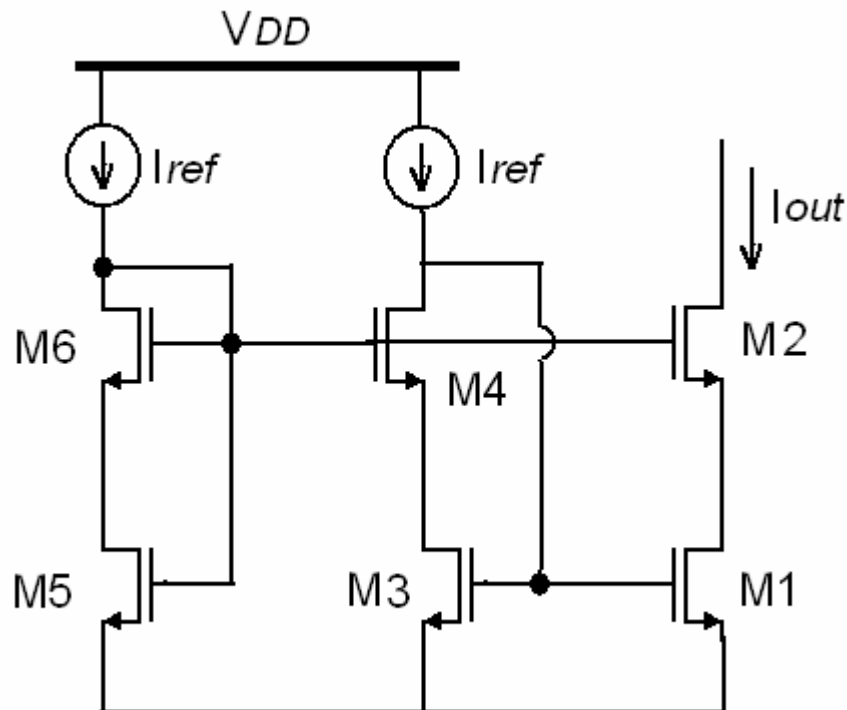
- a) Calculate $G_{m,dm}$, $G_{m,cm}$, A_{dm} and A_{cm} for $V_{id}=0$ and $V_{ic}=0.8V$, assuming that all the transistors are in saturation.
- b) Verify using SPICE. (To verify using SPICE, use a .tf analysis.)



2. High-swing cascode circuit

The circuit shown below is a high-swing cascode circuit. Assume all the transistors have the same channel length which is $1\mu\text{m}$ and channel width of M1-M4 and M6 is $10\mu\text{m}$. I_{ref} and V_{dsat} of M1 are known. Ignore the channel length modulation and body effect.

- What is the operation region of M5?
- If $V_{\text{ds5}} = V_{\text{dsat}}$ of M1. What is the minimum voltage swing at output node such that M1 and M2 are both in saturation? (In terms of V_{dsat} of M1)
- If $V_{\text{ds5}} = V_{\text{dsat}}$ of M1. What is the channel width of M5?



3. Self-biased cascode circuit

In the circuit cascode circuit shown on the next page, the resistor R sustains proper voltage to allow both M1 and M2 remain in saturation. Assume both M1 and M2 have the same size W/L . Mobility μ_p and gate oxide capacitance C_{ox} are known, ignore the channel length modulation and body effect. What are the minimum and maximum values of I_{ref} such that M1 and M2 remain in saturation?

