Introduction to Analog Integrated Circuits (112), DECE, NTUST

Homework 5 (Due date: 11/14)

HW5.1: (20 points)

Using a long-channel model, **prove** that, in strong inversion, the transistor M_R behaves like a resistor ($R_{on,R}$) with its resistance,

$$R_{on,R} = \frac{(W/L)_C}{(W/L)_R} \frac{1}{g_{m,C}}$$

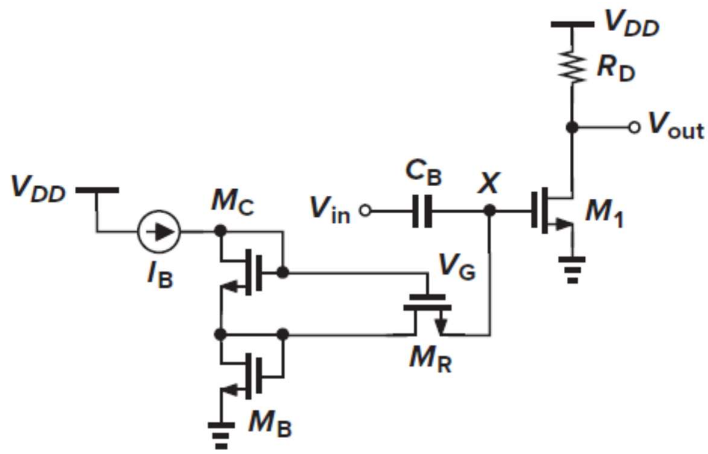

Fig. 5.1

HW5.2: (30 points)

The circuit of Fig. 5.2 is designed with $(W/L)_{1,0} = 8/2$, $(W/L)_{3,2} = 4*8/2$, and $I_{REF} = 100\ \mu$A. Assume $\mu_n C_{ox}$=800μA/V^2, VDD=3V and γ=0. V_{TH}=0.5V

(a) Determine V_X and the acceptable range of V_b.

(b) Estimate the deviation of I_{out} from 400 μA if the drain voltage of M_3 is higher than V_X by 1 V, if λ=0.1V^{-1}.

(c) How to design V_b to have a minimum drain voltage of M_3?

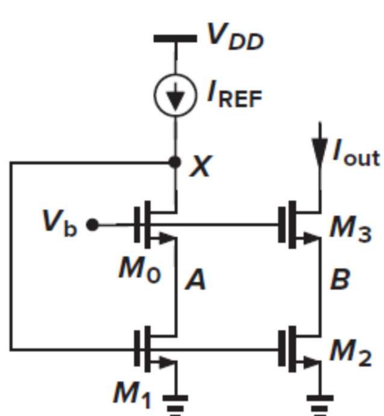

Fig. 5.2

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HW5.3 (30 points)

In the circuit shown in Fig. 5.3, a source follower using a *wide* transistor and a small bias current is inserted in series with the gate of M_3 to bias M_2 at the edge of saturation. Assuming M_0–M_3 are identical and $\lambda \neq 0$, estimate the mismatch between I_{out} and I_{REF} if

(a) $\gamma = 0$ (20 points), and

(b) $\gamma \neq 0$ (10 points).

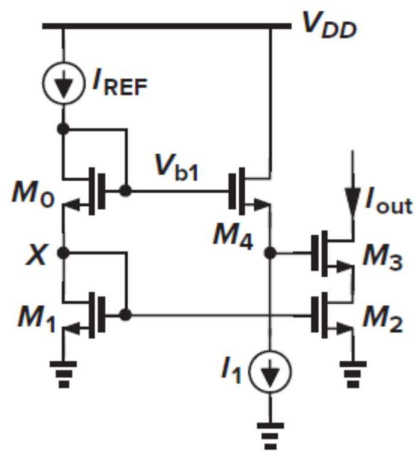

Fig. 5.3

HW5.4: (20 points)

The circuit shown in Fig. 5.4 exhibits a *negative* input inductance. Calculate the input impedance of the circuit and identify the inductive component.

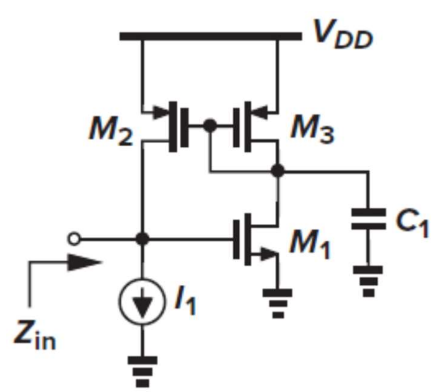

Fig. 5.4