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

Homework 4 (Due date: 10/21)

HW4.1: (20 points)

A differential amplifier is shown in Fig. 4.1. $R_{D1}=R_{D2}=R_D$, $M_1 \neq M_2$, and I_{SS} has a output resistance R_{SS}. If only g_m mismatch is considered, prove that the differential gain is as follows,

$$|A_{DM}| = \frac{R_D}{2}\frac{g_{m1}+g_{m2}+4g_{m1}g_{m2}R_{SS}}{1+(g_{m1}+g_{m2})R_{SS}}.$$

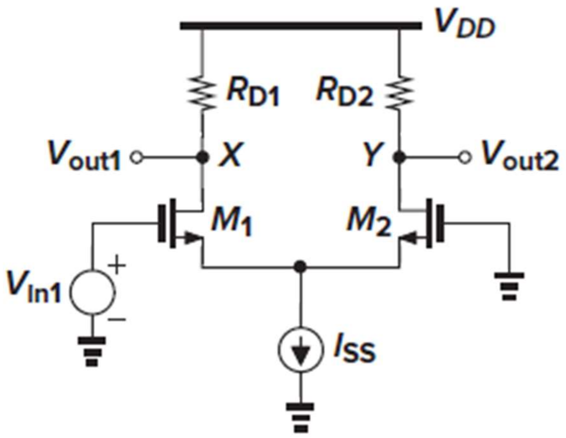

Fig. 4.1

HW4.2: (40 points)

Assuming that all the transistors in the circuits of Figs. 4.2 are saturated and $\lambda \neq 0$, calculate the small-signal differential voltage gain (Av) of each circuit. Assume both amplifiers have positive voltahe gains.

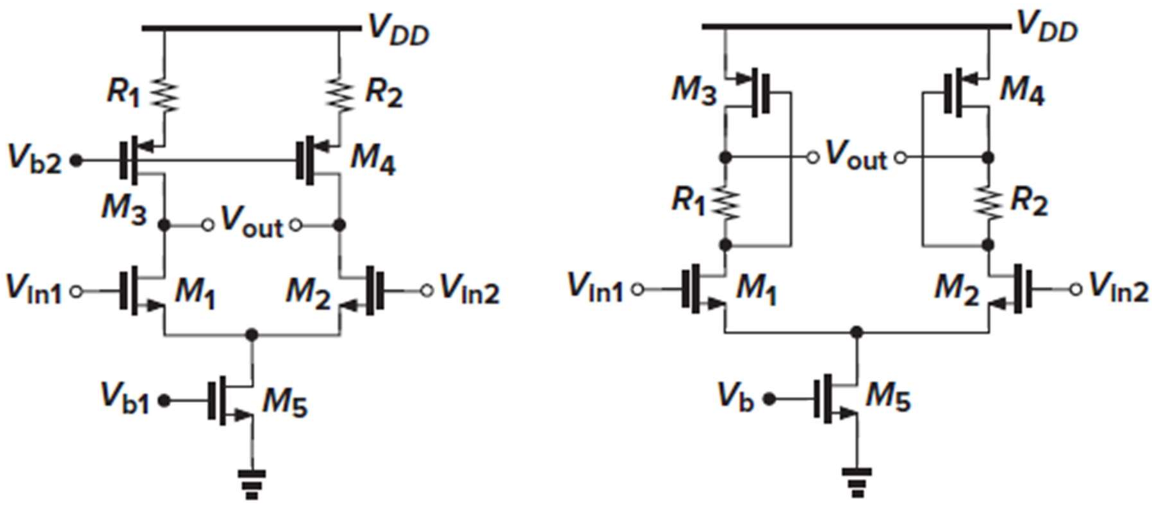

Fig. 4.2

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HW4.3: (40 points)

(a) According to textbook ot lecture, provide your derivation processto show that the equivalent transconductance (Gm) is as follows,

$$\frac{\partial \Delta I_D}{\partial \Delta V_{in}} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}\frac{\dfrac{4I_{SS}}{\mu_n C_{ox} W/L} - 2\Delta V_{in}^2}{\sqrt{\dfrac{4I_{SS}}{\mu_n C_{ox} W/L} - \Delta V_{in}^2}}.$$

Hint: You can refer to Lecture 4, page 9 or Textbook, page 108

(b) Find the maximum Gm (**Gm,max**) and the **ΔVin** to get Gm=Gm,max/2.