

Homework V – Common Mode Feedback

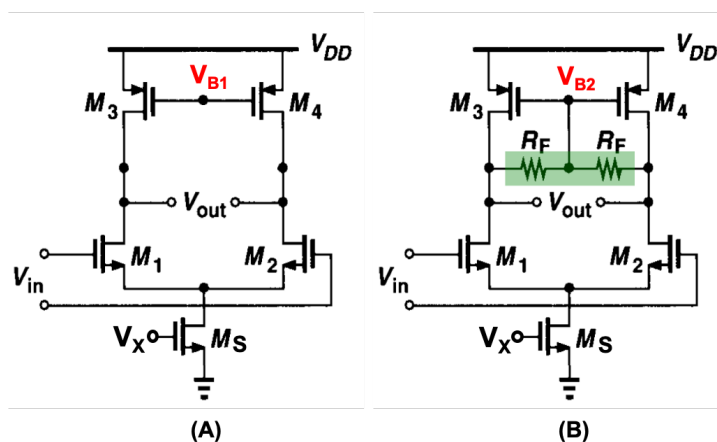
Due date : 2023. 1. 3 10:00pm

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This homework is a differential amplifier with or without common mode feedback. The problem sets include HSPICE simulations and small signal analysis. The SPICE model is cic018.1. Please use the parameters from HSPICE simulation results for hand calculations.

Please note again:

1. Please hand in your report using eeclass system.
2. 若無於繳交期限前，先行向老師說明並獲許可，作業一律不同意補交!
3. 嚴禁抄襲(參考)!
4. Please generate your report with pdf format. At first page please add your student ID and name. Try to make the information “readable”. (Note: Don’t use black color in background for your screen capture figures). (Without performance table, -10pt)
5. Please hand in the spice code file (.sp) for each item of work. Do not include output file.
6. Please fill the number into HW5.xls. (Without excel file, -20pt)
7. Please do not zip your report.
8. Please write down the “values” associated with each variable in the equations. Do not just give answer directly.



(Differential amplifier (A) without and (B) with CMFB)

In each differential amplifier circuit, please use $V_{DD}=1.5V$. Design your M_s and its bias V_x to generate the tail current $30\mu A$.

For the amplifier with CMFB (Circuit B):

- Please **design** your amplifier M1, M2, M3, M4, R_F , and input common mode level to achieve **differential mode DC gain of 35(V/V)**, **common mode DC gain smaller than 0.05 (V/V)**, and the **output common mode level of 1.0V**.
- Print out the small signal parameters using .op command.
- Please use .tf command to simulate the differential and common mode gain, and print out the results.
- Please calculate the differential mode and common mode gains with the small-signal model.

For the amplifier without CMFB (Circuit A):

- Based on the design in (a), please design the bias voltage V_{B1} to achieve the **output common mode level of 1.0V**.
- Please compare the feedback voltage V_{B1} with the bias voltage V_{B2} in (B).
- Please use .tf command to simulate the differential and common mode gain, and print out the results.
- Please calculate the differential mode and common mode gains with the small-signal model.

Discussions:

- Please discuss the precision requirement for the bias voltage V_{B1} .
- Please also use the feedback concept to calculate this common mode gain.

Working Item	Specification	Simulation result	Hand calculation
Vdd	1.5-V		
Tail Current I_{ss}	30 μ A		
Output common mode	1.0V		
Differential voltage gain (V/V)	35		
Common mode gain (V/V) w/o CMFB			
Common mode gain (V/V) wi CMFB	< 0.05		
M_s (W/ $L_N \times m$)			
M1, M2 (W/L $\times m$)			
M3, M4 (W/L $\times m$)			
R_F	Kohm		
V_{B1}	V		
V_{B2}	V		