國立中正大學
113學年度碩士班招生考試
試 題

[第2節]

| 科目名稱	電子學
系所組別	電磁晶片組 電機工程學系－計算機工程組 晶片系統組

If a parameter un-given in the question, you can specify it in the answer sheet.

1. (20%) For an output current whose nominal value is 100 μA, and Q_1 and Q_2 are matched with channel length of 0.5 μm, channel widths of 5 μm, V_t=0.4 V and k'_n =500 μA/V^2. Early voltage is 5 V/μm.

    (a) (5%) What is the required value of R?
    (b) (5%) What is the lowest possible value of V_o?
    (c) (5%) Find the output resistance of current source.
    (d) (5%) Find the change in output current resulting from a +0.5 V change in V_o.
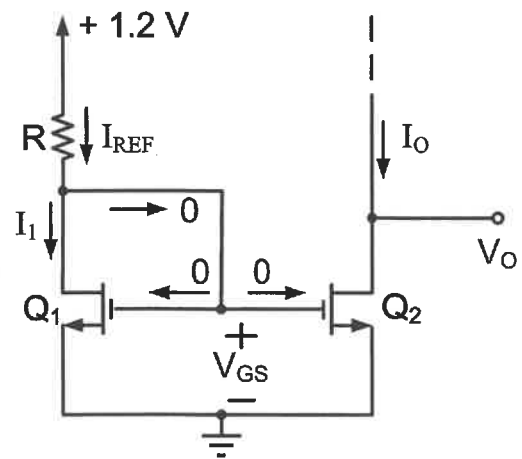
2. (20%) Three MOSFETs are sized to operate at $|V_{ov}|$=0.3V. Let $|V_t|$=0.5V and $|V_A|$=20V, the current sources utilize single transistors and thus have output resistances equal to r_o.

    (a) (5%) If Vs has a zero dc component, find the dc voltages at nodes S_1, G_2, S_3, and G_3. Verify that each of the current sources has the minimum required dc voltage across it for proper operation.
    (b) (5%) Calculate the gain of each of these three stages and the overall voltage gain, A.
    (c) (5%) Find A_f= Vo/Vs.
    (d) (5%) Find the output resistance.
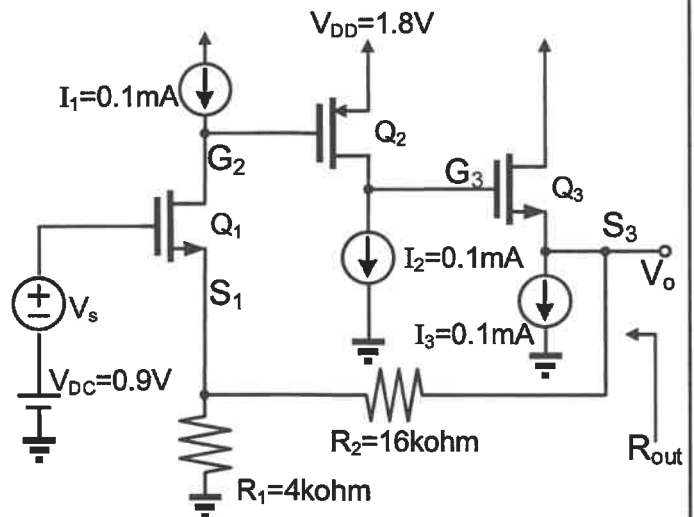
3. (20%) An NMOS transistor operating in the triode region with v_{DS}=0.3V conducts 50μA for v_{GS}=2V and 100μA for v_{GS}=3V, respectively.

    (a) (5%) What is the corresponding value of threshold voltage V_{th} ?
    (b) (5%) If $k_n'=\mu_n C_{ox}$=20μA/V^2, what is the device *aspect* ratio?
    (c) (5%) What current would be excepted to flow with v_{GS}=2.8V and v_{DS}=0.25V?
    (d) (5%) If it operates at v_{DS}=2V, at what value of v_{GS} will the drain-end of the MOSFET channel just become pinch-off.

4. (20%) The current source in a MOSFET differential amplifier provides constant current I=500 µA and its equivalent resistance R_{SS} and capacitance C_{SS} are 100 kΩ and 0.1fP, respectively. The parameters of Q_1 and Q_2 are V_A =25V, C_{gs}=30fF, C_{gd}=5fF, and C_{db}=5fF. The drain resistor R_D is 30 kΩ. Transistors are biased with overdrive voltage V_{ov}=0.3 V. Also, there is a 100fF capacitive load (C_L) existed between each drain and ground.
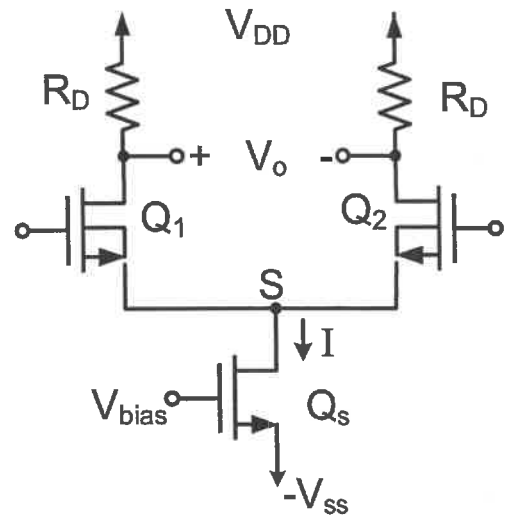
(a) (5%) Find the mid-band differential gain A_d. (5%)

(b) (5%) If the series resistance ($R_{sig,}$) of input signal source for each gate terminal is 20kΩ, please estimate the upper 3-dB frequency f_H by open-circuit time-constant method.

(c) (5%) Find the common-mode gain response $A_{cm}(j\omega)$.

(d) (5%) Which is the dominate corner frequency in CMRR response.

5. (20%) A noninverting op amp provides a direct implementation of the feedback loop. Assume that the op amp has infinite input resistance and zero output resistance.

(a) (5%) Find an expression for the feedback factor β.

(b) (5%) If the open-loop voltage gain A=10^5, find R_2/R_1 to obtain a closed-loop voltage gain A_f of 10

(c) (5%) What is the amount of feedback in decibels?

(d) (5%) If V_s = 1V, find V_o, V_f, and V_i.