**VE311 Electronic Circuit Homework 5**

Due: **June 19th**

*Note:*

*1) Please use A4 size paper or page.*

*2) Please clearly state out your final result for each question.*

*3) Please attach the screenshot of Pspice simulation result if necessary.*

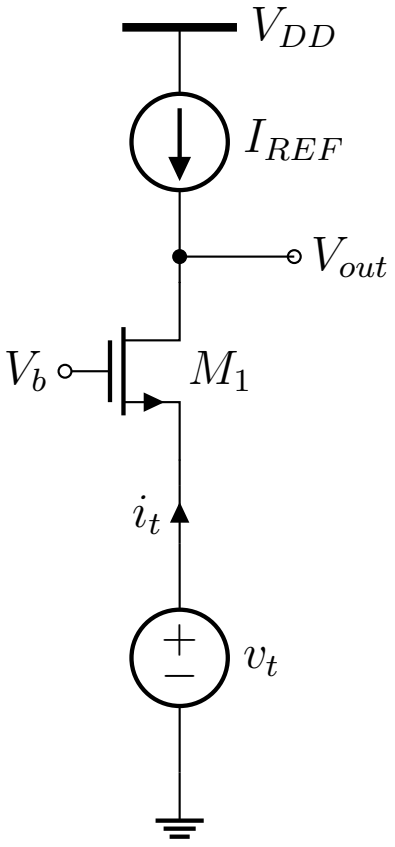
### Question 1. Common Gate (Easy)

In the common gate stage amplifier, the internal resistance of I is $1k\Omega$ , what is the output resistance when $I_{REF} = 0.01mA$ and $0.1mA$ respectively? (Neglect body effect)

Parameter for NMOS: $V_{THN} = 0.7V$, $K_n = 110\mu A/V^2, \lambda = 0.04V^{-1}$

Parameter for PMOS: $V_{THP} = -0.7V$, $K_p = 50\mu A/V^2, \lambda = 0.05V^{-1}$

All the size of transistor is $W = 20\mu m, L = 1\mu m$



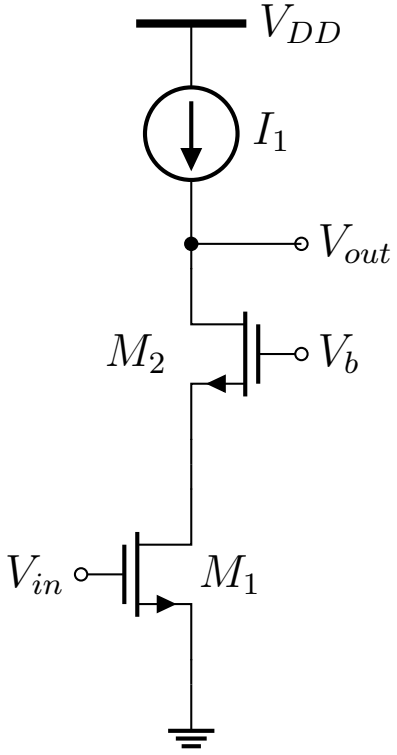
**Question 2. Common Gate Common Source (Medium)**

Find the intrinsic gain $A_v$ and output impedance $R_{out}$ for the amplifier when $I_1 = 0.01$ and $0.1mA$ respectively. (Neglect body effect)

Parameter for NMOS: $V_{THN} = 0.7V$, $K_n = 110\mu A/V^2, \lambda = 0.04V^{-1}$

Parameter for PMOS: $V_{THP} = -0.7V$, $K_p = 50\mu A/V^2, \lambda = 0.05V^{-1}$

All the size of transistor is $W = 20\mu m, L = 1\mu m$



**Question 3. Common Gate Common Source (Medium)**

Find the intrinsic gain $A_v$ and output impedance $R_{out}$ for the amplifier when $I_1 = 0.01$ and $0.1mA$ respectively. (Neglect body effect)

Parameter for NMOS: $V_{THN} = 0.7V$, $K_n = 110\mu A/V^2, \lambda = 0.04V^{-1}$

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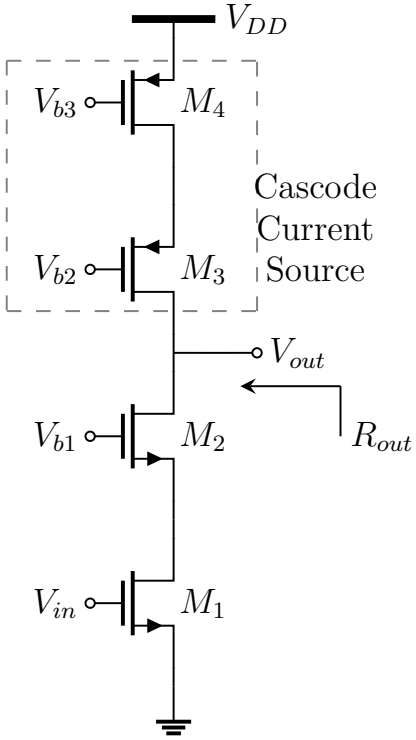


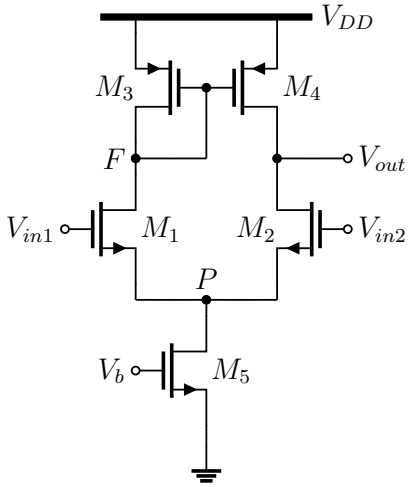
**Question 4. Differential Pair (Hard)**

Find the intrinsic gain $A_v$ for the amplifier when $I_{SS} = 0.02$ and $0.2mA$ respectively. (Neglect body effect)

Parameter for NMOS: $V_{THN} = 0.7V$, $K_n = 110\mu A/V^2, \lambda = 0.04V^{-1}$

Parameter for PMOS: $V_{THP} = -0.7V$, $K_p = 50\mu A/V^2, \lambda = 0.05V^{-1}$

All the size of transistor is $W = 20\mu m, L = 1\mu m$



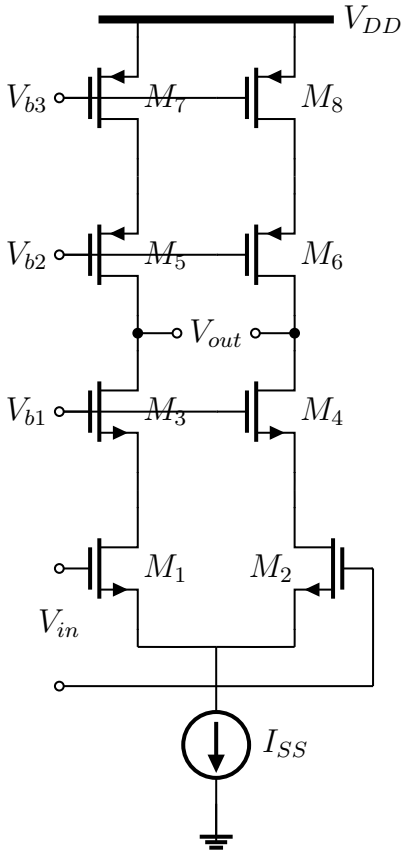
**Question 5. Differential Pair (Hard)**

Find the intrinsic gain $A_v$ for the amplifier when $I_{SS} = 0.02$ and $0.2mA$ respectively. (Neglect body effect)

Parameter for NMOS: $V_{THN} = 0.7V$, $K_n = 110\mu A/V^2, \lambda = 0.04V^{-1}$

Parameter for PMOS: $V_{THP} = -0.7V$, $K_p = 50\mu A/V^2, \lambda = 0.05V^{-1}$

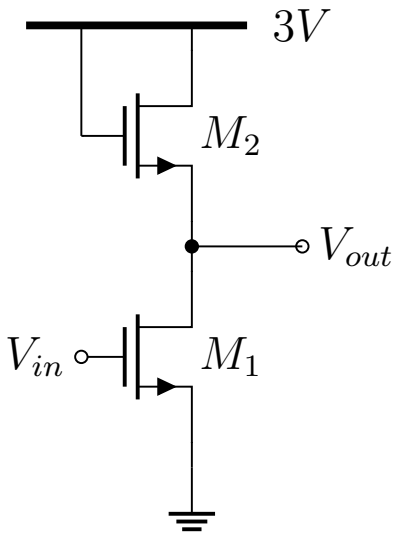
All the size of transistor is $W = 20\mu m, L = 1\mu m$



**Question 6. Common Source with Diode-connected Load (Lunatic)**

Consider the circuit of Fig. 2 with $(W/L)_1 = 50/0.5$ and $(W/L)_2 = 10/0.5$. Assume that $\lambda = \gamma = 0$. Then 3 V for $V_{DD}, 0.7$ V for $V_{TH1}, 0.45$ V$^{\frac{1}{2}}$ for $\gamma$, and 0.9 V for $2\Phi_F$

1) At what input voltage is $M_1$ at the edge of the triode region? What is the small-signal gain under this condition?
2) What input voltage drives $M_1$ into the triode region by 50mV ? What is the small-signal gain under this condition?



**Question 7. Common Source with Resistive Load (Hell)**

Suppose the common-source stage of Fig. 1 is to provide an output swing from 1 V to 2.5 V. Assume that $(W/L)_1 = 50/0.5, R_D = 2\text{k}\Omega$, and $\lambda = 0$.

1) Calculate the input voltages that yield $V_{\text{out}} = 1$ V and $V_{\text{out}} = 2.5$ V.
2) Calculate the drain current and the transconductance of $M_1$ for both cases.
3) How much does the small-signal gain, gm $R_D$, vary as the output goes from 1 V to 2.5 V ? (Variation of small-signal gain can be viewed as nonlinearity.)