1. Assuming all the transistors in the following symmetric circuits are in saturation, $\lambda \neq 0$ and $\gamma = 0$, calculate the small-signal differential voltage gain of each circuit.
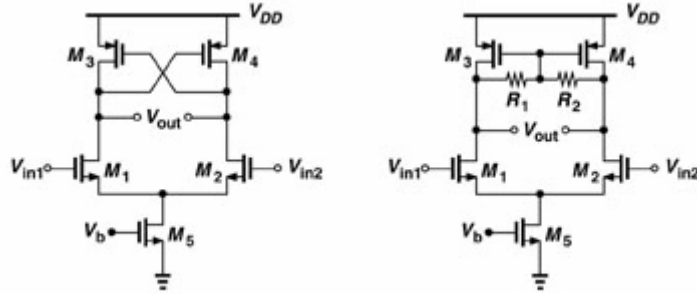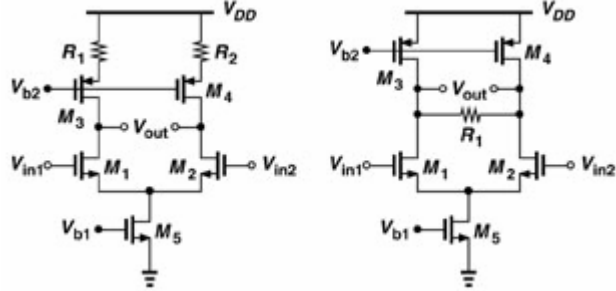


2. In the following symmetric circuit, assume all transistors are operating in saturation region, $\lambda = 0$, and $\gamma = 0$.

a) Find an expression for the small-signal differential voltage gain of the following circuit.

b) What is the small-signal differential voltage gain if $(W/L)_3/(W/L)_5 = 0.5$?
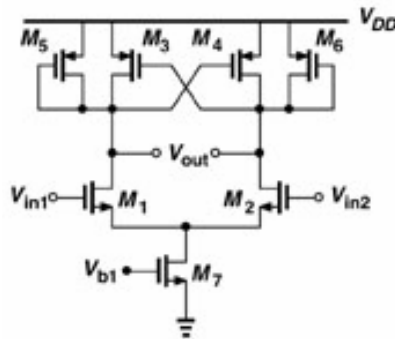
3. In the following circuit all transistors have a W/L of 7μm/0.35μm and M_3 and M_4 are to operate in deep triode region with an on-resistance of 2kΩ. Assuming $I_5=40\mu A$ and $\lambda=\gamma=0$, $V_{DD}=3V$, $V_{TH(NMOS)}=0.5V$, $V_{TH(PMOS)}=-0.6V$, $\mu_nC_{ox}=200\ \mu A/V^2$, $\mu_pC_{ox}=100\ \mu A/V^2$.
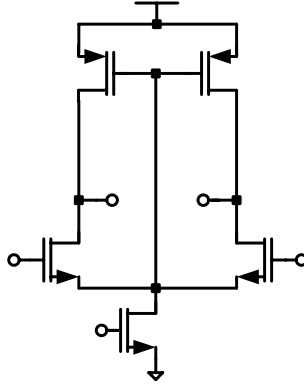
a) Calculate the dc level of the input (input common-mode level) that yields such an on-resistance for M_3 and M_4.
b) Calculate the required V_{bias} of the gate of M_5.
c) Calculate the small-signal differential gain, i.e., $(V_{out1}-V_{out2})/(V_{in1}-V_{in2})$, of the circuit when the input common-mode level is equal to value calculated in part a.

Good luck.