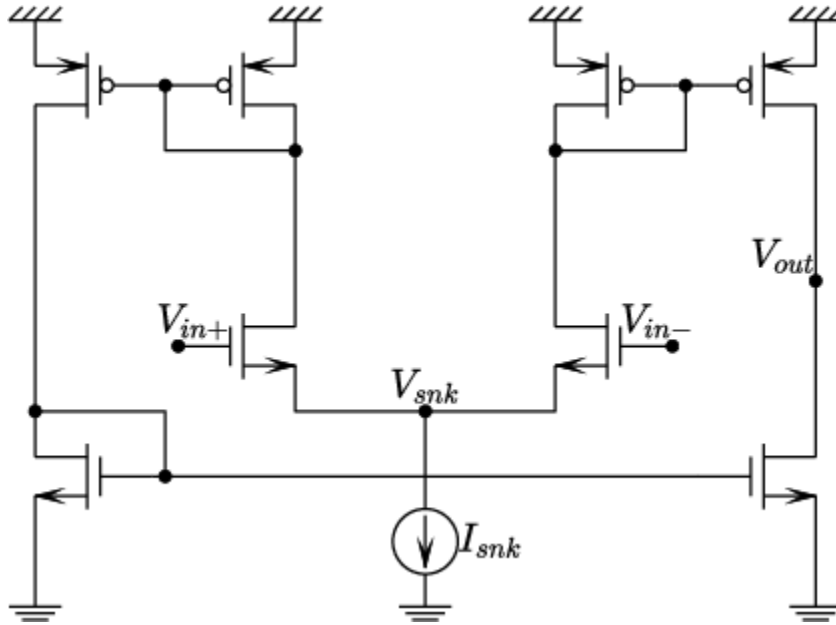


2023 EE530L: Homework assignment 4

- 1) Find the gain of the below differential amplifier from the input $V_{in+} - V_{in-}$ to the output V_{out} . Assume all n-MOSFETs are biased to have a transconductance of 3 mS and an output impedance of $40 \text{ k}\Omega$, while all p-MOSFETs are biased to have a transconductance of 1 mS and an output impedance of $60 \text{ k}\Omega$.

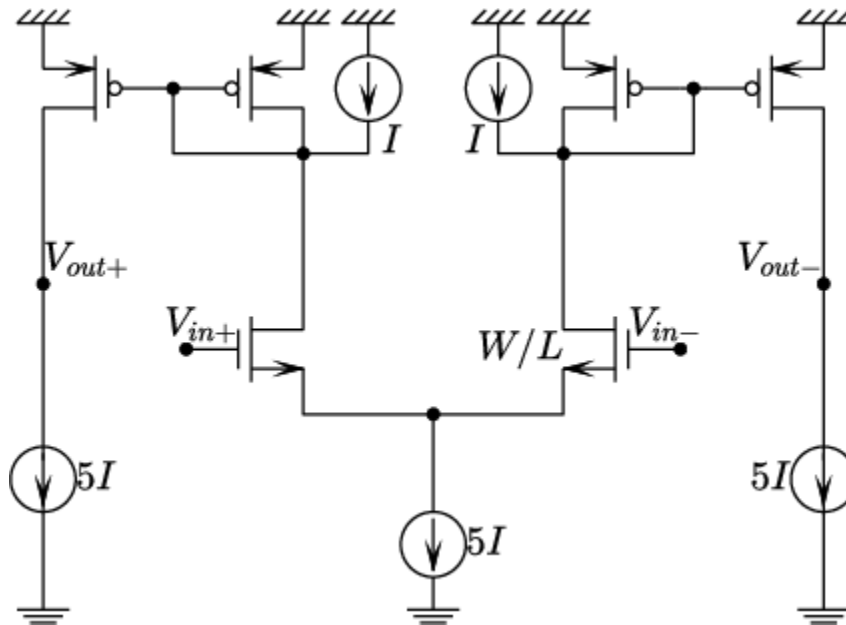


(1 pt)

- 2) Find the nominal output for zero input in the circuit of Question 1 in terms of the supply V_{DD} , the threshold voltages V_{tn} and V_{tp} , and the gate overdrive voltages V_{GSTn} and V_{GSTp} .

(1 pt)

- 3) Find the sizes of all the MOSFETs in the below circuit in terms of the size of the one given input transistor such that all MOSFETs are biased at the same V_{GST} in the nominal zero input condition. Assume the square law is valid for all MOSFETs and that the mobility of the p-MOSFETs is a third that of the n-MOSFETs.



(1 pt)

- 4) Find the allowed range of the input common-mode in the circuit of Question 3, in terms of the supply V_{DD} , the threshold voltages V_{tn} and V_{tp} , and the gate overdrive voltages V_{GSTn} and V_{GSTp} , so that all transistors remain in the active region with a differential input of $0.4V_{GSTn}$. Recall that the common-mode input voltage is $(V_{in+} + V_{in-})/2$, and the differential input is $V_{in+} - V_{in-}$. Assume linear amplification for the specified differential input.

(1 pt)