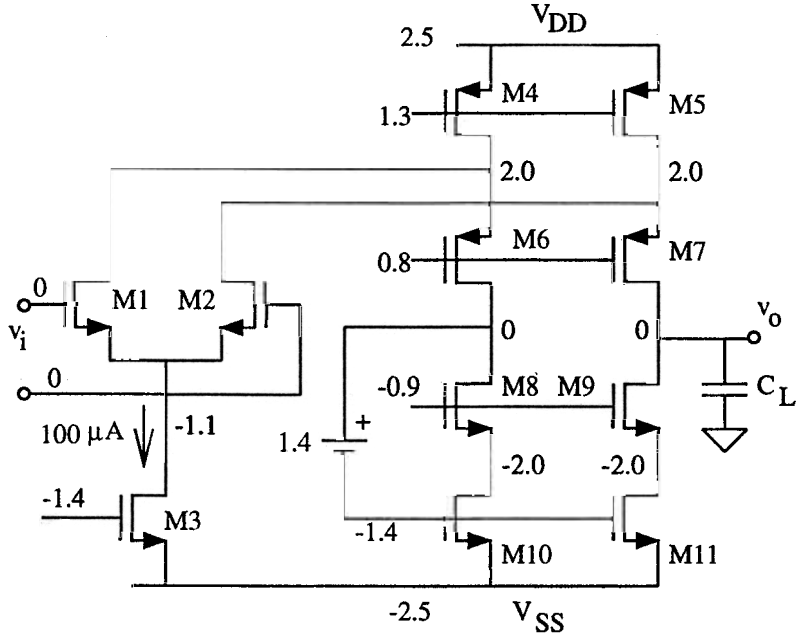
Question 2. (5 Marks) A folded cascode amplifier, similar to the one designed in the lab is shown. All the bias voltages are shown as well. Assume $V_{TP} = -0.9\text{V}$, $V_{TN} = 0.8\text{V}$.



a) Estimate the input common-mode range, both directions

negative: nmos $V_{on} = V_{GS} - V_T = 0.3\text{V}$, min $V_{D3} = 0.-2.5 + 0.3 = -2$

$V_{GS1} = 1.1\text{V}$, min $V_{in} = -2.2 + 1.1 = 1.1\text{V}$

2

positive: V_{D1}, V_{D2} fixed at 2.0V (by sources of M6, M7)

increase V_i to $2.0\text{V} + V_T = 2.8\text{V}$

b) Estimate the output voltage range both directions.

negative: -2V fixed by sources of ~~M8~~, M9

$V_{DS9,min} = V_{on} = 0.3\text{V}$ ∴ $V_{o,min} = -1.7\text{V}$

2

positive: +2V at V_{S7} fixed by source of M7

$|V_{DS7}|_{min} = 0.3\text{V}$, ∴ $V_{o,max} = +1.7\text{V}$

c) For $C_L = 2$ pF, what is the slew rate?

$$\text{Slew Rate} = \frac{I_3}{C_L} = \frac{100\mu\text{A}}{2\text{pF}} = 50\text{V}/\mu\text{sec}$$

1