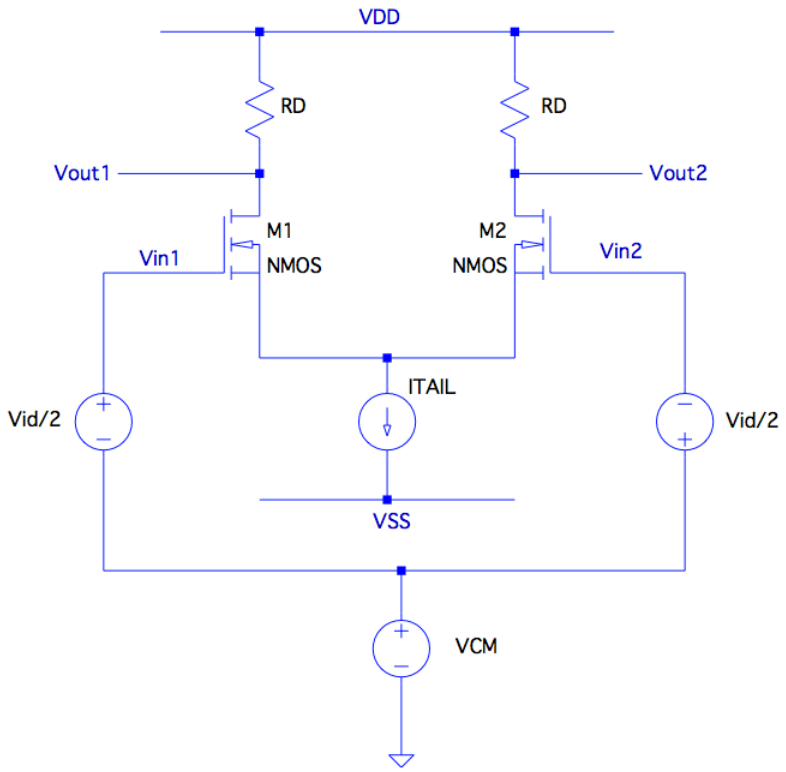
Design an nMOST differential pair with the following parameters:
I_{TAIL} = 0.4 mA, V_{TH}=0.5V, $\mu C_{ox}(W/L)$ = 4mA/V^2, V_{DD}=1.5V, V_{SS}=–1.5V, R_D=2.5KΩ
Channel length modulation is negligible

Use LTSPICE to find:

a. V_{OV} and V_{GS} at equilibrium
b. For V_{CM}=0 what are the values of V_S, I_{D1}, I_{D2}, V_{D1}, V_{D2}?
c. Repeat (b) for V_{CM}=1V
d. Repeat (b) for V_{CM} = 0.2V
e. What is the highest value of V_{CM} for which M_1 and M_2 remain in saturation?
f. If the current source I_{TAIL} requires a minimum voltage of 0.4V to operate properly, what is the lowest value allowed for V_{CM}?
g. What is the range of differential mode operation (i.e. the range of $V_{id}=V_{in1}–V_{in2}$ for which M_1 and M_2 are "ON")
h. Assuming the output differential pair is taken single-ended, plot the differential voltage amplification $A_{Vd}=v_{out1}/(v_{id})$ and the common mode voltage amplification $A_{Vc}=v_{oc}/v_{ic}$.



Deliverables

For each question provide the LTSPICE circuit/analysis/model you used and the plots/logfile that illustrate your results. On the plots provided, make sure to clearly label the axis and any relevant quantity. On the logfile provided make sure to highlight in yellow the quantities of interest. To generate good quality plots, you are strongly encouraged to export your LTSPICE data to Matlab. For examples of good quality plots and annotated logfiles see slides 17-18 and 30-31 of the document "*basic DP*" on the course website.

Try to fit each answer on one page.