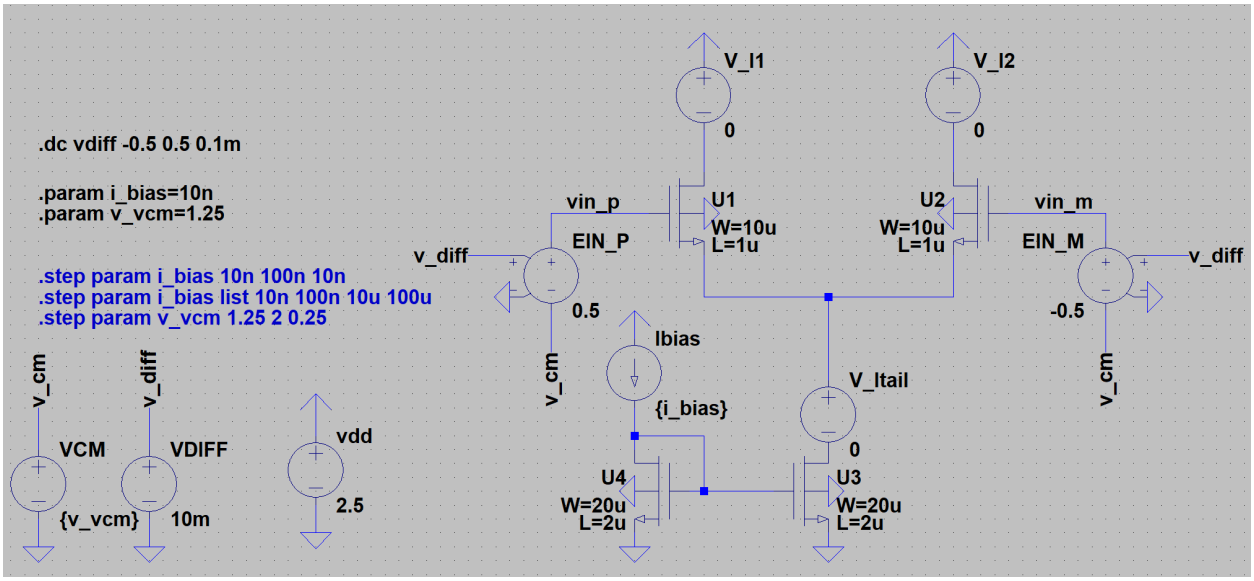
EE 493B / EE 551 Linear Integrated Circuits
Project 8
Differential Pairs
35 Points

Objective
To better understand the operation of a differential pair.

Special Instructions About This Project
We will go through the technical analysis of this project in class together. You still need to write a report summarizing the results. A starting LTspice schematic is available on eCampus.

Part 1 – Differential Pair Bias Current Analysis (20 Points)
Answer the following questions. Answers can be qualitative in nature (i.e. no need for precise numerical values). Provide simulation results to justify all of your answers.



1. What is the purpose of the controlled voltage sources (the "E" sources)?
    a. What are the resulting "DC" levels of the input voltages?
    b. What are the resulting differential and common-mode input voltages?
2. Subthreshold Currents (I_{bias} = 10nA)
    a. Plot I_1 and I_2 on one subplot. Plot I_1-I_2 on another subplot.
    b. Approximately, what is the input linear range of the differential pair in subthreshold? How does this compare to the ballpark estimate we developed in lectures?
3. Subthreshold I_{bias} Sweeps (10nA to 100nA)
    a. Sweep the bias current, but make sure it stays within subthreshold current values. What changes in the traces? What stays the same?
    b. To aid your analysis, plot the data two ways.
        i. Plot the same traces as above (Plot I_1 and I_2 on one subplot. Plot I_1-I_2 on another subplot.)
        ii. Plot those traces, but this time, normalize them to the Tail current of the differential pair (ex. I_1 / I_{Tail})
4. Above Threshold Currents (I_{bias} = 50µA)
    a. Plot I_1 and I_2 on one subplot. Plot I_1-I_2 on another subplot.
    b. Approximately, what is the input linear range of the differential pair in above threshold? How does this compare to the subthreshold case?

5. Above Threshold I_{bias} Sweeps (10μA to 100μA)
    a. Only plot the normalized cases.
    b. What changes? What stays the same?
6. Comparison of subthreshold and above threshold I_{bias} sweeps.
    a. Compare using normalized values.

Part 2 – Differential Pair Common-Mode Analysis (10 Points)
Answer the following questions. Answers can be qualitative in nature (i.e. no need for precise numerical values). Provide simulation results to justify all of your answers.

7. Sweep the common-mode input voltage (1.25V to 2V) using a bias current of 50μA. (Do not normalize the current to I_{Tail}).
    a. As you sweep the common-mode voltage, what changes (list one item)? What stays the same (list two items)?
8. For the two items that stay the same, how can you "break" this? When "breaking" this, what was the cause?
9. For the item that says changes, what is the cause for this change?
    a. How can we "fix" this so to minimize the change? If using this "fix," what new problem does it introduce?

Quality of Report (5 Points)
Please make sure that all numbers are readable, that the figures are large enough, and that there are no gross errors in terms of grammar, spelling, or punctuation.