24 Fall ECEN 704: VLSI Circuit Design

Design Post-lab Report

Lab8: Operational Transconductance Amplifiers

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Section:601

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Description:

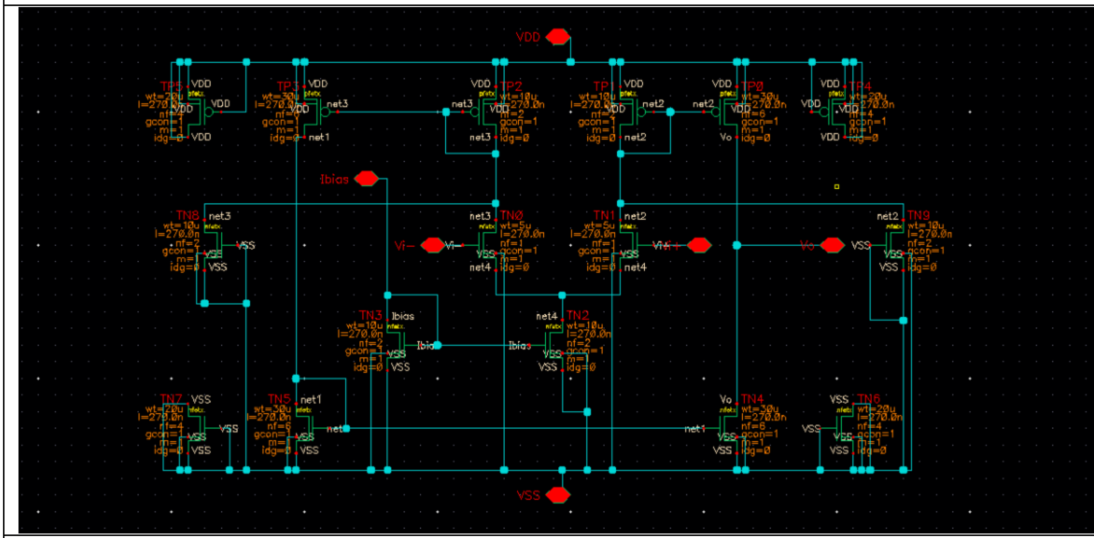
The operational transconductance amplifier (OTA) is a fundamental component in analog electronics, converting input voltage to output current. Its versatility allows it to serve in applications like filters, ADCs, oscillators, and as the core of operational amplifiers, making it essential in many analog and mixed-signal systems.

Design & result

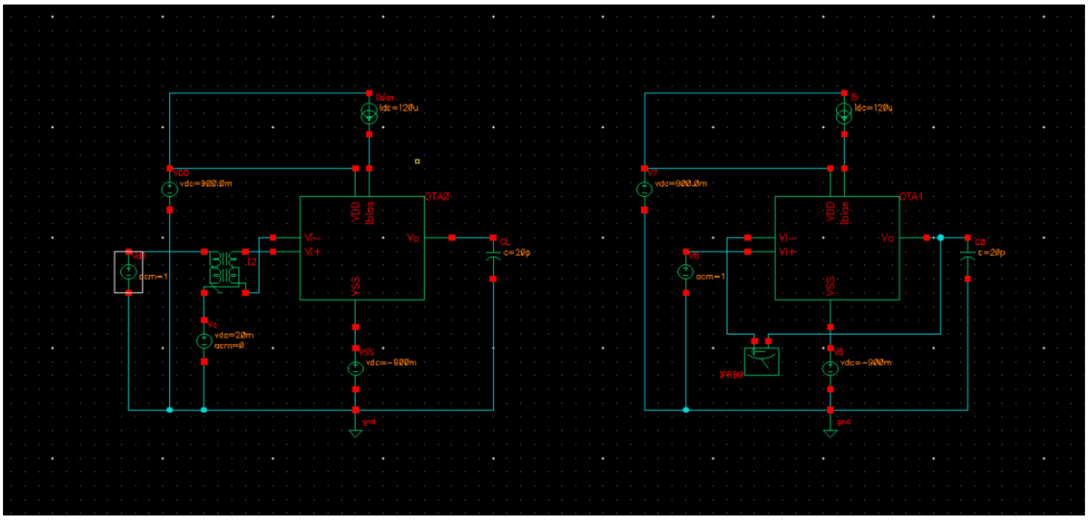
Design the three current mirror OTA

G_m	> 500 µA/V
Slew Rate	> 10 V/µs
Peak-to-Peak Output Swing	> 1 V
Load Capacitance	20 pF
Power	< 1 mW (not including bias current source)
Power Supply	V_{DD} = $-V_{SS}$ = 0.9 V

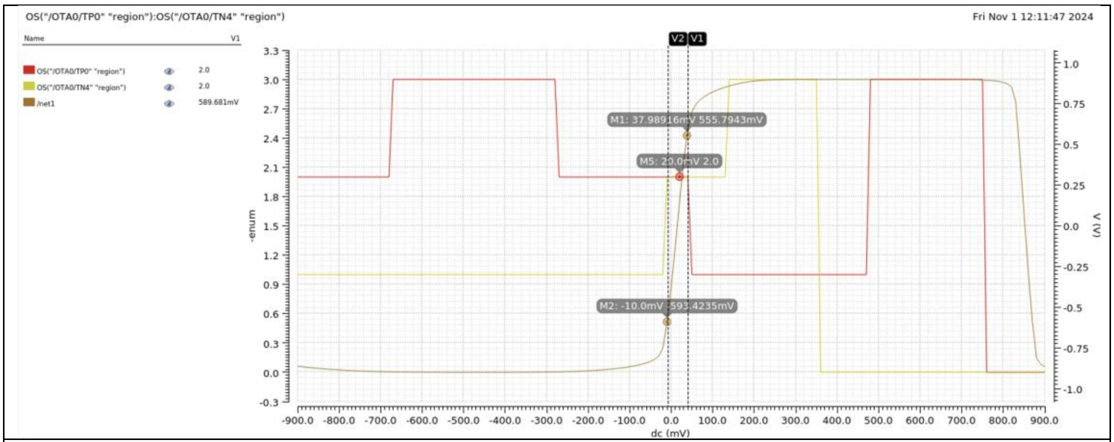
schematic



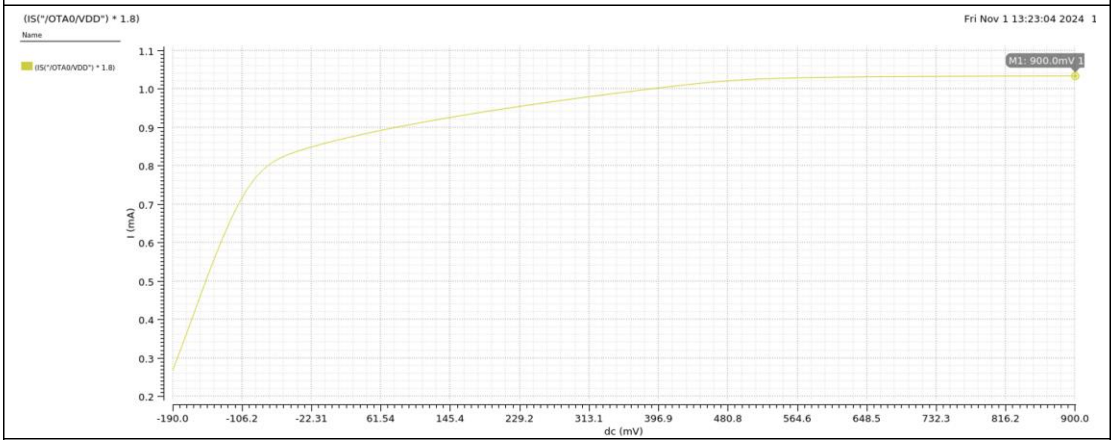
testbench



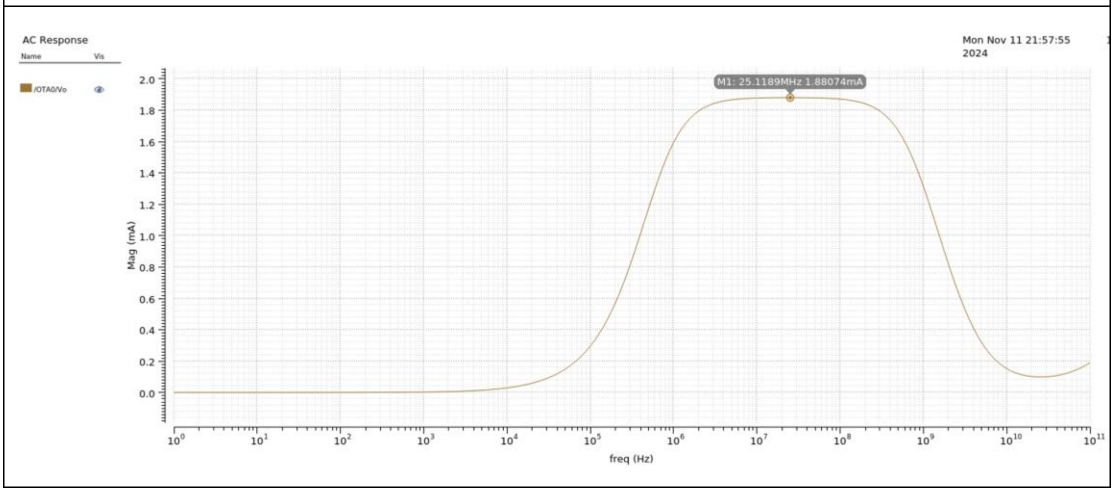
Output swing



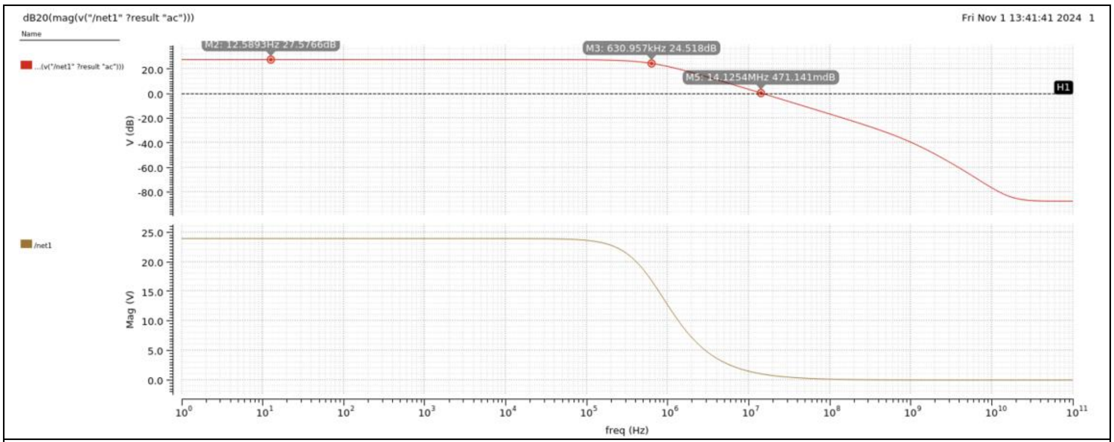
Power consumption



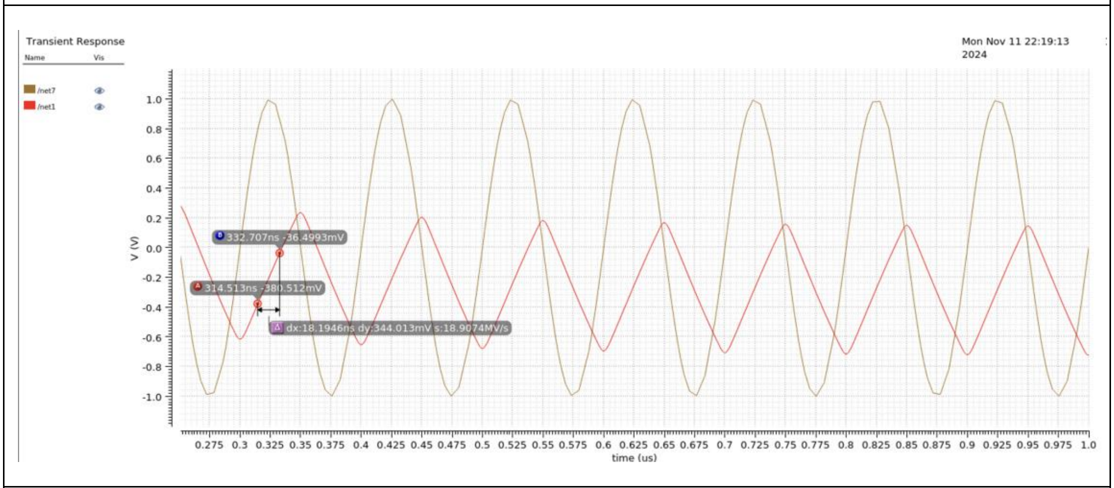
Gm



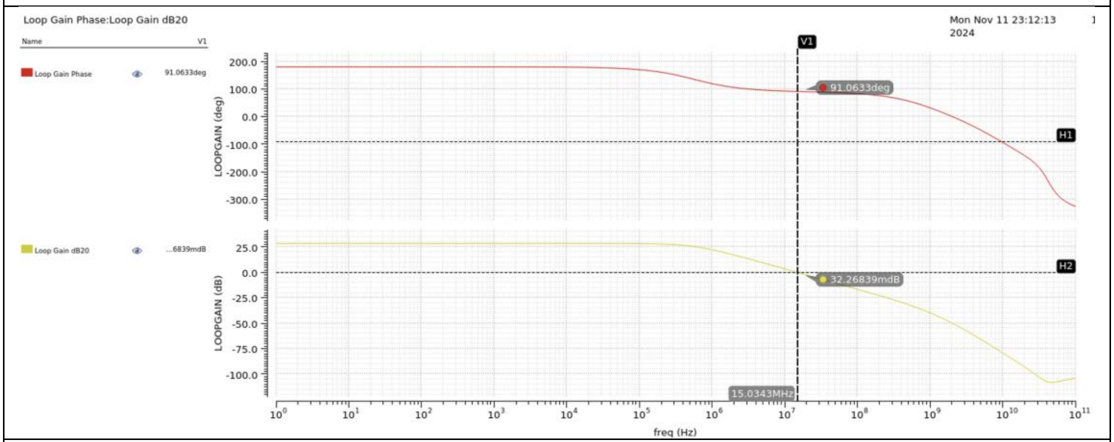
Open-loop Voltage gain / Dominant pole / Gain-bandwidth



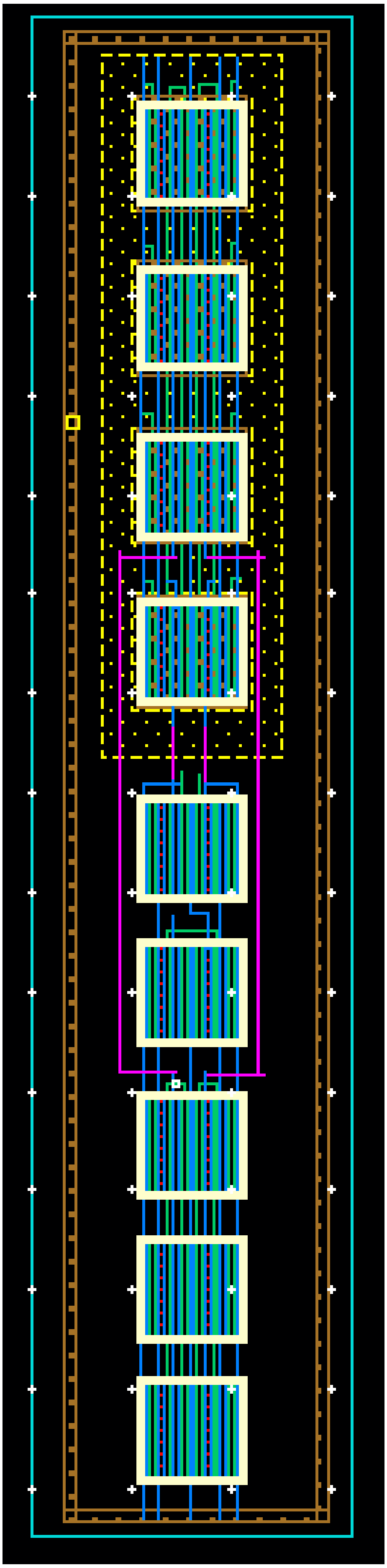
Slew rate

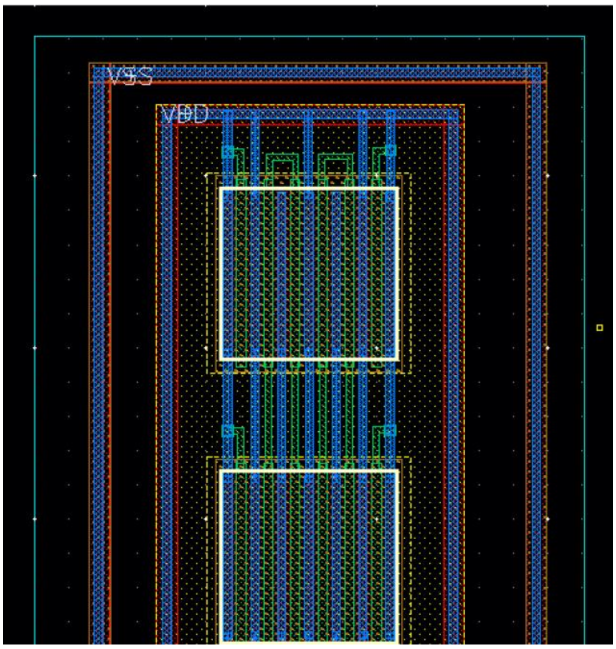


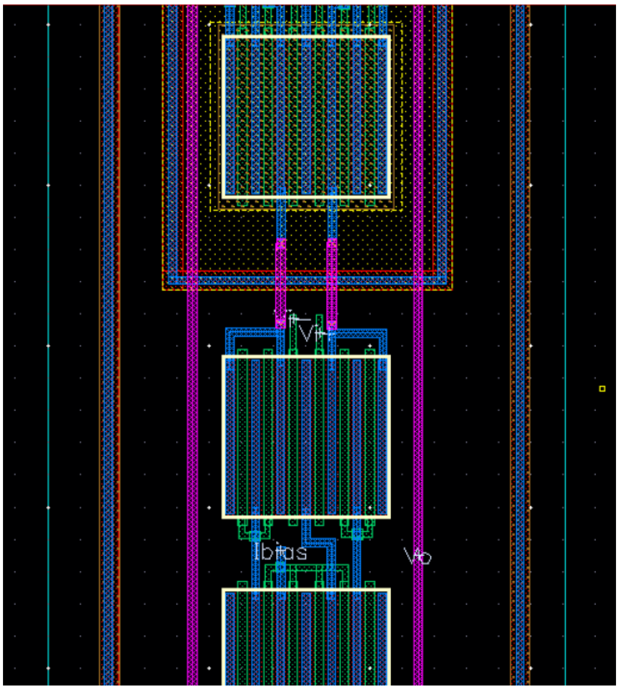
Phase margin in unity-gain buffer configuration

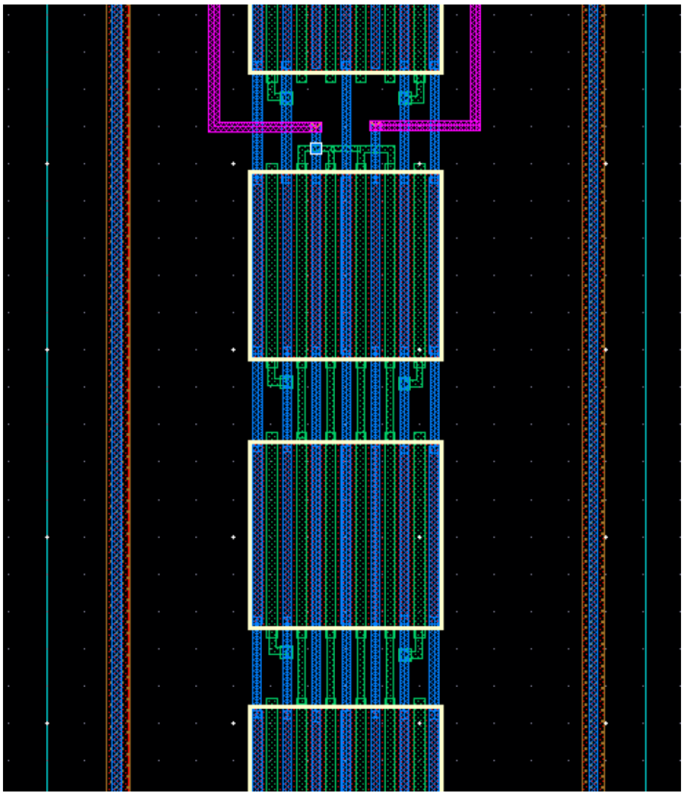


layout

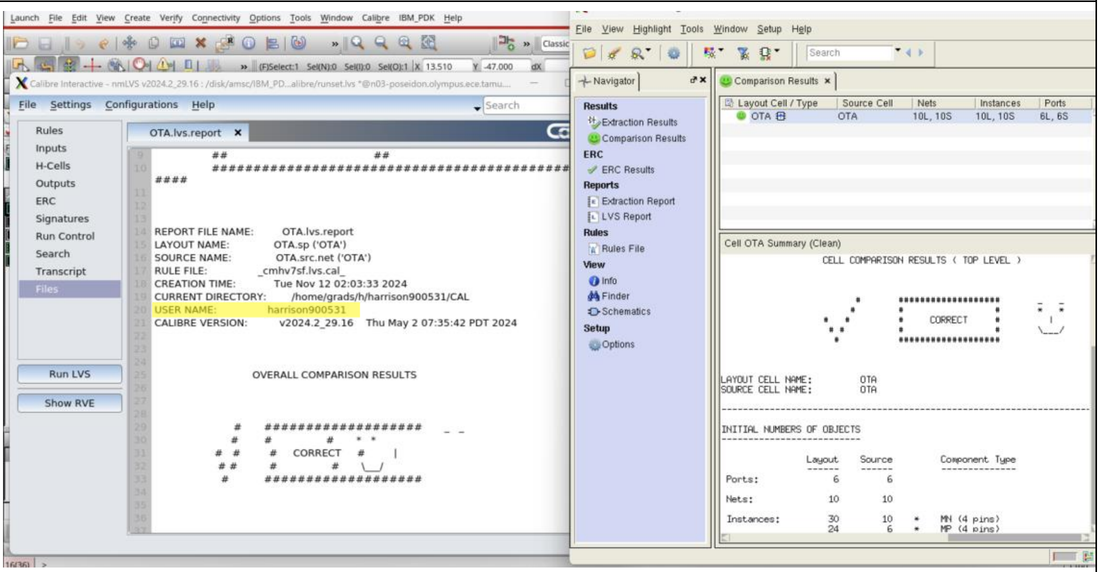



VSS
VDD

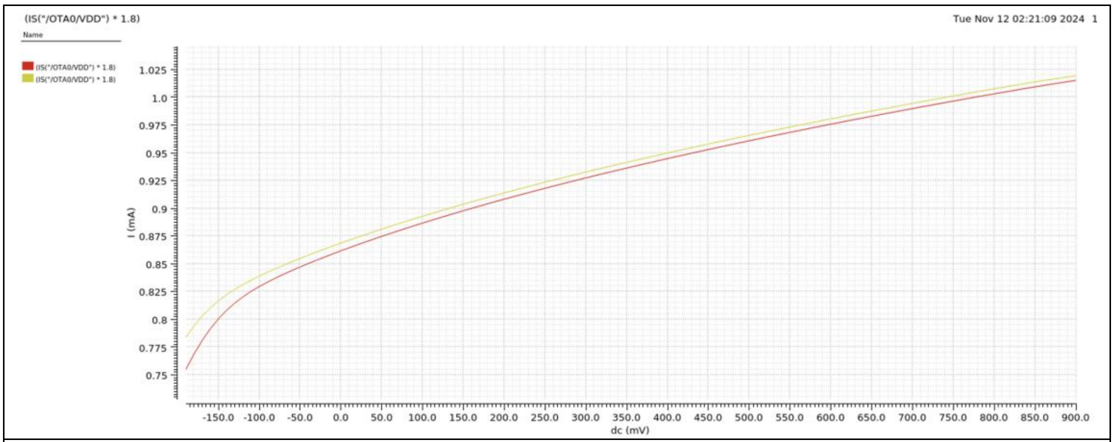

Ibias
Vo



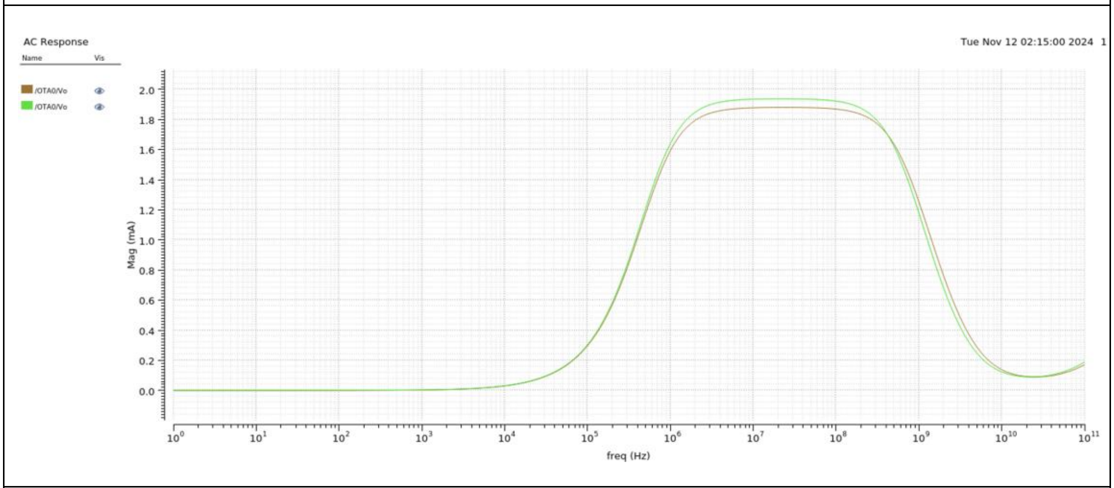
LVS



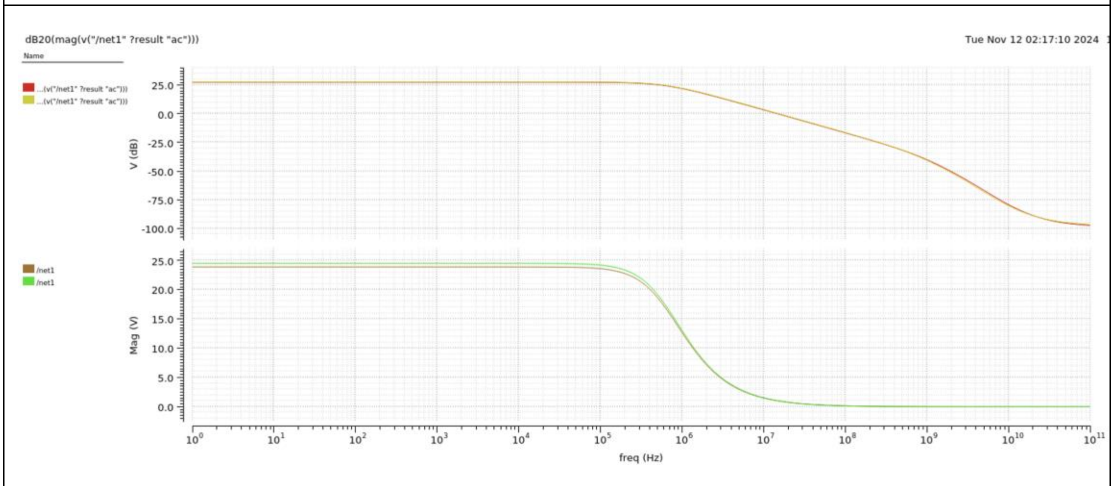
Post power



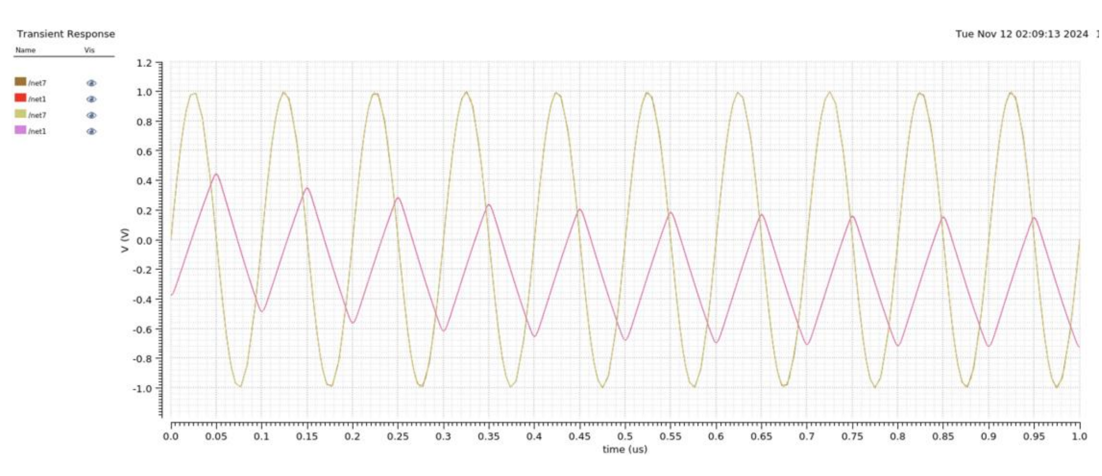
Post Gm



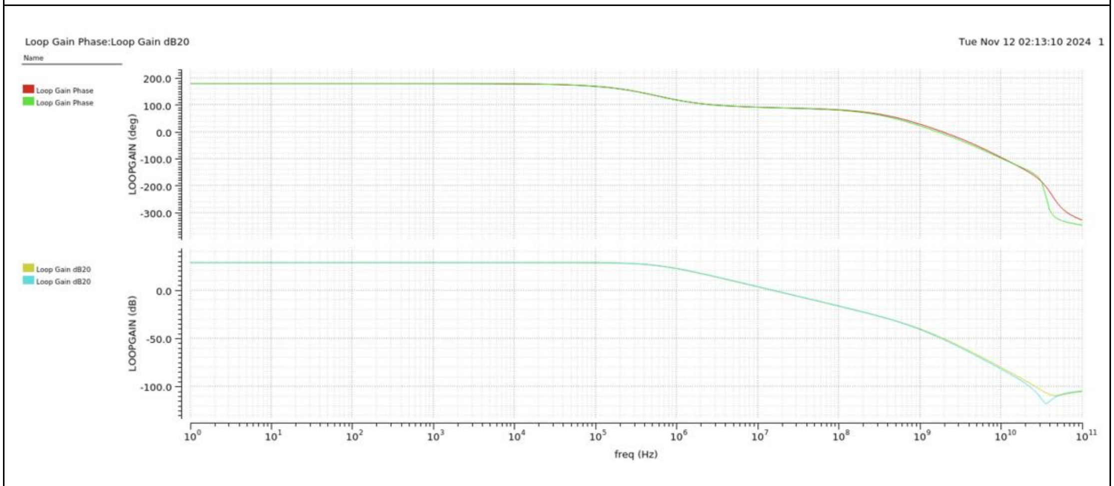
Post Open-loop Voltage gain / Dominant pole / Gain-bandwidth



Post SR



Post stability



Discussion:

The difference between this lab and Lab 6 (differential pair) lies in the testing of the region and the output swing. In Lab 6, we applied a DC voltage to the common mode side, whereas in this lab, we apply it to the differential side when testing the output swing. The primary distinction is that the DC voltage on the common mode side is used for DC bias to keep the MOSFET in the active region. In contrast, for the output swing, we need to apply the voltage to the differential side to obtain the differential voltage, which allows us to determine the maximum and minimum output voltages.

To plot the transconductance (Gm) in this lab, based on the definition (Gm = Io/Vi), I anticipated obtaining a plot similar to that of the voltage gain (Av). However, I ended up with a plot resembling the drain current (Id), which starts off inactive and then becomes active.

Conclusion:

After finishing lab 8, we have gained a solid understanding of the operational transconductance amplifier (OTA) and its role in analog systems. We explored how an

OTA converts input voltage to output current and learned to configure it for various functions like amplification and integration. Through hands-on experience, we’re now better equipped to utilize OTAs in complex electronic designs.