Differential Amplifier Analysis Report

Design Summary of Differential Amplifier:

1. DC Gain (Small-Signal):

   - Measured from Bode Plot ~ 99.4 dB
   - Converted to linear scale:

     $A_v = 10^{(99.4/20)} \sim 9410$ V/V

2. -3 dB Bandwidth (f_{-3dB}):

   - Gain drops by 3 dB from peak (96.4 dB)
   - $f_{-3dB} \sim 170$ Hz (from graph)

3. Unity Gain Bandwidth (UGB or GBW):

   - Gain = 0 dB point ~ 1.45 MHz
   - Confirmed via: $GBW = A_v \times f_{-3dB} \sim 9410 \times 170 \sim 1.6$ MHz

4. Phase Margin (PM):

   - Phase at UGB (1.45 MHz) ~ -88 degrees
   - Phase Margin = 180 + (-88) = 92 degrees

5. Large-Signal Gain (Transient Simulation):

   - Output swing ~ 500 mV peak-to-peak
   - Input differential = 20 mV peak-to-peak
   - $A_v = 500 \text{ mV} / 20 \text{ mV} = 25$ V/V
   - In dB: $20 \cdot \log_{10}(25) \sim 28$ dB

Summary Verdict:

- Small-Signal Gain: 99.4 dB (9410 V/V)
- -3 dB Bandwidth: ~170 Hz
- Unity Gain Bandwidth: ~1.45 MHz
- Phase Margin: ~92 degrees (Very Stable)
- Large-Signal Gain: ~28 dB (Practical behavior)

Conclusion:

The differential amplifier is functioning correctly with accurate biasing, ideal small-signal behavior, proper large-signal limitations, and excellent stability (high phase margin). This stage is ideal for progressing toward a 2-stage op-amp design.