A Two Stage CG Amplifier with Body Effect

\[ R_{n1} = \frac{R_{A1}}{1 + \gamma_1} = \frac{1}{g_{m1}(1 + \gamma_1)} \]

\[ R_{n2} = \frac{R_{A2}}{1 + \gamma_2} = \frac{1}{g_{m2}(1 + \gamma_2)} \]

Replace \( M_1 \) with its Norton Drain Circuit
where
\[ i_{d1}(sc) = -Gm_{a1} \frac{U_{tA1}}{R_{a1}} \]

\[ Gm_{a1} = \frac{1}{R_{tA1} + R_{a1} \| R_{o1}} \]

\[ R_{a1}' = \frac{R_{a1}}{1+\lambda_1} = \frac{1}{g_{m1}(1+\lambda_1)} \]

\[ R_{id1} = R_{o1} \left( 1 + \frac{R_{tA1}}{R_{a1}} \right) + R_{tA1} \]

Make a Thévenin equivalent circuit looking out of the source of Mz.

\[ U_{tA2} = -i_{d1}(sc) R_{id1} \]

\[ R_{tA2} = R_{D1} + R_{id1} \]

![Diagram](image-url)
Replace Mz with its Norton drain circuit

\[ V_0 = -i_{dz}(sc) R_{idz} || R_{tdz} \]

\[ = + Gm_{dz} V_{tz} R_{idz} || R_{tdz} \]

where

\[ Gm_{dz} = \frac{1}{R_{tz} + R_{idz} || R_{oz}} \]

\[ R_{idz} = R_{oz} \left( 1 + \frac{R_{tsz}}{R_{idz}} \right) + R_{tz} \]

Combine results to obtain

\[ V_0 = + Gm_{dz} \left[ - \left( - Gm_{z} V_{tz} \right) R_{idz} \right] R_{idz} || R_{tdz} \]

Thus the voltage gain is

\[ A_V = \frac{V_0}{V_{tz}} = Gm_{z} R_{idz} \frac{Gm_{dz} R_{idz} || R_{tdz}}{R_{tdz}} \]
The output resistance is

\[ R_{out} = R_{idz} \parallel R_{td2} \]

To solve for the input resistance, we must solve for \( R_{td1} \). This is given by

\[ R_{td1} = R_{o1} + R_{in2} \]

where

\[ R_{in2} = R_{idz} \frac{R_{o2} + R_{td2}}{R_{idz} + R_{o2}} \]

The input resistance is given by

\[ R_{in} = R_{id1} = R_{id1} \frac{R_{o1} + R_{td1}}{R_{o1} + R_{o1}} \]