24 Fall ECEN 704: VLSI Circuit Design

Design Pre-lab Report

Lab9: Two-Stage Miller Operational Amplifier

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A_{v0}	> 50 dB > 316
CMRR	> 60 dB > 1000
GBW	> 2 MHz
PM	> 45°
Output Swing (peak-to-peak)	> 1 V
~~Load Capacitor~~	~~30 pF~~
~~Load Resistor~~	~~∞ (open circuit)~~
Power Dissipated	< 500 µW (including bias current source)
~~Power Supply~~	~~VDD = −VSS = 0.9 V~~

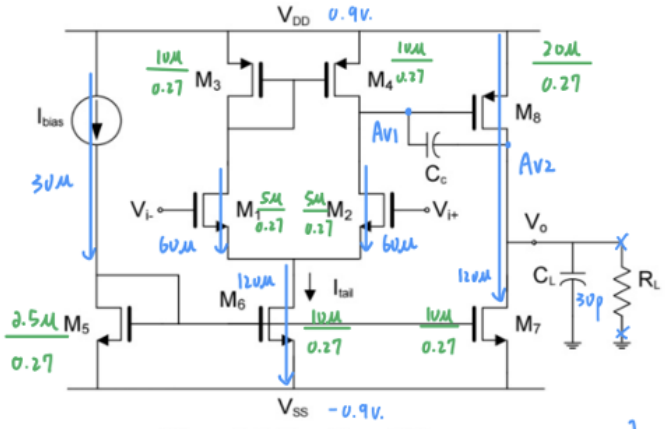


Figure 9-3: Two-Stage Miller op-amp $n\lambda = 0.146$ $p\lambda = 0.183$

$$A_{vo} = g_{m1}(r_{ds2} \parallel r_{ds4})\, g_{m8}(r_{ds7} \parallel r_{ds8})$$

$g_{m1} = 648.91\,\mu$ $g_{m8} = \sqrt{2 I_D \mu_p C_{ox} \frac{W}{L}_8} = 908.82\,\mu$

$r_{ds2} = \frac{1}{\lambda I_D} = 114k$ $r_{ds4} = 91k$ $\boxed{50.6k}$

$r_{ds7} = 57k$ $r_{ds8} = 45k$ $\boxed{25.14k}$

$A_{vo} = 750.2$

$A_{CM} = -\frac{1}{2 r_{ds6} g_{m3}} = 1.932\,m$ $g_{m3} = 454\,\mu$

$CMRR = \frac{A_{vo}}{A_{CM}} = 388k$

320 pF (0.32 nF)

$WGBW = \frac{g_{m1}}{C_c} = \frac{648.91\,\mu}{C_c} > 2MHz$ $C_c < 3.244 \times 10^{-10}$

$WGBW = 2.595M$ $C_c = 250\,pF$

$$PM = 90^\circ - \tan^{-1}\frac{\omega_{GBW}}{\omega_{p2}} - \tan^{-1}\frac{\omega_{GBW}}{\omega_z}$$

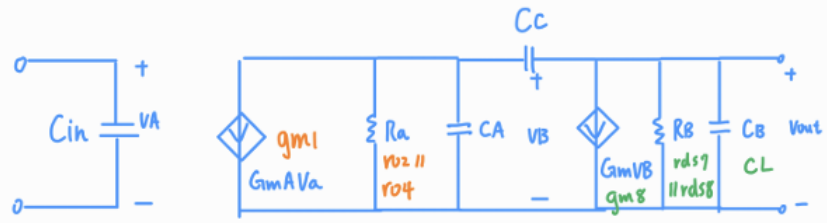
$$\omega_{p2} = \frac{-g_{m8}}{C_L} = 30.2M \qquad \omega_z = \frac{g_{m8}}{C_c} = 3.63M$$

$$PM = 90^\circ - 4.91^\circ - 35.5^\circ = 49.59$$

Swing: $-0.9 + V_{eff7} \sim 0.9 - V_{eff8} = -0.716 \sim 0.64$

$$\sqrt{\frac{2I_D}{K_n\left(\frac{W}{L}\right)_7}} = 0.189 \qquad \sqrt{\frac{2I_D}{K_p\left(\frac{W}{L}\right)_8}} = 0.26$$

Power : $1.8 \times (30\mu + 2I_{tail}) = 486\,W$



$$\omega_{p1} = \frac{-1}{G_{mB} R_B C_c R_A} = \frac{-1}{g_{m8}(r_{o7} \| r_{o8}) C_c (r_{o2} \| r_{o4})} = \frac{-1}{|A_{V2}| C_c R_A}$$

$$\omega_{p2} = \frac{-G_{mB}}{C_B} = \frac{-g_{m8}}{C_L}$$

$$\omega_z = \frac{G_{mB}}{C_c} = \frac{g_{m8}}{C_c}$$

$$\omega_{GBW} = \frac{G_{mA}}{C_c} = \frac{g_{m1}}{C_c}$$