The figure shows a cascode amplifier. $M_1$ is operated as a CS amplifier with a small-signal voltage $v_s$ and a dc bias voltage $V_{B1}$ applied to its gate. $M_2$ is operated as a CG amplifier with a dc bias voltage $V_{B2}$ applied to its gate. $M_3$ and $M_4$ form a current mirror with an input dc current $I_{REF}$. For each MOSFET, it is given that $g_m = 1/200$, $g_{mb} = 1/400$, and $r_0 = 50\,\Omega$. Solve for $i_{o(sc)}$ and $v_{o(oc)}$. To simplify the solution, assume $r_{01} = r_{02} = \infty$ when solving for $i_{o(sc)}$. Then assume $r_{01} = r_{02} = 50\,\Omega$ when using $i_{o(sc)}$ to calculate $v_{o(oc)}$.

\[
\chi = \frac{g_{mb}}{g_m} \quad r'_{s} = \frac{1}{g_m + g_{mb}} = \frac{1}{g_m (1 + \chi)} \quad r_{id} = r_0 \left( 1 + \frac{R_{ts}}{r'_{s}} \right) + R_{ts}
\]

\[
\begin{align*}
g_m &:= \frac{1}{200} \\
g_{mb} &:= \frac{1}{400} \\
\chi &:= \frac{g_{mb}}{g_m} \\
\chi &:= 0.5 \\
r_0 &:= 50000 \\
v_s &:= 1 \\
i'd_1 &:= g_m v_s \\
i'd_2 &:= i'd_1 \\
i_{sc} &:= i'd_2 \\
i_{sc} &:= 5\times10^{-3} \\
r'_{s2} &:= \frac{1}{g_m (1 + \chi)} \\
r'_{s2} &:= 1.333\times10^2 \\
R_{ts2} &:= r_0 \\
r_{id2} &:= r_0 \left( 1 + \frac{R_{ts2}}{r'_{s2}} \right) + r_0 \\
r_{id2} &:= 1.885\times10^7 \\
v_{oc} &:= -i_{sc} \cdot R_{p2} \left( r_0 \cdot r_{id2} \right) \\
v_{oc} &:= -2.493\times10^2
\end{align*}
\]

Answers are $i_{sc}/v_s$ and $v_{oc}/v_s$. 

---

**Professor Leach**

**Instructions.** Print your name in the space above. **Honor Code:** I have neither given nor received help on this quiz. Initials __________