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#9

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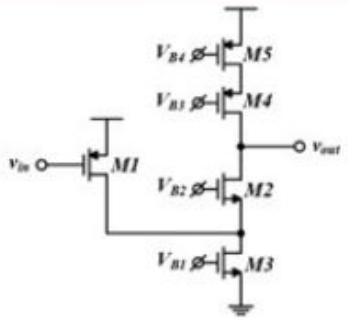
Thursday Analog Quiz



All transistors are biased at gm/ID = 10 S/A and have early voltage VA = 10 V. Assume gm*ro >> 1 and neglect body effect. Calculate Av = Gm*Rout.

$$A_V = G_m R_{out}$$

$$G_m = g_{m_1}$$

$$R_{out} = g_{m_4} r_{o_4} r_{o_5} // g_{m_2} r_{o_2} (r_{o_3} // r_{o_1})$$

as M_3 carry double the current of M_1 so $g_{m_3} = 2 g_{m_1}$

$$r_{o_3} = \frac{r_{o_1}}{2} \Rightarrow R_{out} = g_m r_o^2 // g_m r_o \left(\frac{r_{o_1}}{3}\right) = g_m r_o^2 // \frac{g_m r_o^2}{3}$$

$$R_{out} = \frac{\frac{g_m^2 r_o^4}{3}}{\frac{4 g_m r_o^2}{3}} = \frac{g_m^2 r_o^4}{4 g_m r_o^2} = \frac{g_m r_o^2}{4}$$

$$A_V = G_m R_{out} = (g_m r_o^2)\frac{1}{4} = \frac{1}{4}\left(g_m \frac{V_A}{I_D}\right)^2$$

$$A_V = \frac{1}{4}\left(\frac{g_m}{I_D} \cdot V_A\right)^2 = 2500$$