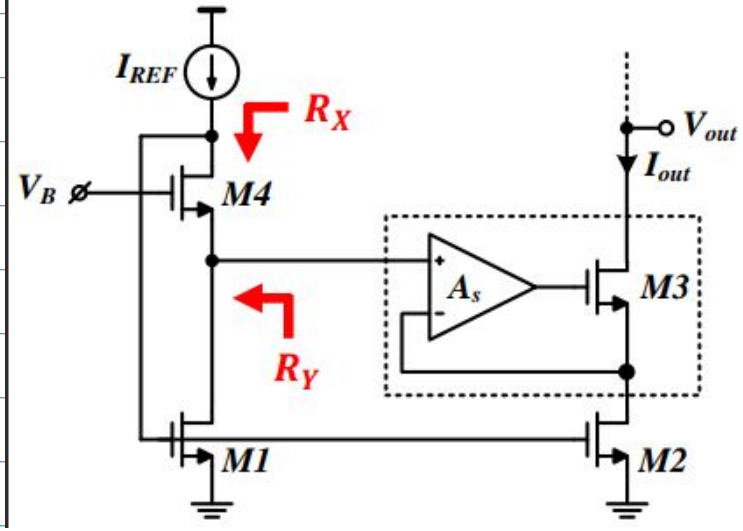
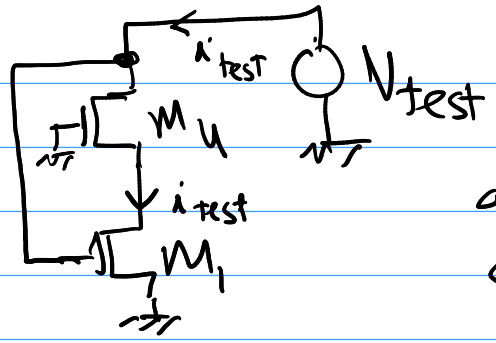
ADT
Analog Designer's Toolbox
From Designers... To Designers
#7
adt.master-micro.com

Assume M1 and M4 have gm = 1mS and gds = 10uS. You can use the approximation gm/gds >> 1 and neglect body effect. Find RX and RY.

Hints:
1- You can ignore M2, M3, and As completely. They don't affect RX and RY. You need to apply vtest and get vtest/itest at the required node.



1) R_X :



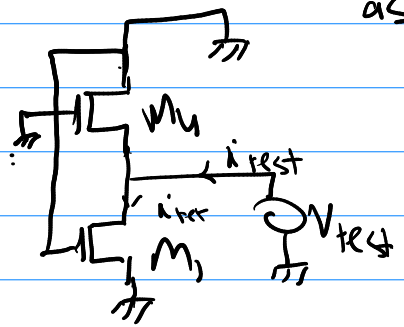
as $V_{GS_1} = V_{test}$

so

$$i_{test} = g_{m_1} V_{test}$$

$$\frac{V_{test}}{i_{test}} = \frac{1}{g_m} = \frac{1}{1mS} = 1000\,\Omega$$

2) R_Y :



as M_1 acts as CS, its output voltage:

$$V_{test} = \frac{V_{GS_1}}{A_v} = \frac{V_{GS_1}}{g_{m_1} r_o}$$

and $i_{test} = i_1 = g_{m_1} V_{GS_1}$

$$\frac{V_{test}}{i_{test}} = \frac{\frac{V_{GS_1}}{g_m r_o}}{g_m V_{GS}} = \frac{V_{GS}}{g_m r_o} \cdot \frac{1}{g_m V_{GS}} = \frac{1}{g_m^2 r_o} = \frac{1}{(10^{-3})^2 \cdot \left(\frac{1}{10 \cdot 10^{-6}}\right)}$$

$$R_Y = 10\,\Omega$$