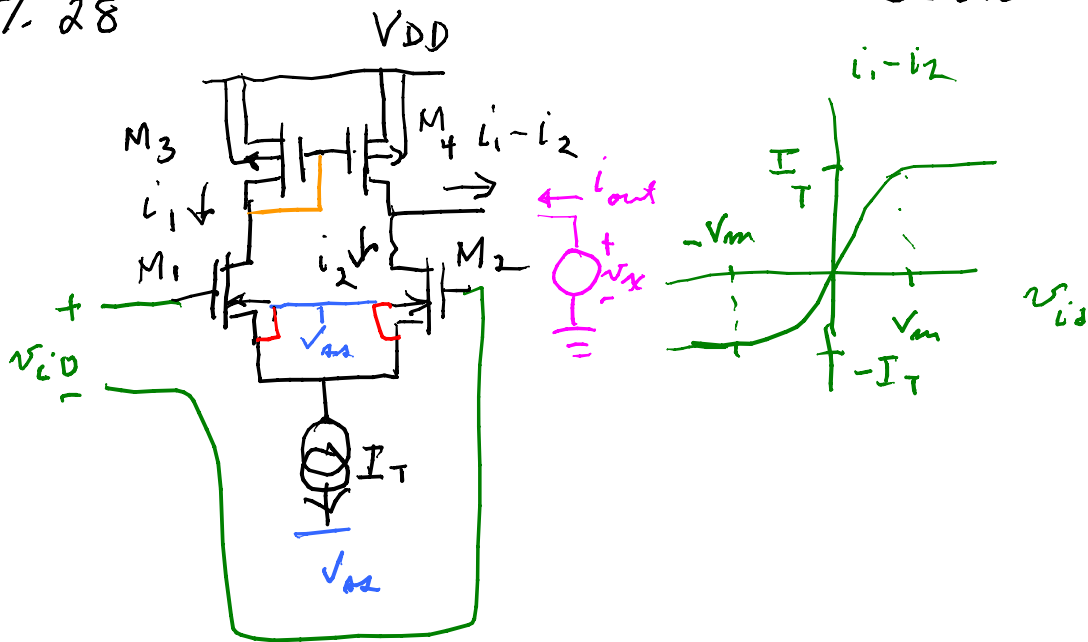


Fig 7.28

05/01/06
EE312



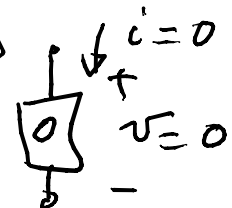
for small signal behavior

Fig 7.29 Eq. 7.141-142 $g_{m_i} = g_m$

$$i_o = \left[g_{m_1} \left(\frac{g_{m_4}}{g_{m_3}} \right) + g_{m_2} \right] \frac{v_{id}}{2} = 2g_m \cdot \frac{v_{id}}{2} = g_m v_{id}$$

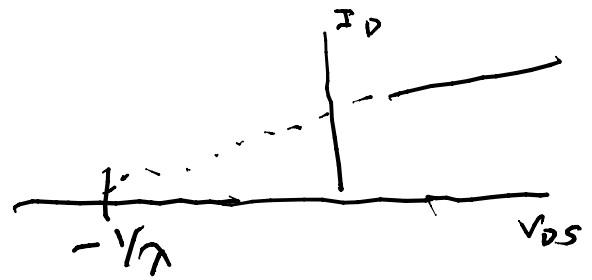
This is for output impedance is ∞ , $R_o = \infty$
But R_o is present due to λ ; use fig. 7.30

at the tail point we see a nullator
for small signals

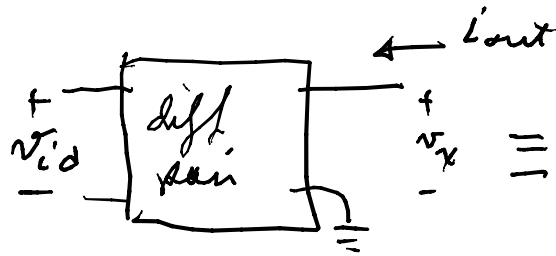


$$\left. \frac{i_{out}}{v_{out} = v_x} \right| = \left[\frac{1}{r_{o2} + (1 + g_{m_2} r_{o2}) (1/g_{m_1})} + \frac{1}{r_{o4}} \right] \quad (\approx 0 \text{ if } \lambda \rightarrow 0)$$

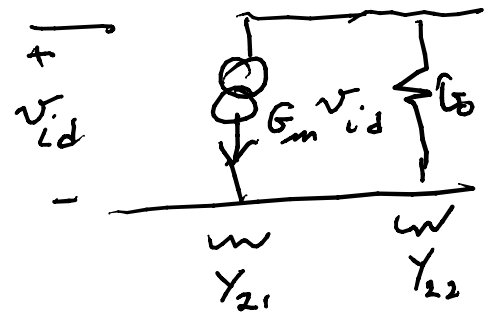
$\uparrow$ apply $v_{in} = 0 = v_{id} = G_o v_x$



Use G_m & G_o for the admittance matrix of the differential pair



(Y-matrix basis)



$$Y_{\text{diff pair}} = \begin{bmatrix} 0 & 0 \\ G_m & G_o \end{bmatrix} \quad \begin{array}{l} \text{at DC} \\ \text{small} \\ \text{signal} \end{array}$$