7-3-13

Lec 32

$$R_c = \frac{1}{g_{m5}}\left(1 + \frac{C_L}{C_c}\right)$$

$$\frac{1}{\mu C_{ox}\left(\frac{W}{L}\right)_c \cdot \left(V_{SG_c} - |V_T|\right)} = \frac{1}{\mu C_{ox}\left(\frac{W}{L}\right)_5 \left(V_{SG_5} - |V_T|\right)} \cdot \left(1 + \frac{C_L}{C_c}\right)$$

$$V_{SG_c} - |V_T| = V_X - V_C - |V_T|$$

$$= \left(V_{DD} - V_{SG_5}\right) - \left(V_{DD} - V_{SG_9} - V_{SG_{10}}\right) - |V_T|$$

$$= V_{SG_{10}} + \left(V_{SG_9} - V_{SG_5}\right) - |V_T|$$

If M_9 & M_5 are identically biased,

$$V_{SG_9} = V_{SG_5}$$

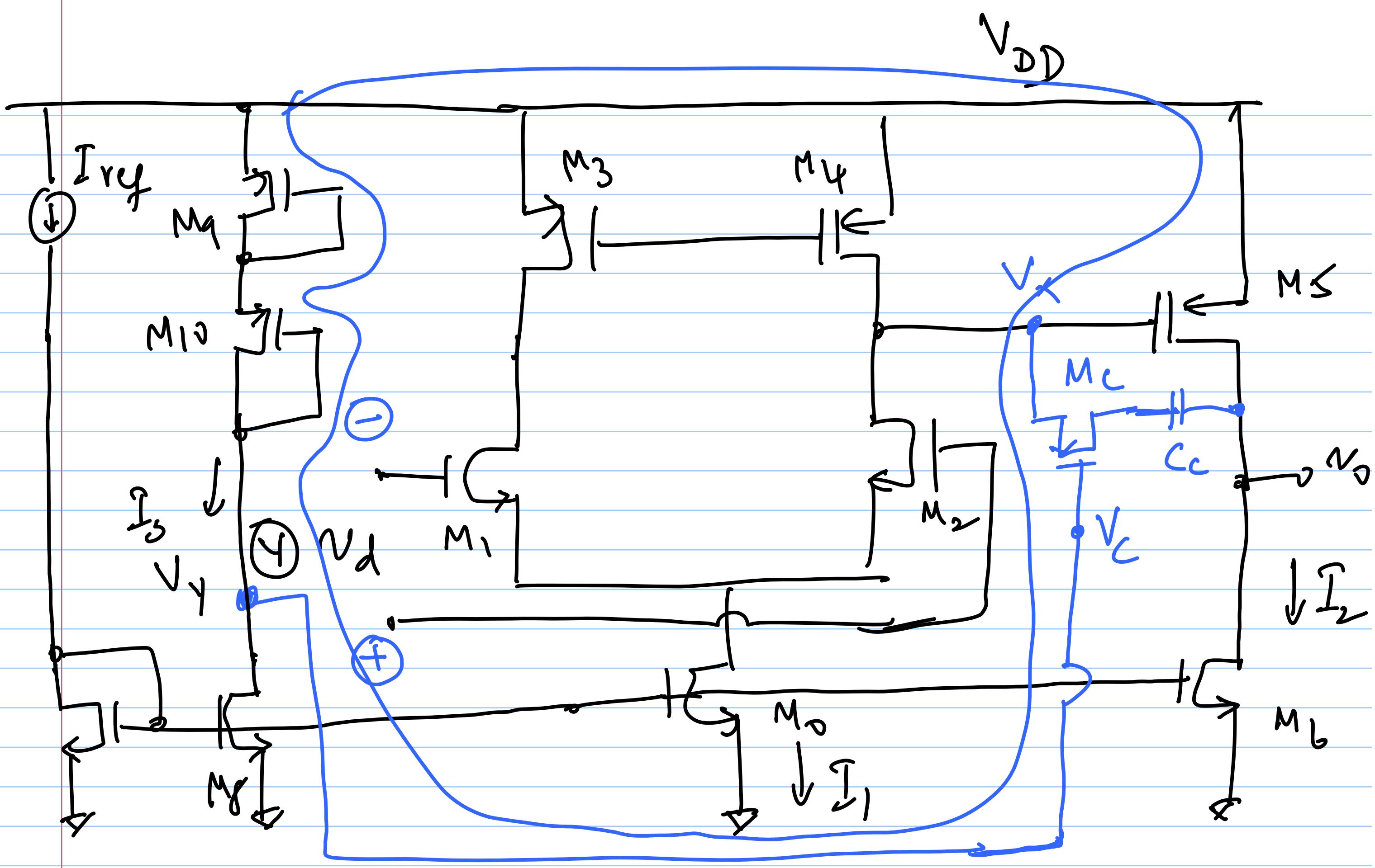
$$\Rightarrow V_{SG_c} - |V_T| = V_{SG_{10}} - |V_T|$$

$$\left(\frac{W}{L}\right)_c \left[V_{SG_{10}} - |V_T|\right] = \left(\frac{W}{L}\right)_5 \left(V_{SG_5} - |V_T|\right) \times \left(\frac{C_c}{C_L + C_c}\right)$$

$$\left(\frac{W}{L}\right)_c = \left(\frac{W}{L}\right)_5 \frac{V_{SG_5} - |V_T|}{V_{SG_{10}} - |V_T|} \cdot \frac{C_c}{C_L + C_c}$$

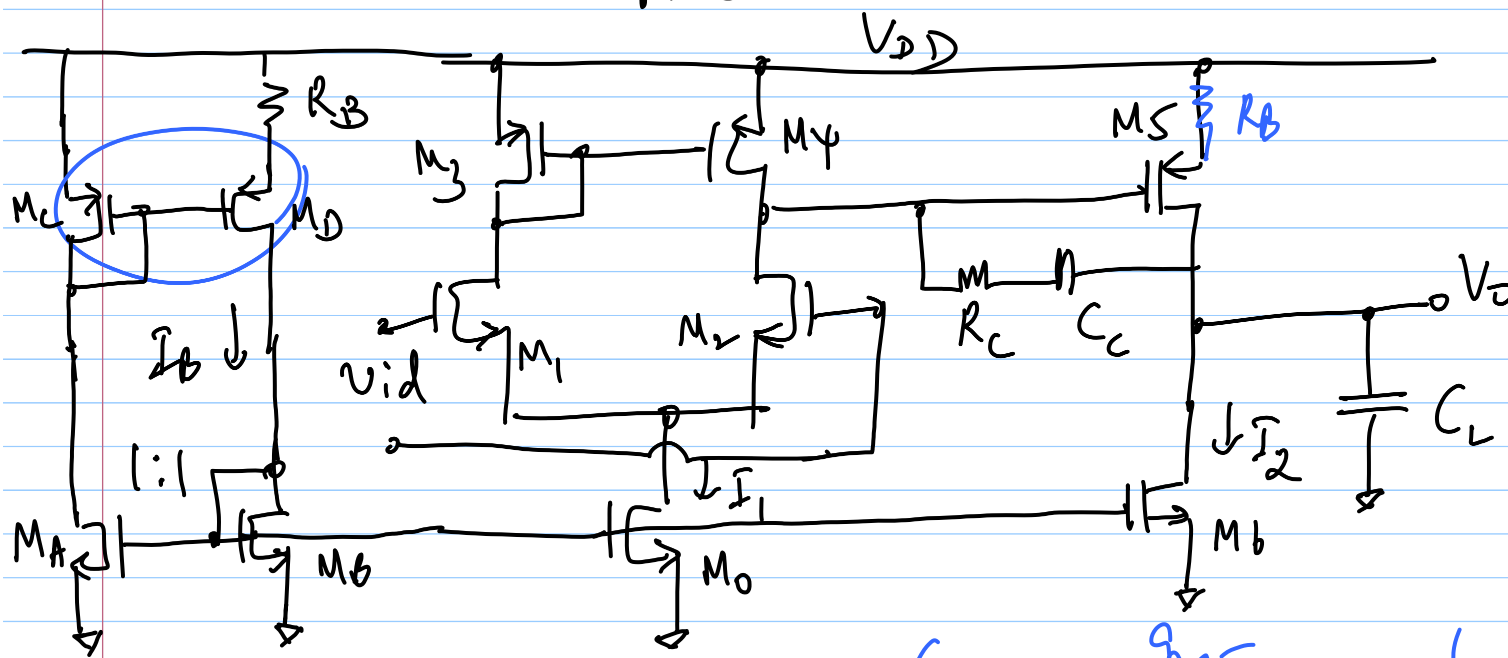
$$= \left(\frac{W}{L}\right)_5 \frac{\sqrt{\dfrac{2I_2}{\mu C_{ox} (W/L)_5}}}{\sqrt{\dfrac{2I_3}{\mu C_{ox} \left(\frac{W}{L}\right)_{10}}}} \cdot \frac{C_c}{C_L + C_c}$$

$$\boxed{\left(\frac{W}{L}\right)_c = \left[\left(\frac{W}{L}\right)_5 \left(\frac{W}{L}\right)_{10} \cdot \left(\frac{I_2}{I_3}\right)\right]^{1/2} \cdot \left(\frac{C_c}{C_L + C_c}\right)}$$



2) Use a physical resistor for R_c

& make g_{m5} track R_c



$$G_{m_2} = \frac{g_{m5}}{1+g_{m5}R_B} \to \frac{1}{R_B}$$

$$g_{m5} \propto \frac{1}{R_c} \propto \frac{1}{R_B}$$

$$I_2 \propto \frac{1}{R_B^2}$$

* Need a startup ckt.

$$V_{SG_C} = V_{SG_D} + I_B R_B \quad \text{———} (1)$$

$$\left(\frac{W}{L}\right)_D = n\left(\frac{W}{L}\right)_C \Rightarrow V_{ov_D} = \frac{V_{ov_C}}{\sqrt{n}}$$

$$V_{ov_C} = \frac{V_{ov_C}}{\sqrt{n}} + I_B \cdot R_B$$

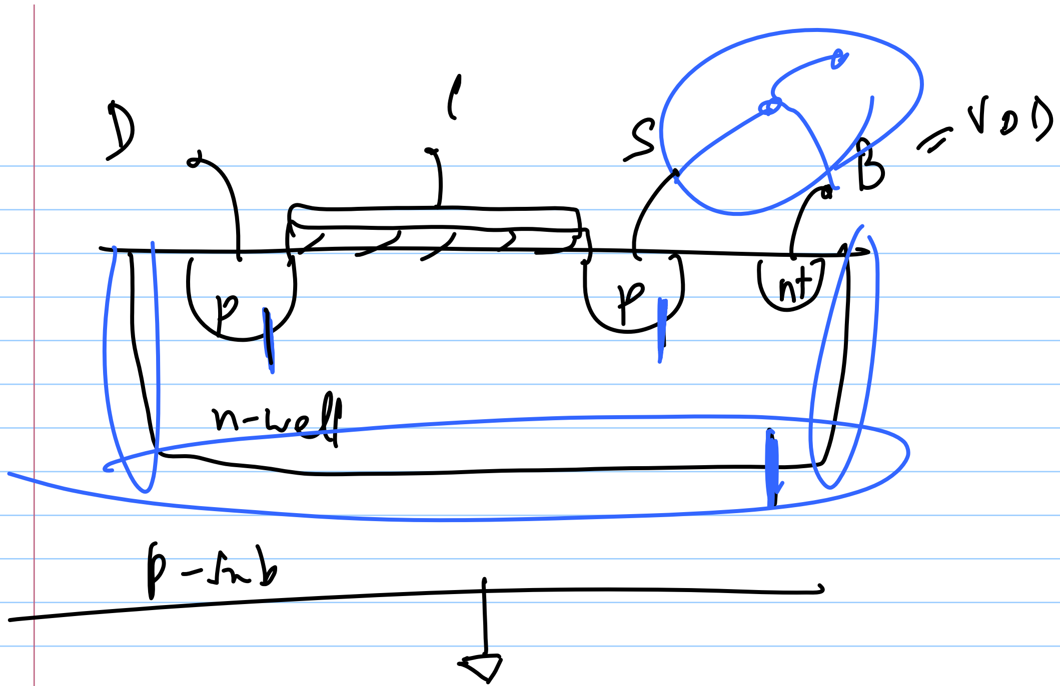
$$g_m = \frac{2I_D}{V_{ov}}$$

$$\Rightarrow \frac{2I_B}{g_{m_c}} = \frac{2I_B}{\sqrt{n}\, g_{m_c}} + I_B R_B$$

$$g_{m_c} = \frac{2(1 - 1/\sqrt{n})}{R_B}$$

$$\sqrt{2K_p' \left(\frac{W}{L}\right)_c I_B} = \frac{2(1 - 1/\sqrt{n})}{R_B}$$

$$I_B = \frac{2}{K_p' R_B^2} \cdot \alpha$$



* Mirror I_B into I_1 & I_2

$$I_2 = m I_B$$

$$g_{m5} = \sqrt{2k_p' \left(\frac{W}{L}\right)_5 \cdot I_2}$$

$$= \sqrt{2k_p' \left(\frac{W}{L}\right)_5 \cdot m \cdot \frac{2}{k_p' R_B^2} \cdot \alpha}$$

$$= \frac{\beta}{R_B} \propto \frac{\beta}{R_C}$$