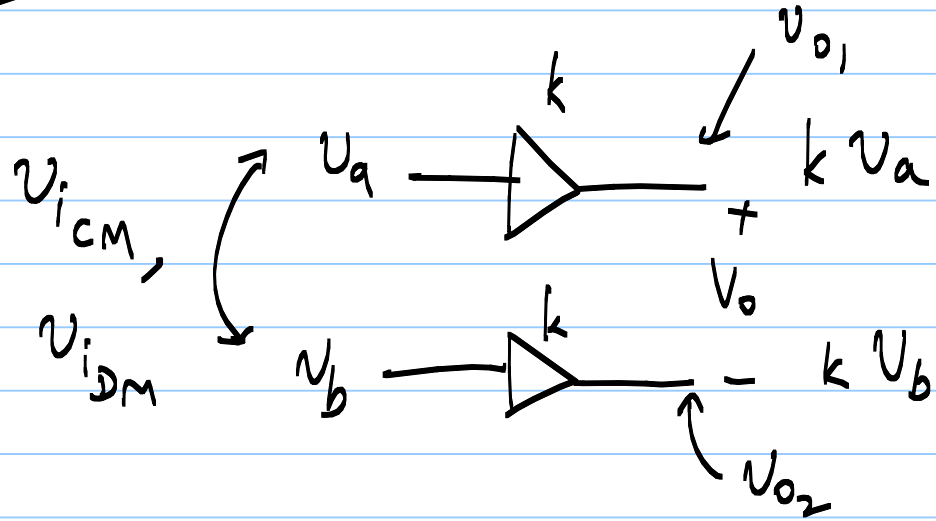
25/9/2020

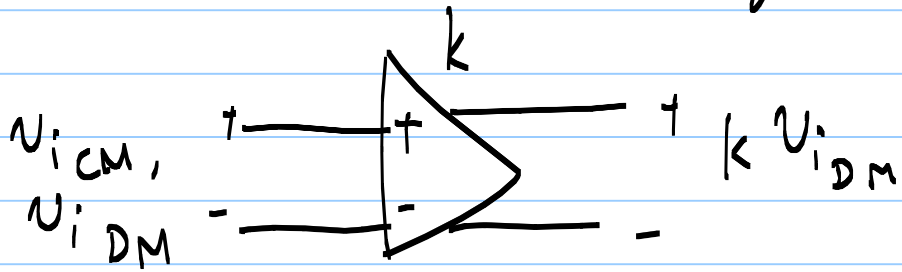
Lecture 31



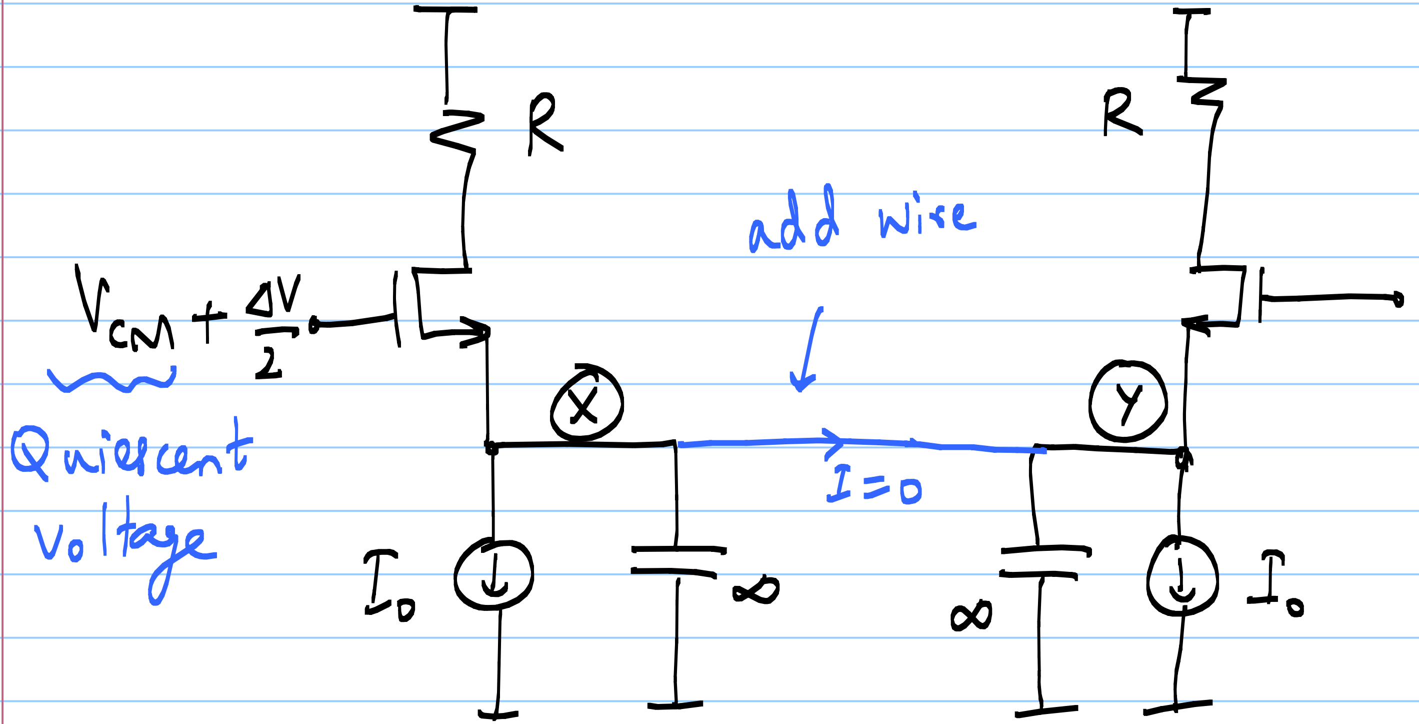
$$v_{oCM} = \frac{v_{o_1} + v_{o_2}}{2} = \frac{k\,(v_a + v_b)}{2} = k\,v_{iCM}$$

$$v_{oDM} = \frac{v_{o_1} - v_{o_2}}{2} = \frac{k\,(v_a - v_b)}{2} = k\,v_{iDM}$$

* We want to amplify only v_{iDM}



$\{ v_{oCM} = 0 \}$

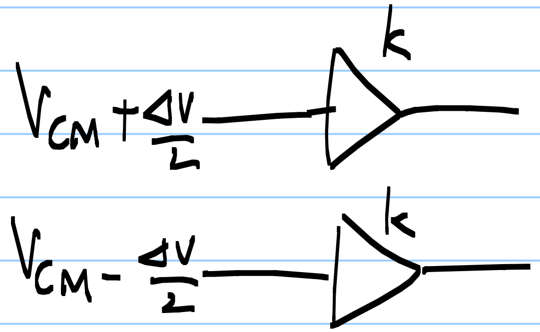


$$V_x = V_{CM} - V_{GS_1}\Big|_{I_o}$$

$$V_y = V_{CM} - V_{GS_2}\Big|_{I_o}$$

$$\boxed{V_x = V_y}$$

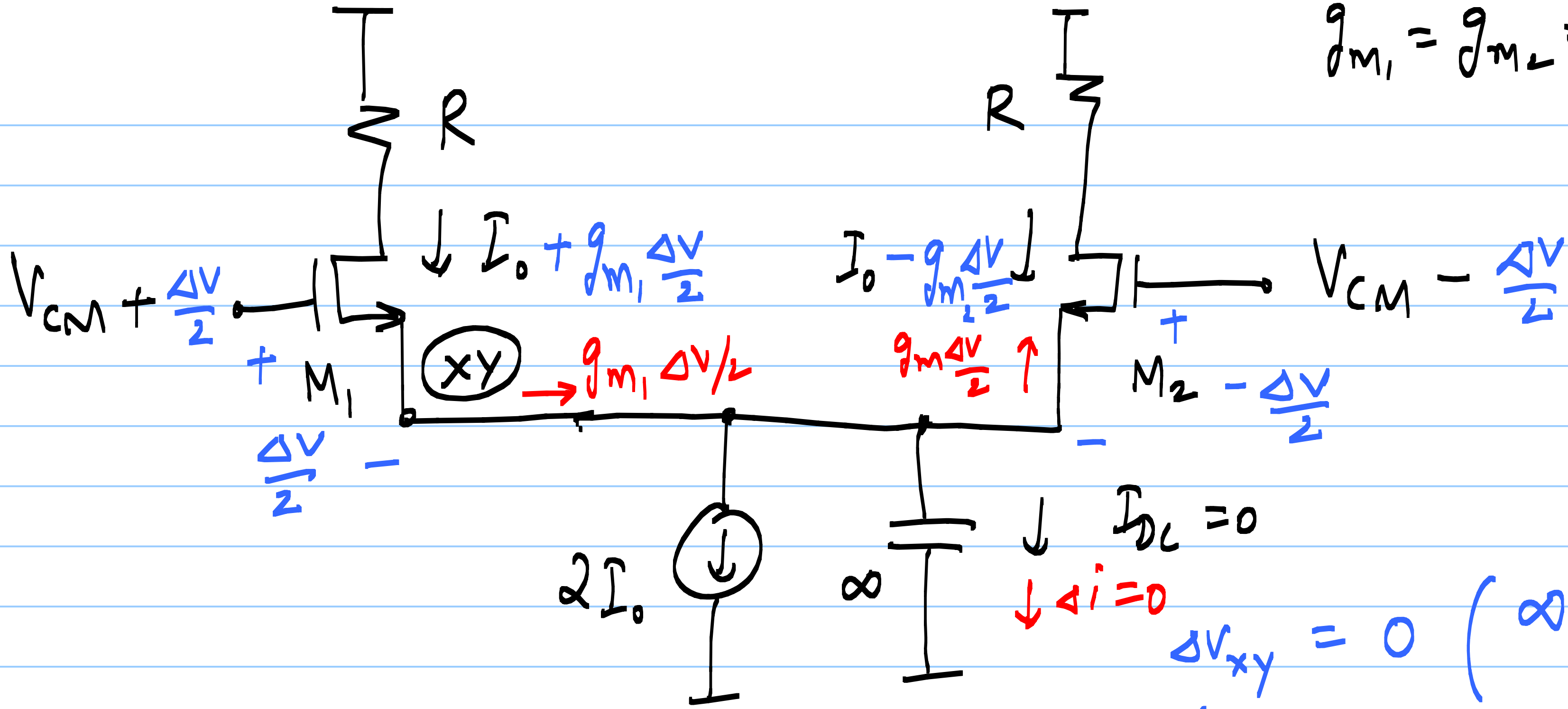
$$\Delta V_x = \Delta V_y = 0 \quad (\infty \text{ cap})$$



$$V_{iCM} = V_{CM}$$

$$V_{iDM} = \frac{\Delta V}{2}$$

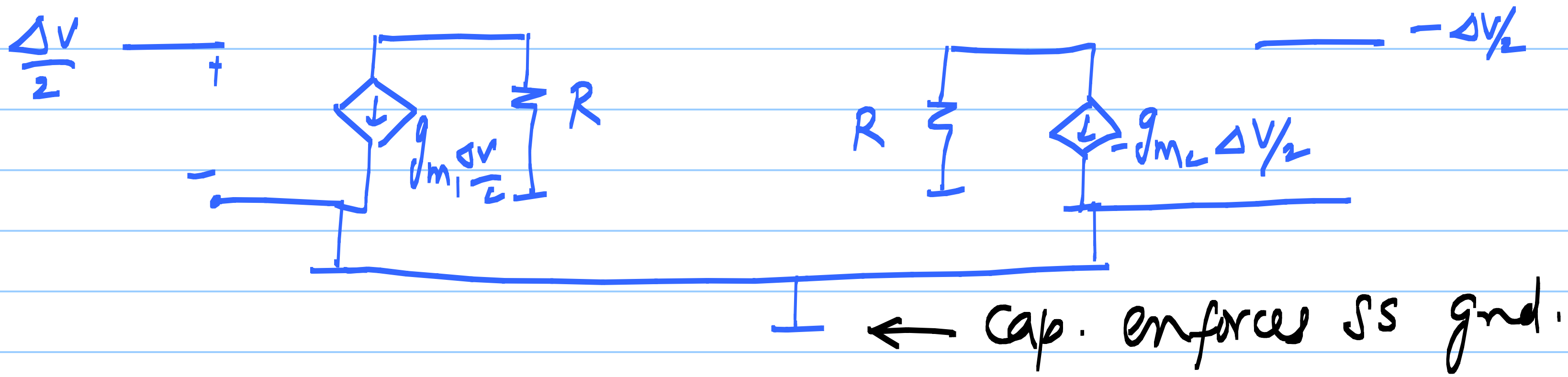
$g_{m_1} = g_{m_2} = g_m$

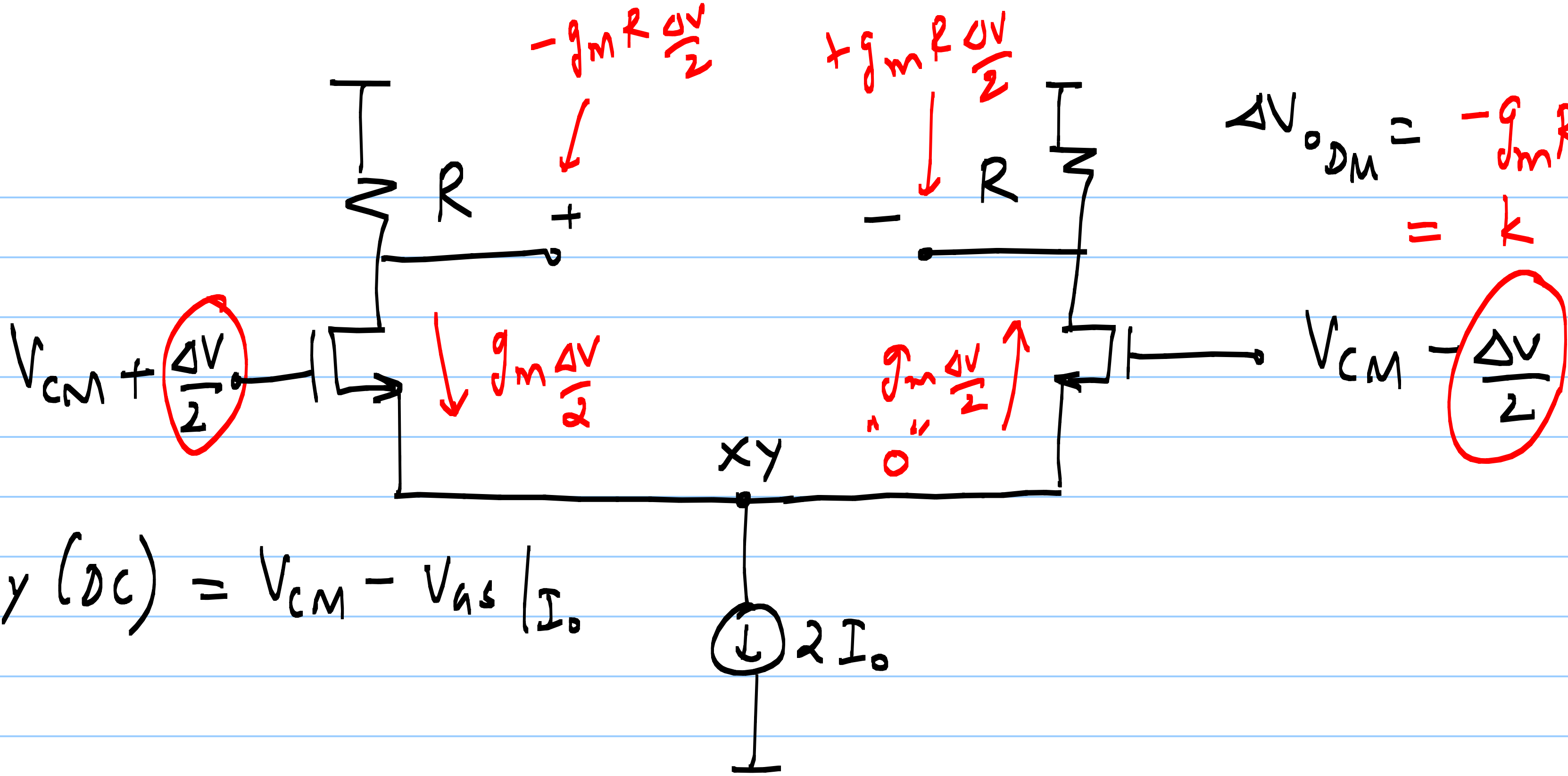


$\Delta V_{xy} = 0$ (∞ cap)
(inc. ground)

$$V_{xy}\ (DC) = V_{CM} - V_{GS_{1,2}}\Big|_{I_0}$$

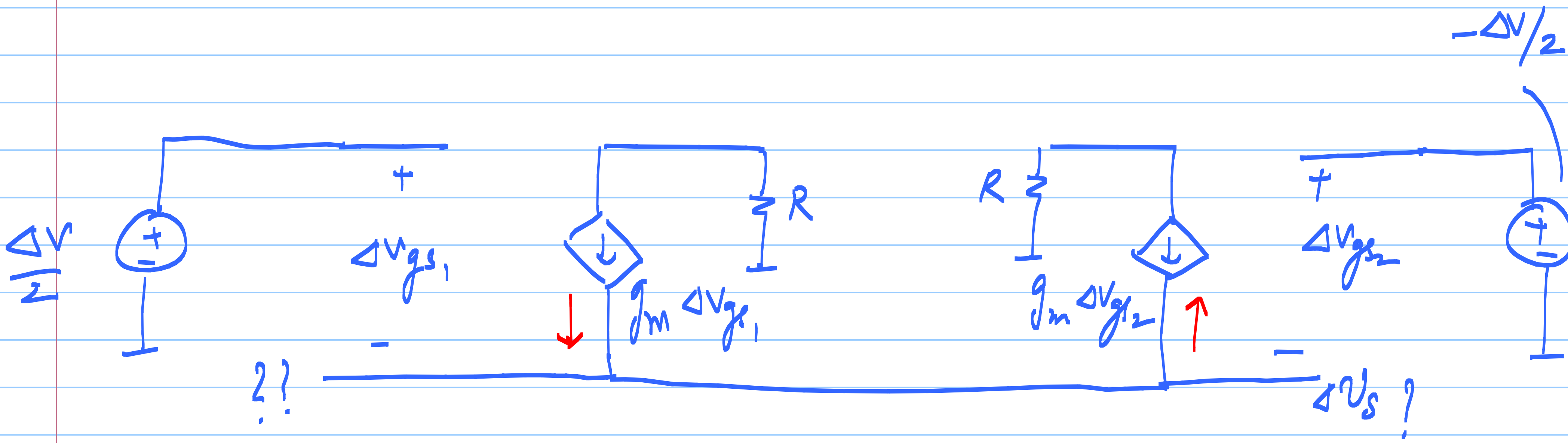
Inc. eq. circuit





$$\Delta V_{oDM} = -g_m R \Delta V = k\, \Delta V_{iDM}$$

$$V_{xy}(DC) = V_{CM} - V_{GS}\big|_{I_0}$$

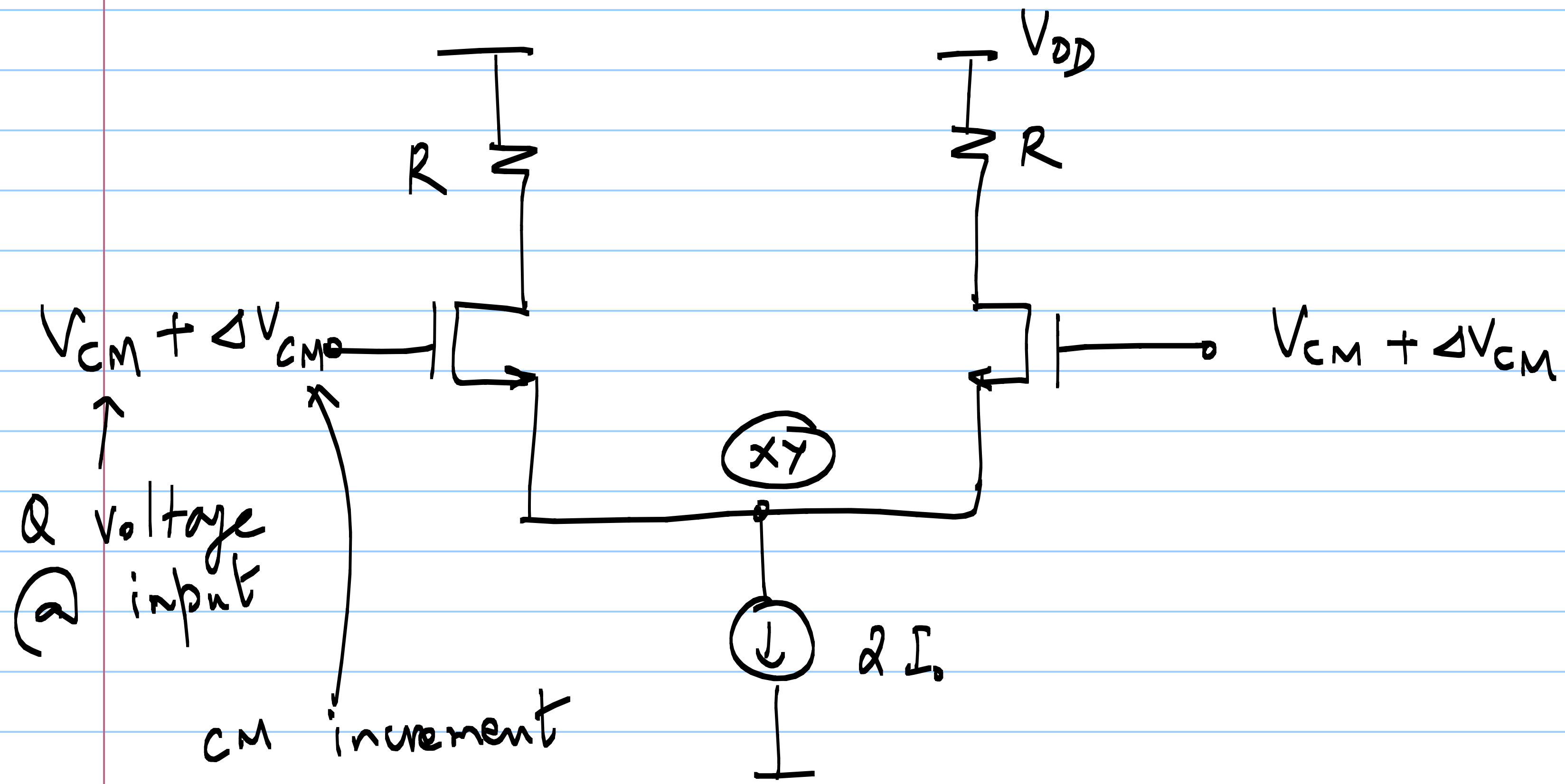


$$g_m \Delta v_{gs_1} + g_m \Delta v_{gs_2} = 0$$

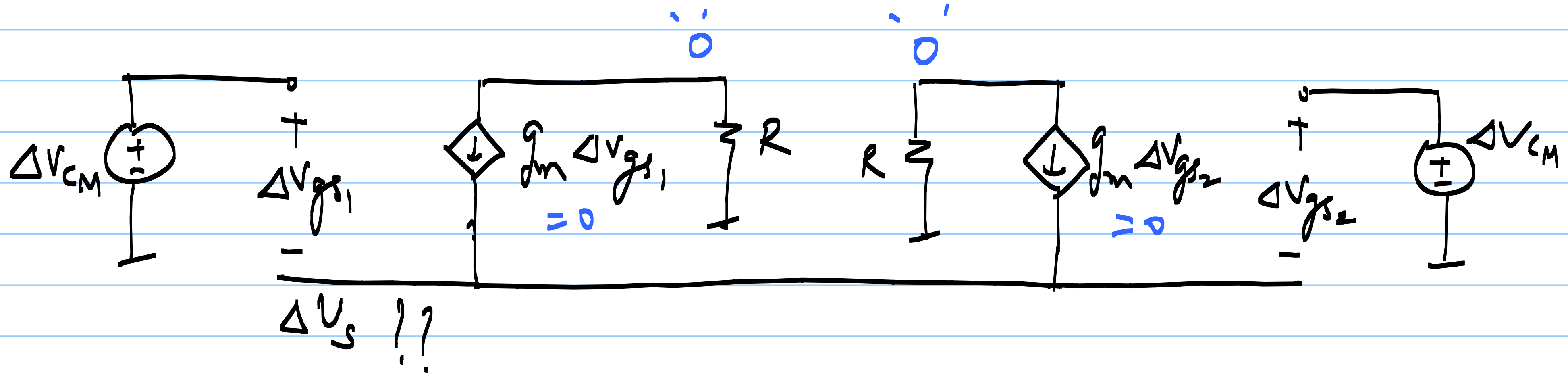
$$g_m(\Delta V_{g_1} - \Delta V_s) + g_m(\Delta V_{g_2} - \Delta V_s) = 0$$

$\Delta V_{g_1} = +\frac{\Delta V}{2}$, $\Delta V_{g_2} = -\frac{\Delta V}{2}$

$$\boxed{\Delta V_s = 0}$$



inc. eq.:



KCL @ source: $g_m \Delta V_{gs_1} + g_m \Delta V_{gs_2} = 0$

$$g_m(\Delta V_{g_1} - \Delta V_s) + g_m(\Delta V_{g_2} - \Delta V_s) = 0$$

$$\Delta V_{g_1} = \Delta V_{g_2} = \Delta V_{CM}$$

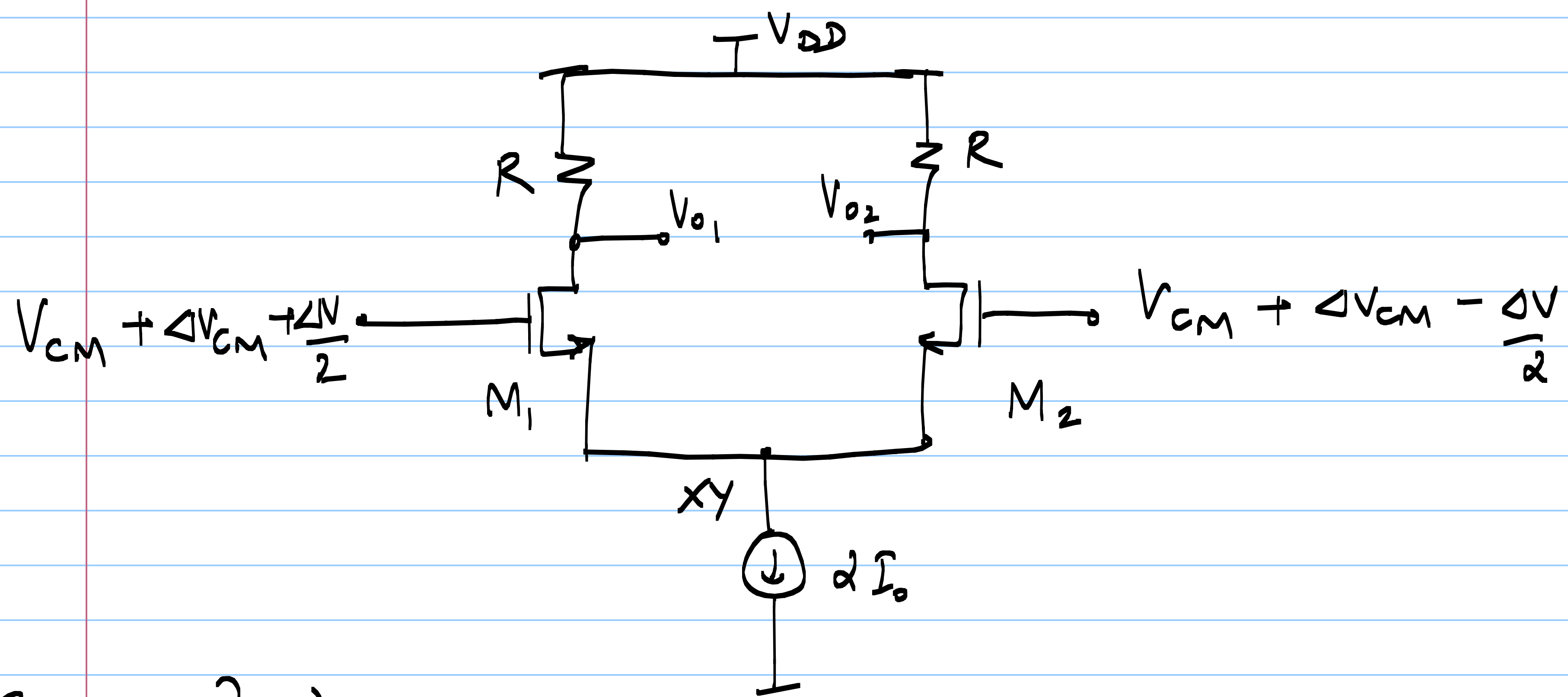
$$2\Delta V_{CM} = 2\Delta V_s$$

$$\boxed{\Delta V_s = \Delta V_{CM}}$$

$$\Delta V_{gs_1} = \Delta V_{gs_2} = 0$$

$\Delta V_{o_{CM}} = 0 \Rightarrow$ This circuit has 0 CM gain

"Differential Amplifier" we want



{ DC } 1) V_{CM} : $I_{D_1} = I_{D_2} = I_o$; $V_{xy} = V_{CM} - V_{GS}\big|_{I_o}$

$V_{o_1} = V_{o_2} = V_{DD} - I_o R$;

2) ΔV_{CM} :

$$\Delta i_{d_{1CM}} = \Delta i_{d_{2CM}} = 0$$

$$\Delta V_{o1_{CM}} = \Delta V_{o2_{CM}} = 0$$

$$\Delta V_{xy} = \Delta V_{CM}$$