MISMATCH.

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- **Random Mismatch :**
  - Due to random variations in dimensions/material parameters
  - Random uncorrelated variations from one place to another.
  - Relative random mismatch decreases with device area and parameters like $\mu_n C_{ox}$,V_{th},C_{area},R_{sh}.
- **Process Parameter mismatch**

$$\sigma_{\frac{\Delta C}{C}} = \frac{A_{\Delta C}}{\sqrt{WL}}$$

$$\sigma_{\frac{\Delta R}{R}} = \frac{A_{\Delta R}}{\sqrt{WL}}$$

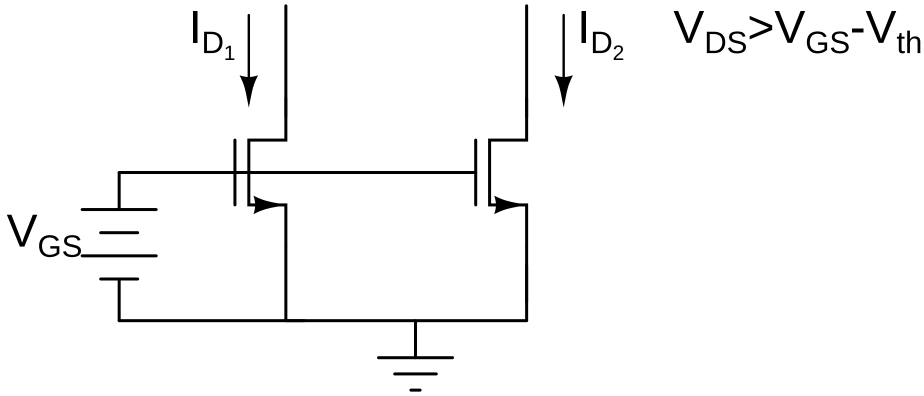
- **MOSFET mismatch**

$$I_D = \frac{\beta}{2}(V_{GS} - V_{th})^2$$

  - β and V_{th} have random variations.

$$\sigma_{\frac{\Delta\beta}{\beta}} = \frac{A_\beta}{\sqrt{WL}}$$

$$\sigma_{V_{th}} = \frac{A_{V_{th}}}{\sqrt{WL}}$$



Consider two transistors biased in saturation with the same V_{GS}

$$\sigma_{\frac{\Delta\beta}{\beta}} = \sigma_{\frac{\beta_1-\beta_2}{\frac{\beta_1+\beta_2}{2}}}$$

$$\sigma_{V_{th}} = \sigma_{V_{th1}-V_{th2}}$$

$$\Delta I_D = I_1 - I_2 = \frac{\beta_1}{2}(V_{GS} - V_{th1})^2 - \frac{\beta_2}{2}(V_{GS} - V_{th2})^2$$

$$\Delta I_D = \frac{\beta_1}{2}(V_{GS}-V_{th0}-(V_{th1}-V_{th0}))^2 - \frac{\beta_2}{2}(V_{GS}-V_{th0}-(V_{th2}-V_{th0}))^2$$

$$\Delta I_D = \frac{\beta_1}{2}(V_{GS}-V_{th0})^2(1-\frac{V_{th1}-V_{th0}}{V_{GS}-V_{th0}})^2 - \frac{\beta_2}{2}(V_{GS}-V_{th0})^2(1-\frac{V_{th2}-V_{th0}}{V_{GS}-V_{th0}})^2$$

Assume β is the same for both transistors and it has only V_{th} mismatch

$$\Delta I_D = \frac{\beta}{2}(V_{GS} - V_{th0})^2\frac{2(V_{th2} - V_{th1})}{V_{GS} - V_{th0}}$$

$$\Delta I_D = \frac{2I_d}{(V_{GS} - V_{th0})}(V_{th2} - V_{th1})$$

Assume V_{th} is the same for both transistors and it has only β mismatch

$$\Delta I_D = \frac{\beta_1 - \beta_2}{2}(V_{GS} - V_{th})^2$$

Since we consider small variations , we can apply SUPERPOSITION theorem to find the combined effect of both.

$$\Delta I_D = \frac{\beta_1 - \beta_2}{2}(V_{GS} - V_{th})^2 + \frac{2I_d}{(V_{GS} - V_{th0})}(V_{th2} - V_{th1})$$

$$\Delta I_D = \frac{(\beta_1 - \beta_2)\beta}{2\beta}(V_{GS} - V_{th})^2 + \frac{2I_d}{(V_{GS} - V_{th0})}(V_{th2} - V_{th1})$$

$$\Delta I_D^2 = \sigma_{\frac{\Delta\beta}{\beta}}^2 I_D^2 + \frac{4\sigma_{V_{th}}^2}{(V_{GS} - V_{th})^2} I_D^2$$

$$\sigma_{\frac{\Delta I_D}{I_D}}^2 = \sigma_{\frac{\Delta\beta}{\beta}}^2 + \frac{4\sigma_{V_{th}}^2}{(V_{GS} - V_{th})^2}$$