MOS CAPACITOR MODEL

\[ C_{gs} = \frac{2}{3} WL \cdot \text{Cox} + WL_{ov} \cdot \text{Cox} \]

\[ C_{gd} = WL_{ov} \cdot \text{Cox} \]

\[ C_{db} = \frac{C_{db0}}{\sqrt{1 + \frac{V_{PB}}{V_{0}}}} \]
\( \frac{2}{3} \) \( W \) \( L \) \( \text{Cox} \) is gate to channel cap when device active channel is connected to source 

\[ \frac{2}{3} \] factor due to channel shape

\( W \) \( L \) \( \text{Cov} \) is gate overlap capacitance 

\( \text{L} \) \( \text{ov} \) is overlap length

\( \text{C}_{\text{db}0} \) is drain body capacitance when \( \text{V}_{\text{dB}} = 0 \)

\( \text{V}_{\text{dB}} \) is drain body voltage (reverse bias voltage)

\( \text{V}_{0} \) is junction built-in voltage 

\( \text{V}_{0} \approx 0.7 \text{ V} \)
MOSFET MODEL WHEN $V_{SB} = 0$

$G$

$C_{gd}$

$V_{gs}$

$C_{gs}$

$V_{gs} - V_{ds}$

$r_0$

$C_{db}$

$S$

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MOSFET UNITY GAIN FREQ

FREQ WHERE SHORT-CIRCUIT CURRENT GAIN EQUALS 1.

$C_{gd} \leq SC_{gd}V_{gs}$

$I_0 = g_m V_{gs} - SC_{gd}V_{gs}$

CAN SHOW TYPICALLY $SC_{gd}V_{gs} \ll g_m V_{gs}$

$I_0 \approx g_m V_{gs}$
\[ V_{qs} = \frac{I_i}{s(C_{qs} + C_{gd})} \]  \hspace{1cm} (2)

\[ 1 + 2 \Rightarrow \ \frac{I_o}{I_i} = \frac{g_m}{s(C_{qs} + C_{gd})} \]  \hspace{1cm} (3)

Let \( 3 = 1 \) to find when \( I_o = I_i \):

\[ \left| \frac{g_m}{s(C_{qs} + C_{gd})} \right| = 1 \Rightarrow \omega_T = \frac{g_m}{C_{qs} + C_{gd}} \]

\[ f_T = \frac{g_m}{2\pi (C_{qs} + C_{gd})} \]

Recall \( g_m = \mu_n C_{ox} \left( \frac{W}{L} \right) V_{ov} \)

\[ C_{qs} = \frac{2}{3} W L C_{ox} \]

Assuming \( C_{gd} \ll C_{qs} \)

\[ f_T = \frac{3 \mu_n V_{ov}}{4 \pi^2 L^2} \] \hspace{1cm} independent of \( W \)

Proportional to \( \frac{1}{L^2} \)

Proportional to \( V_{ov} \)
\[ \left| \frac{I_o}{I_i} \right| \text{dB} \quad \text{from (3)} \]

\[
\text{LET } s = j\omega
\]

\[ -20 \text{ dB/dec} \]

\[ W_t = 2\pi \text{ shift} \]

\[ W_t = \frac{g_m}{C_{gs} + C_{gd}} \]