MOS TRANSISTOR CAPACITANCE.

10 JANUARY 2006

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- **Capacitance variations in different operating regions :**
  - In the **TRIODE REGION** $C_{gs} = C_{gd} = \frac{WLC_{ox}}{2} + C_{ov}W$.
  - In the **SATURATION REGION** $C_{gs} = \frac{2}{3}WLC_{ox} + C_{ov}W$ $C_{gd} = C_{ov}W$.
  - If Transistor is OFF $C_{gs} = C_{gd} = C_{ov}W$.

- **Unity Gain frequency f_T of MOS transistor**

$$I_d(s) = g_m V_{gs}(s) - I_g(s)\frac{C_{gd}}{C_{gd} + C_{gs}}$$

$$V_{gs}(s) = \frac{I_g(s)}{s(C_{gs} + C_{gd})}$$

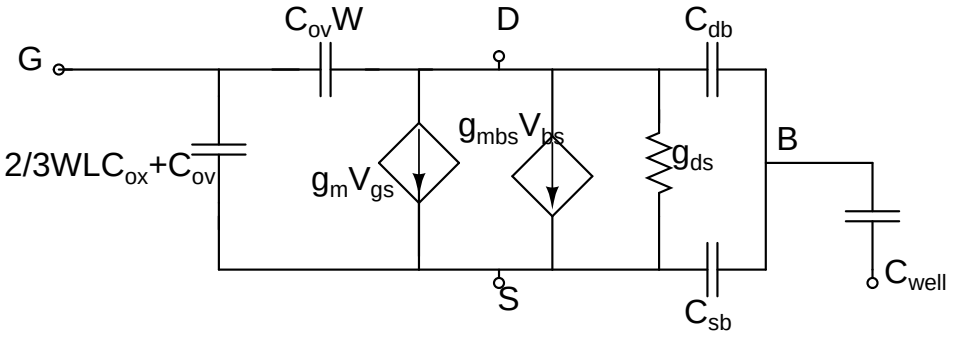

Figure 1: SMALL SIGNAL EQUIVALENT CIRCUIT

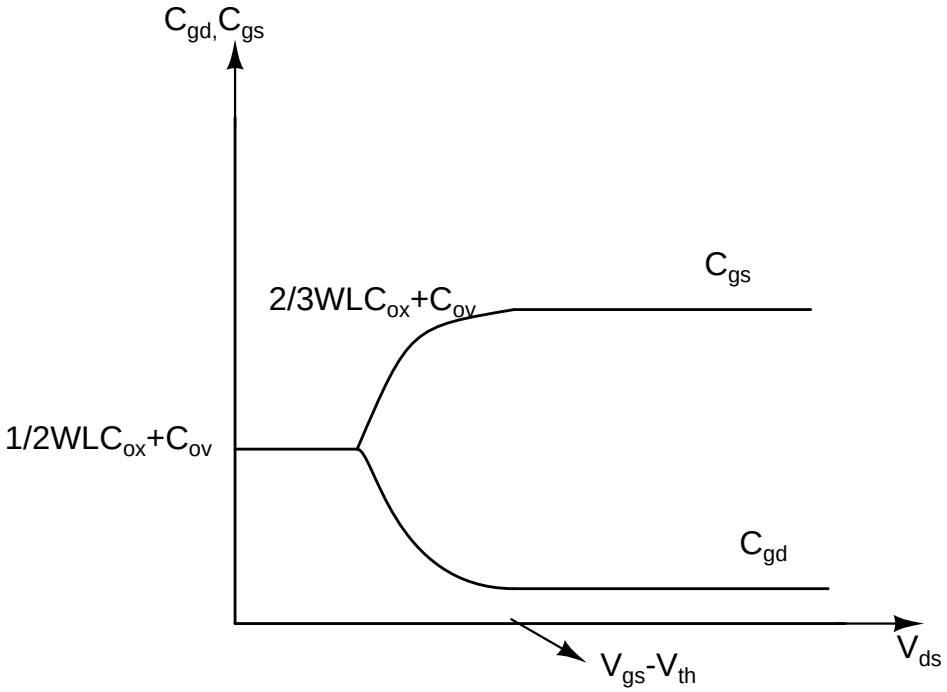

Figure 2: CAPACITANCE PLOT

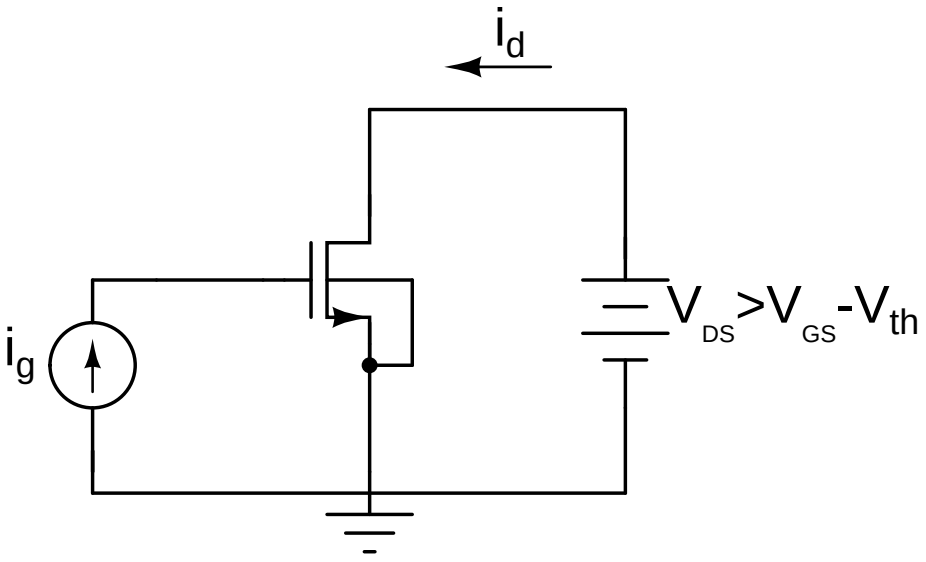

Figure 3: TRANSISTOR BIASED IN SATURATION

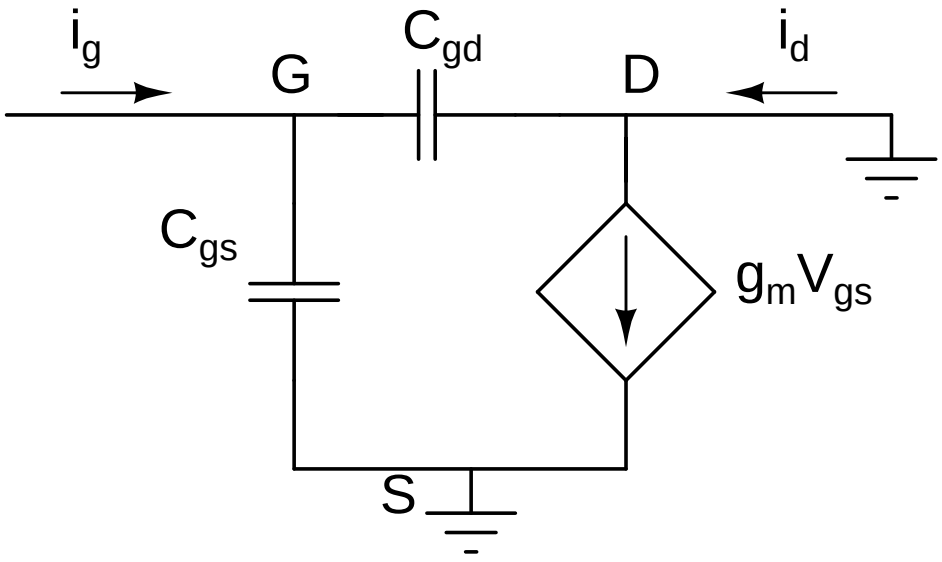

Figure 4: SMALL SIGNAL EQUIVALENT CIRCUIT

$$\frac{I_d(s)}{I_g(s)} = \frac{g_m - sC_{gd}}{s(C_{gs} + C_{gd})}$$

Since C_{gd} is small , it is neglected

Therefore

$$\frac{I_d(s)}{I_g(s)} = \frac{g_m}{s(C_{gs} + C_{gd})}$$

$$f_T = \frac{g_m}{2\pi C_{gs}}$$

$$g_m = \mu_n C_{ox} \frac{W}{L}(V_{gs} - V_{th})$$

$$C_{gs} = \frac{2}{3} W L C_{ox}$$

$$f_T = \frac{3}{2}\mu_n \frac{V_{gs} - V_{th}}{L^2}$$

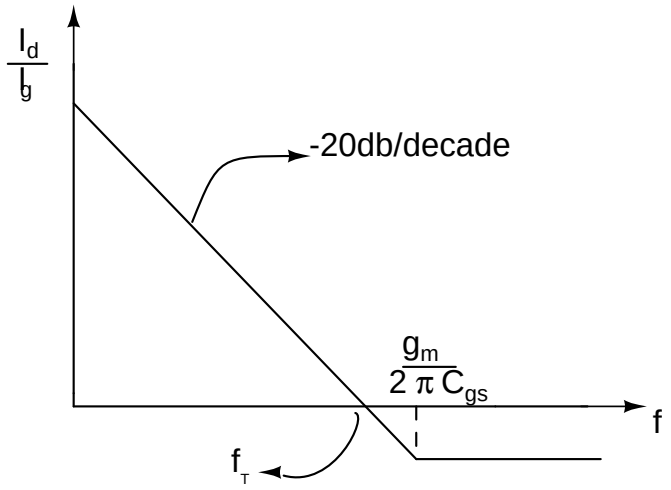

Figure 5: PLOT OF GAIN VERSUS FREQUENCY