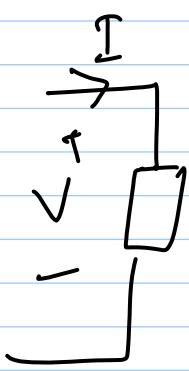


25-10-12

Lec 37



$$I = f(v)$$

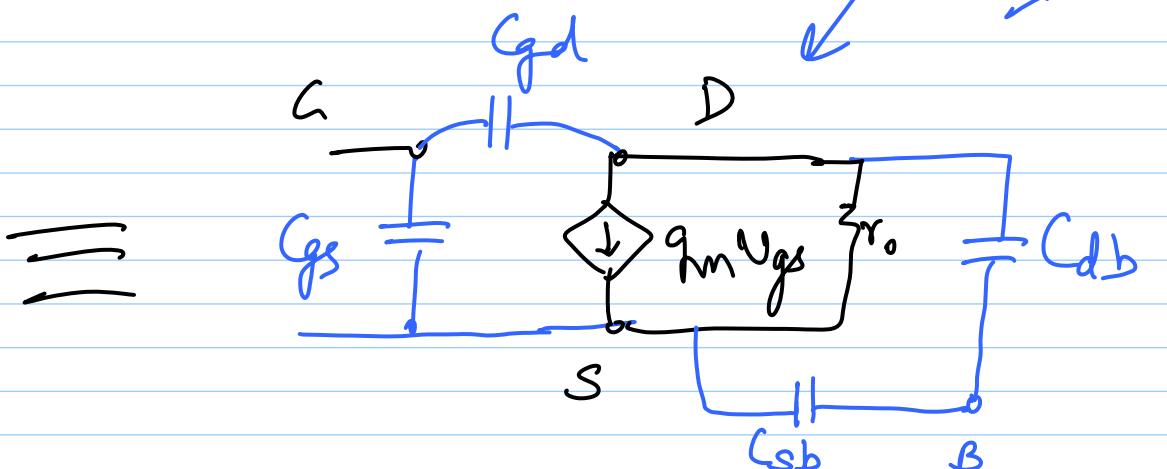
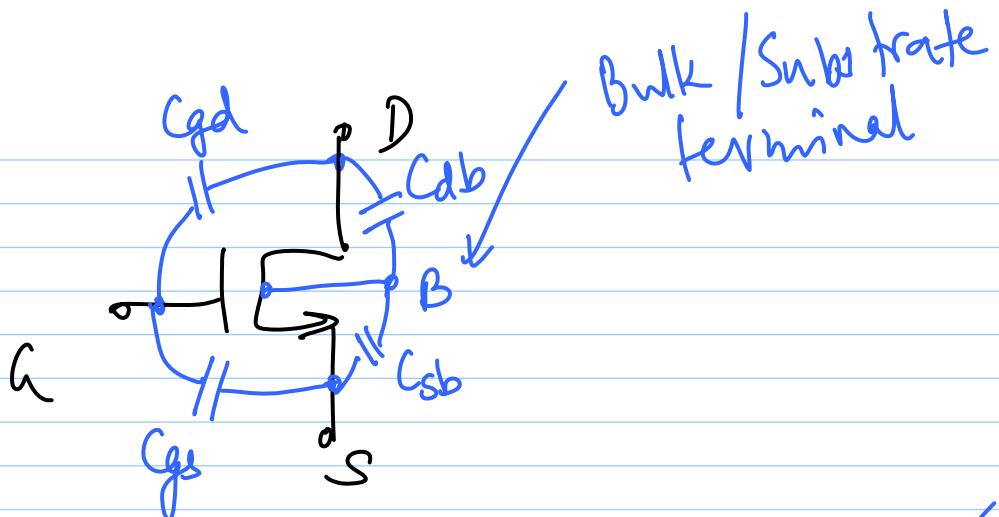
linearized around
op pt. w/ig
Taylor Series approx.

Elements w/ memory

$$r = \frac{1}{f'(v)}$$

Nonlinear diff. eqns

↳ linear diff. eqns (op pt.)
↳ L, C in inc. eq. ckt.



* $C_{gs} \gg C_{gd}, C_{db}, C_{sb}$

* $C_{gs} \approx \frac{2}{3} W \cdot L \cdot C_{ox}$

saturation

$fF/\mu m^2$

or F/m^2

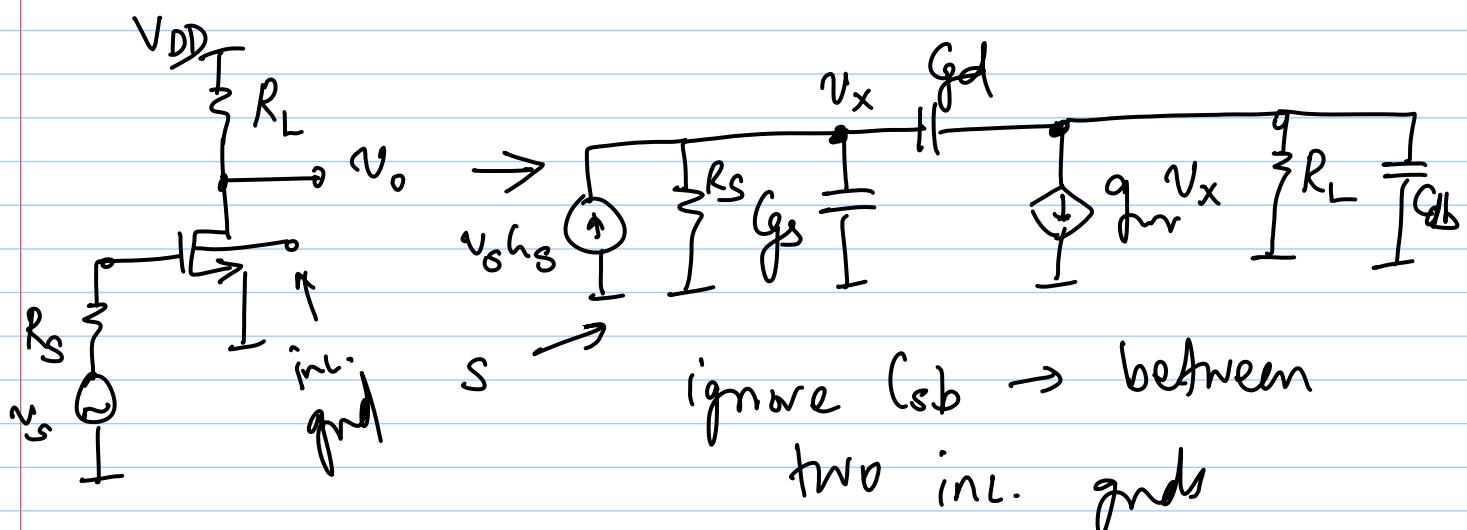
* $C_{gd} \sim C_{db} \sim C_{sb}$

* All cap values change based on the regions of operation \rightarrow Sat, triode, off

earlier $\Rightarrow \frac{V_o}{V_s} = \text{gain}$

now

$\frac{V_o}{V_s} (\Delta) = \text{T.F. from i/p to o/p}$



$$v_x \cdot s(g_s) + (v_x - v_0) \cdot s(g_d + v_x \cdot h_s) = v_s h_s \quad \text{--- (1)}$$

$$(v_0 - v_x) \cdot s(g_d) + v_0 (h_L + s(a_b)) + g_m v_x = 0 \quad \text{--- (2)}$$

eliminate v_x

$$\rightarrow v_x [s(g_s + g_d) + h_s] = v_0 \cdot s(g_d) + v_s \cdot h_s$$

$$\begin{aligned} v_0 & \left[\frac{(h_L + s(a_b + g_d)) - s(g_d)}{s(g_d) - g_m} \right] \\ & = \frac{v_s h_s}{s(g_s + g_d) + h_s} \end{aligned}$$

$$\frac{v_0}{v_s} = \frac{-g_m}{h_L} \left[1 - \frac{s(g_d)}{g_m} \right]$$

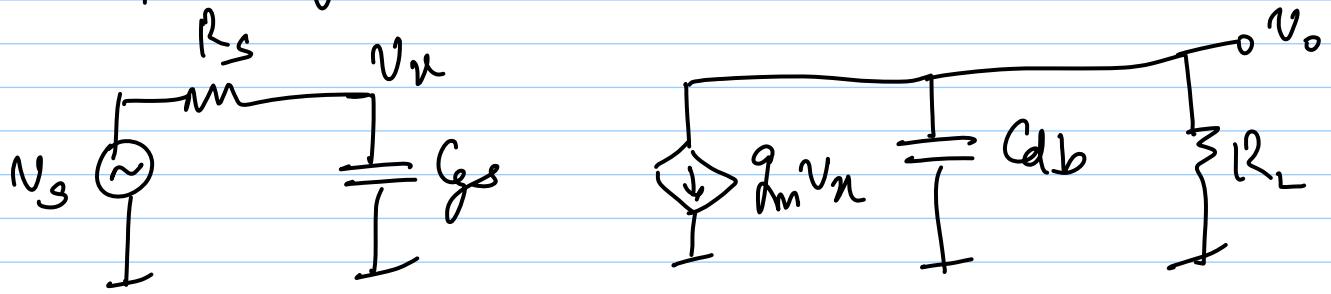
$$\frac{\sigma^2}{h_L h_s} \left[G_d (g_s + C_d g_s + C_b g_d) \right]$$

$$+ \frac{s}{h_L h_s} \left[h_L (g_s + g_d) + h_s (g_d + a_b) + g_m g_d \right] + 1$$

(Kw)

Kw

$$\text{If } G_{dL} = 0$$



$$\frac{V_o(s)}{N_s} = \frac{V_N(s)}{N_s} \cdot \frac{V_o}{V_N}(0)$$

$$= \frac{1/s C_{gs}}{R_s + 1/s C_{gs}} \cdot \frac{-q_m}{C_L + s C_{db}}$$

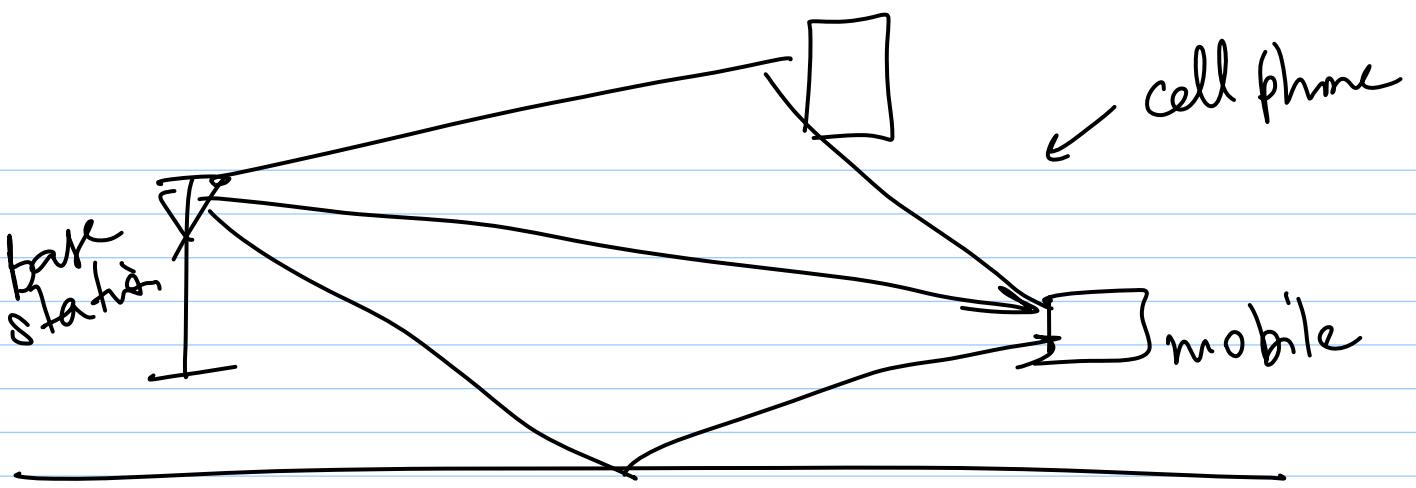
$$= \frac{-q_m R_L}{(1 + s C_{gs} R_s)(1 + s C_{db} R_L)}$$

\uparrow
i/p pole (LHP)

\uparrow
o/p pole (LHP)

$$p_1 = \frac{-1}{R_s C_{gs}} ; \quad p_2 = \frac{-1}{R_L C_{db}}$$

w/ $G_{dL} \Rightarrow$ RHP zero



Zeros \rightarrow * multiple paths from input
to output

* phase shifts along different
paths are different

$$\frac{V_o}{V_s} = \frac{-\frac{g_m}{h_L} \left[1 - \frac{s G_d}{g_m} \right]}{\frac{s^2}{G_L h_S} \left[G_d G_S + G_b G_S + G_b G_d \right] + \frac{s}{G_L h_S} \left[G_L (G_S + G_d) + h_S (G_d + G_b) + g_m G_d \right] + 1}$$

$G_S \gg G_{db}, G_d ; (R_m \cdot R_d) \gg 1$