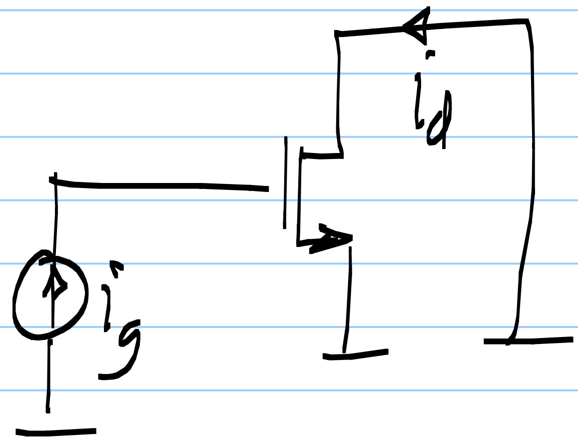
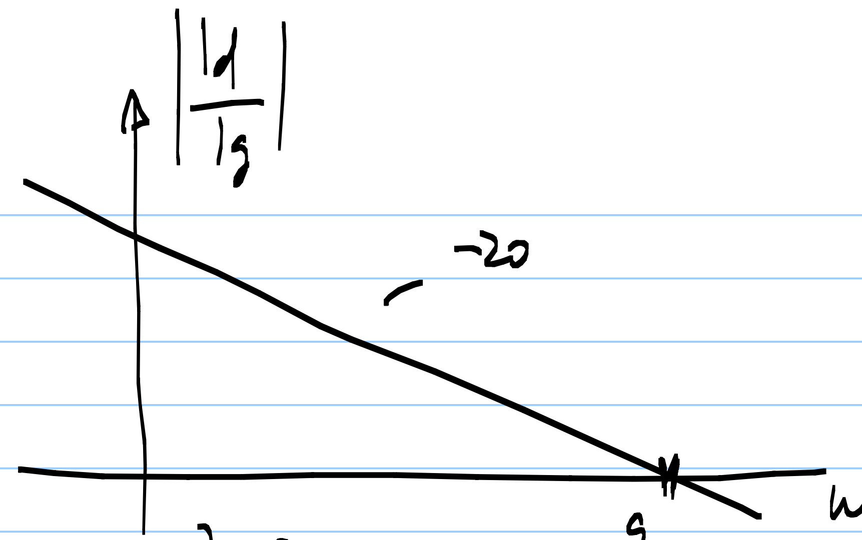
Lecture 8

21/1/2016





Transit freq: $\omega_T = \frac{g_m}{C_{gs}}$

$$h_{21} = \frac{I_d(s)}{I_g(s)} = \frac{g_m}{sC_{gs}}$$

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

$$\omega_T = \frac{g_m}{C_{gs}} = \frac{\mu_n C_{ox} \frac{W}{L} (V_{GS} - V_T)}{\frac{2}{3} W L C_{ox}} = \frac{3}{2} \cdot \frac{\mu_n (V_{GS} - V_T)}{L^2}$$

For high speed circuits

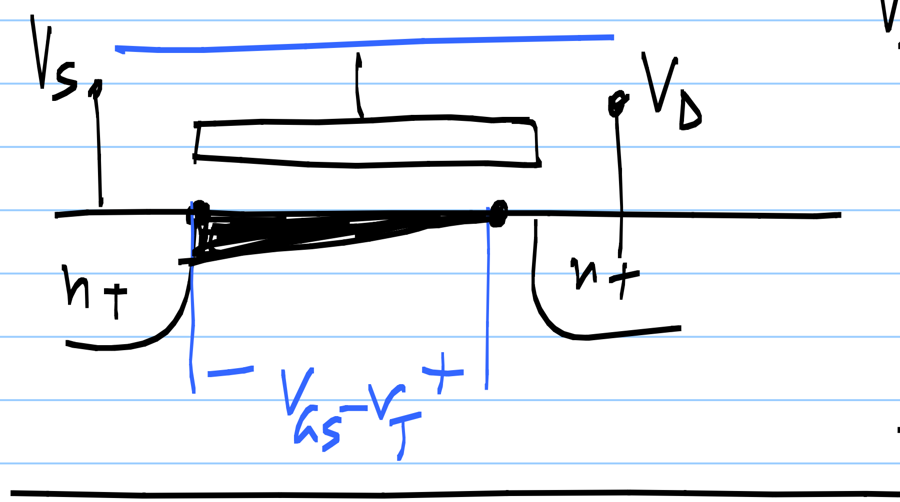
- * nMOS amplifiers ($\mu_n > \mu_p$)
- * Bias @ large ($V_{GS} - V_T$)] Swing limits ↓
- * Use short channel length (L)] $\Rightarrow \frac{g_m}{g_{ds}}$ ↓ (λ ↑)

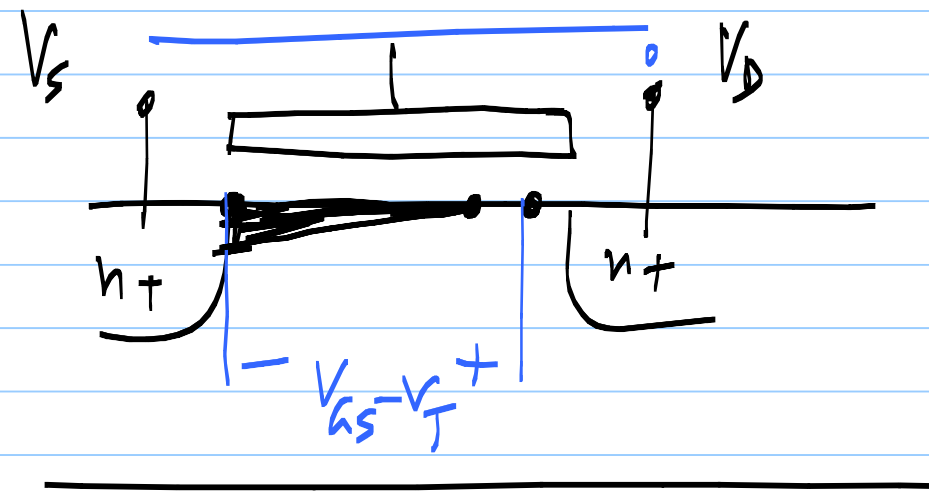
Sat. region

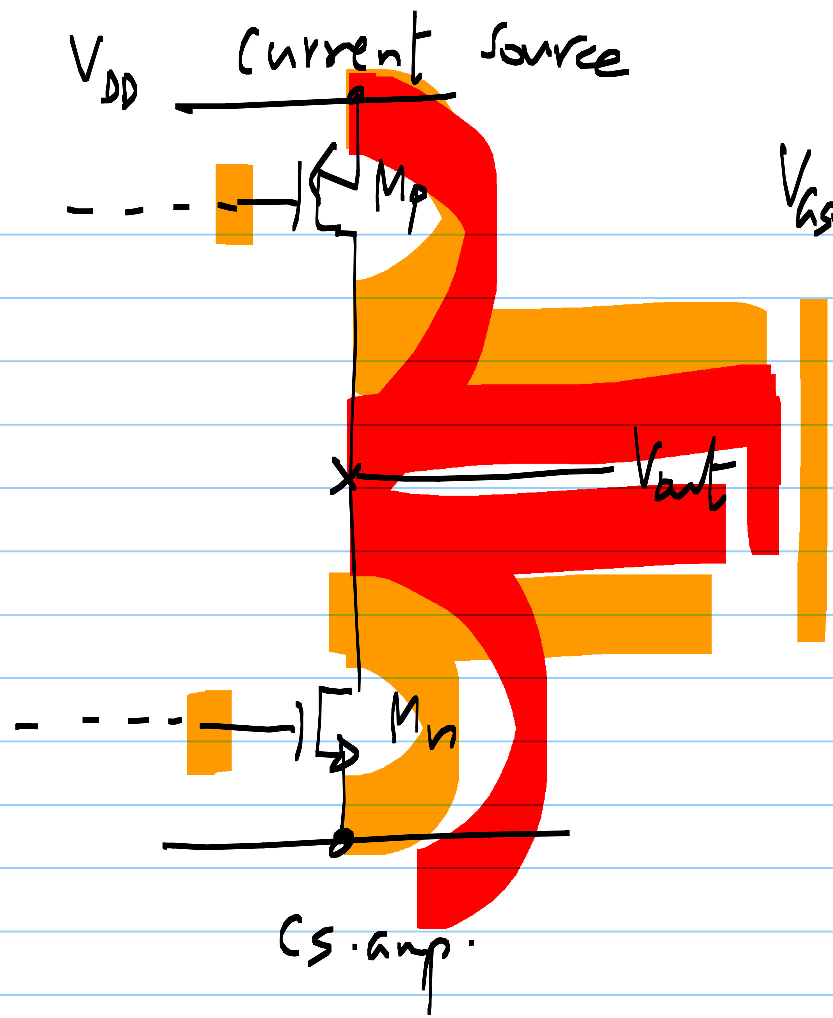
$$I_D = \frac{\mu_n C_{ox}}{2} \frac{W}{L} (V_{GS} - V_T)^2 (1 + \lambda V_{DS})$$

$$\frac{W}{L'} = \frac{W}{L} (1 - \delta L / L)$$

$$\lambda = \frac{k_\lambda}{L}$$

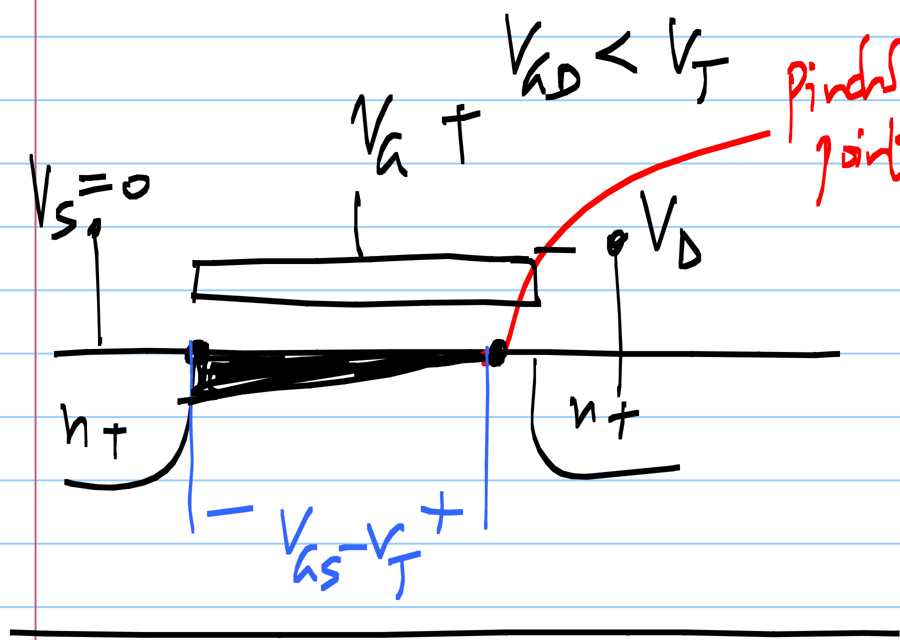




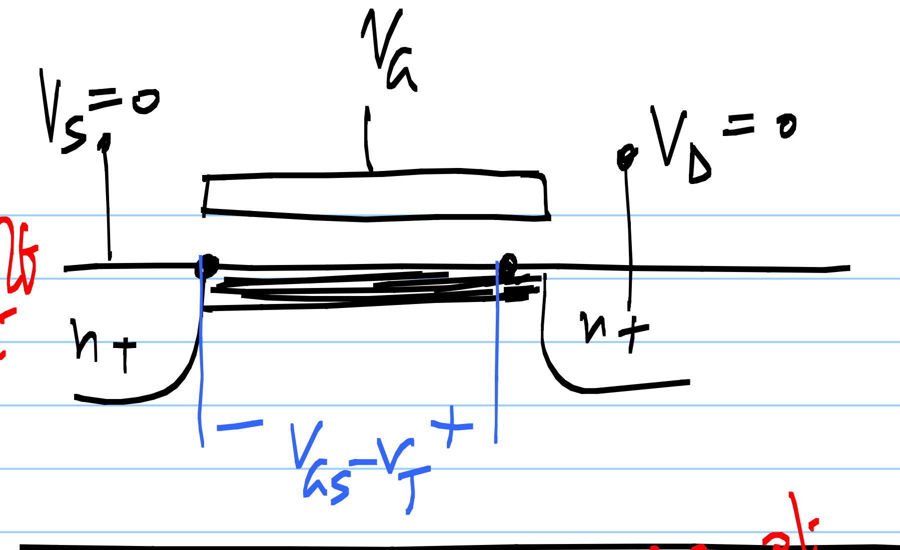


CS. amp.

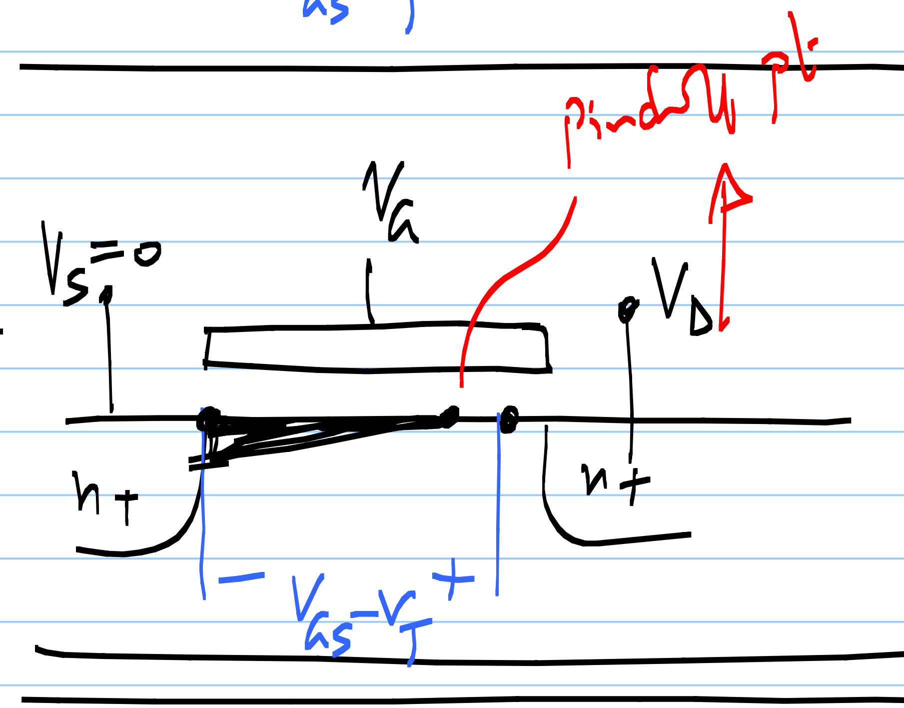
$$V_{GSn} - V_{Tn} < V_{out} < V_{DD} - (V_{SGp} - V_{Tp})$$



$V_S = 0$
V_G
$+$
$V_{GD} < V_T$
$-$
V_D
$n+$
$n+$
$- V_{GS} - V_T +$
pinch off point



$V_S = 0$
V_G
$V_D = 0$
$n+$
$n+$
$- V_{GS} - V_T +$

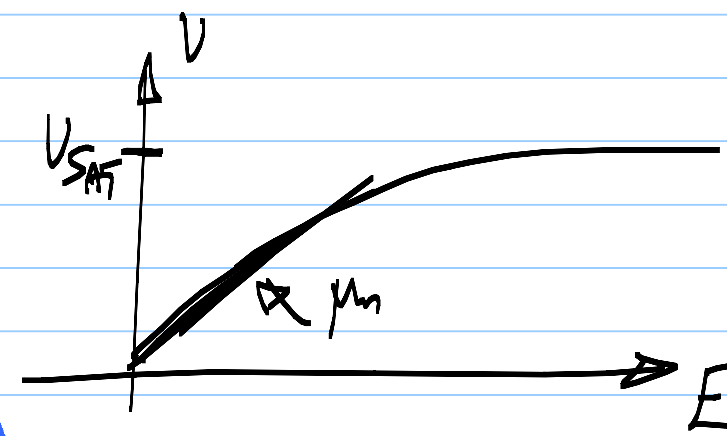


pinch off pt
$V_S = 0$
V_G
V_D
$n+$
$n+$
$- V_{GS} - V_T +$

$$I_D = \frac{\mu_n C_{ox}}{2} \cdot \frac{W}{L} (V_{GS} - V_T)^2$$

Carrier velocity : $\mu_n \cdot E$

$$\mu_n \left(\frac{V_{GS} - V_T}{L} \right) \rightarrow v_{SAT}$$



$$\frac{W C_{ox}}{2} \cdot (V_{GS} - V_T) \cdot v_{SAT}$$

I_D in velocity saturated region

Velocity saturated region :

Linear w/ V_{GS}

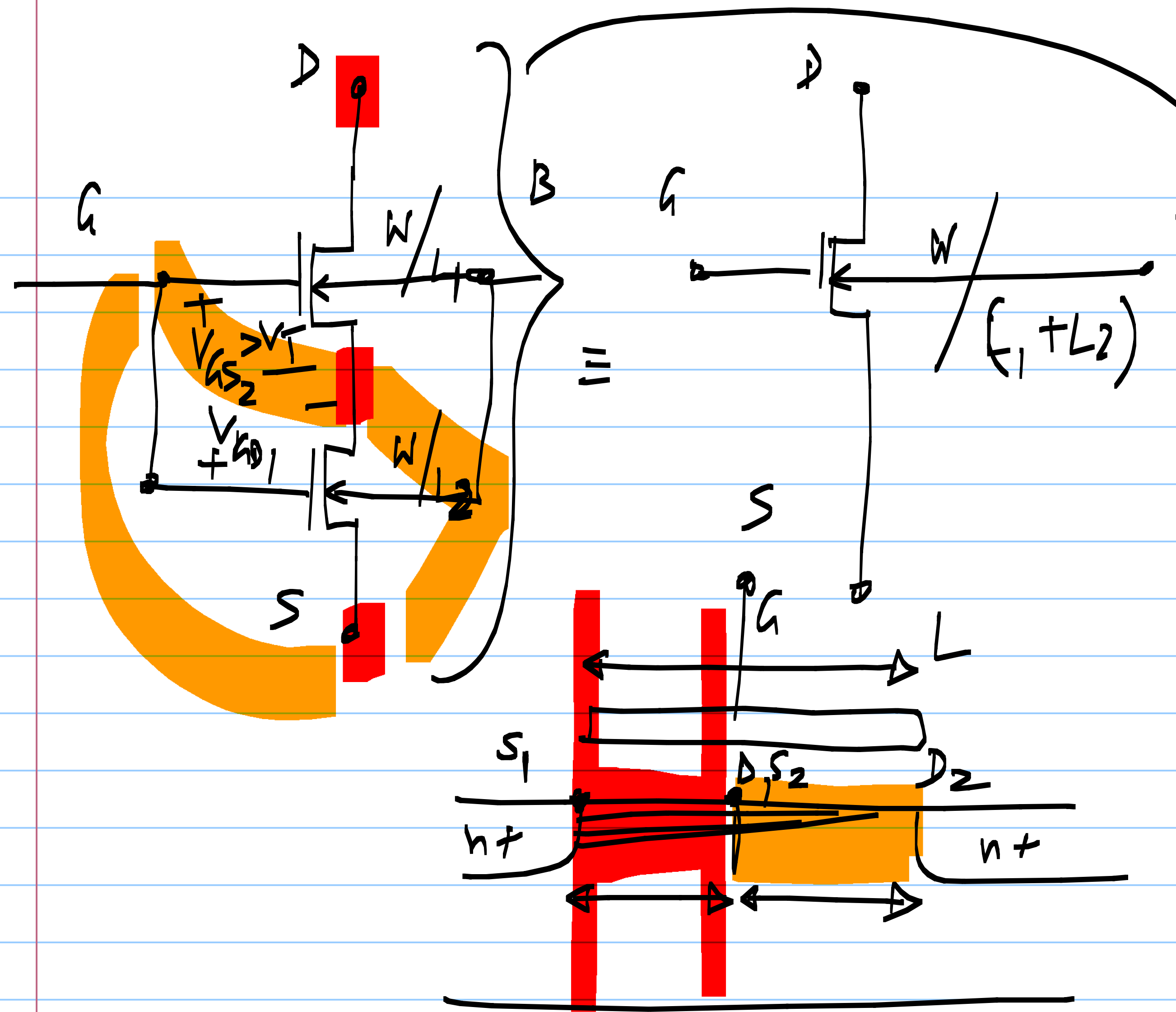
$$I_D = \frac{W C_{ox}}{2} (V_{GS} - V_T) \cdot v_{SAT}$$

} Saturation region

$$g_m = \frac{\partial I_D}{\partial V_{GS}} = \frac{W C_{ox}}{2} \cdot v_{SAT}$$

Constant g_m

$$\omega_T = \frac{\frac{W C_{ox}}{2} \cdot v_{SAT}}{\frac{2}{3} W L C_{ox}} = \frac{3}{4} \frac{v_{SAT}}{L}$$



Series connection of $\frac{W}{L_1}$ & $\frac{W}{L_2}$

≡ Single transistor with W & length L_1+L_2