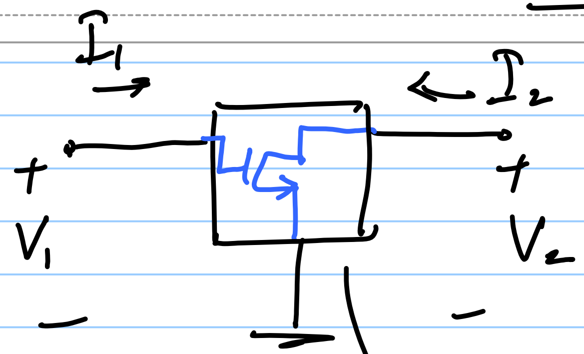
Note Title 06-Aug-19

6/8/19

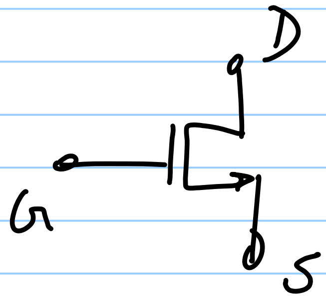
Lec 6



$$[y] = \begin{bmatrix} 0 & 0 \\ y_{21} & 0 \end{bmatrix} \Rightarrow I_2 = g(V_1)$$

large

$I_D = 0$ if $V_{GS} < V_T$ Cut off



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

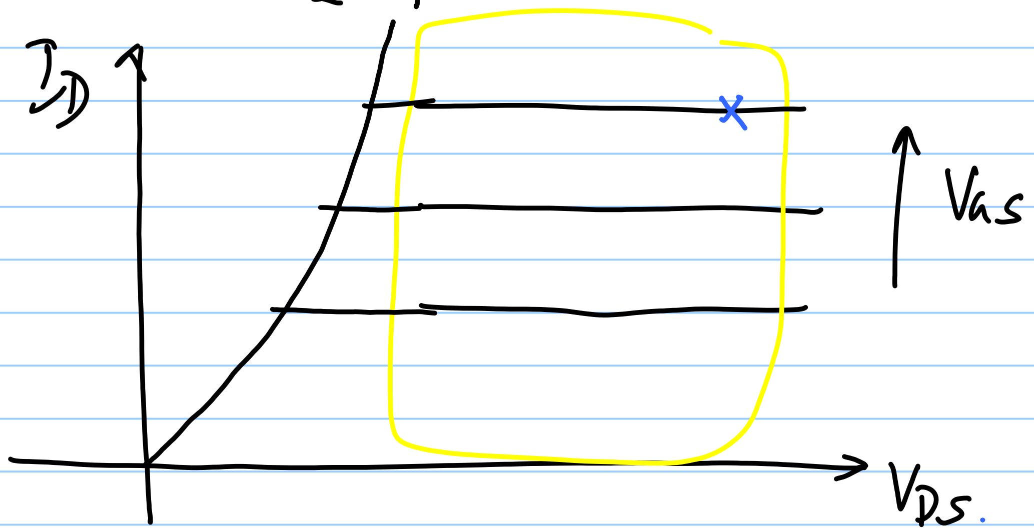
if $V_{GS} \geq V_T$ and $V_{DS} < V_{GS} - V_T$

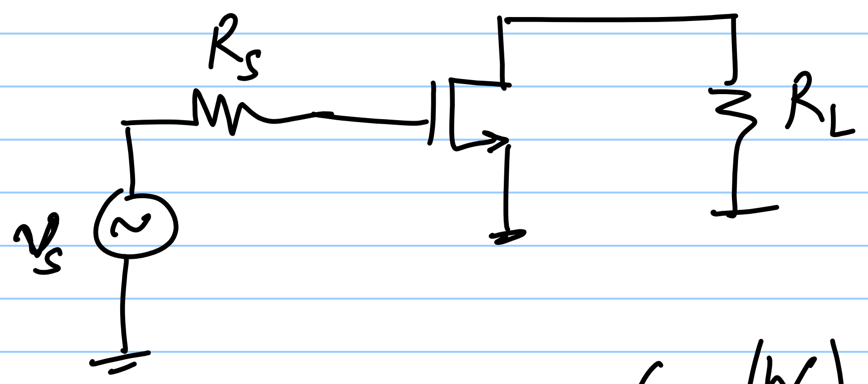
Triode

Saturation

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

if $V_{GS} \geq V_T$
and
$V_{DS} \geq V_{GS} - V_T$





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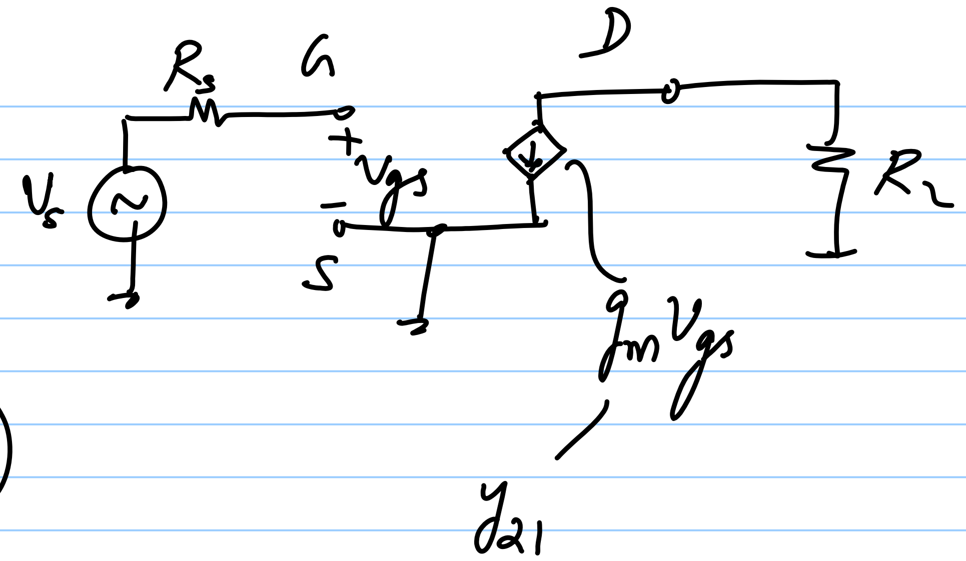
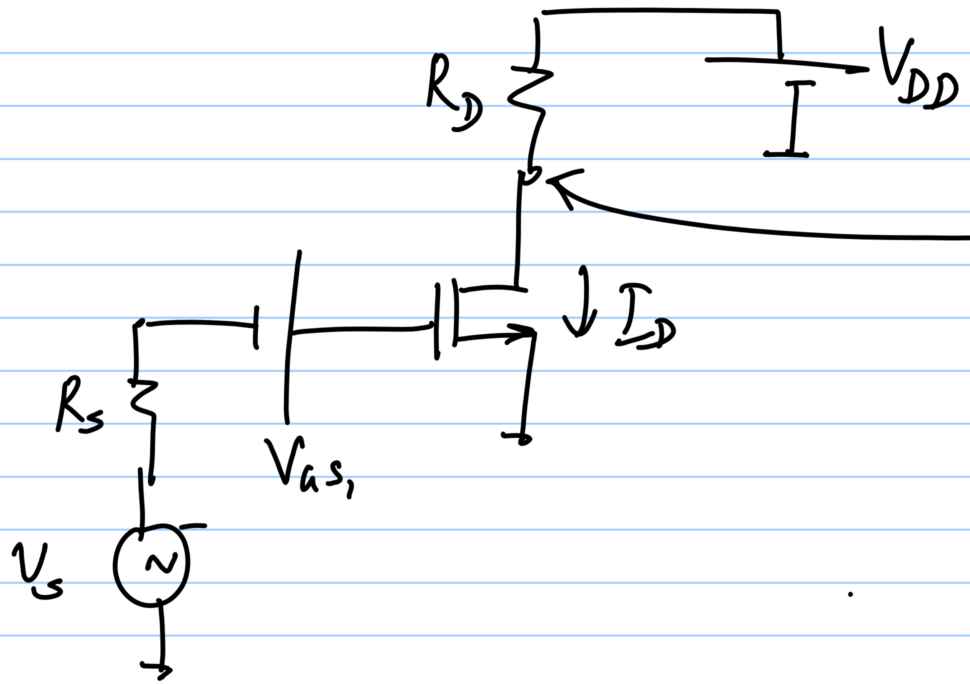


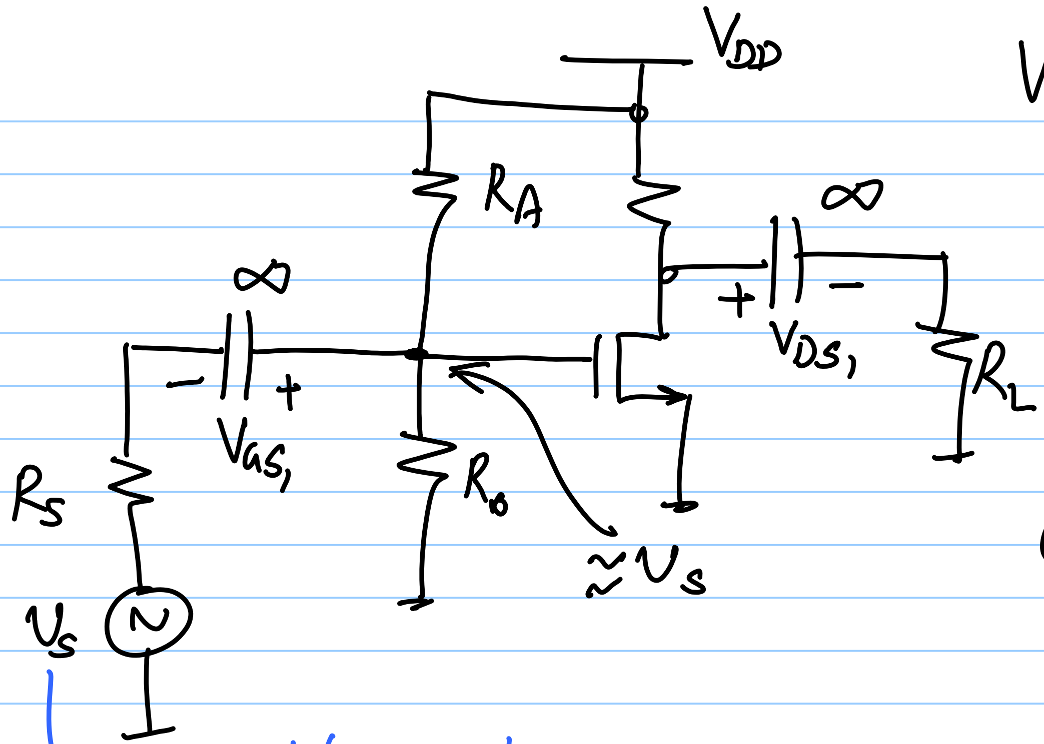
$$g_m = \mu_n C_{ox}\left(\frac{W}{L}\right)(V_{GS} - V_T)$$

$$= \frac{2 I_D}{V_{GS} - V_T}$$

$$= \sqrt{2 \mu_n C_{ox}\left(\frac{W}{L}\right) I_D}$$



$$V_{DS_1} = V_{DD} - I_D R_D$$

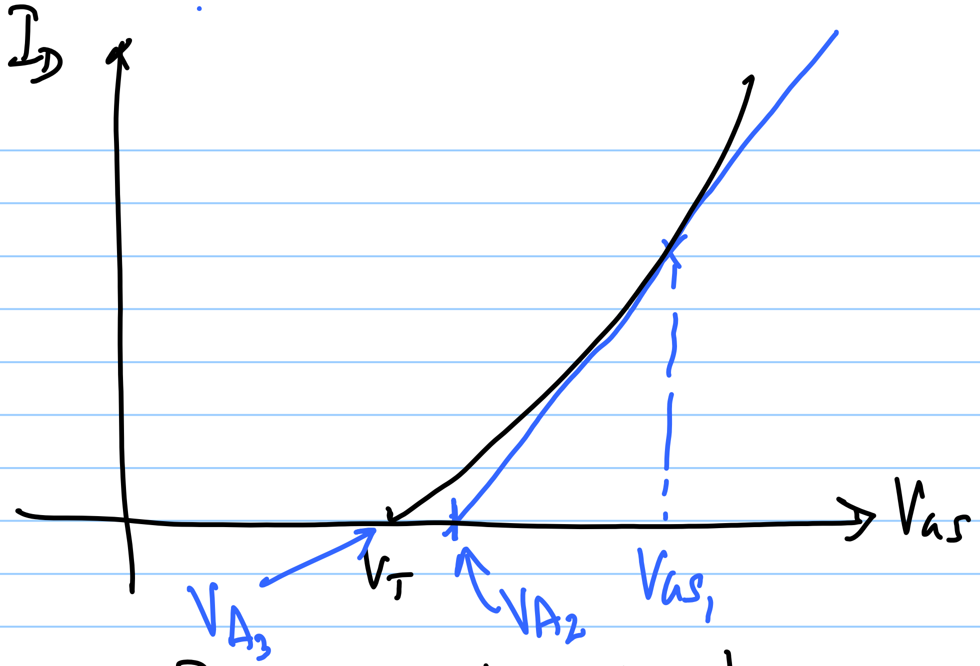


$V_A \sin\omega t$

$$V_{GS_1} = \frac{R_B}{R_A + R_B} \cdot V_{DD}$$

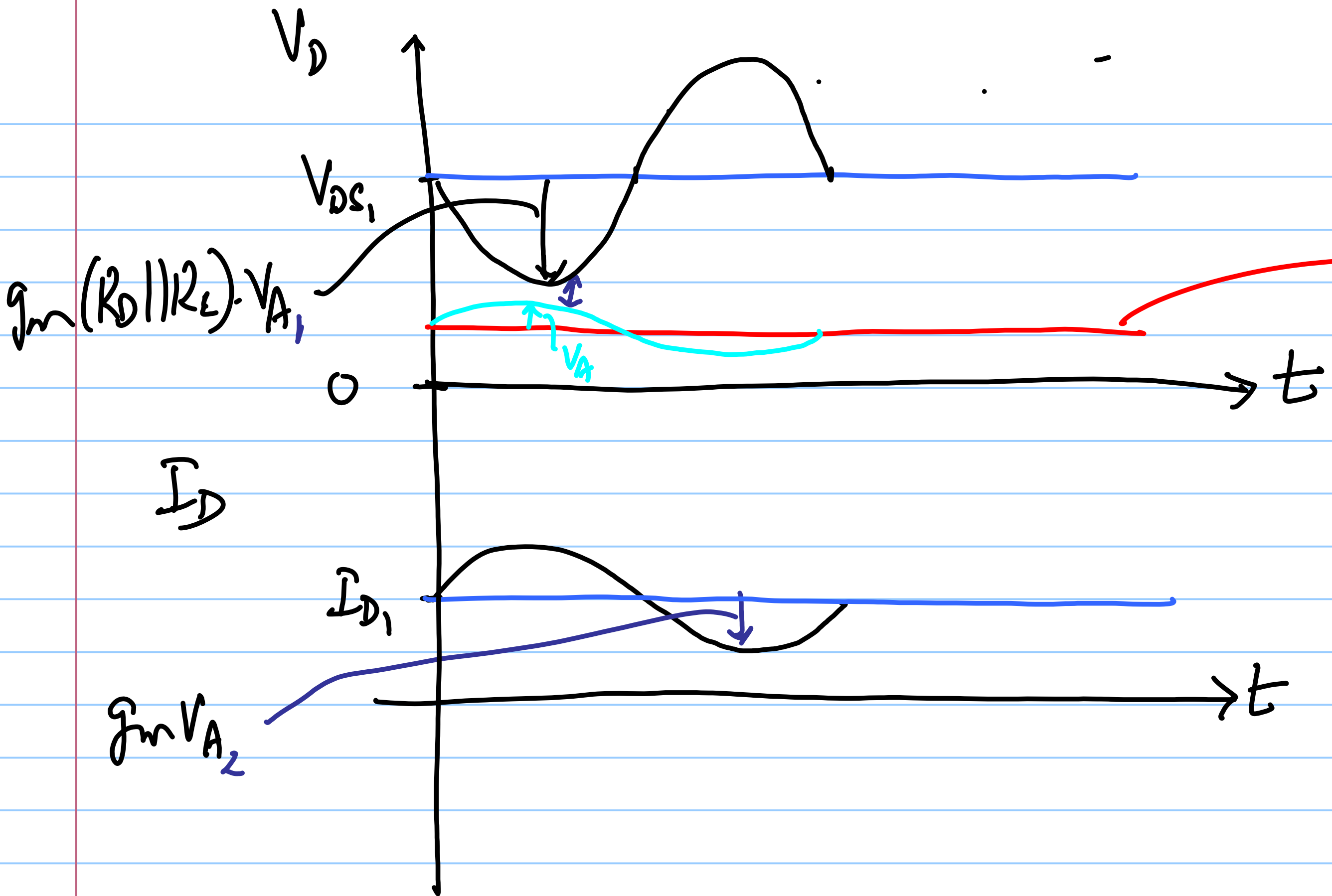
$$R_A \| R_B >> R_S$$

$$\text{Gain} \approx -g_m (R_D \| R_L)$$



$$I_D = I_{D_1} + g_m V_A \sin\omega t$$

$$V_D = V_{DS_1} - g_m (R_D \| R_L) \cdot V_A \sin\omega t$$



$$V_{A\,max} = \min\{V_{A_1}, V_{A_2}\}$$

Triode limit

$V_D = V_{GS} - V_T$ @ minimum drain voltage in 1st half cycle

$$V_{DS_1} - g_m (R_D \| R_L) \cdot V_{A_1} = V_{GS_1} + V_{A_1} - V_T$$

$$V_{A_1} = \frac{V_{DS_1} - (V_{GS_1} - V_T)}{1 + g_m (R_D \| R_L)}$$

Cutoff limit

$$I_D = I_{D_1} + g_m V_A \sin \omega t$$

$$0 = I_{D_1} - g_m V_{A_2}$$

$$V_{A_2} = \frac{I_{D_1}}{g_m}$$

$$V_{A_{max}} = \min(V_{A_1}, V_{A_2})$$

Gate limit

$$V_{GS} = V_T \quad @ \text{ cutoff limit}$$

$$V_{GS_1} + V_A \sin\omega t$$

$$V_{GS_1} - V_{A_3} = V_T \Rightarrow V_{A_3} = V_{GS_1} - V_T$$