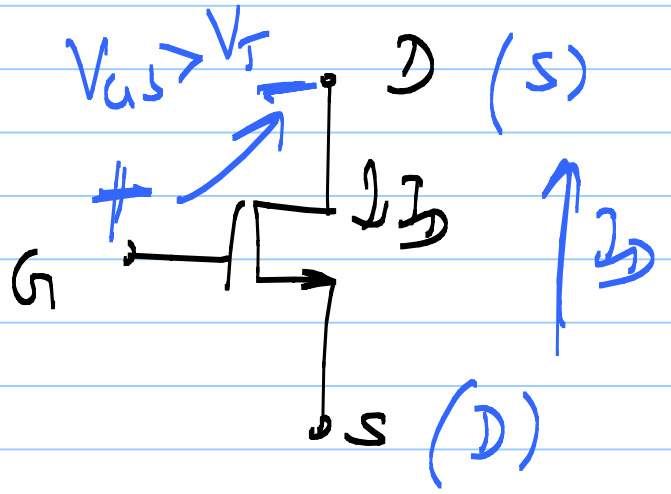
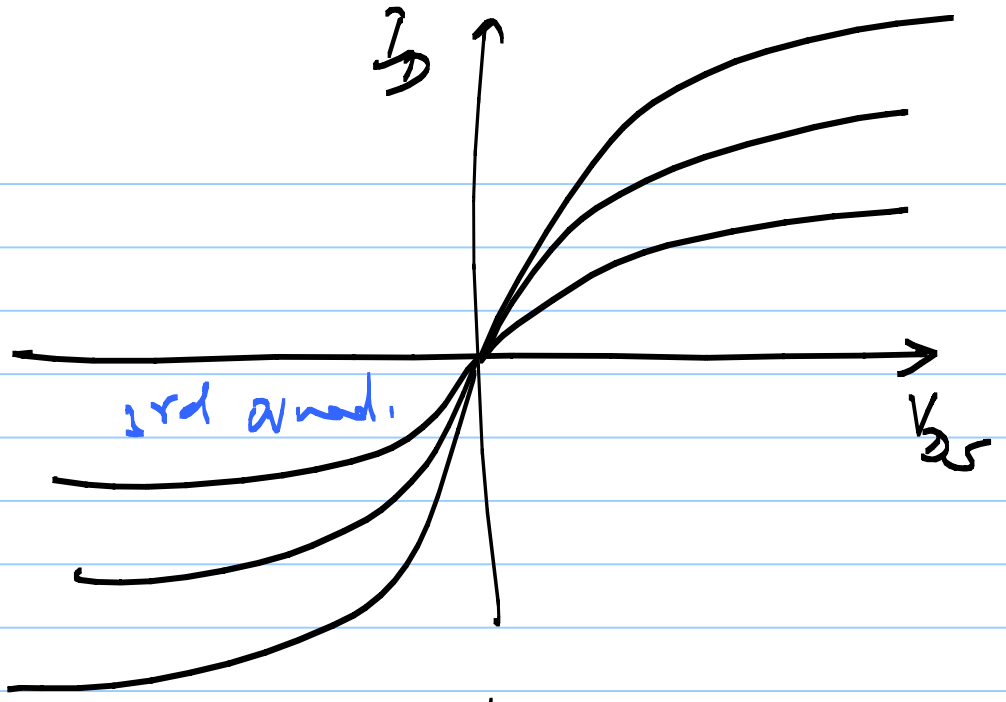
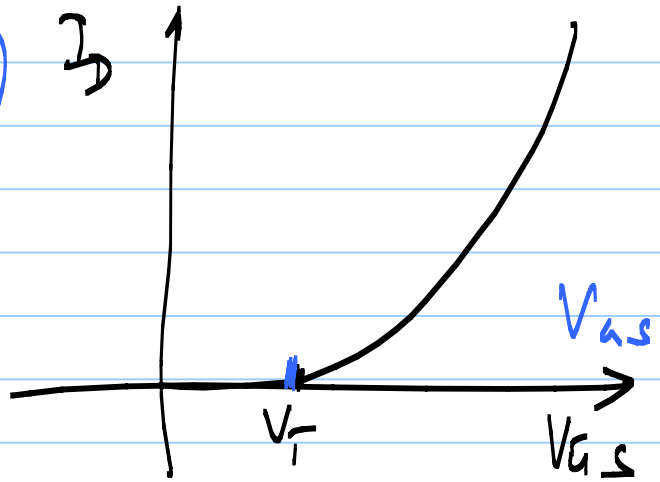
21/8/2020

Lecture 11







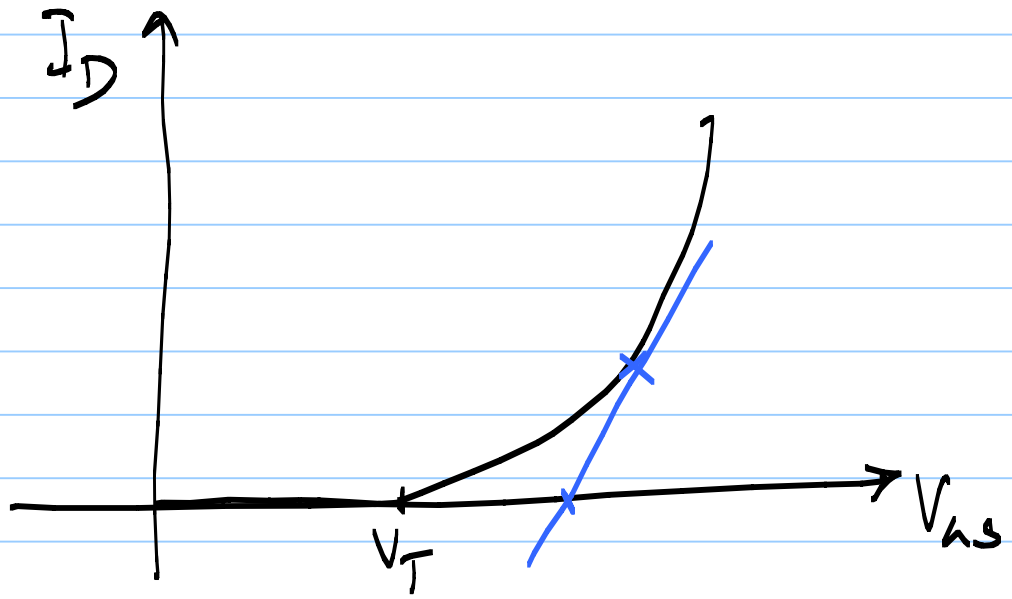
Cutoff condition @ V_{GS}

$I_D = 0 \Rightarrow V_{GS} \leq V_T$

$V_{GS} = V_T$ limit

$V_{GS_1} + V_A \underbrace{\sin \omega t}_{-1} = V_T$

$V_{A_3} = V_{GS_1} - V_T = 1.5\,V - 1\,V = 500\,mV$



In sat. regim

$$I_D = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)\left(V_{GS}-V_T\right)^2$$ — No dep. on V_{DS}

$$I_D = f(V_{GS}, V_{DS})$$

$$I_D + i_d = f(V_{GS}+v_{gs}, V_{DS}+v_{ds})$$

$$= f(V_{GS}, V_{DS}) + \frac{\partial I_D}{\partial V_{GS}}\cdot v_{gs} + \frac{\partial I_D}{\partial V_{DS}}\cdot v_{ds}$$

($\frac{\partial I_D}{\partial V_{GS}} \to g_m$; $\frac{\partial I_D}{\partial V_{DS}} \to 0$)

$$+ \frac{1}{2}\frac{\partial^2 I_D}{\partial V_{GS}^2}\cdot v_{gs}^2 + \frac{1}{2}\frac{\partial^2 I_D}{\partial V_{DS}^2}\cdot v_{ds}^2$$

($\frac{\partial^2 I_D}{\partial V_{DS}^2} \to 0$)

$$+ \frac{\partial^2 I_D}{\partial V_{GS}\,\partial V_{DS}}\cdot v_{gs}\cdot v_{ds} + \cdots$$

($\frac{\partial^2 I_D}{\partial V_{GS}\,\partial V_{DS}} \to 0$)

$$\cancel{I_D} + i_d = \cancel{I_D} + g_m v_{gs} + \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right) \cdot v_{gs}^2$$

$g_m v_{gs}$: desired term (A)

$\frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right) \cdot v_{gs}^2$: undesired term (NL) (B)

$$(B) << (A)$$

$$\frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right) \cdot v_{gs}^2 << g_m v_{gs}$$

$$\frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right) \cdot v_{gs}^2 << \mu_n C_{ox}\left(\frac{W}{L}\right)(V_{GS} - V_T) \cdot v_{gs}$$

$$\underline{\underline{v_{gs} << 2(V_{GS} - V_T)}}$$

In our example : $V_{gs} = \min\{V_{A_1}, V_{A_2}\} = 0.25V$

$2(V_{as_1} - V_T) = 1V$

(B) $\approx$ 25% of (A) { Not small enough }

THD : "Total Harmonic Distortion"

% age.