EE 2301 02/11/21

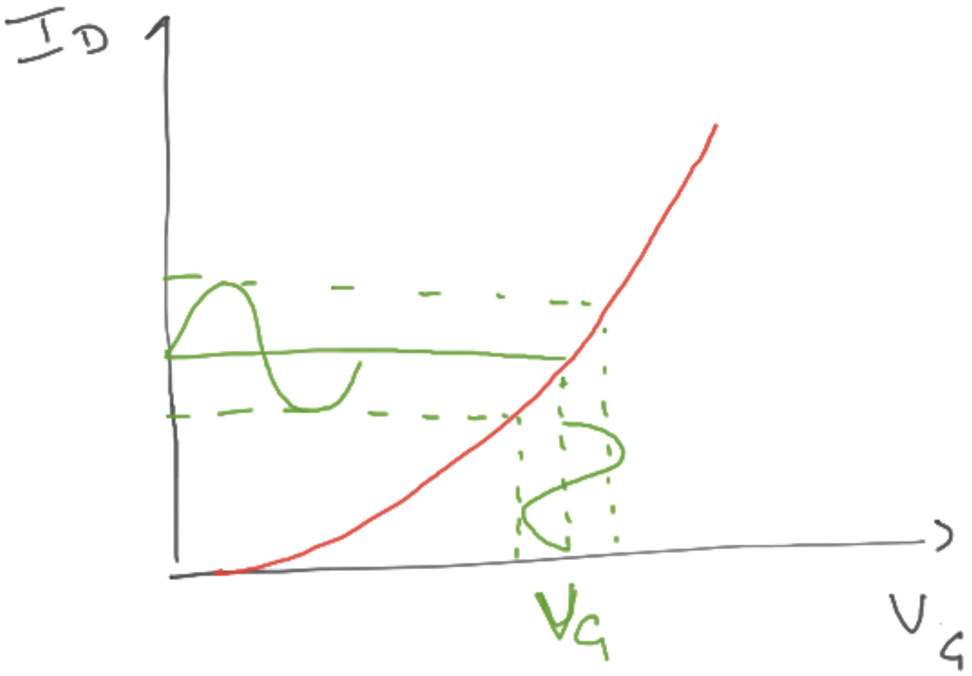
Design a CS amplifier such that it satisfies the following parameters use NMOS

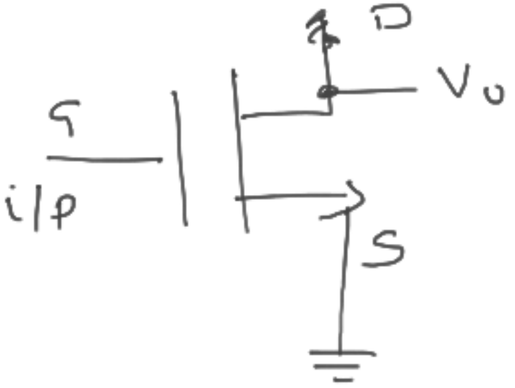
Group 1:
- $I_{DQ} = 2\,mA$ $I_{Dt} = 4\,mA$ $V_{DD} = 12\,V$
- $W = 10\,\mu$ $L = 0.5\,\mu$ $R_{in} = 42\,k\Omega$
- $f_{in} = 2\,kHz$ $V_{in\,peak} = 100\,mV$

Q2:
- $I_{DQ} = 1.4\,mA$ $I_{Dt} = 2.8\,mA$ $V_{DD} = 12V$
- $W = 10\,\mu$ $L = 0.5\,\mu$ $R_{in} = 100k\Omega$
- $f_{in} = 2\,kHz$ $V_{in\,peak} = 100\,mV$

Use basic MOSFET model $V_{TO} = 1V$
$R_{is} = 0\,\Omega$ Also calculate the gain of the amplifier.

Transfer characteristic

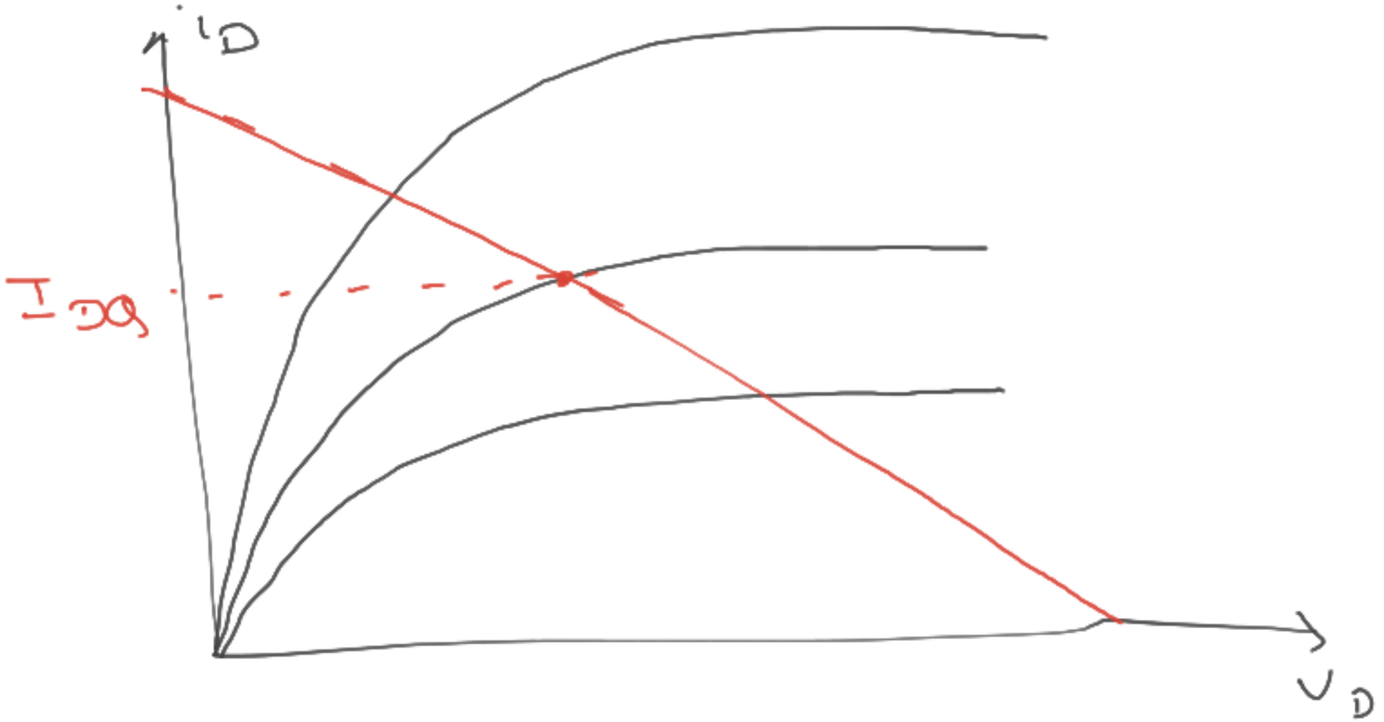




$$i_D = \frac{g_m}{1} v_g$$

transconductance

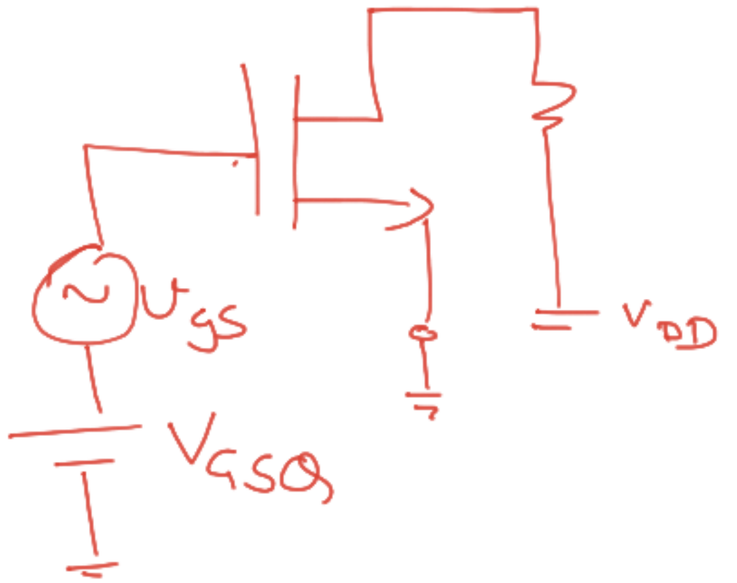
Output Characteristics



$$v_{GS} = V_{GSQ} + v_{gs}$$

$$i_D = K_n (v_{GS} - V_{TO})^2$$

K_n : $\frac{1}{2}\mu_n C_{ox}\frac{W}{L}$



$$= K_n \left[V_{GSQ} + v_{gs} - V_{TO} \right]^2$$

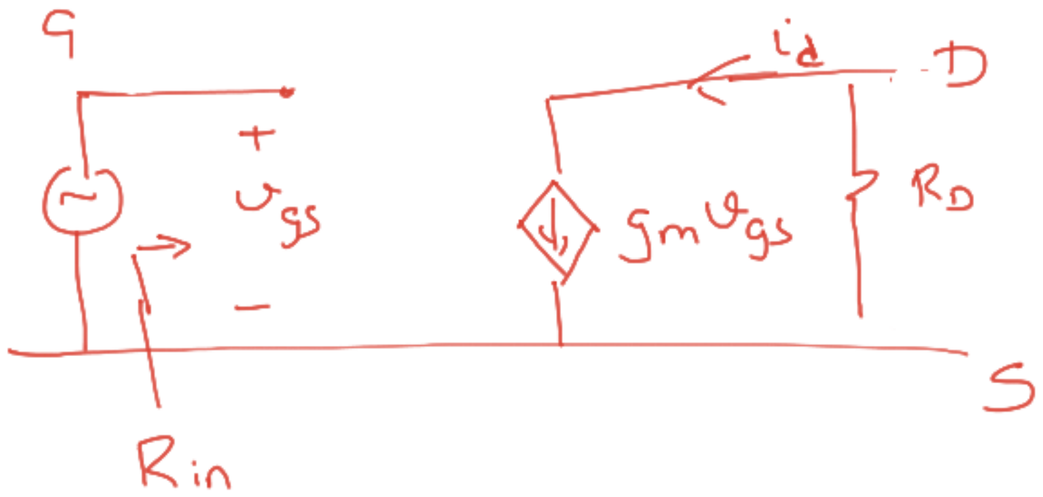
$$= K_n \left[V_{GSQ} - V_{TO} \right]^2 + 2 K_n \left[V_{GSQ} - V_{TO} \right] v_{gs} + \underbrace{K_n v_{gs}^2}_{=0}$$

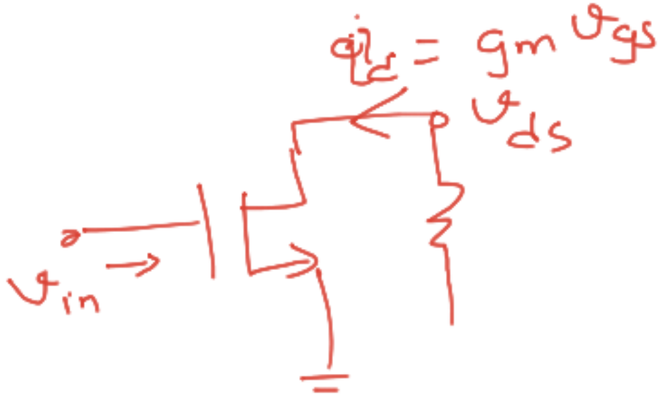
$$= I_{DSQ} + 2 K_n (V_{GSQ} - V_{TO})\, v_{gs}$$

$$= I_D + i_d$$

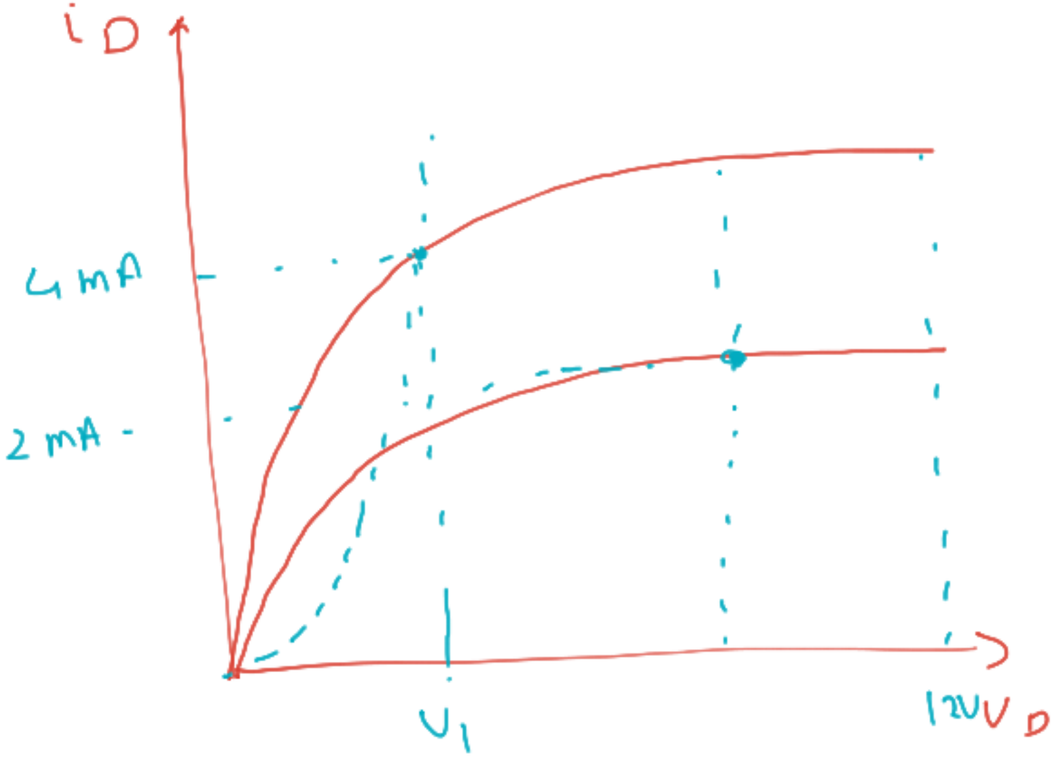
$$i_d = \underbrace{2K_n(V_{GSQ} - V_{TO})}_{g_m} v_{gs} \qquad g_m = \frac{i_d}{v_{gs}}$$

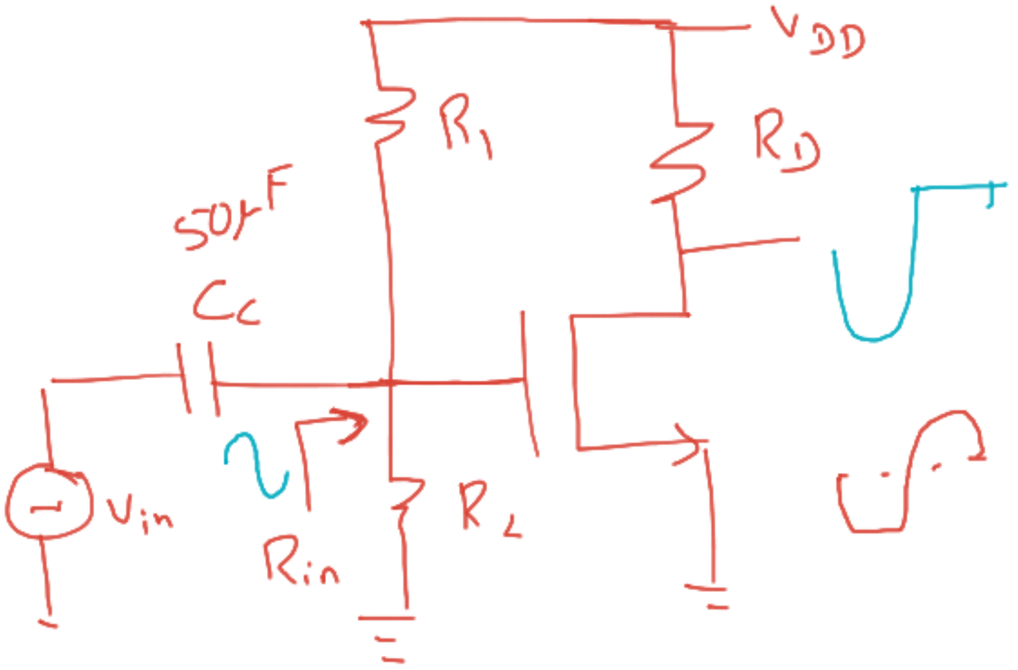
$$g_m = 2\sqrt{K_n I_{DSQ}}$$


G
D
S
i_d
+
v_{gs}
−
$g_m v_{gs}$
R_D
R_{in}


$i_d = g_m v_{gs}$
v_{ds}
v_{in}

$I_{DSQ} = 2\ mA$





$$V_{out} = g_m \vartheta_{gs} R_D$$

$$A_V = \frac{V_{out}}{V_{gs}} = g_m R_D$$