

Q1

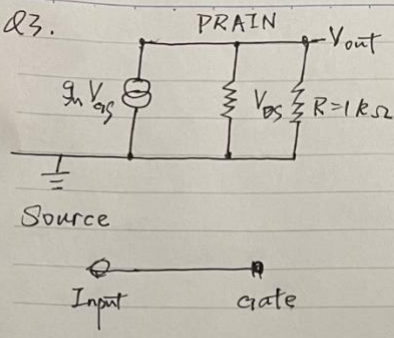
BCABA

Q2

(a) Small Signals are small changes that are so small that they stay in a region on the curve where everything looks like a straight line.

(b) Clipping is a form of distortion. When the signal is digitized, or when analog or digital signal conversion occurs at any other time, shearing may occur, resulting in partial signal loss. To avoid clipping, a limiter can be used to dynamically reduce the signal.

Q3.



Source

Input gate

Sol.

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

$$\text{So } \begin{cases} 3 = \frac{1}{2} \mu C \frac{W}{L} (V_{GS} - V_T)^2 (1 + \lambda) \\ 3.4 = \frac{1}{2} \mu C \frac{W}{L} (V_{GS} - V_T)^2 (1 + 10\lambda) \end{cases}$$

$$\therefore \lambda = 3.08 \times 10^{-2}$$

$$r_o = \frac{1}{\lambda I_D} = 12.5 \text{ k}\Omega$$

Q4. (a)

$$V_{DD} = V_D + V_{DS}$$

$$V_D = I_D R_D$$

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

$$V_{GS} = \frac{R_2}{(R_1 + R_2)} V_{DD}$$

$$\therefore V_{DS} = 1.09 \text{ V}$$

$$I_{DQ} = 2.76 \times 10^{-4} \text{ A}$$

(b)

$$g_m = \mu C \frac{W}{L} (V_{GS} - V_T) = 2.08 \times 10^{-3} \text{ S}$$

$$r_o = \frac{1}{\lambda I_D} = 1.85 \times 10^5 \Omega$$

(c)  $g = g_m R_L = -16.64 \text{ S}$

Q5. sol

(a) 
$$\begin{cases} V_{DD} = I_D (R_D + R_S) + V_{DS} \\ V_G = \frac{R_2}{R_1 + R_2} \cdot V_{DD} \\ V_{GS} = V_G - V_S \\ V_S = I_D \cdot R_S \end{cases}$$

$$\therefore I_D = 4.5 \times 10^{-4} \text{ A}$$

$$V_{DSQ} = 2.75 \text{ V}$$

b) sol. When  $R_L = \infty$ .

$$g_m = \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_T) = 9.4 \times 10^{-4} \text{ A/V}$$

$$A = \frac{V_{out}}{V_i} = \frac{-\mu_n g_m V_{GS}}{V_{GS}} = -\mu_n g_m = -3.76$$

c)  $A' = 0.75 \text{ A} = -2.82$

$$A = \frac{V_{out}}{V_i} = - \frac{g_m (R_D \parallel R_L)}{1 + g_m R_S}$$

$$\therefore R_D \parallel R_L = \frac{R_D R_L}{R_D + R_L} \cdot R_D = 4 \text{ k}\Omega$$

$$\therefore R_L = 12 \text{ k}\Omega$$