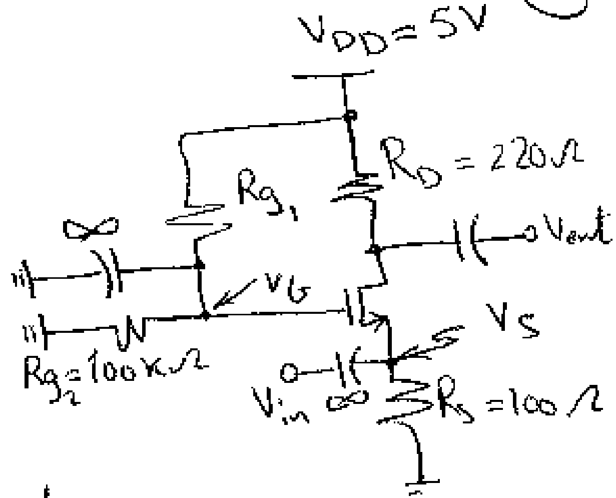
Q4



$V_t = 2V$, $K_n = 200 mA/V^2$

$K_n = 0.2 \ A/V^2$

$|V_A| = \infty$

(a) For $I_d = 10 \ mA$

$\therefore V_S = 1V$

Assuming the transistor operate in sat.

$\therefore I_d = K_n (V_{gs} - V_t)^2$

$10m = 0.2 (V_{gs} - V_t)^2$

$\therefore V_{gs} = 2.224V \Rightarrow \boxed{V_g = 3.224V}$

$V_g = 5 * \frac{R_{g2}}{R_{g1} + R_{g2}} = 5 \frac{1}{\frac{R_{g1}}{R_{g2}} + 1}$

$\therefore \frac{R_{g1}}{R_{g2}} = \frac{5}{V_g} - 1 \Rightarrow \boxed{R_{g_1} = 125 K\Omega}$

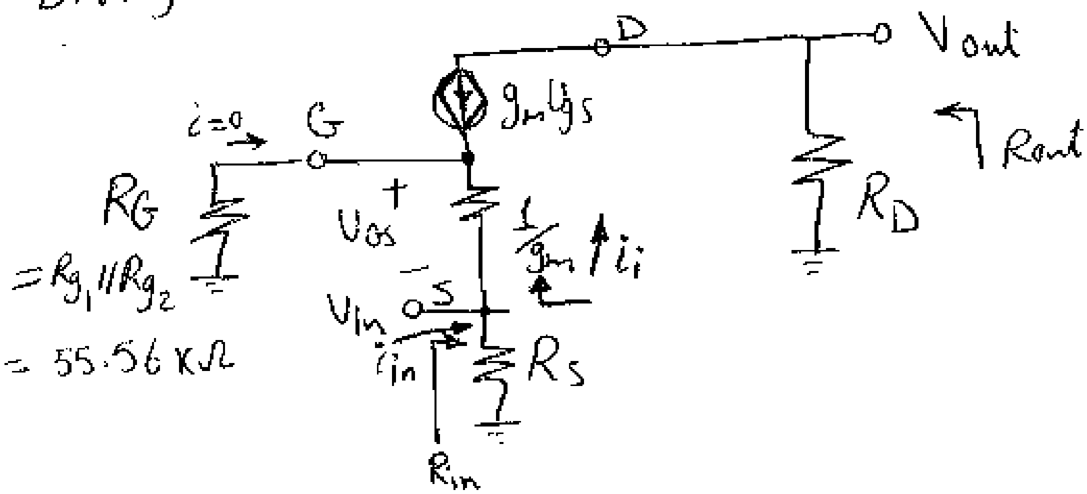
$V_{DS} = 5 - 10m * R_D - V_S$

$V_{DS} = 1.8V$

$\therefore V_{DS} > V_{GS} - V_t \Rightarrow$ Device in saturation

(b) $g_m = 2 K_n (V_{gs} - V_t) = 2 \sqrt{I} \sqrt{K_n} \Rightarrow \boxed{g_m = 89.4 \ mA/V}$

(c) Drawing the small signal T-model for the CG stage. (4)



(d) $V_{out} = -g_m V_{gs} R_D \rightarrow (1)$

$$i_i = \frac{V_{in}}{1/g_m} = g_m V_{in}$$

but $i_i = -g_m V_{gs} = g_m V_{in}$

$\Rightarrow V_{gs} = -V_{in}$ (which could have been written directly bec no current is flowing in the gate terminal ∴ AC voltage $V_g = 0$)

$$\therefore \boxed{\frac{V_{out}}{V_{in}} = g_m R_D} = 19.668 \text{ V/V}$$

$$R_{in} = \frac{1}{g_m} // R_S = \frac{R_S}{1 + g_m R_S} = 10.06\ \Omega$$

$$R_{out} = R_D = 220\ \Omega$$

(e) new gain $= g_m R_D // R_L$ ← 1KΩ

$= 16.12$ V/V