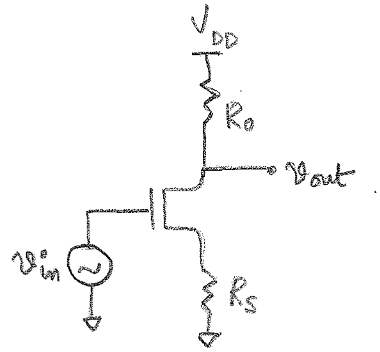
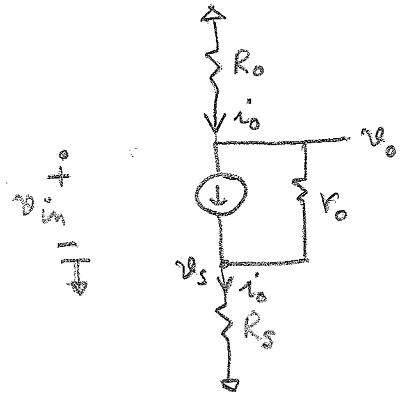


$\Rightarrow$



METHOD 1

$$v_o = -i_o R_o \;;\; v_s = i_o R_s$$

$$i_o = g_m(v_{in} - v_s) + \frac{v_o - v_s}{r_o}$$

$$-\frac{v_o}{R_o} = g_m v_{in} - i_o g_m R_s + \frac{v_o}{r_o} - \frac{v_s}{r_o} \quad ; \quad v_s = i_o R_s = -\frac{v_o}{R_o} R_s$$

$$\therefore \frac{v_s}{r_o} = -v_o \frac{R_s}{R_o r_o}$$

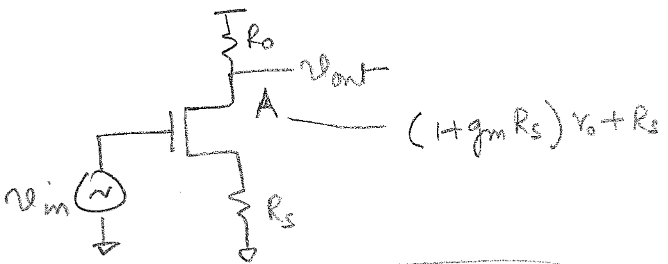
$$-\frac{v_o}{R_o} = g_m v_{in} + \frac{v_o}{R_o} g_m R_s + \frac{v_o}{r_o} + v_o \frac{R_s}{R_o r_o}$$

$$-g_m v_{in} = v_o \left[\frac{1}{R_o} + \frac{g_m R_s}{R_o} + \frac{1}{r_o} + \frac{R_s}{R_o r_o} \right]$$

$$\frac{v_o}{v_{in}} = \frac{-g_m}{\frac{1}{R_o \| r_o} + \frac{R_s}{R_o}\left(g_m + \frac{1}{r_o}\right)} \quad \text{or} \quad \frac{v_o}{v_{in}} = \frac{-g_m R_o r_o}{(1 + g_m R_s) r_o + R_o + R_s}$$

$$\text{or} \quad \frac{v_o}{v_{in}} = \frac{-g_m R_o r_o}{(1 + g_m r_o) R_s + r_o + R_o} \quad \text{— (1)}$$

METHOD 2 : By inspection



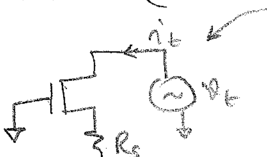
$$\therefore \frac{v_o}{v_{in}} = -\frac{\text{resistance in drain}}{\text{resistance in source}}$$

$$= -\frac{R_o \| [(1+g_m R_s) r_o + R_s]}{R_s + 1/g_m}$$

$$= \frac{(1+g_m R_s) r_o R_o + R_s R_o}{(1+g_m R_s) r_o + R_s + R_o} \cdot \frac{g_m}{(1 + R_s g_m)} \quad \text{— (2)}$$

Not able to get (1) = (2) !

Also when resistance looking the drain $(1+g_m R_s) r_o + R_s$ is derived the gate is shorted ($v_{in} = 0$) & circuit used is,



but if $v_{in} \neq 0$ it would influence i_t and resistance looking into the drain would be different! Why is gate/input shorted when calculating resistance into the drain.