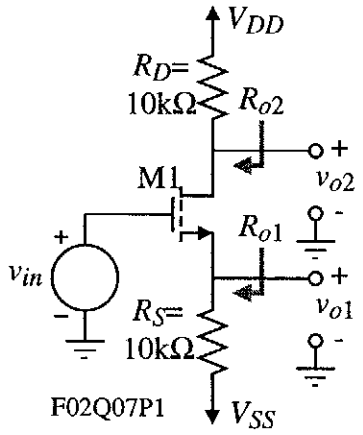
QUIZ NO. 7 - SOLUTION

(Average Score = 6.8/10 for only those students taking the quiz)

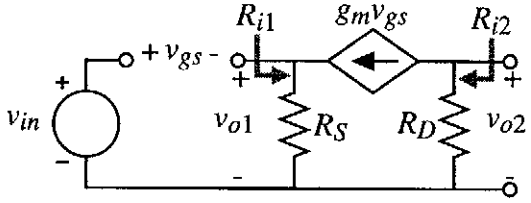
If $k_n = 1\text{mA/V}^2$, $V_{TN} = 1\text{V}$, $I_{DS} = 0.5\text{mA}$ and $\lambda = 0\text{V}^{-1}$, find the numerical values of the following small signal functions: v_{o2}/v_{in}, v_{o1}/v_{in}, R_{o1} and R_{o2}.



F02Q07P1

Solution

Small signal model:



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$$g_m = \sqrt{2 \cdot k_n \cdot I_{DS}} = \sqrt{2 \cdot 1 \cdot 0.5} = 1\text{mS}$$

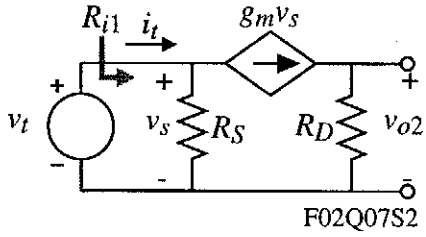
$$\frac{v_{o2}}{v_{in}} = \left(\frac{v_{o2}}{v_{gs}}\right)\left(\frac{v_{gs}}{v_{in}}\right) = (-g_m R_D)\left(\frac{1}{1+g_m R_S}\right) = \left(\frac{-g_m R_D}{1+g_m R_S}\right) = \frac{-10}{11} = \underline{-0.909\ \text{V/V}}$$

$$\frac{v_{o1}}{v_{in}} = \left(\frac{v_{o1}}{v_{gs}}\right)\left(\frac{v_{gs}}{v_{in}}\right) = (g_m R_S)\left(\frac{1}{1+g_m R_S}\right) = \left(\frac{g_m R_S}{1+g_m R_S}\right) = \frac{10}{11} = \underline{\pm 0.909\ \text{V/V}}$$

(This circuit happens to be a phase splitter because it creates a ± version of the input multiplied times 0.909 in this case.)

$$R_{o2} = R_D = \underline{10\text{k}\Omega}$$

R_{o1} probably requires the use of a small signal model to make sure to avoid mistakes.



F02Q07S2

We see that,

$$i_t = \frac{v_s}{R_S} + g_m v_s = v_s\left(\frac{1}{R_S} + g_m\right) = v_t\left(\frac{1}{R_S} + g_m\right)$$

$$\therefore \quad R_{o1} = \frac{v_t}{i_t} = \left(\frac{R_S}{1+g_m R_S}\right) = \frac{10\text{k}\Omega}{11} = \underline{0.909\text{k}\Omega}$$