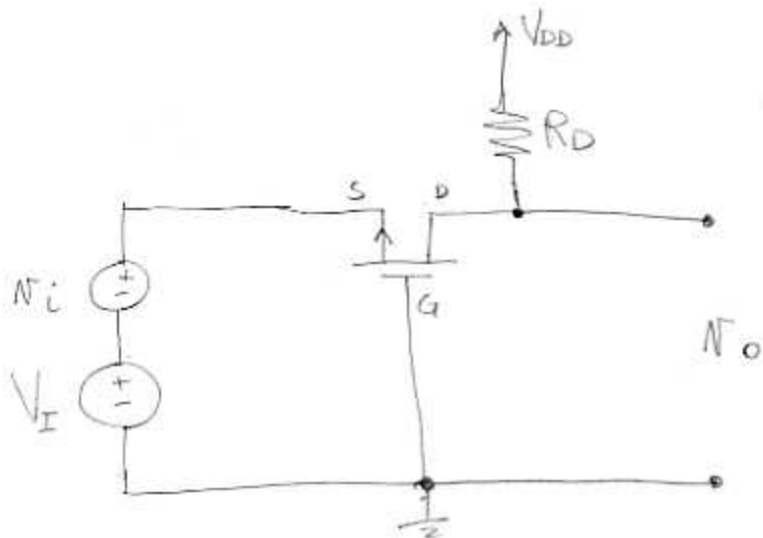A) common gate configuration.

Consider the following connection:

A.1) Considering $V_T = 2.9 V$, $K = 0.82$

$$\left(\text{where } I_{D_{SAT}} = \frac{K}{2}(V_{GS} - V_T)\right), \quad V_{DD} = 9 V$$

find a combination of V_I, R_D
such that the transistor is
in saturation region

A.2) Using the small signal model
for the transistor find: $A_V = \frac{v_o}{v_i}$,
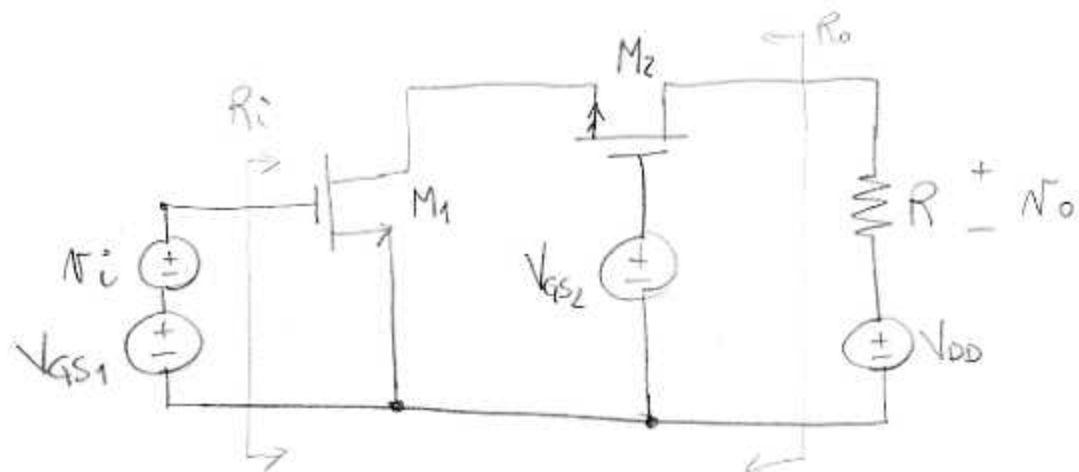R_i the input resistance and R_o the output
resistance.

A.3) based on the values that you found in A.1, what should be input range in order for the analysis in A.2 to make sense?

A.4) Based on the values found in A.1 what is the maximum output range? (by output range I mean

$$V_{osmax} - V_{osmin})$$

what is the maximum input range?

A.5 Extra question) How would you set R_D and V_I in order to maximize the output range while having

$$A_v = 10$$

c) Cascode configuration

C.1) Assuming V_{GS1}, V_{GS2}, R and V_{DD} such that the two transistors are in saturation find:
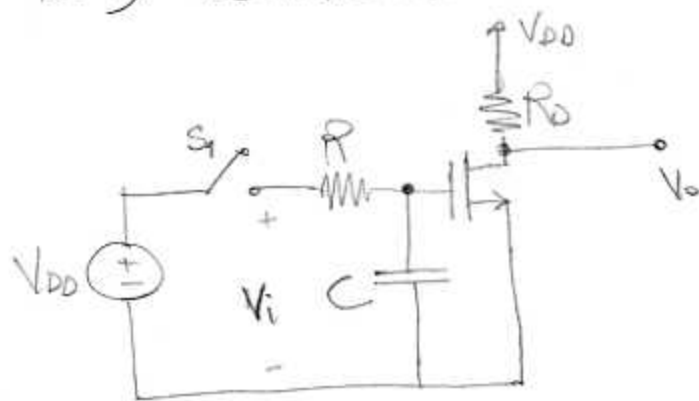
    I) $A_N = \dfrac{N_o}{N_i}$

    II) R_i

    III) R_o

C.2 Extra) Can you find V_{GS1}, V_{GS2}, R such that both M_1 and M_2 are in saturation?

    (use $V_T = 2.9$, $K = 0.82$, $V_{DD} = 12V$)

B) B.1) Consider the circuit

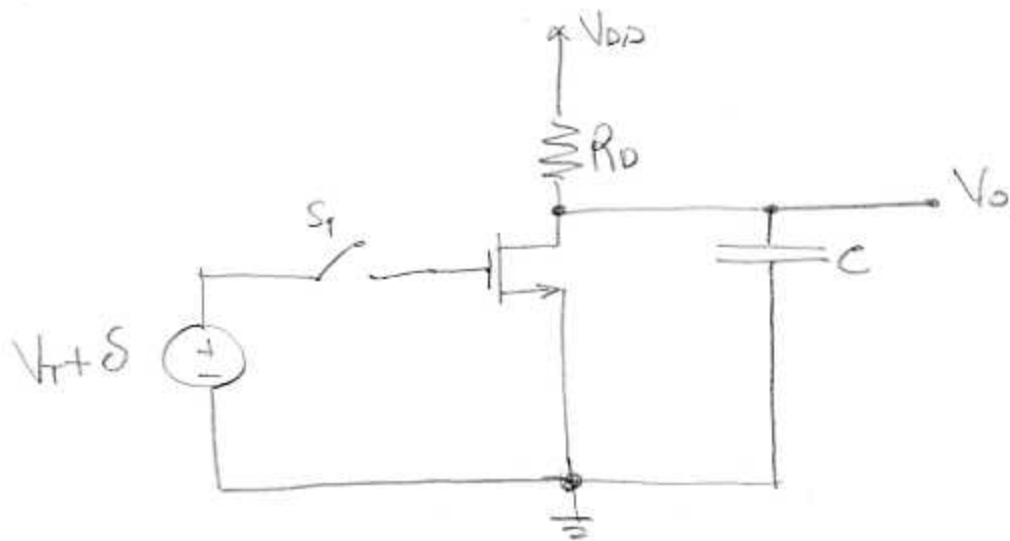S_1 is a switch that closes at $t=0$, so basically V_i is a step function with amplitude equal to V_{DD}.

I) Describe, qualitatively, how the circuit works. (What happens for $t>0$).

II) White equations for V_o. Since the transistor will be in different regions (cutoff, Saturation, triode) you are supposed to write three expressions for V_o.

III) Compute t_1 and t_2 where t_1 is the time when the transistor enters the saturation region an t_2 when it enters the triode region.

B.2) Consider now this circuit:

As in problem B.1, S_1 switches on for $t=0$.

I) Describe qualitatively what happens for $t>0$

II) Write expressions for V_0

III) Compute t_1 and t_2 whose meaning is the same as B.1.III

[For both circuits: there are no numbers, so I'm not expecting answers in terms of numbers. It is very important that you try to comment on the results that you find]