HW#7, Electronic Circuit, Spring semester 2020

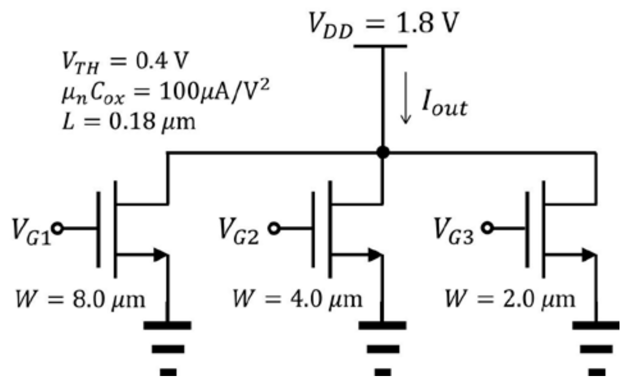
May 11, 2020

Due: 23:55, May 15 (Friday night)

We have 8 problems.

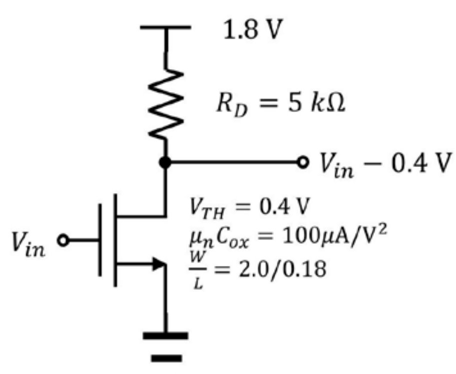
In your answer file, specify both the **SOLUTION PROCEDURE** and the **FINAL SOLUTION**.

1. Consider the circuit shown in the figure. All three MOSFETs have the same parameters, except for the channel width, W. Calculate a sum of all drain currents, when $V_{G1} = V_{G2} = V_{G3} = 1$ V.

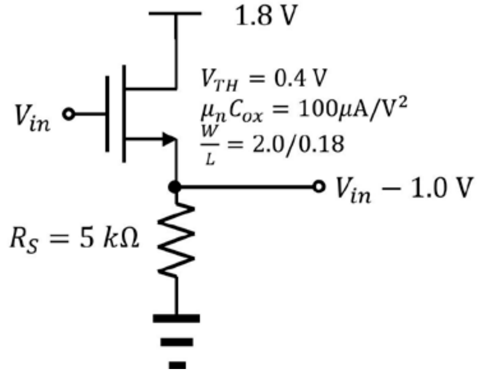


2. Consider the same circuit in the last problem. In this problem, we may apply either 0 V or 1 V to each gate terminal, individually. Then, a triplet (V_{G1} , V_{G2} , V_{G3}) is converted into the output current. There can be eight cases, for example, (0 V, 0 V, 0 V), (0 V, 0 V, 1 V), (0 V, 1 V, 0 V), and so on. Then, what is the smallest difference between two closest output currents?

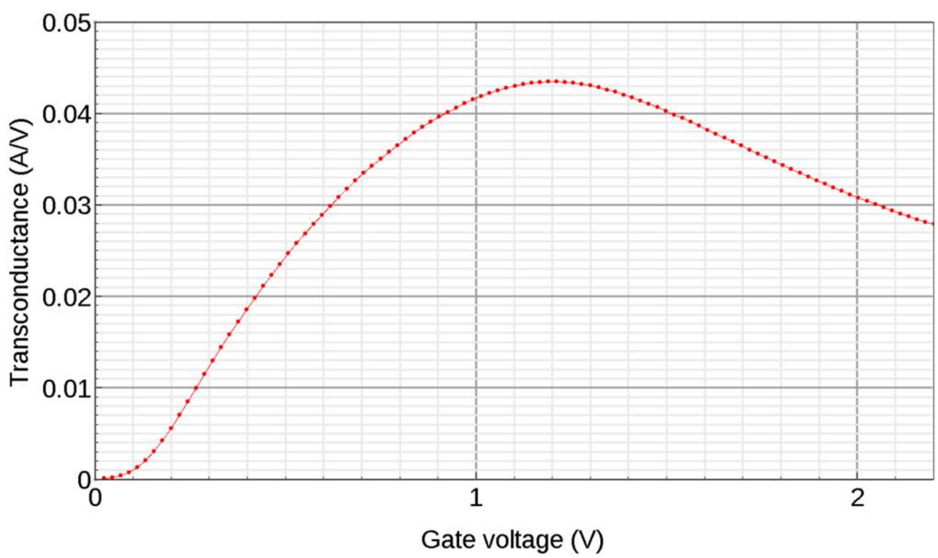
3. Calculate the input voltage, V_{in}.



4. Calculate the input voltage, V_{in}. (Assume that the threshold voltage is a constant, 0.4 V.)

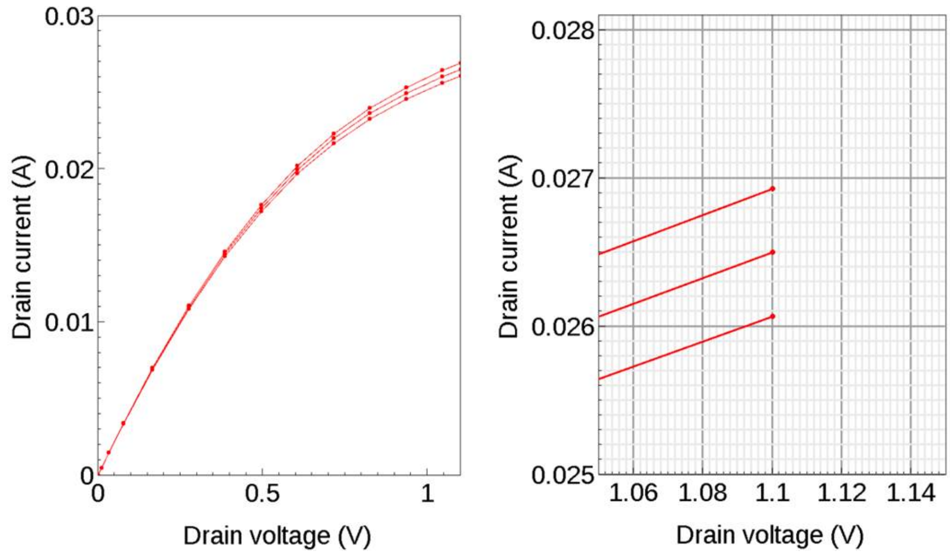


5. The transconductance of a MOSFET (whose width is 1 micron) is shown as a function of the gate voltage. The drain bias voltage is fixed. From the figure, find the optimal gate voltage to maximize the transconductance. Also write the maximum transconductance.



6. Based on the answer of the last problem, the gate bias voltage is fixed to the optimal value. The drain bias voltage is also the same with the last problem. However, the width of the MOSFET is not 1 micron but 50 nm. When a small-signal voltage excitation of 100 sin(377t) μV is applied to the gate terminal, calculate the small-signal current response of the drain current.

7. The I_D–V_{DS} curve of a MOSFET is shown. For three gate bias voltages (1.09 V, 1.1 V, and 1.11 V), the drain voltages are swept from 0 V to 1.1 V. The right figure is the magnified version of the original graph. Calculate the transconductance at V_{GS} = 1.1 V and V_{DS} = 1.1 V.



8. From the above figures, calculate the output resistance of the MOSFET (r_o) at V_{GS} = 1.1 V and V_{DS} = 1.1 V.