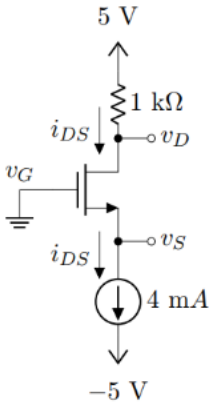
Assignment 3

BRAC University

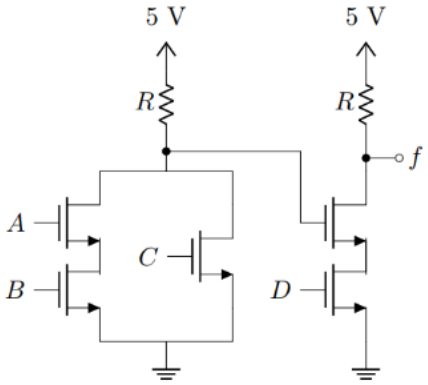
Semester: Spring 2023
Course No: CSE251 — Full Marks: 10×4×2.5=100 [Bonus: 15]
Course Title: Electronic Devices and Circuits — Deadline: **8 April 2023**

Note: The formulas for a MOSFET are given in Ques 2.

1.



Circuit 1



Circuit 2

Part a: Refer to the **Circuit 1** above. For the MOSFET, $V_T = 1$ V and $k = k'_n \frac{W}{L} = 4\ \text{mA}/V^2$.

(a) **Identify** the value of the gate voltage v_G and the drain-source current i_{DS}. [0.5+0.5]

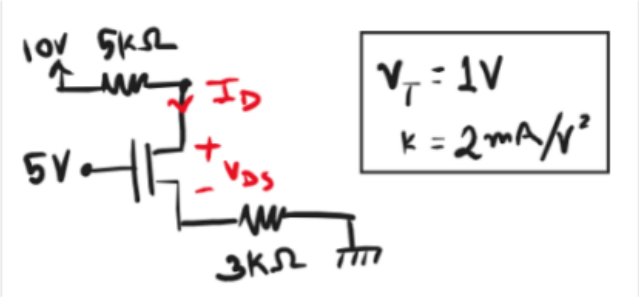
(b) **Calculate** the value of the drain voltage v_D using the 1 kΩ resistor. [1]

(c) **Analyze** the circuit to find v_S. Here, **use** the Method of Assumed State. You must **validate** your assumptions. [Hint: assume $v_S = x$] [3+2]

Part b: **Analyze** the **Circuit 2** above to find f in terms of *boolean* inputs A, B, C, and D. [3]

2.

Analyze the following circuit to find the values of I_D and V_{DS} **using** the Method of Assumed State. You must **validate** your assumptions.
Hint: Use I_D as unknown x. Use Ohm's law to represent V_D and V_S in terms of x.



For MOSFET

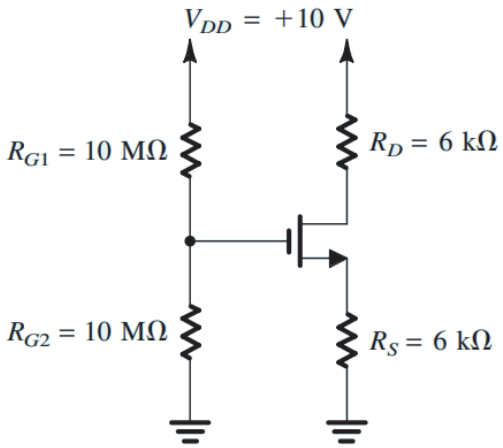
$$k = k_n' \frac{W}{L}$$

$$I_D = 0, \text{ if } V_{GS} < V_T$$

$$I_D = k\left[(V_{GS} - V_T)\,V_{DS} - \frac{1}{2}V_{DS}^2\right], \text{ if } V_{GS} \geq V_T \text{ and } V_{DS} < (V_{GS} - V_T)$$

$$I_D = \frac{1}{2}k\,(V_{GS} - V_T)^2, \text{ if } V_{GS} \geq V_T \text{ and } V_{DS} \geq (V_{GS} - V_T)$$

3. Analyze the circuit shown in the following Figure to determine the voltages at all nodes and the currents through all branches. Let V_T = 1 V and $k_n'(W/L)$ = 1 mA/V^2. **[10]** *[Hints: current at the gate terminal is zero for a MOSFET]*.



4. Implement using MOSFETs: **[10]**

(a) f = (A + B)C

(b) f = ($\overline{A}$B+CD)

(c) f = AB+A+CD (with and without simplifying the logic)

BONUS: An NMOS transistor is operating at the edge of saturation with an overdrive voltage V_{OV} and a drain current I_D. If V_{OV} is doubled, and we must maintain operation at the edge of saturation, what should V_{DS} be changed to? **Find** the value of drain current results. Does changing V_{OV} change the process parameter k? **[0.5+3+1.5]**