East West University
Department of Computer Science and Engineering

Course: CSE251 Electronic Circuits
Expt No.: 6
Title: Measurement of Parameters and I-V characteristics of an N-channel MOSFET

Objectives:

1. To measure the threshold voltage V_t and the process transconductance K_n of an N-channel enhancement type MOSFET.
2. To measure the I-V characteristics (I_D vs. V_{DS}) of an N-channel enhancement type MOSFET.

Circuit Diagram:

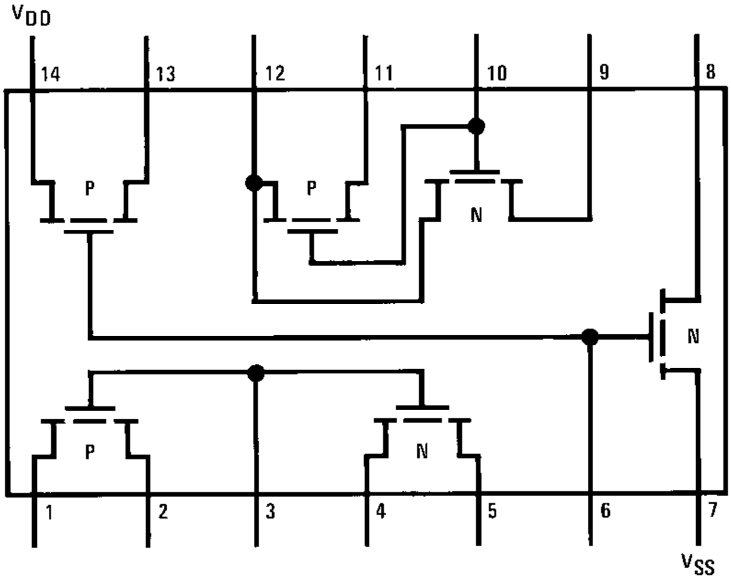

Figure 1. Pin diagram of CD4007C IC.

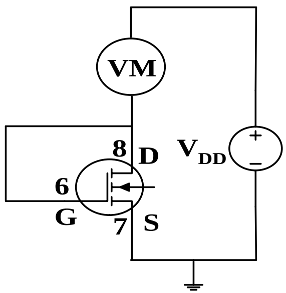

Figure 2. Circuit for measurement of V_t and K_n of an NMOSFET.

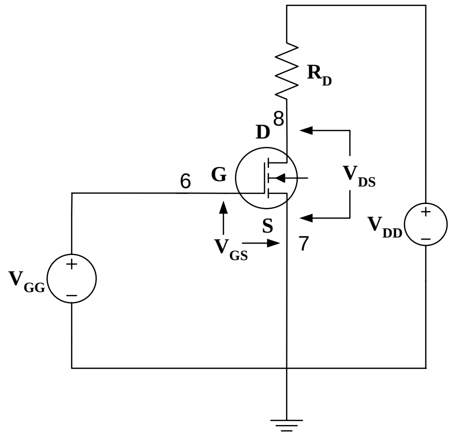

Figure 3. Circuit for measurement of I-V characteristics of an NMOSFET.

Equipments and Components Needed:
1. Digital trainer board
2. DC power supply
3. Digital multimeter
4. DC Voltmeter
5. CD4007C IC (1 pc)
6. Resistor (1KΩ 1 pc)
7. Breadboard
8. Connecting wires

Lab Procedure:

MEASUREMENT OF V_t AND K_n:
1. Measure the resistance and connect the circuit as shown in Figure 2. Note that a voltmeter (VM) is in series with the drain and V_{DD}; and **G** and **D** are shorted. **Use the pin numbers as shown in Figure 2.**
2. Set V_{DD} to 10V from the DC power supply unit and measure the reading of the voltmeter. The threshold voltage $V_t = V_{DD}$ – VM reading.
3. Now replace the voltmeter by 1KΩ resistance and measure the voltage drop across the resistance. Divide it by the resistance to get I_D. Measure V_{GS} and calculate the process transconductance from $K_n = 2I_D/(V_{GS}-V_t)^2$.

MEASUREMENT OF I-V CHARACTERISTICS:

4. Connect the circuit as shown in Figure 3 and set $V_{GG} = V_t$+1V from the trainer board variable power supply.
5. Use the DC power supply unit as V_{DD}. Now change V_{DD} from 0 and measure V_{DS} and V_{RD} (voltage across R_D resistance). Calculate I_D from $I_D=V_{RD}/R_D$. Take around 15 data up to V_{DS} = 7V. **Be careful so that V_{DD} does not exceed 15V**.
6. Set V_{GG} to V_t+2V and V_t+3V and repeat step 5.

7. Have the datasheet signed by your instructor.

Post-Lab Report Questions:

1. You have V_t and K_n. Note that here K_n is equivalent to $K'_n(W/L)$ of the text. For three V_{GG} ($V_{GG} = V_{GS}$) values of Figure 3, use the linear (triode) and saturation current expressions to tabulate the I_D for each V_{DS} and plot the I_D-V_{DS} curves using your calculated and experimental data on the same graph. Use MATLAB for plotting.

$$I_D = K_n\left[(V_{GS} - V_t)V_{DS} - V_{DS}^2/2\right]; \textit{linear}$$

$$I_D = (K_n/2)\left[(V_{GS} - V_t)^2\right]; \textit{saturation}$$

2. Write your observation and comments on the calculated and experimental graphs, especially in the saturation regions.
3. For $V_{GG} = V_t$+3V, take two experimental data points in saturation and calculate the slope. From the slope, obtain output resistance r_o.
4. Simulate the circuit shown in Figure 3 using PSPICE. For simulation use MbreakN3 MOSFET and DC sweep analysis with nested loop for the three different values of V_{GG}. To set the parameters, double click on MbreakN3 and set W and L to 1E-6 (1um). Now select MbreakN3 (it will turn red) and go to Edit→Model→Edit Instance Model (Text). Delete everything in the appeared window and write the followings (put your values of V_t and K_n) and click OK.

```
.MODEL MbreakN3 NMOS
LEVEL  = 3
VTO  = 1.8
KP  = 100E-6
```