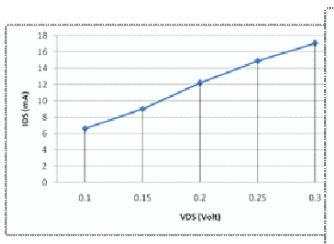
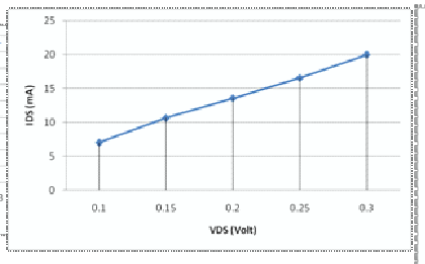
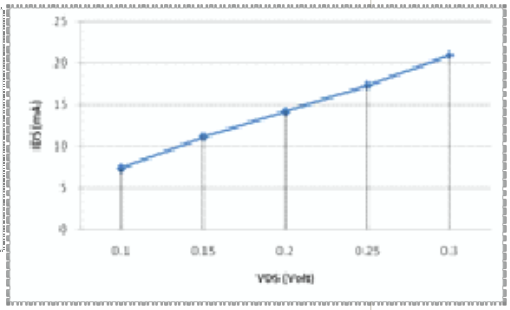
Experiment 9
MOS Transistor
Post-Lab Report

MOSFET As Voltage-Controlled Resistor

Q1. For each value of (V_{GS} - V_T) (2, 3, and 4 V), plot I_D versus V_{DS}. What kind of curve do you get? What is the slope for (V_{GS} - V_T)= 2, 3, and 4 V?







We get an increasing curve.
Slopes are 52.35, 64.96, and 68 (mA/V) respectively.

Q2. The inverse of the slope has units of V/A or Ohms. What is the resistance between drain and source of the MOSFET when (V_{GS} - V_T)= 2, 3, and 4 V? Complete TABLE 1.

Table 1.

V_{GS} - V_T (Volts)	R_{DS}(Ohms)
2	19.102
3	15.394
4	14.705

Q3. What are your conclusions?

As VGS-VT increases the slope increases which make the Ids to increase and Vds variesis quit constant so Rds will decreases since relation between Ids and Rds is inversely proportion.

Q4. In what region of operation is the MOSFET biased for the conditions described above? Can you explain why this region is called linear, or ohmic?

The MOSFET is turned on in the linear or ohmic region. It is called ohmic since the transistor is turned on, and a channel has been created which allows current to flow between the drain and source. The MOSFET operates like a resistor, controlled by the gate voltage relative to both the source and drain voltages.

Q5. The current equation in the linear or ohmic region is given by:

$$I_D = \frac{k}{2}(2(V_{GS} - V_T)V_{DS} - V_{DS}^2)$$

How is this equation related to the voltage-controlled resistor behavior of the MOSFET that you have just seen? For what range of values of V_{DS} is the linear resistor approximation valid (i.e. the error in current values is less than 5%)? What is the value of R_{DS} that you get from the equation? How does it compare with the values of R_{DS} in TABLE B-2 (use the value of k calculated in part A)?

MOSFET becomes a voltage controlled resistor where ID is controlled by the gate voltage relative to both the source and drain voltages.

0.1 V < Vds < 0.2 V

Substitute values of (Vgs - Vt) and Vds in the equation to get Id the Vds= Rds*Id
Rds= 9.36 milliOhm (Vgs-Vt = 2 Volts)

Rds= 6.107 milliOhm (Vgs-Vt = 3Volts)

Rds= 4.56 milliOhm (Vgs-Vt = 4Volts)
These values are much smaller than that in table B-2.

Q6. List some applications of a voltage-controlled resistor.

The MOSFET can be used as a voltage controlled resistor which can be used in audio applications to ensure that distortion is minimized. Applications include oscillators (where both frequency of operation and the feedback can be controlled), filters, modulators and automatic gain controls.

MOSFET Logic Gate

Q7. For this MOSFET gate, what are the values of high voltage (corresponding to logic 1) and the low voltage (corresponding to logic 0)? Note that when the two inputs are high, the output voltage is lower than the low value when only one input is high.

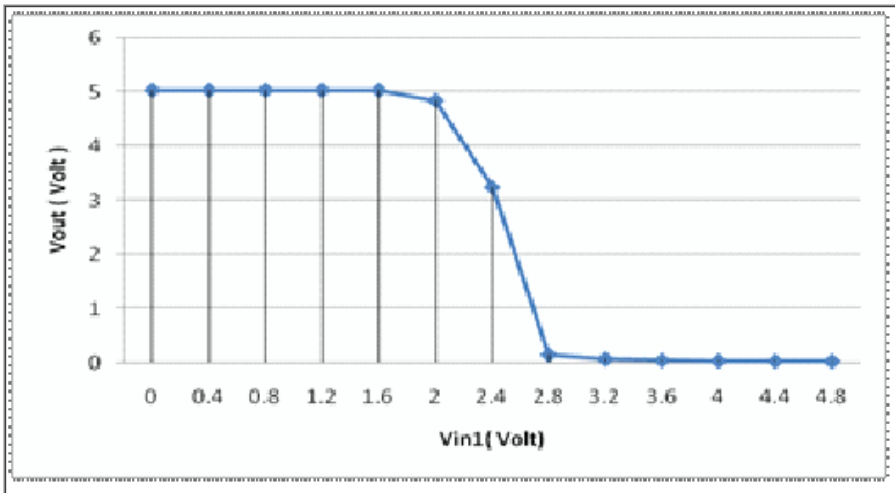
High Voltage = 5.034 Volt.

Low Voltage = 0.03 Volt.

Q8. How is the value of the low voltage affected by the value of the 470 Ohm resistor? Would increasing this resistance make the output low value higher or lower?

There is a very low resistance in the MOSFET, so there is in principle voltage division between RD and this resistance, but practically this effect is negligible. So the value of the resistor RD has no effect on the output voltage and the output voltage got only affected by VDD.

Q9. Plot VOUT versus VIN1. Indicate at what value of the input voltage does the output switch states?



Vout switch states at Vin1= 2.8 Volt