Department of Electrical & Computer Engineering
North South University

Analog Electronics I Lab
EEE111L
Spring 2021
Sec: 11

Lab Experiment 07
Switching Characteristics of MOSFET

Objective

- To study the switching characteristics of MOSFET

Enhancement n-type MOSFET

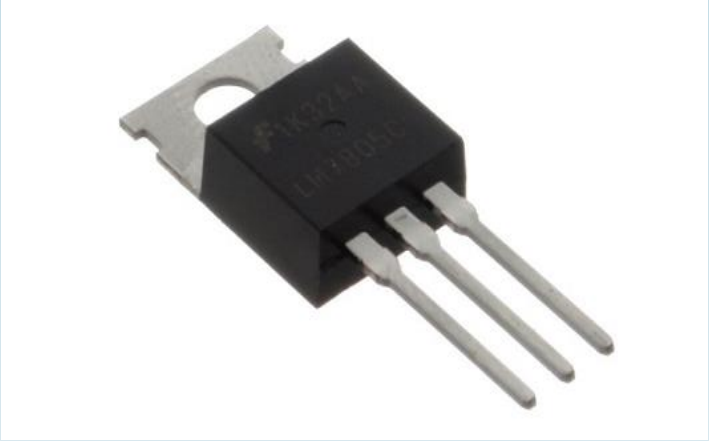
Theoretical Concept

- Basic knowledge about MOSFET
- Transfer Characteristics &
- Output Characteristics of enhancement n-type of MOSFET

MOSFET

→ Tri-terminal, uni-polar, voltage-controlled, high input impedance device

→classified into two types viz., depletion-type and enhancement-type



MOSFET SWITCHING CIRCUIT

MOSFET:

Metal **O**xide **S**emiconductor **F**ield **E**ffect **T**ransistor

Type of MOSFET:

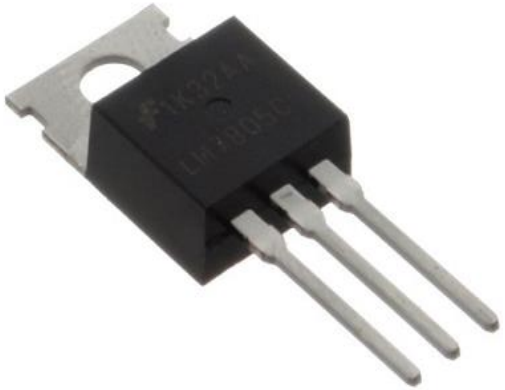
1) Depletion type MOSFET
   - P- Channel
   - N-Channel
2) Enhancement type MOSFET
   - P- Channel
   - N-Channel

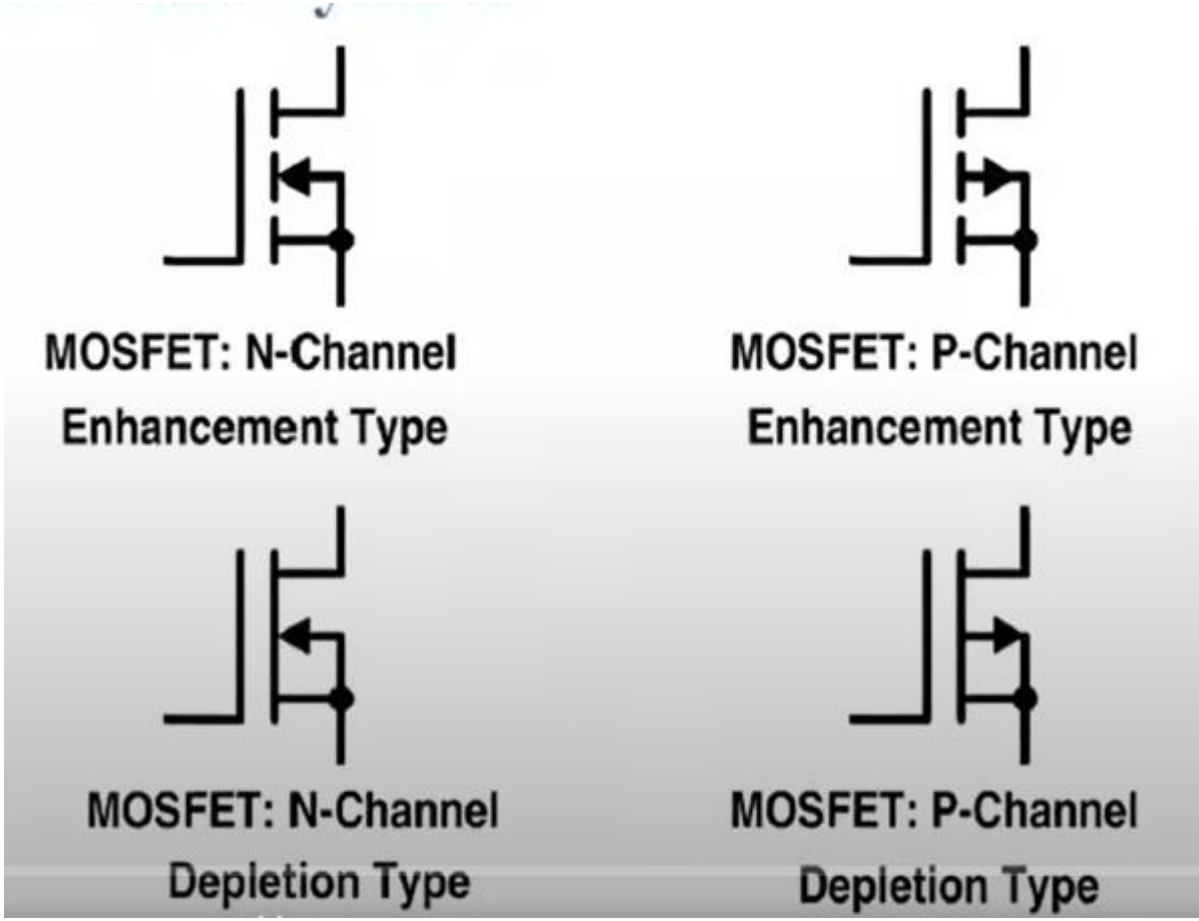
MOSFET Models:

IRF510	IRF510 5.6A 100V N-Channel Power MOSFET
IRF520	IRF520 10A 100V N-Channel Power MOSFET
IRF530	IRF530 14A 100V N-Channel Power MOSFET
IRF540	IRF540 30A 100V N-Channel Power MOSFET
IRF610	IRF610 3.3A 200V N-Channel Power MOSFET
IRF620	IRF620 6A 200V N-Channel Power MOSFET
IRF630	IRF630 9A 200V N-Channel Power MOSFET
IRF634	IRF634 8.1A 250V N-Channel Power MOSFET
IRF640	IRF640 18A 200V N-Channel Power MOSFET

IRF720	IRF720 3.3A 400V N-Channel Power MOSFET
IRF730	IRF730 5.5A 400V N-Channel Power MOSFET
IRF740	IRF740 10A 400V N-Channel Power MOSFET
IRF820	IRF820 2.5A 500V N-Channel Power MOSFET
IRF830	IRF830 4.5A 500V N-Channel Power MOSFET
IRF840	IRF840 8A 500V N-Channel Power MOSFET
IRF1010N	IRF1010N 85A 55V N-Channel Power MOSFET
IRF1404	IRF1404 202A 40V N-Channel Power MOSFET
IRF1405	IRF1405 169A 55V N-Channel Power MOSFET

MOSFET's Symbols

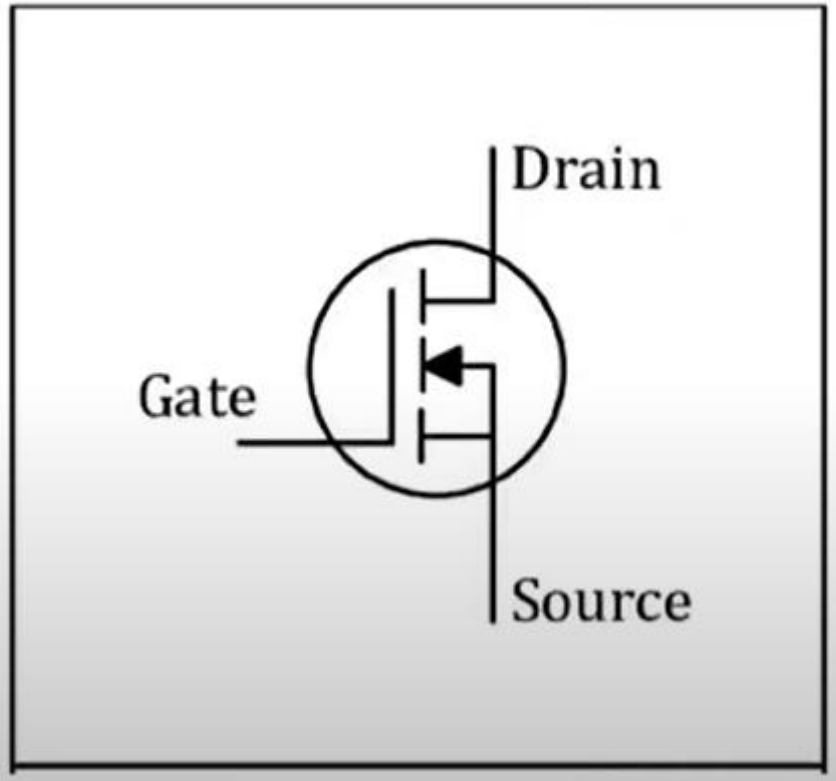




MOSFET Pins:

A MOSFET has 3 pins-

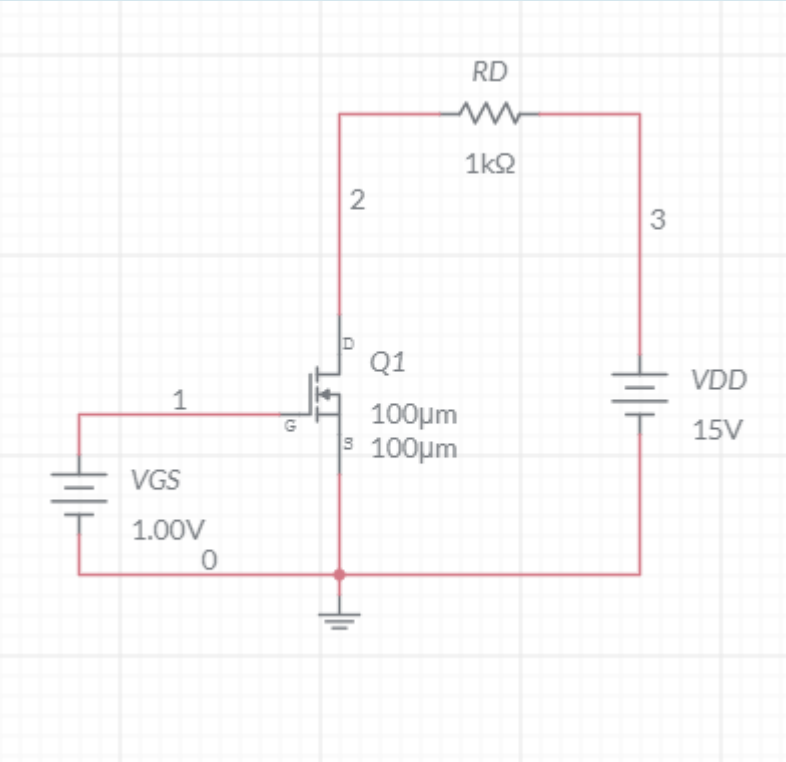
1. *Drain*
2. *Gate*
3. *Source*



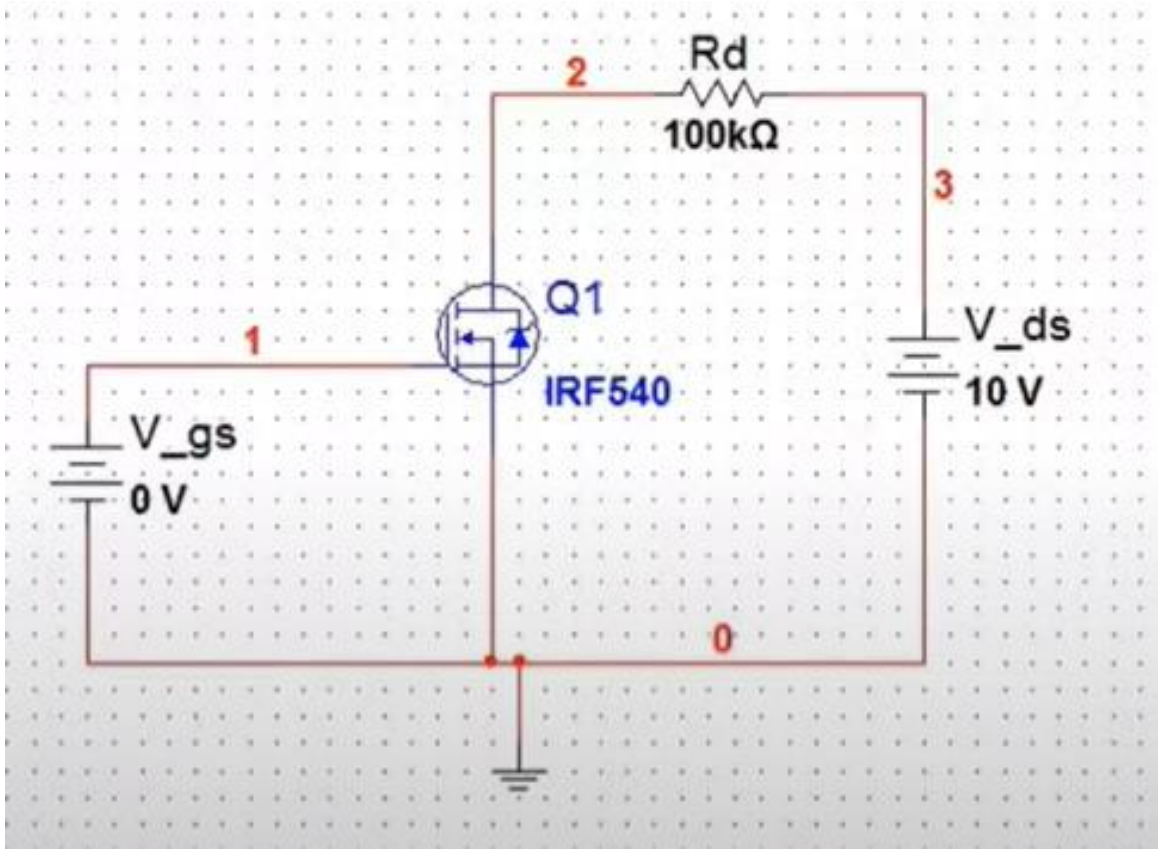
Equipments

- Resistor
- DC power Supply
- Connecting Wires
- DMM
- IRF540

Experimental Circuits



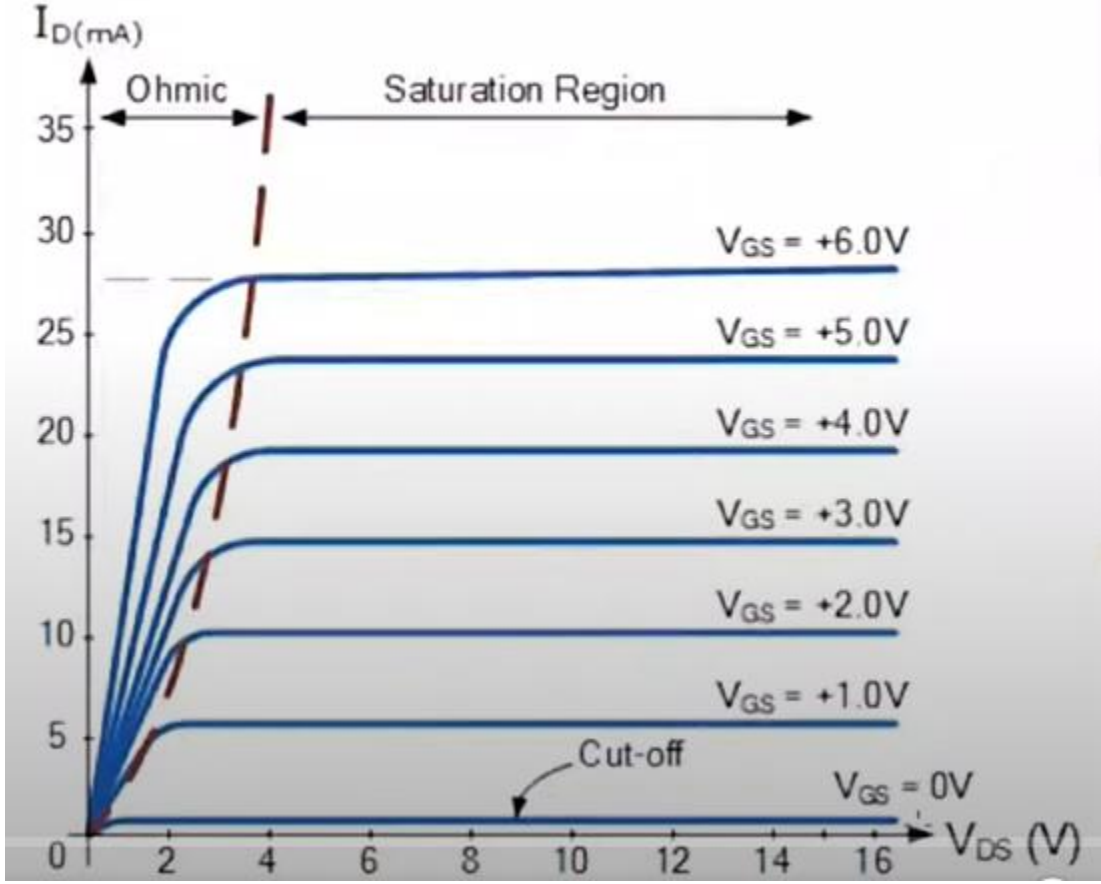
Experimental Circuit



MOSFET Output Characteristics

Three working regions

1. Cut-Off region
2. Saturation region
3. Ohmic region



Characteristics Curves

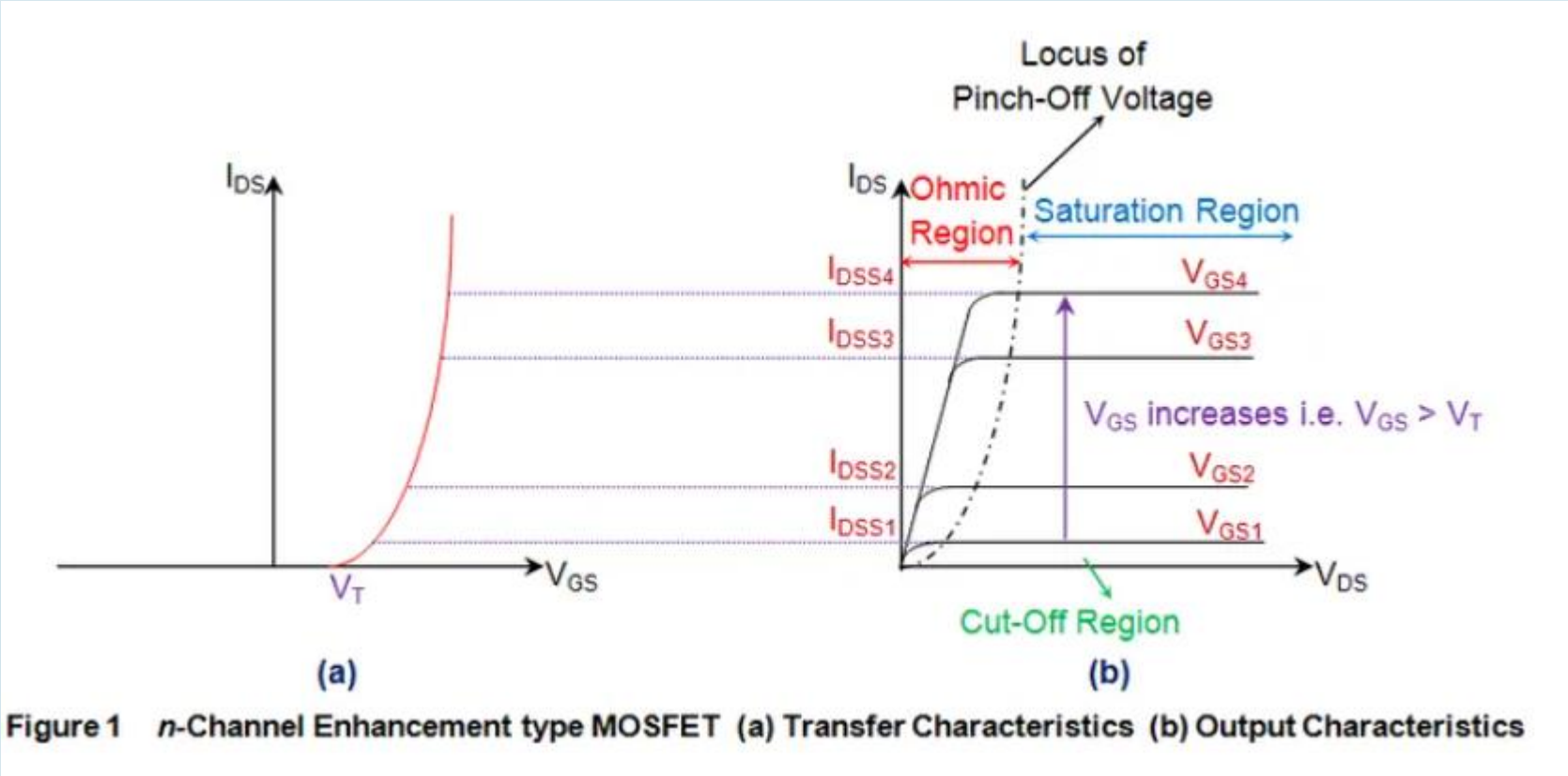


Figure 1 *n*-Channel Enhancement type MOSFET (a) Transfer Characteristics (b) Output Characteristics

MOSFET's operating regions

1. Cut-Off Region

   Cut-off region is a region in which the MOSFET will be OFF as there will be no current flow through it. In this region, MOSFET behaves like an open switch and is thus used when they are required to function as electronic switches.

2. Ohmic or Linear Region

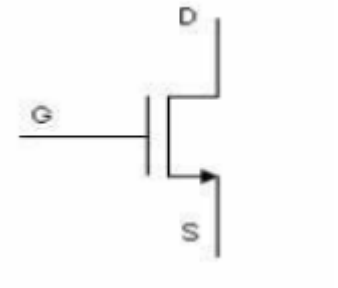
   Ohmic or linear region is a region where in the current I_{DS} increases with an increase in the value of V_{DS}. When MOSFETs are made to operate in this region, they can be used as amplifiers.

3. Saturation Region

   In saturation region, the MOSFETs have their I_{DS} constant inspite of an increase in V_{DS} and occurs once V_{DS} exceeds the value of pinch-off voltage V_P. Under this condition, the device will act like a closed switch through which a saturated value of I_{DS} flows. As a result, this operating region is chosen whenever MOSFETs are required to perform switching operations.

MOSFET Voltage controlled Device & It acts as a switch

A voltage input to the gate controls the flow of current from source to drain. The gate does not draw a continuous current. Though, the gate draws a surge of current to charge the gate capacitance.



Notes:

- Threshold voltage is the voltage applied between gate and source of a MOSFET that is needed to turn the device on for linear and saturation regions of operation.

- The value of the threshold voltage is dependent from some physical parameters which characterize the MOSFET structure such as: the gate material, the thickness of oxide layer, substrate doping concentrations (density) NA, oxide –interface fixed charge concentrations (density), channel length L, channel width W

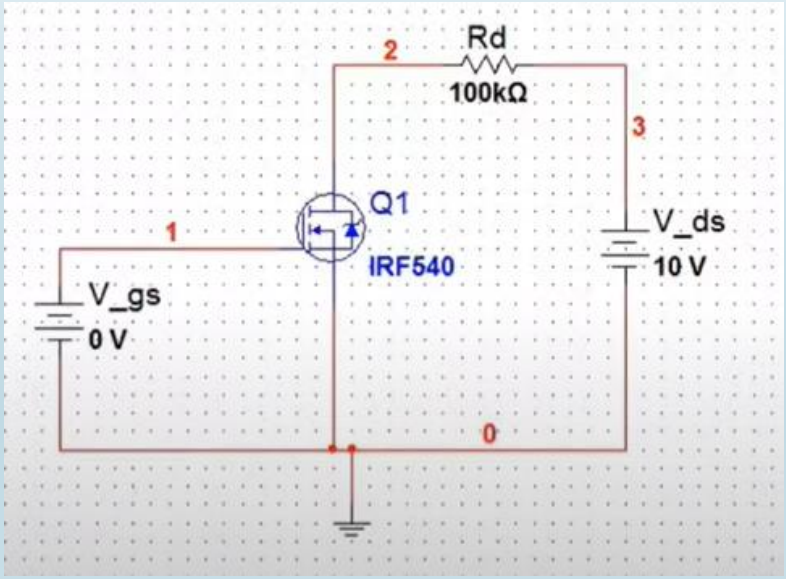
Circuit Construction :

- <u>To select IRF540:</u>

→Click on **Place Basic**

→Click on **Select all families**

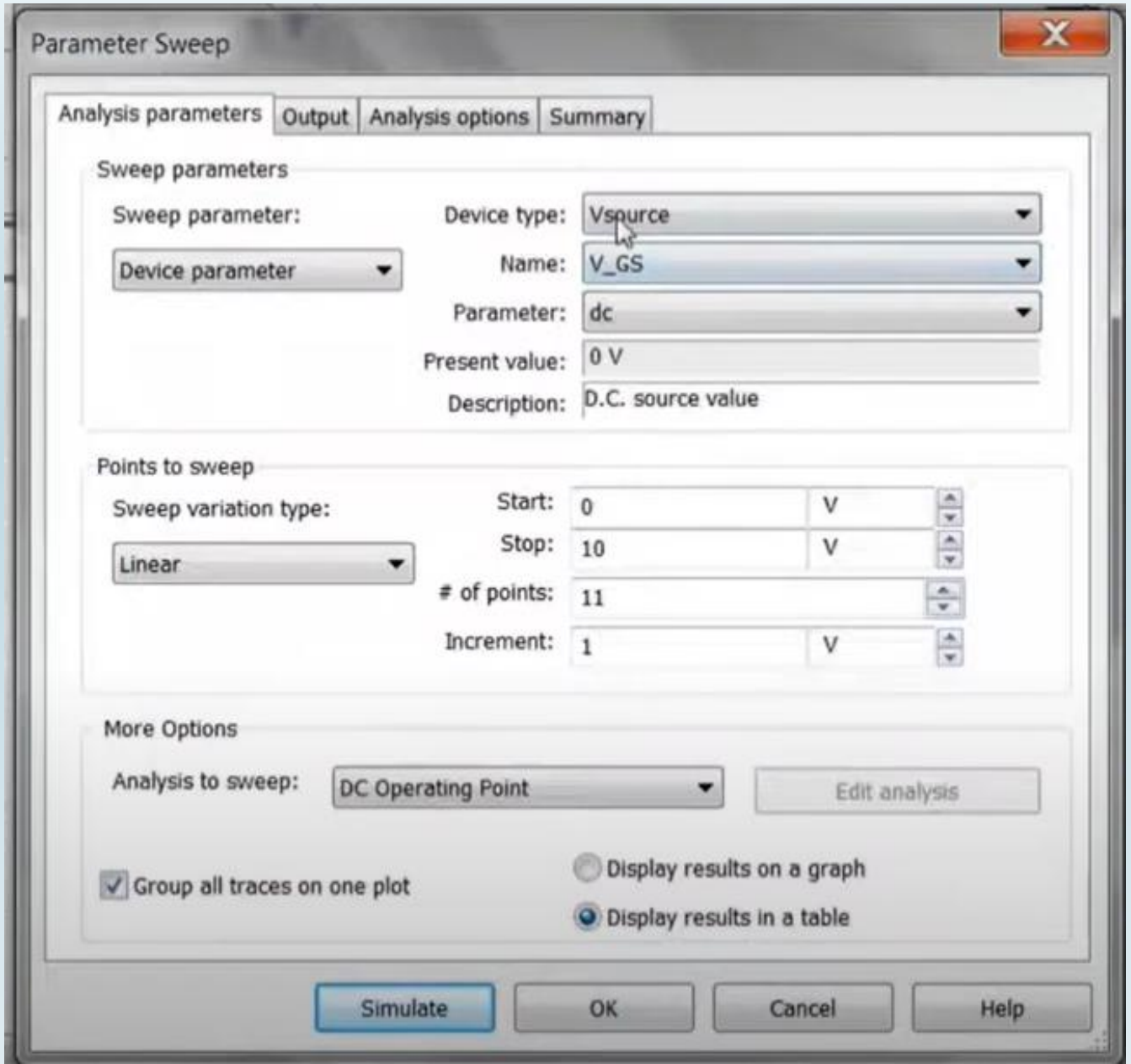
→Under **Component** type “IRF540” and select it



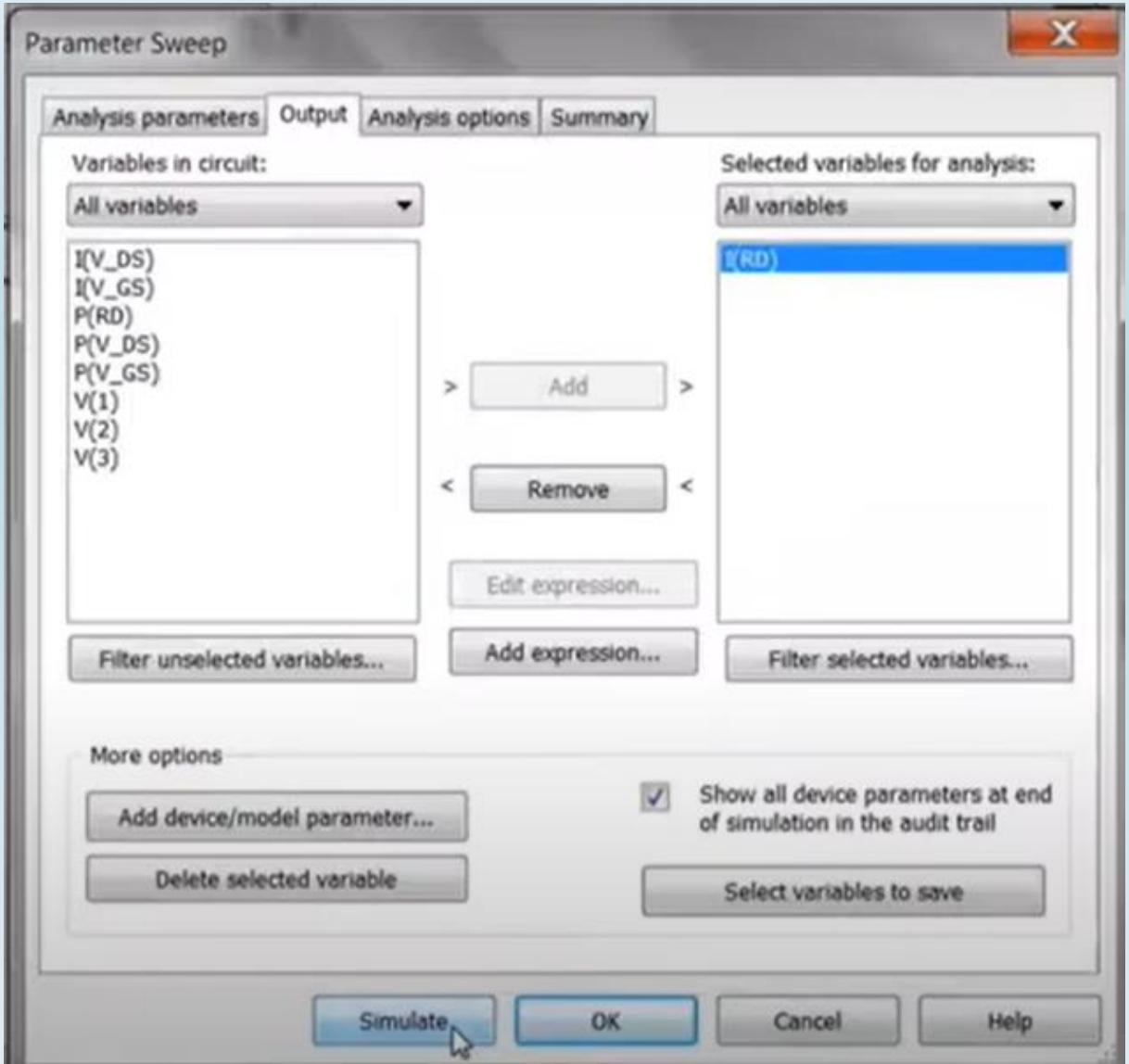
Simulation

- Click on “Simulate”
- Click on “Analysis”
- Select “Parameter Sweep”

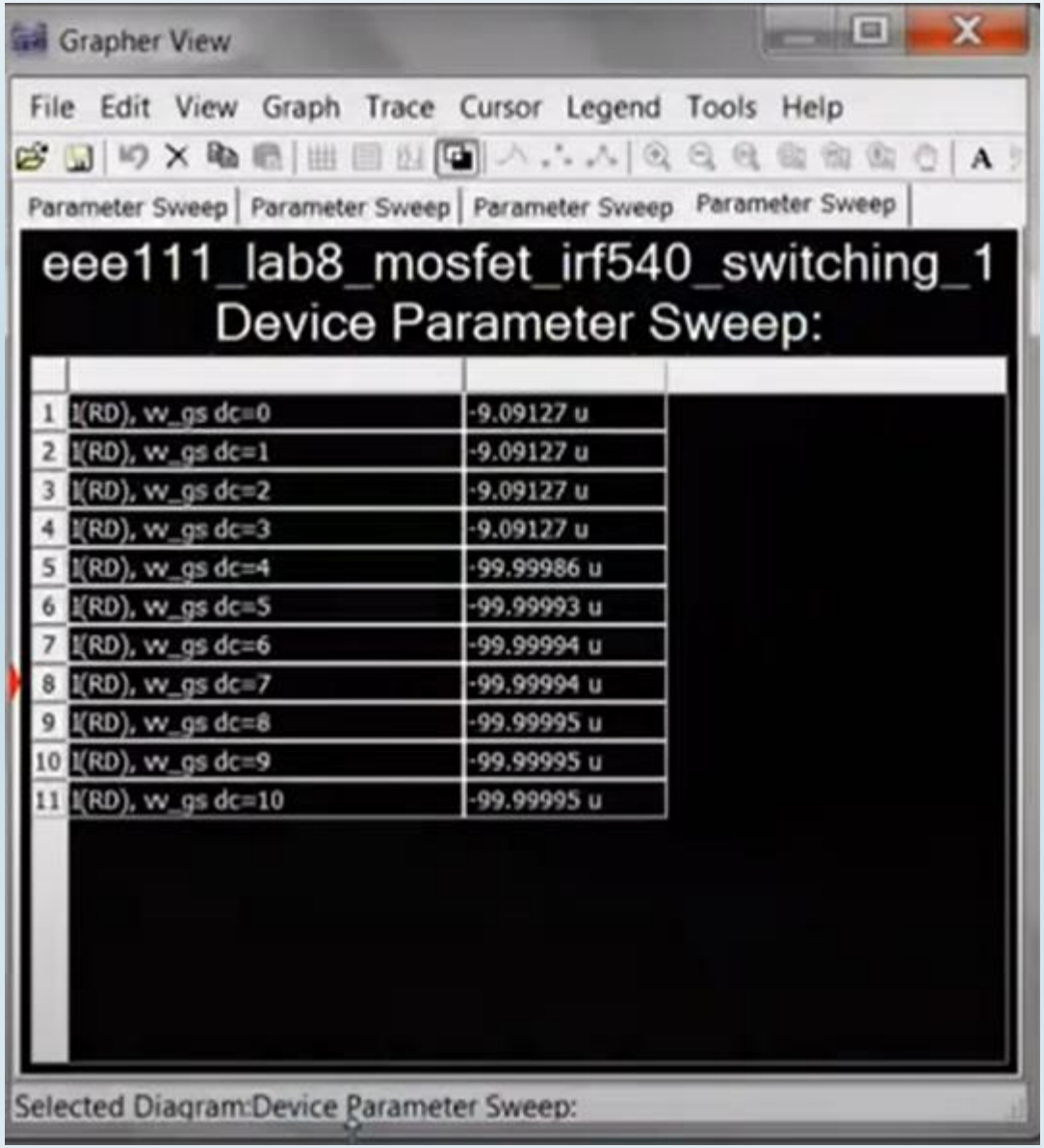
Parameter Sweep→ Analysis Parameters



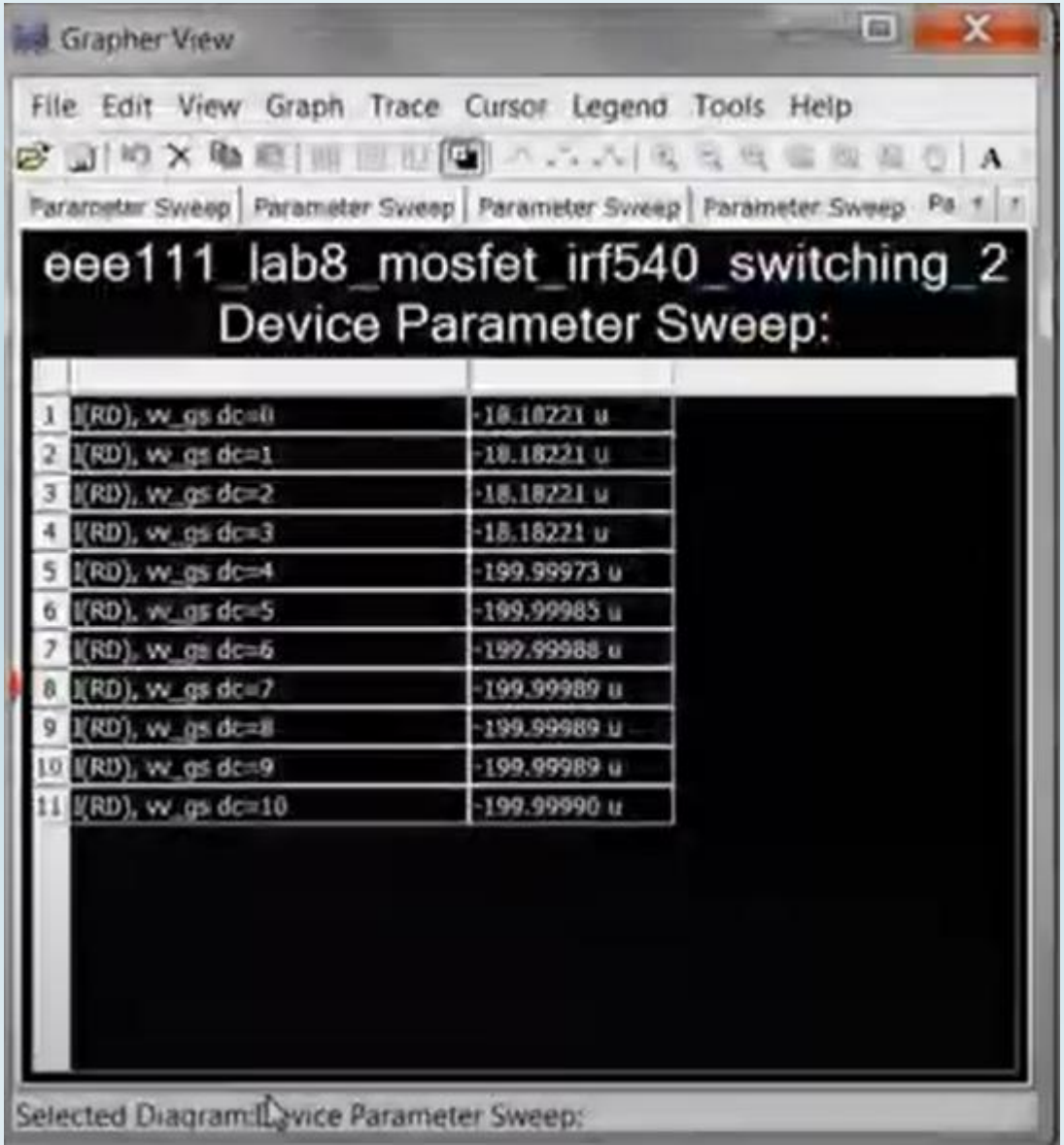
Parameter Sweep→ Output→ Add "I(RD)" →Simulate



Parameter Sweep for Vds = 10V



Parameter Sweep when V_ds = 20 V



References:

- https://www.youtube.com/watch?v=P_qwv1SIQsY

- https://www.electrical4u.com/mosfet-characteristics/