

MOSFET

PRESENTED BY

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WHAT IS A MOSFET?



- Metal Oxide Semiconductor Field Effect Transistor
- Three-terminal device: Source, Drain and Gate
- Transistors are used for switching and amplification in circuits



THINGS TO KNOW

- A **semiconductor** (eg: Si) has an electrical conductivity value between a conductor and an insulator.
 - Current conduction occurs through free movement of **electrons or holes**.
 - **Doping** introduces impurities into a pure semiconductor for the purpose of modulating its electrical properties.
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HOW DOPING WORKS

Silicon has 4 valence electrons: $[\text{Ne}]3s^23p^2$

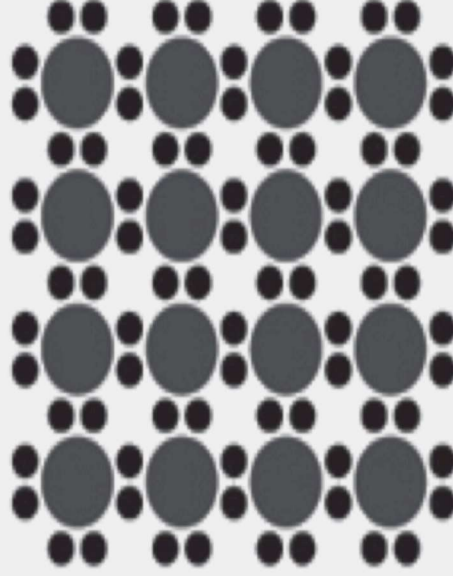
● Silicon

● Electron

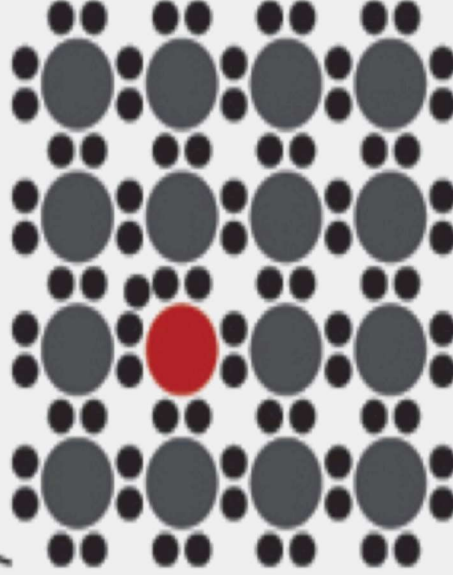
● Phosphorus

● Boron

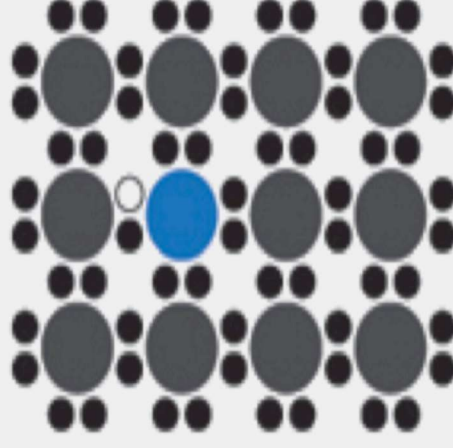
doped semiconductor



Array of Si atoms

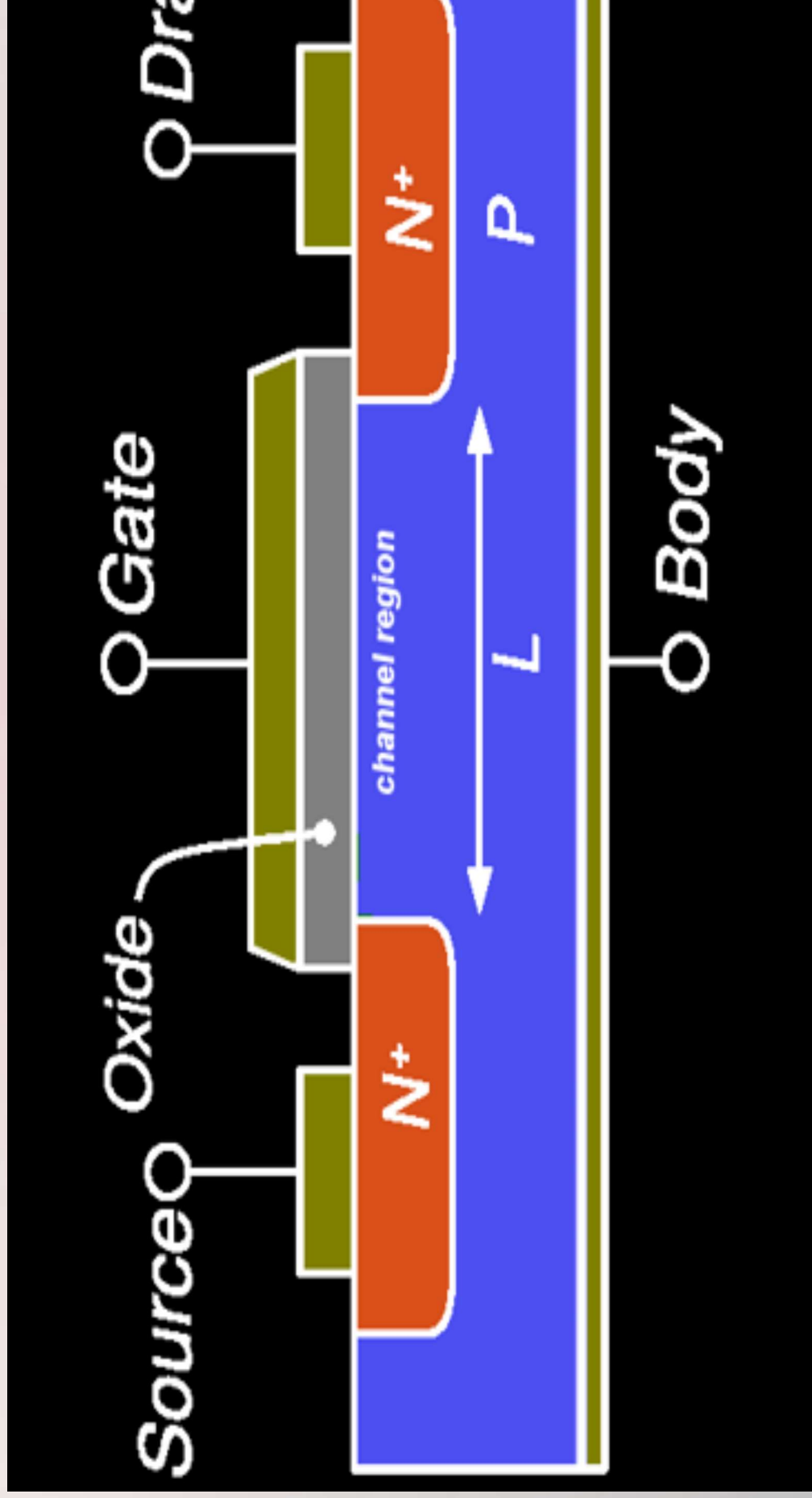


n-type semiconductor



p-type semiconductor

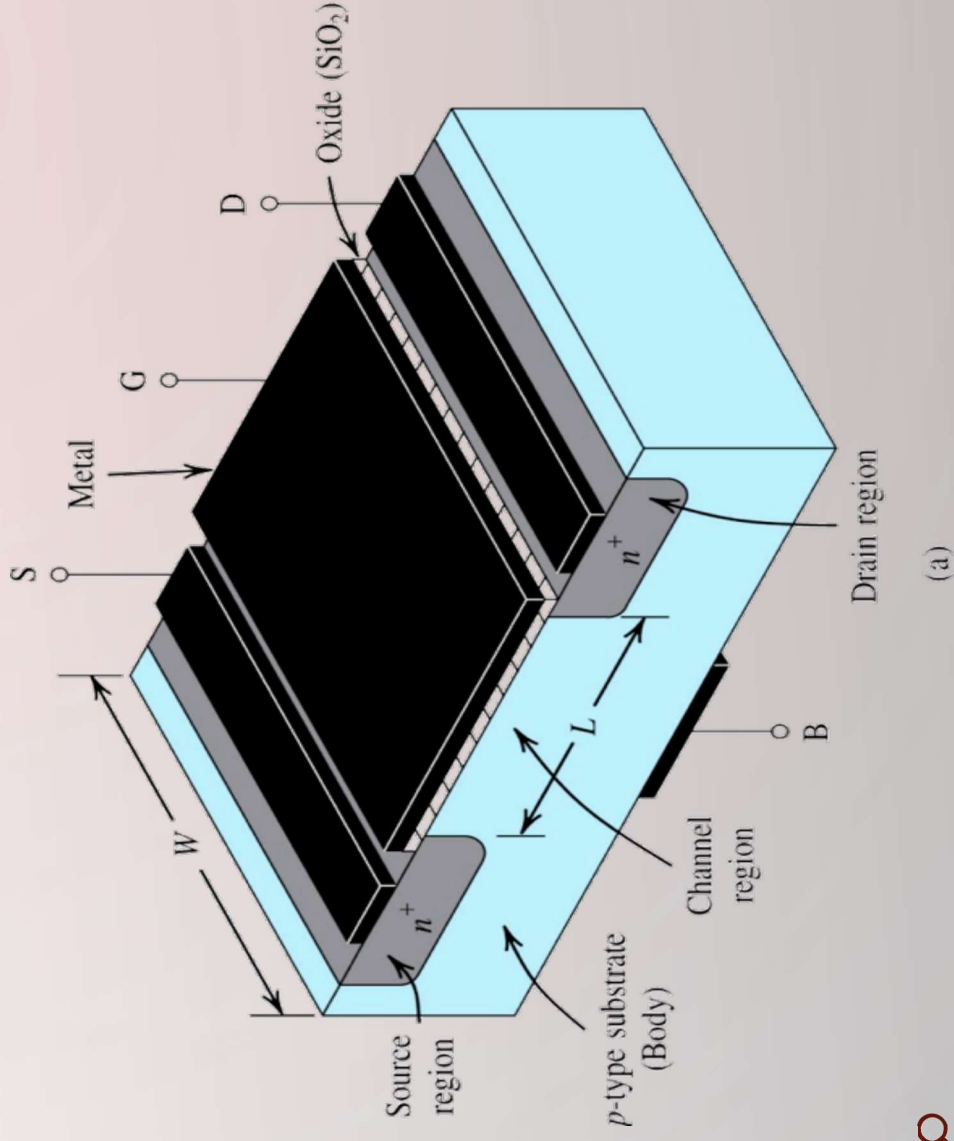
DEVICE STRUCTURE OF N-CHANNEL MOSFET



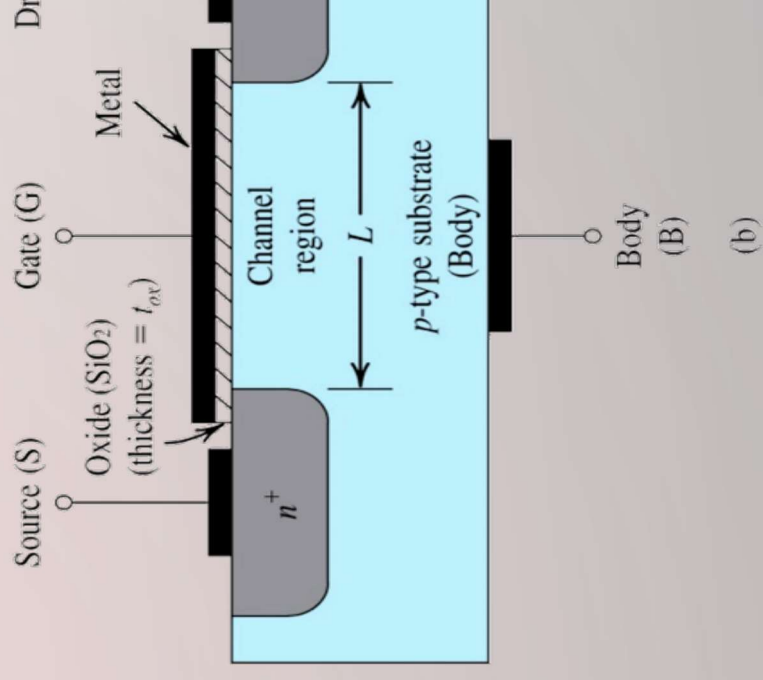
DEVICE STRUCTURE OF ENHANCEMENT MOD N-CHANNEL MOSFET

- The gate terminal is a conducting surface (Metal)
- The gate terminal is separated by a layer of insulator (oxide) from the channel
- The (semiconductor) substrate is doped with p-type impurity
- Source and Drain are doped with n-type impurity
- The gate, source and drain have conducting metal contacts

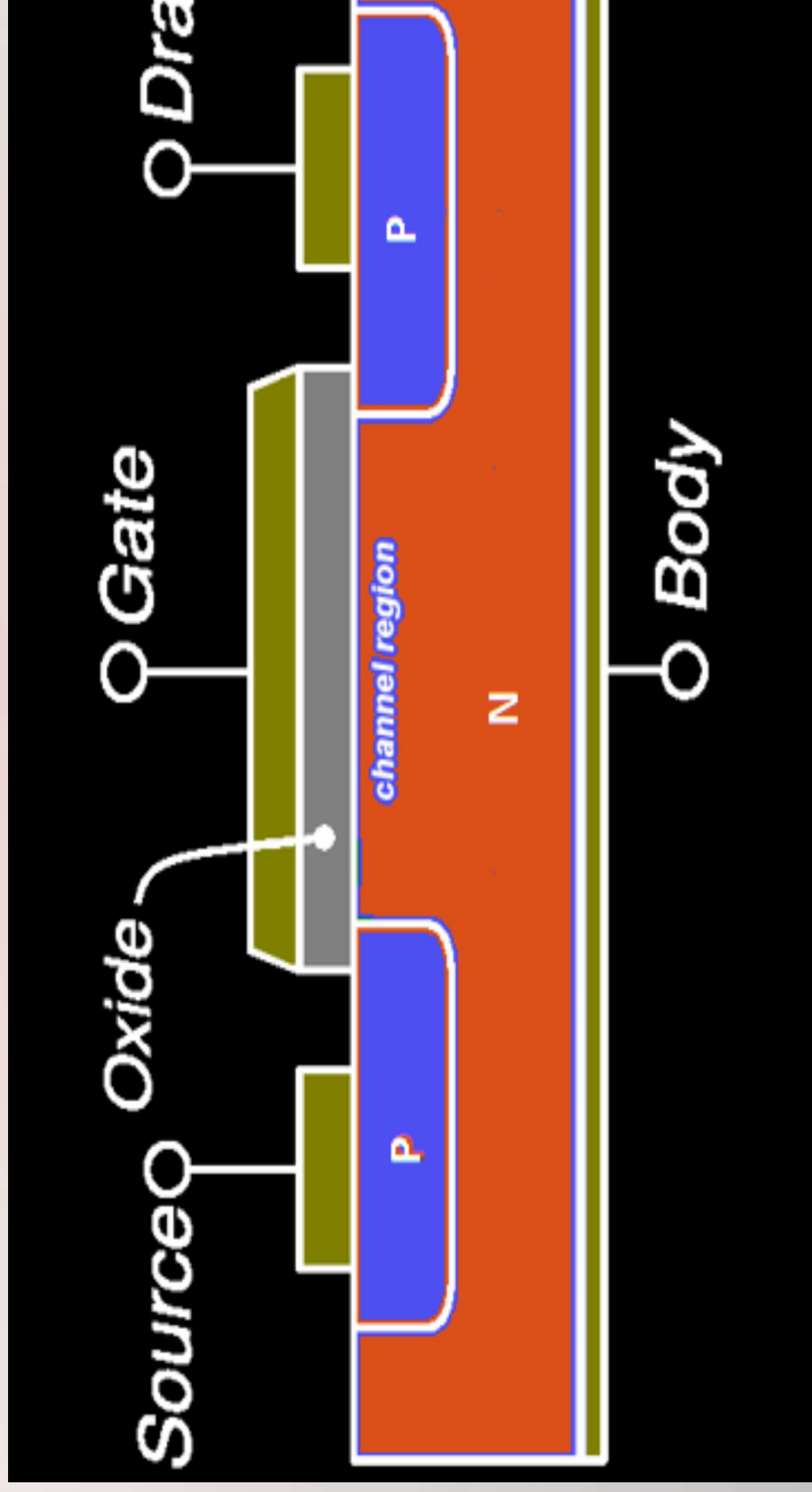
PERSPECTIVE VIEW



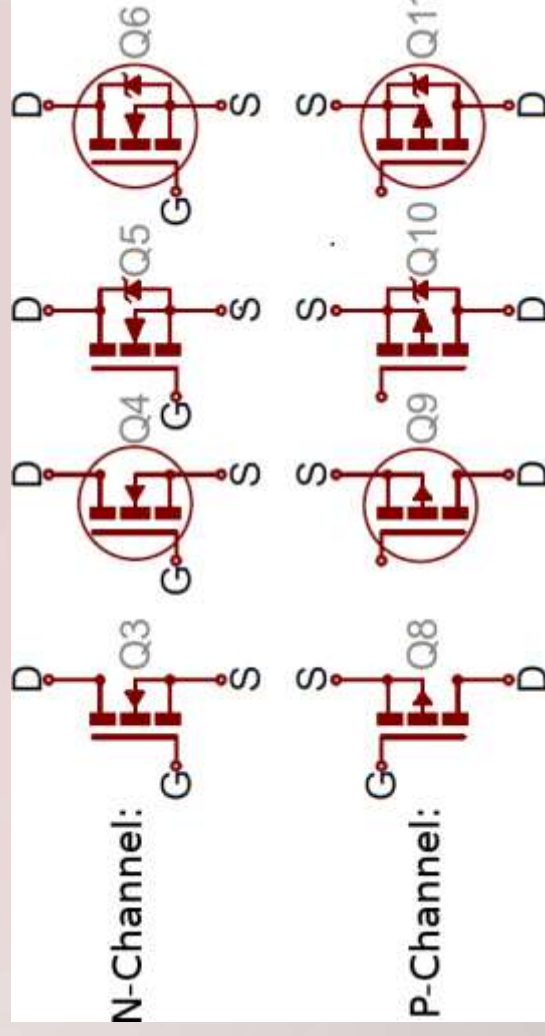
CROSS SECTIONAL VIEW



DEVICE STRUCTURE OF P-CHANNEL MOSFET



CIRCUIT SYMBOLS COMMONLY USED



FURTHER CLASSIFICATIONS

- In addition to NMOS & PMOS explained earlier, they can in turn be further classified into
 - Enhancement mode
 - Depletion mode

WHAT IS ENHANCEMENT MODE ?

- Enhancement mode MOSFETS comes devoid of a “channel”
- Depletion mode comes with a channel by default
- A channel can roughly be described as a conduction path that enables MOSFET to work

HOW DOES ENHANCEMENT MOSFET WORK WITHOUT A CHANNEL ?

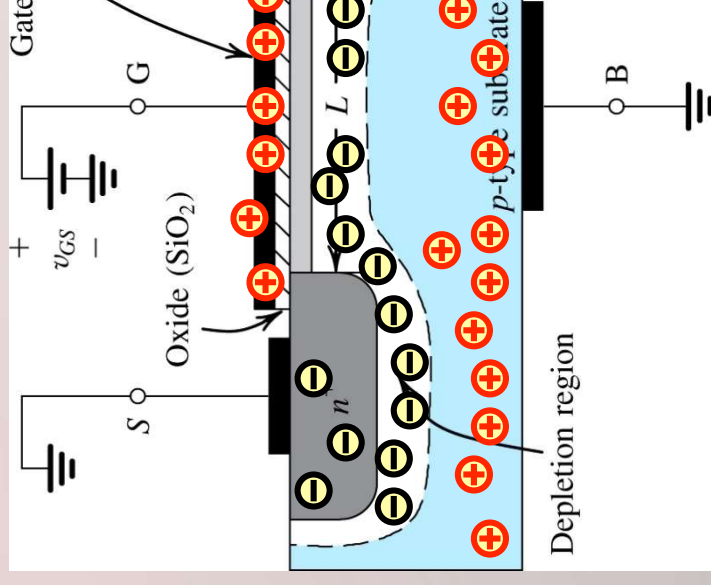
- This is where the gate voltage plays a significant part
- Gate voltage serves to create the channel in enhancement mode, while depletion mode it can be used to “deplete” the channel; As in destroy
- Enhancement mode and depletion mode can be summarized as normally and normally closed switches respectively.

CONDUCTION IN AN ENHANCEMENT MODE N-MOSFET

❖ Creation of the channel by applying gate voltage

- Threshold voltage : Gate voltage must be higher than V_t , only then is the conduction path created

❖ Channel is just the 'path'; Additional potential difference is needed to instigate and sustain charge flow. This is provided by applying a potential difference voltage between drain and source terminals

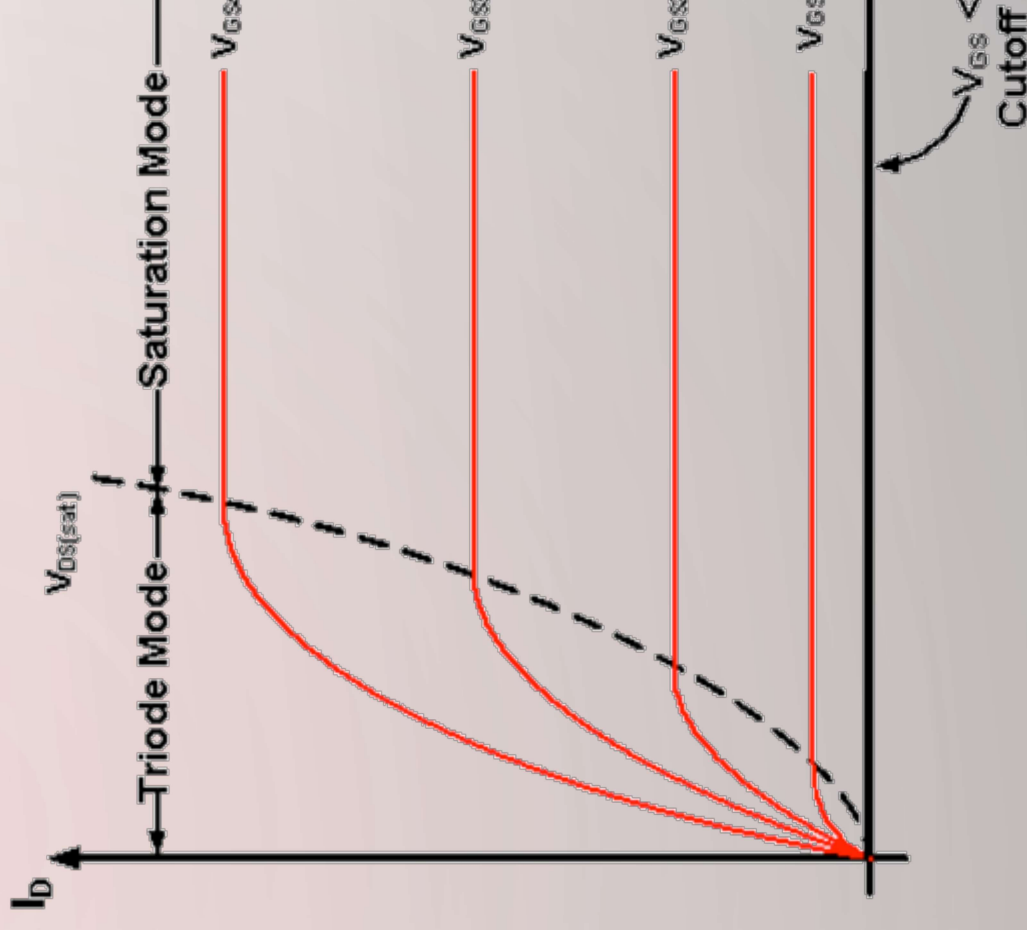


I-V CHARACTERISTICS OF MOSFET

❖ The plot is between the drain current and the drain-source voltage, for different values of gate voltage

❖ MOSFET operating regions:

- Cutoff mode
- Triode/Linear mode
- Saturation mode





APPLICATIONS

- Microprocessors for switching purposes
 - Radio frequency amplifiers
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