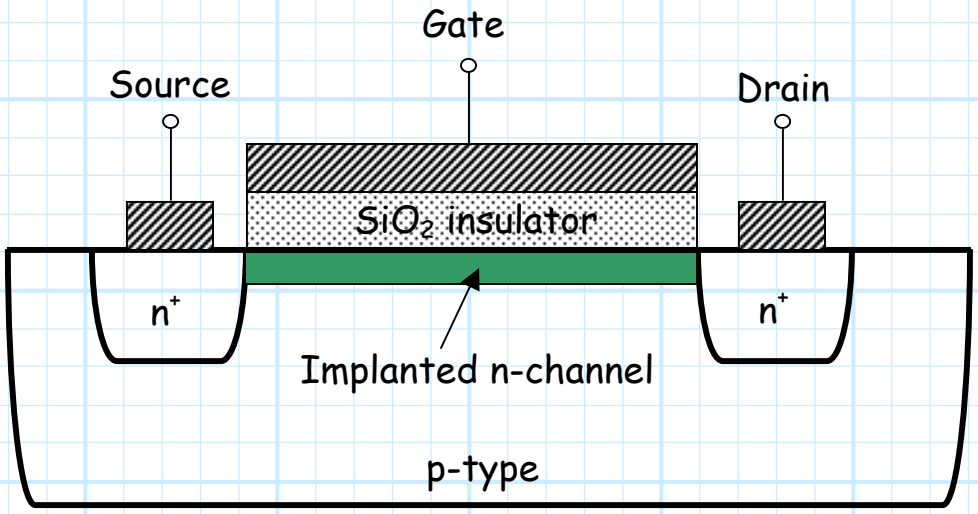
The Depletion MOSFET

The physical construction of a **depletion** MOSFET is identical to the **enhancement** MOSFET, with one exception:

The conduction channel is physically implanted (rather than induced)!



Thus, for a **depletion NMOS** transistor, the channel conducts **even if** v_{GS}=0!

* If the value of v_{GS} is **positive**, the channel is **further enhanced**. That is, more free electrons are attracted to the channel, and its **conductivity increases**.

* If the value of v_{GS} is **negative**, free electrons are **repelled** from the channel! The conductivity of the channel is thus **decreased**. We call this phenomenon **channel depletion**.

* If the value of v_{GS} becomes sufficiently negative, **all** of the free electrons in the channel will be **repelled**—the channel is said to be **completely depleted**!

* A channel that is completely depleted **cannot conduct**. In other words, the depletion MOSFET is in **cutoff**!

* Thus, the **negative** value of v_{GS} at which the channel is completely depleted is the **threshold voltage** V_t for a **depletion** NMOS device.

In other words, to have a **conducting** channel, the gate-to-source voltage v_{GS} must be greater than the threshold voltage V_t:

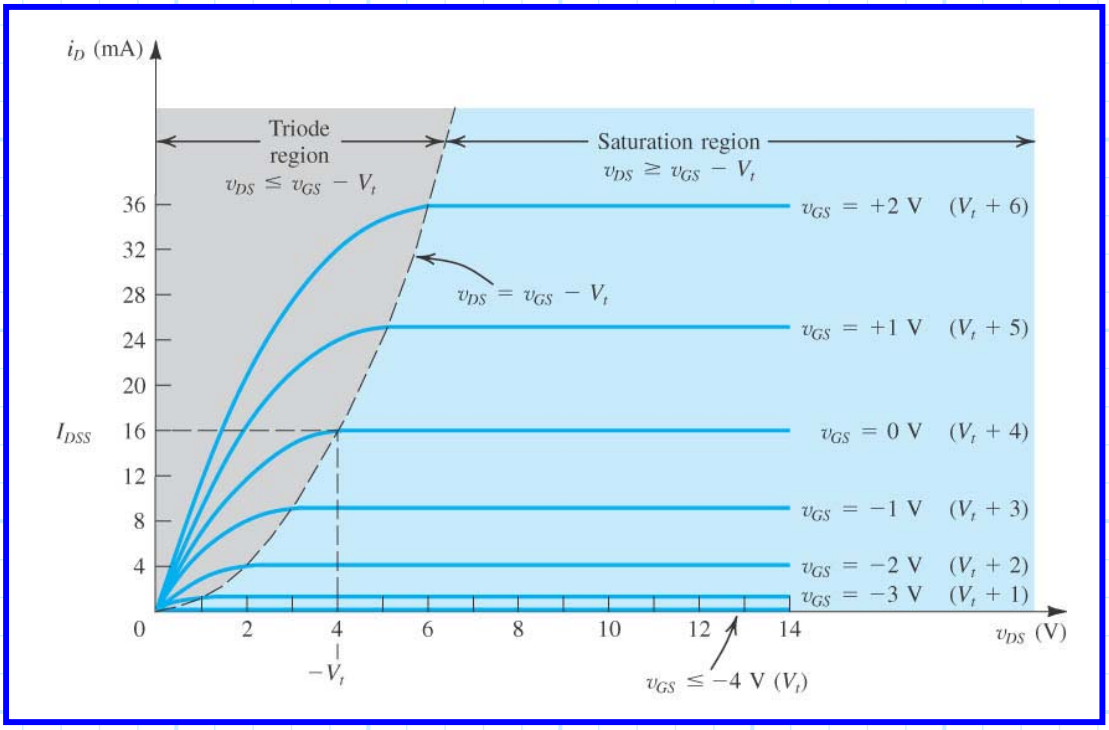
$$v_{GS} > V_t$$

Just like the **enhancement** NMOS device!
Moreover, this means that to have a **conducting** channel, the **excess gate voltage** must be positive:

$$v_{GS} - V_t > 0$$

Just like the **enhancement** NMOS device!

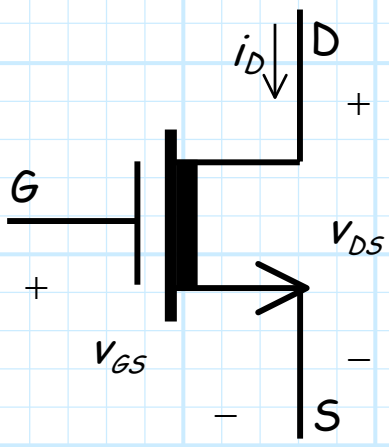
We find then that an enhancement MOSFET and a depletion MOSFET are **precisely** identical in **nearly** every way (e.g., same **modes**, same **equations**, same **terminal** names).



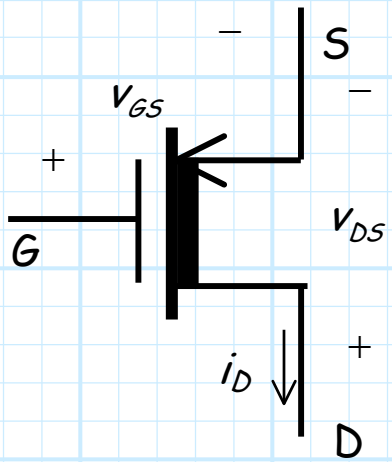
There are just **two** differences to remember:

1. The **threshold voltage** for a depletion **NMOS** device is **negative** (i.e., $V_t < 0$). While the threshold voltage for a depletion **PMOS** device is **positive** (i.e., $V_t > 0$).

2. The **depletion** MOSFET has a slightly different **circuit symbol**.



Depletion NMOS



Depletion PMOS