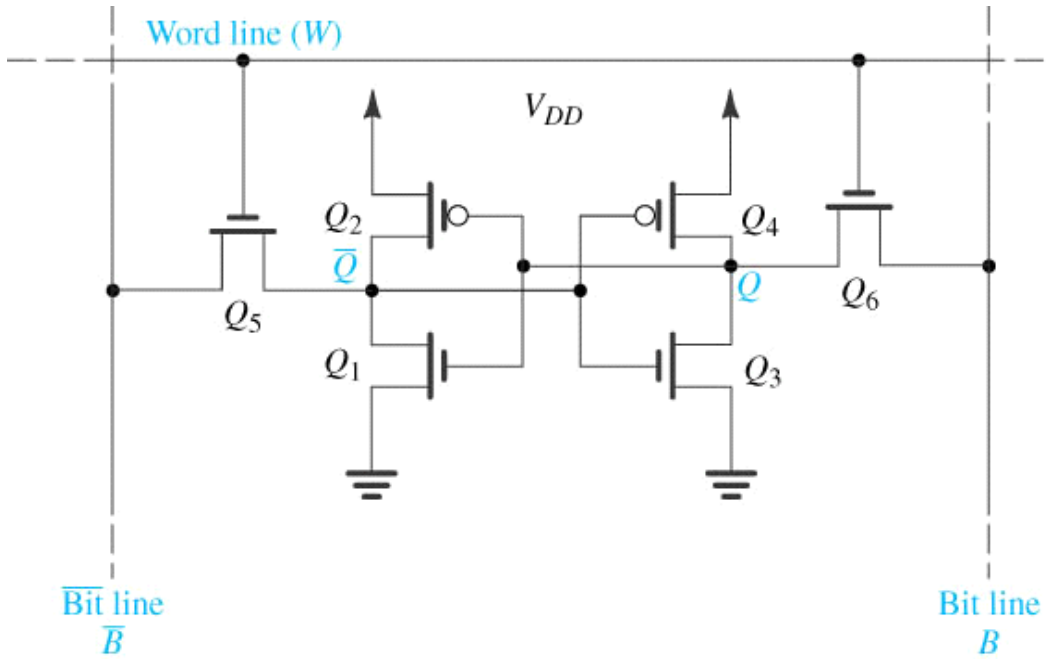
Memory Cells

Q: *So, what exactly is a storage cell? How is it **made**?*

A: There are **two** primary types of memory cells that are used: **static** and **dynamic**. The result is two types of semiconductor memories: Static RAM (**SRAM**) and Dynamic RAM (**DRAM**).

Static Memory Cells

We've already studied this! The basic SRAM memory cell is a S/R flip-flop:



In this figure, "Bit Line" refers to the **column** at which the cell resides, and "Word Line" refers to the **row** at which the column resides.

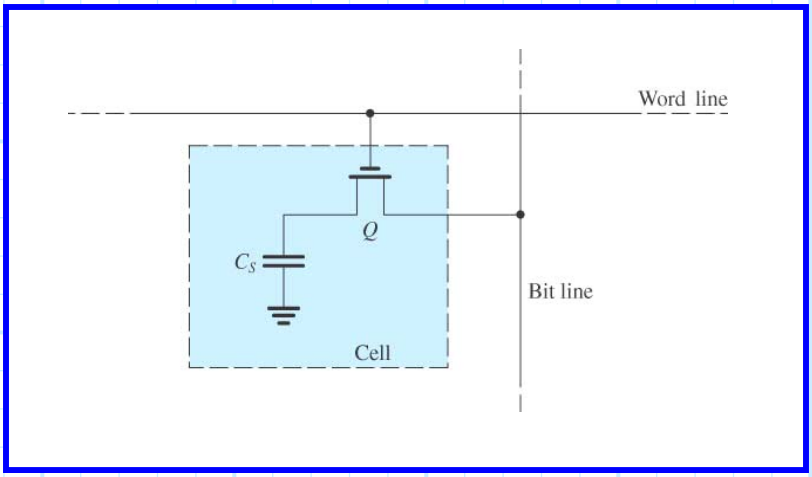
Hence, by enabling the proper **row** (by selecting the proper M-bit word), the S/R flip-flop is **enabled** (a conducting path is established between it an the bit lines). We can then enable the proper **column** (by selecting the proper N-bit word) and then either:

1. **Read** the latch state by sensing the bit lines
2. **Write** to the latch by driving the bit lines to the proper digital state.

Once we are done, we can **disable** the memory cell, and the latch will **remain** at its present state—until some **later** time when we need to either read from it or write to it **again**!

Dynamic Memory Cells

The basic memory cell of a DRAM is simply a small **capacitor**!



Q: *Yikes! How can a **capacitor** be used as memory cell?*

A: It's actually pretty simple: a **charged** capacitor can represent a binary state of 1 and a **discharged** capacitor can represent a binary state of 0!

Just as with a static cell, enabling a **word** line results in a conducting path connecting the storage cell (i.e., capacitor) to the **bit line**.

Then, by enabling the bit line we can either:

1. **Read** the cell by sensing if it is charged or discharged.
2. **Write** to the cell by either charging or discharging the capacitor.

Q: *I see! Once the memory cell is disabled (disconnected from the bit line), the capacitor **retains** it charge until we need to read or write again, **right?***

A: **Ideally** this would be true, but in actuality it is **not**. The problem is that these integrated circuit capacitors are **very** small, and so they **do not hold much charge**!

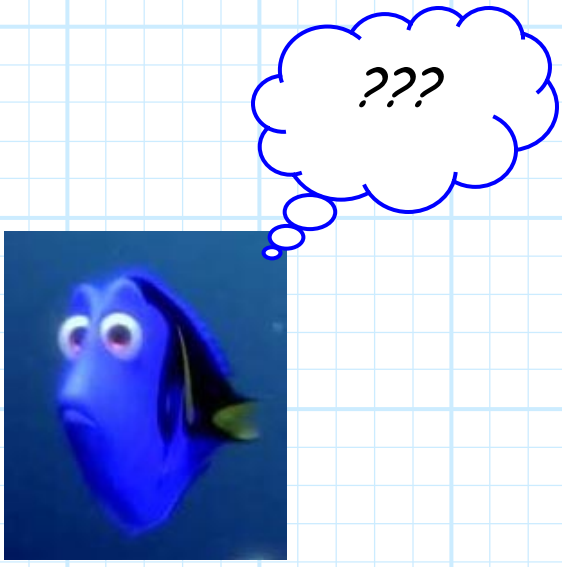
Additionally, the capacitor dielectrics are **not** (in fact cannot) be **perfect** insulators. As a result, the charge will "**leak**" from the capacitor—the capacitor will **discharge** over time.

The real problem is that it **does not take long** for this charge to completely leak away!

As a result, a dynamic memory cell (capacitor) must be **refreshed**.

The process of refreshing a memory cell is actually quite **simple**—we simply **read** the value of the cell (before it completely discharges) and then **write** the same value back to it (e.g., recharge the capacitor).

Therefore:



Advantages of DRAM:

1. Less space.
2. Less cost.

Advantages of SRAM:

1. Faster speed.
2. Lower power.
3. No refresh required!