CS1025 Lab Report n°5

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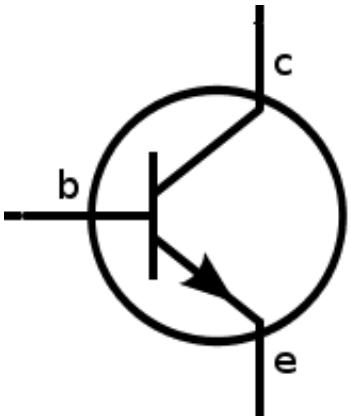
# Using transistors as switches

During this lab, 2 circuits were built, all using an DC power supplies set to 5 Volts. All circuits contained also a 1k Ohms resistor, a diode as well as 2N7000 E-MOSFET chips (transistors).

## What is a transistor?

A transistor is used mainly for two different tasks, the most common use is as a simple switch, it is also used as an amplifier. Put simply: it will conduct current when a voltage is applied to the base.

Here is the diagram for a transistor:



First Circuit

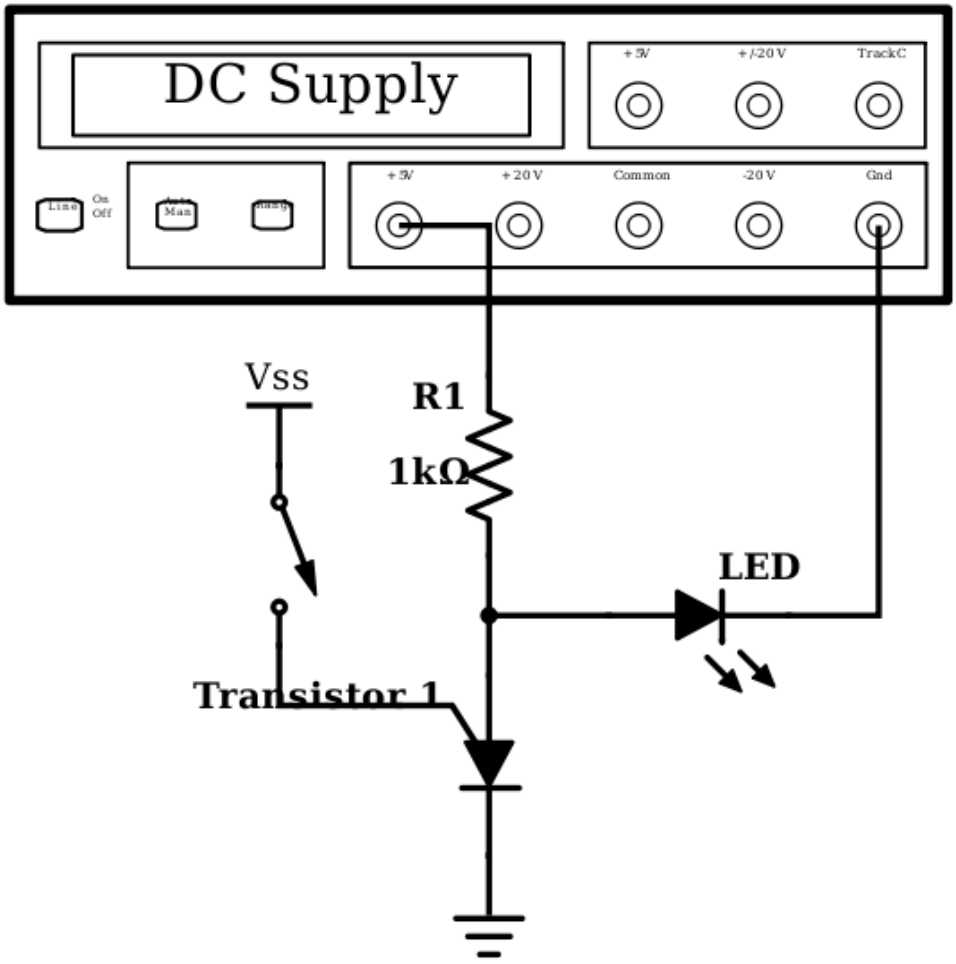



*Diagram for the first circuit, contains 5V dc inputs, a transistor and an LED.*

| INPUT (A) | OUTPUT (Y) |
|---|---|
| 0 | 1 |
| 1 | 0 |

*Test truth table*

| INPUT (A) | OUTPUT (Y) |
|---|---|
| 0 | 1 |
| 1 | 0 |

*Truth table for a NOT Gate*

As the truth tables are the same, we can confirm that this circuit is in fact a NOR gate (inverter).

| INPUT Voltage | OUTPUT Voltage |
|---|---|
| 0V | 5V |
| 5V | 0V |

*Table of the input and output voltages.*

As said earlier, a transistor will conduct current when a voltage is applied to the base. Therefore, it will not let current through it when no voltage is applied through the input. This makes it so that all the current applied from the DC power of 5V will stay in the loop (resistor, LED to the ground). Therefore, after the LED becomes a short circuit, the output at that LED is the same as the input (5V). This is confirmed by the table as seen above.

However, when the input applied to the base is HIGH, the transistor will let current through it into ground (as there is nothing connected to that part of the circuit). The power that was going through the LED when that input was LOW will not continue to flow as that power is drained and therefore the LED will not light up. This means that the output voltage at the LED will be of 0V (or close to) as no current is flowing through this part of the circuit, in this case the LED needs a cut in voltage of 0.7V (which will not be met), so the output taken at the LED is of 0V.

## Second Circuit

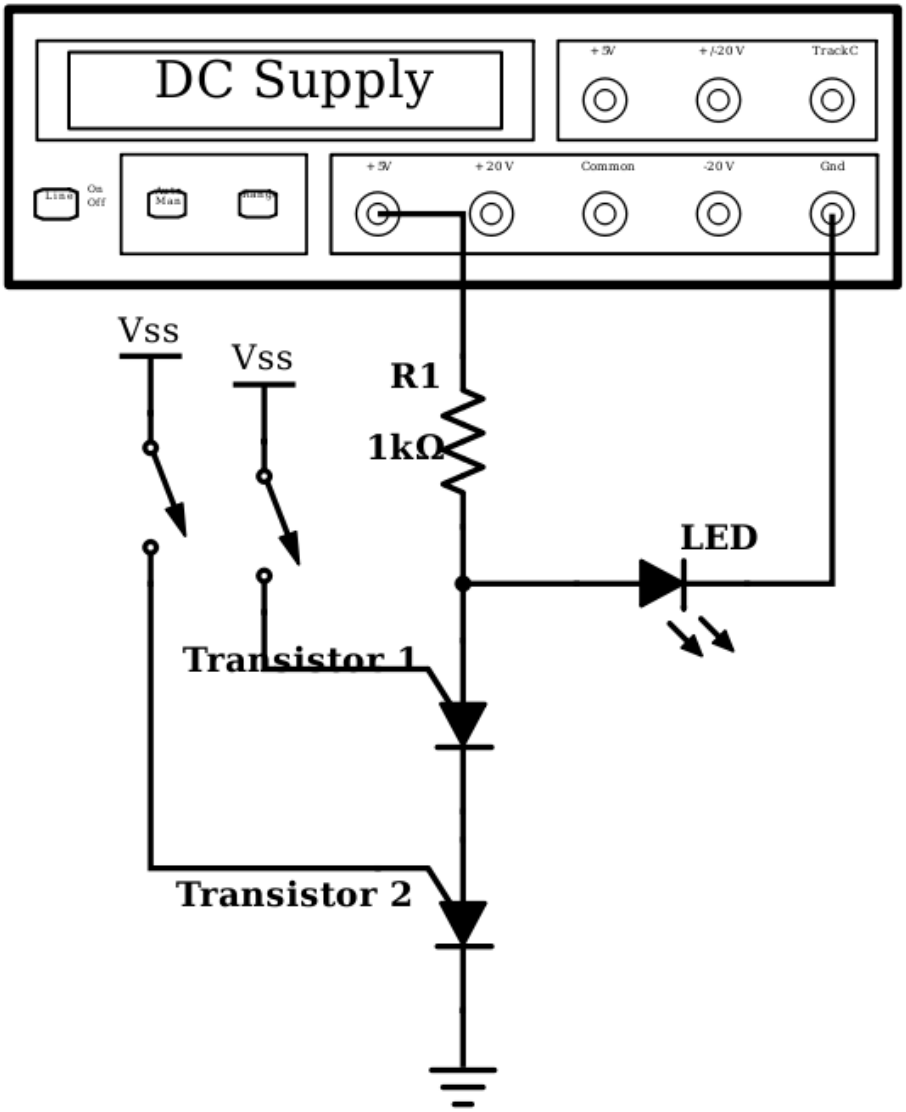



*Diagram for the second circuit, contains multiple inputs using 5V dc voltages as well as 2 transistors*

| INPUT A | INPUT B | OUTPUT Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

*Truth table for the second circuit*

| INPUT A | INPUT B | OUTPUT Y |
|---|---|---|
| 0V | 0V | 5V |
| 0V | 5V | 5V |
| 5V | 0V | 5V |
| 5V | 5V | 0V |

*Table of Input and output voltages*

For this circuit, two inputs are used as well as two transistors. This leads to 4 different possibilities (as there are 2 separate inputs). It is also noticeable that it simulates a NAND Gate.

- When both inputs are LOW, none of the transistors will let current through (and therefor drain current either). This means that current will flow through the LED into ground. The output at the LED is then the same as the input: 5V.
- When one of the inputs is HIGH and the other is LOW, there are two possibilities. The first one is that current is drained from the source but will not pass the second transistor and it will not let current through it. Therefore, the output at the LED is the same as above: the same as the input, 5V. The second possibility is that the second transistor will drain current from the output of the first. But, as the first transistor doesn't let any current through, it will drain no current and therefore the loop containing the LED acts the same as in the first possibility. The output voltage at the LED is the same as the input: 5V.
- Finally, when both inputs are HIGH, both transistors then drain power from the source. This means that little to no power is going through the LED loop. Therefore, the cut in voltage of the LED will not be met and so the output voltage at the LED will be of 0V.

## Use of the resistors in these circuits

The resistor connected right after the power supply limits the current through the LED (so it doesn't burn out). Therefore, using a resistance with a bigger value will limit the current flowing even more (this is shown using Ohm's law: V = IR). This means that it will allow less current to flow through the LED part of the circuit when the transistors drain power from the source.

## Conclusion

To conclude this lab, we have seen that transistors can act as switches by draining current from the source depending on the value of the input it is given. We have also seen it can create logic gates such as a NOT gate as well as a NAND gate.

## Websites used:

For creating the diagrams of each circuit:

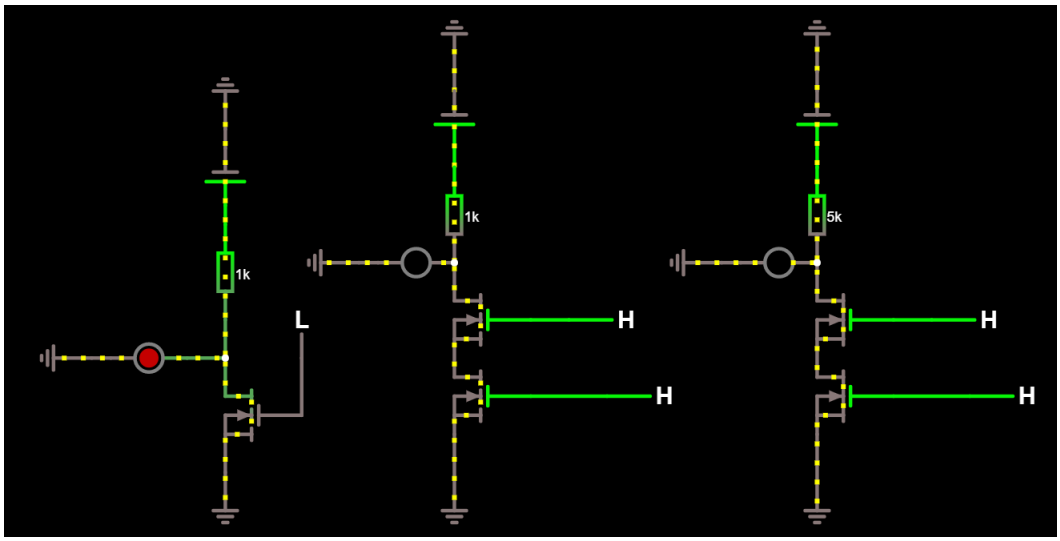
- https://www.digikey.com/schemeit/

For simulating some of the results:

- http://www.falstad.com/circuit/

I created a simulation for all of the circuits using this website as I struggled to make those work during the lab session.

Here is the link to my simulation: http://tinyurl.com/yboyed35




*Screenshot from the simulation of the circuits.*