Labs for Module 1

NEW: FAQ! (https://canvas.kth.se/courses/36215/pages/faq-lab-module-1)

The task to demonstrate to the Lab Assistant is at the end

Fall 2022 has a Power Supply instead of an Arduino in the Lab Kit

If you don't have an Arduino you can skip all parts relating to this

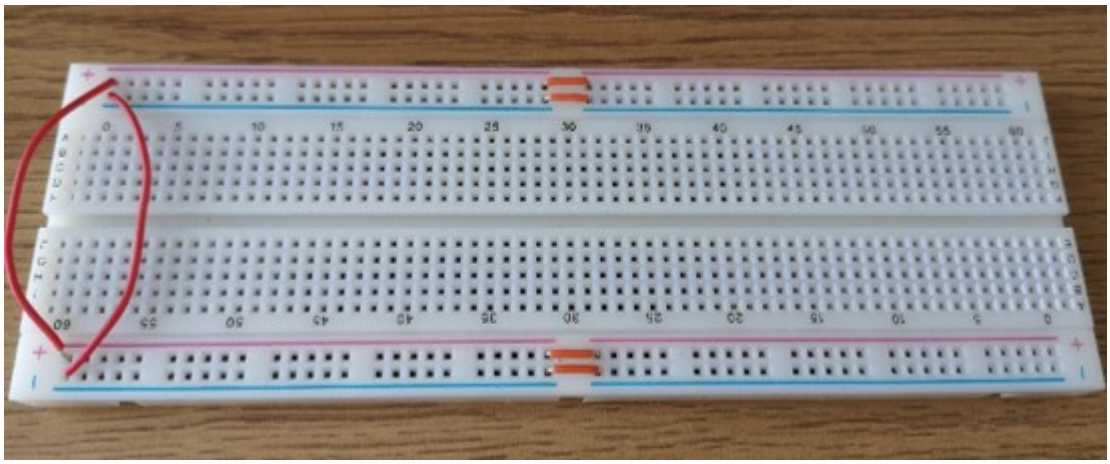
Getting started: Testing an XOR gate (74HC86)

NOTE: You can do this test without the logic analyzer generator in the Arduino

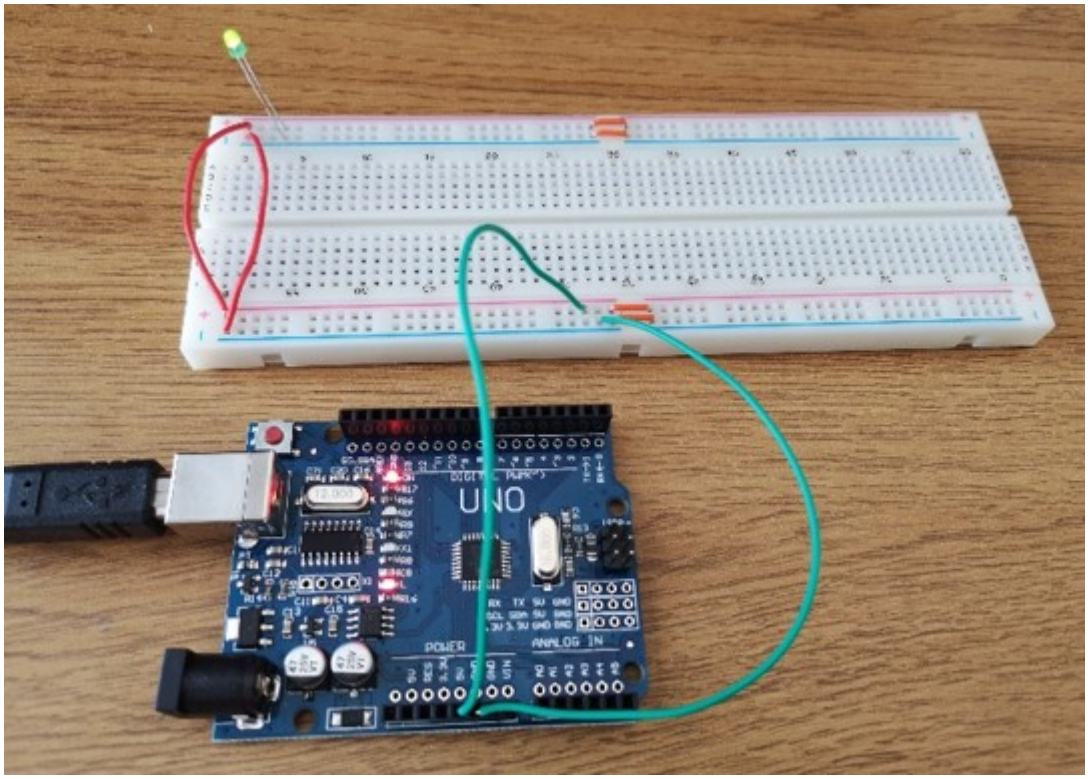
NOTE: You can also power the Arduino with a USB power supply or phone charger

NOTE: Never connect the Arduino output pins to the output from the gates!

Connect the bus bars on the breadboard together (4 short jumpers and 2 long jumpers



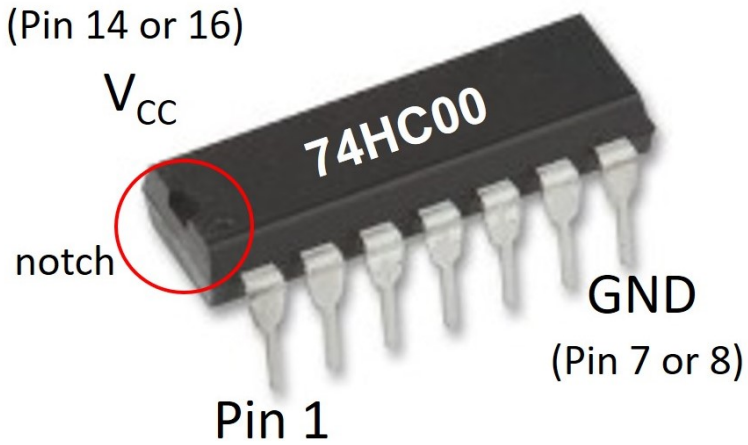
Connect 5V to “+” and GND to “-“ on the breadboard



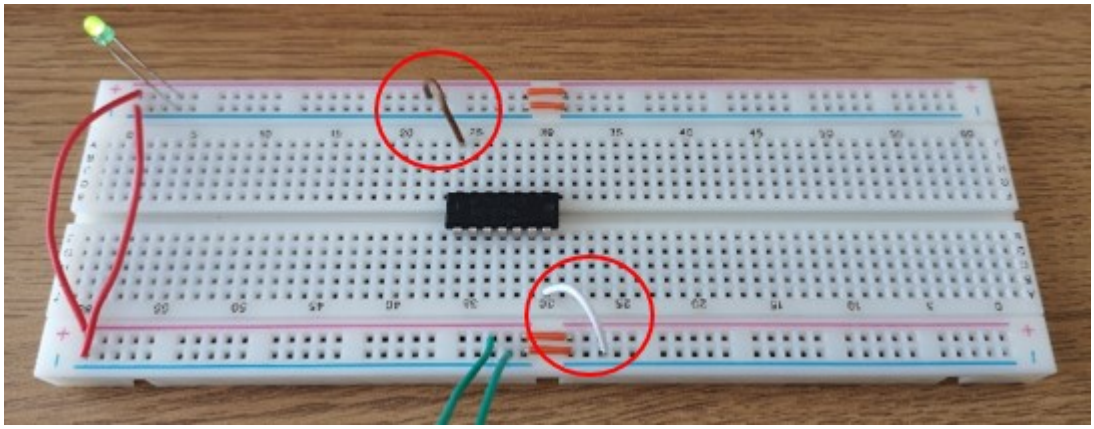
Connect the 74HC86 Integrated Circuit on the breadboard.

Note the notch and pin 1.

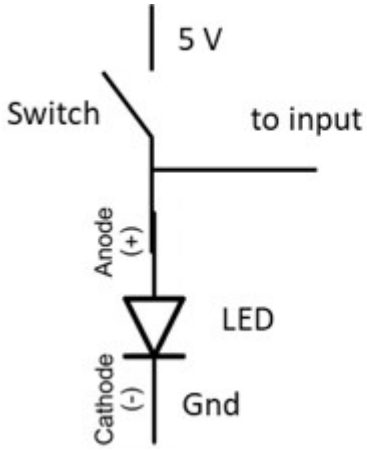
Always connect V_{CC} = 5 V and GND to all ICs
Identify pin 1 in relation to notch and text

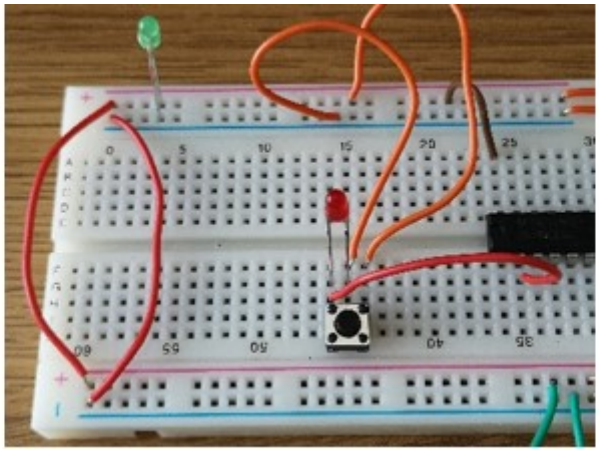


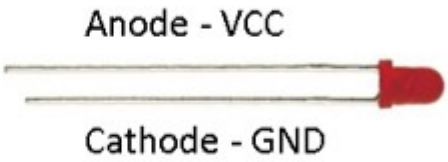
Connect VCC (pin 14) to “+” (5 V) and GND (pin 7) to “-“ (GND on Arduino)



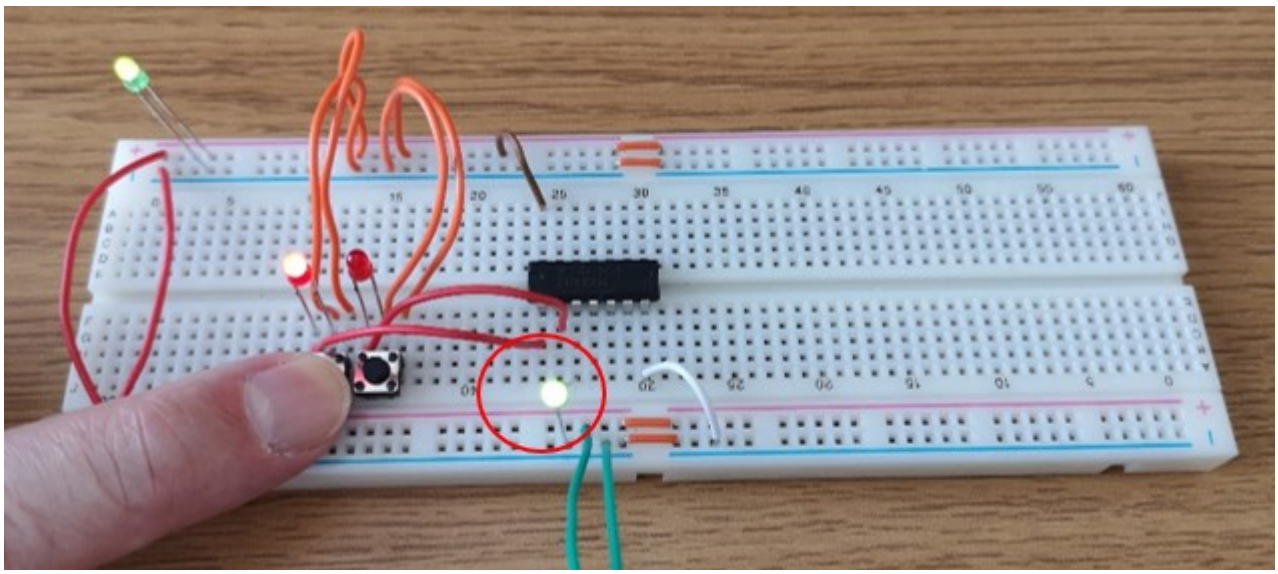
Connect pushbutton switches with LEDs according to the schematic, and then to the inputs (for instance pin 1 and 2).







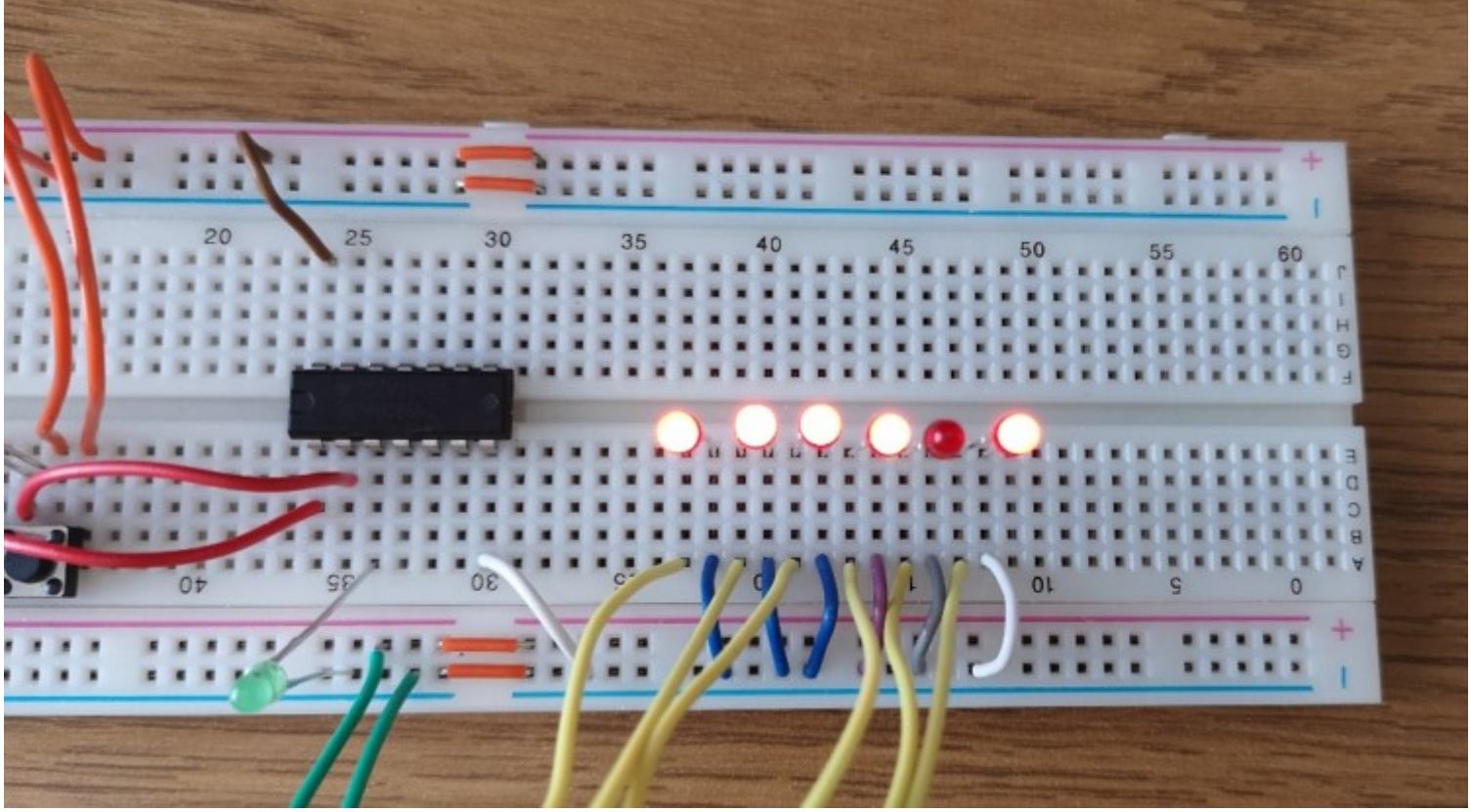
Connect an LED to the output (for instance pin 3)
Note that the short leg on the LED should be connected to GND.



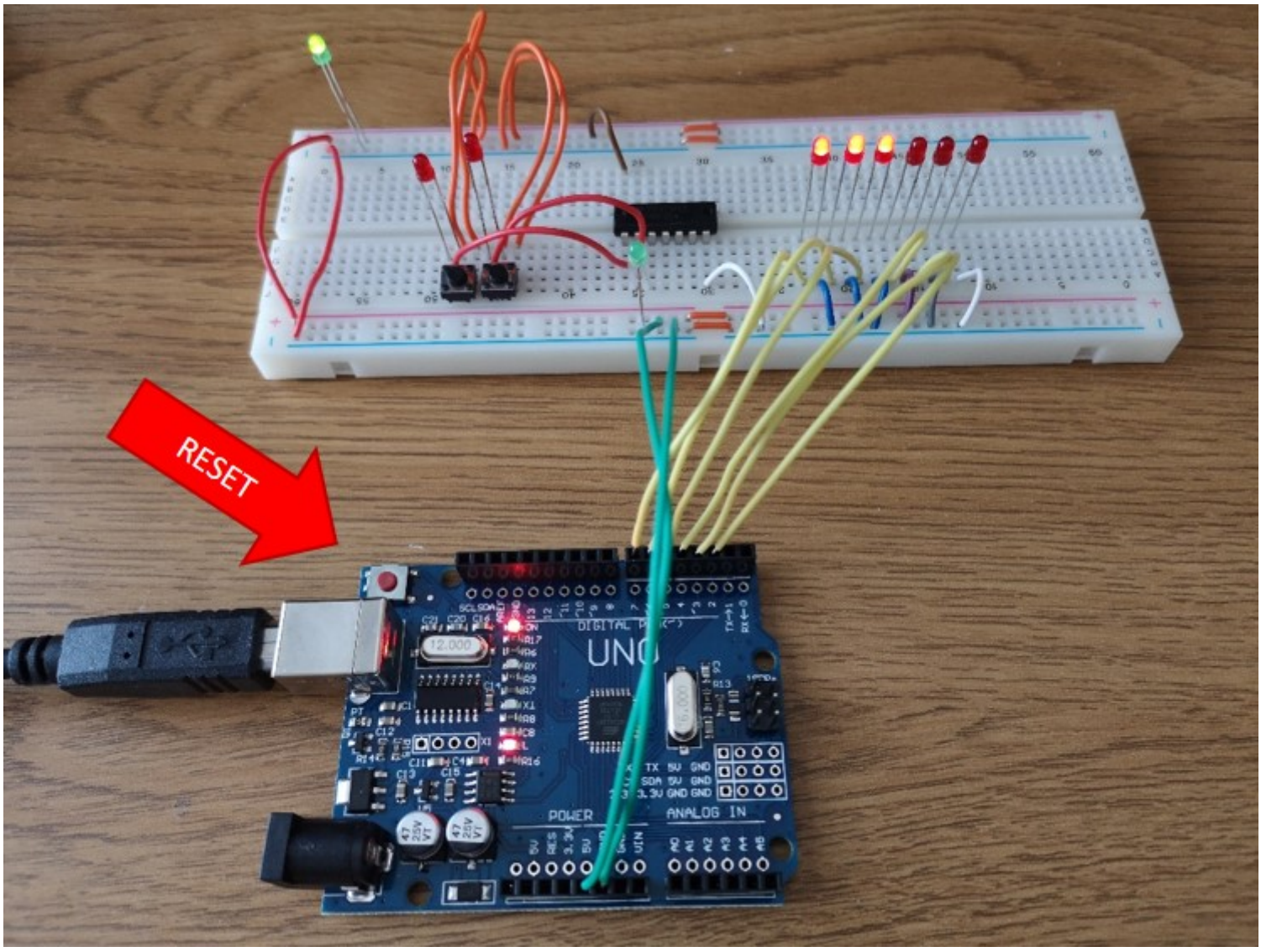
Connect “1” or “0” to the inputs by pressing the switches

Verify the truth table for the XOR gate

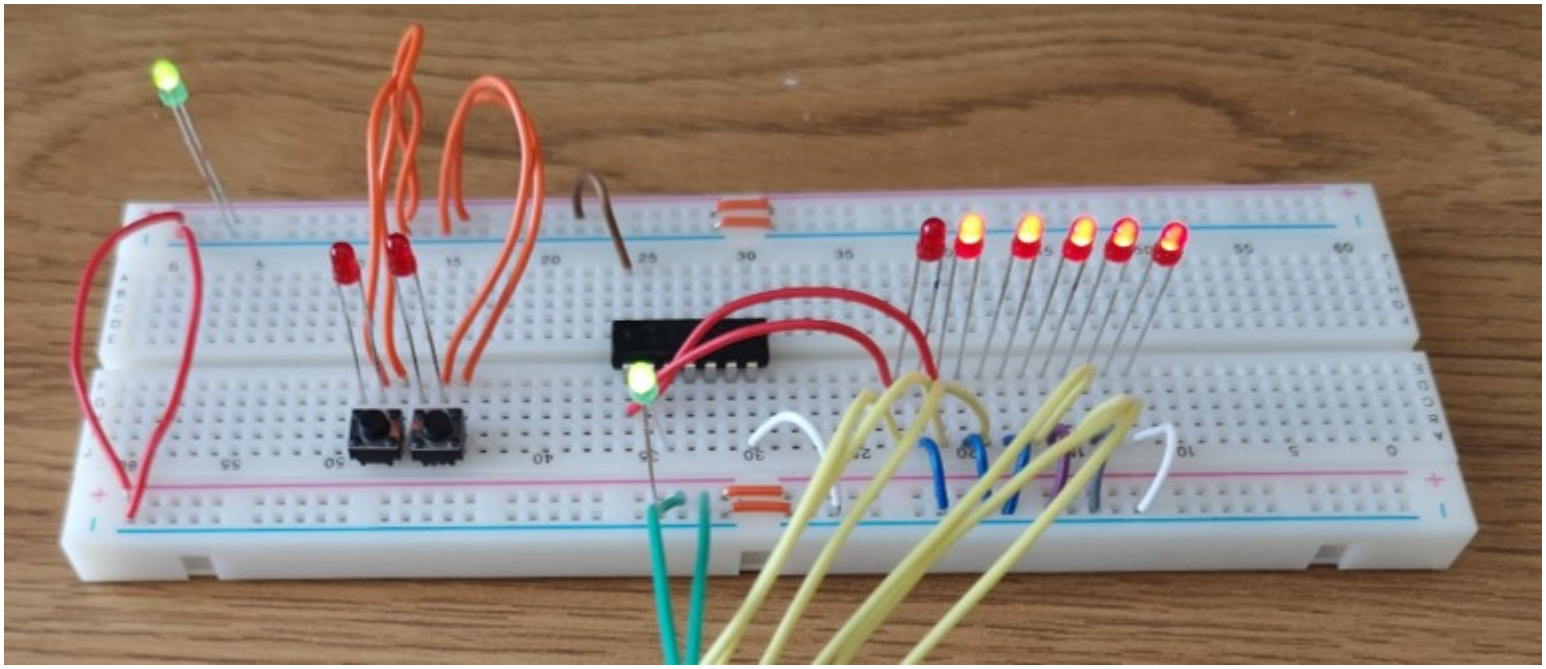
Connect pins 2 – 7 from the Arduino to the breadboard and use LEDs to see the logic states. They should blink in sequence



If they stop blinking, press the Reset button next to the USB connector on the Arduino

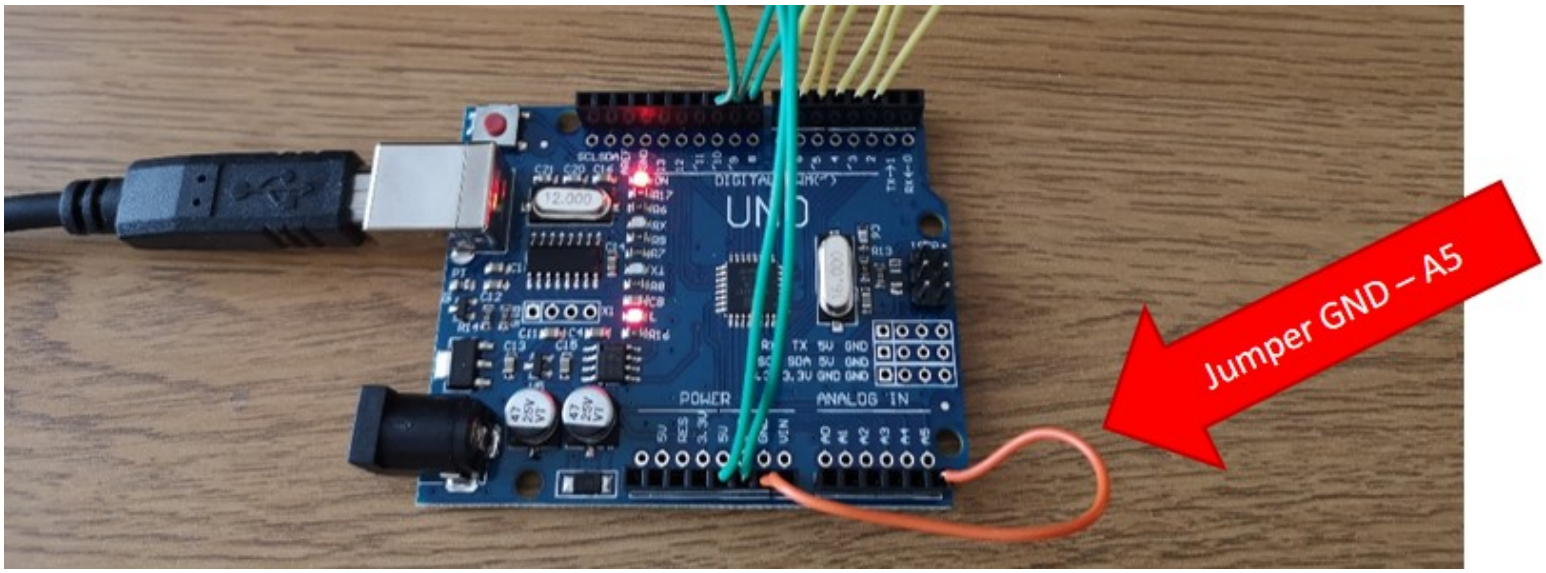


Connect two of these signals to the XOR gate inputs to verify the truth table.

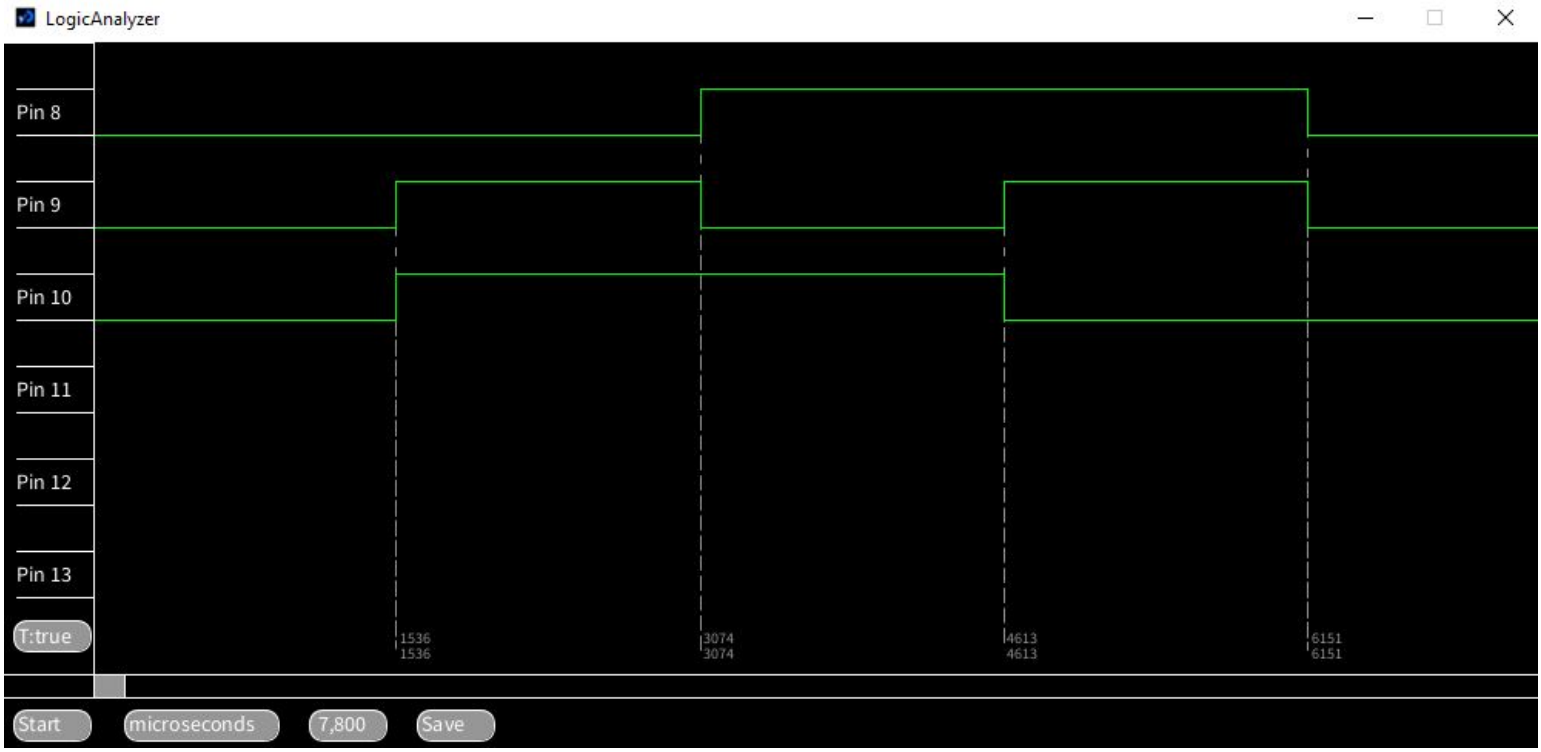


Connect the inputs to pin 8 and 9, and the output to pin 10 on the Arduino and test the LogicAnalyzer (run in “Processing”)

Note the jumper cable between GND and pin “A5” on the Arduino makes the logic analyzer run faster



Example output in “Processing” is shown below.



Testing other basic gates

NOTE: Never connect the outputs from two gates together!

Replace the 74HC86 with other logic gates such as 74HC00, 74HC08, and 74HC32.

These have the same pin configuration (see Quick Reference). Verify the truth tables.

Next try the 74HC02, 74HC04, 74HC11 and 74HC21.

They have different pin configurations, and may need more input signals, but the connections for VCC (pin 14) and GND (pin 7) are the same.

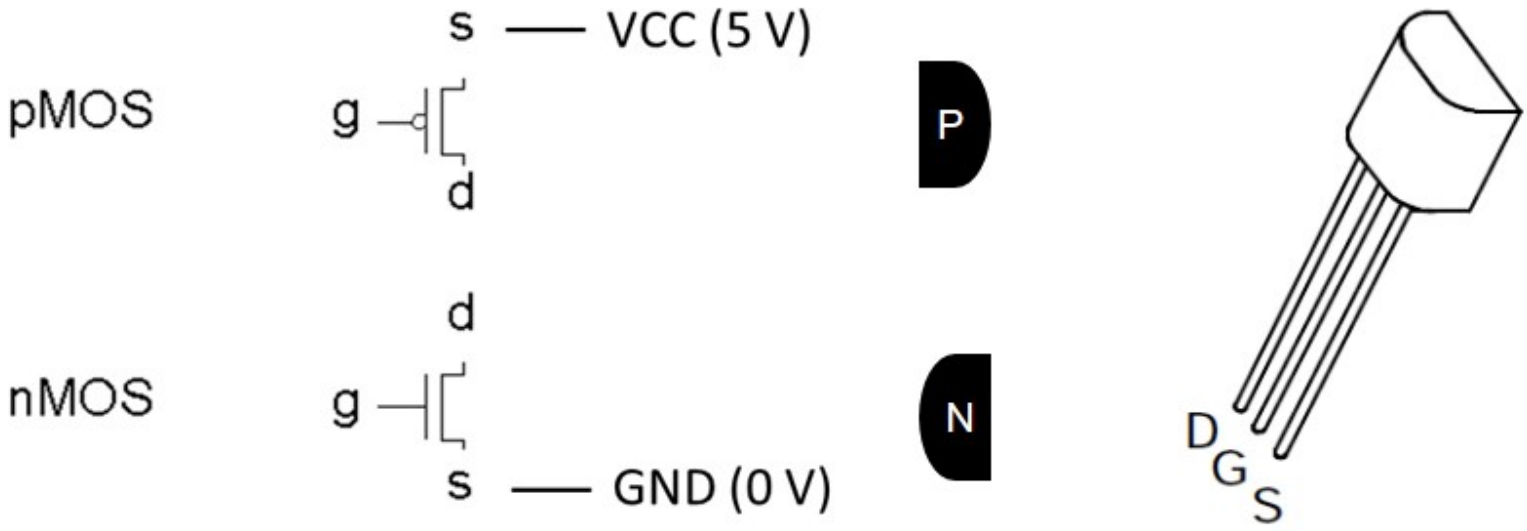
Try connecting some simple circuits from the textbook.

Building CMOS gates with discrete MOSFETs

NOTE: The Source and Drain connections on the MOSFETs have to be connected correctly otherwise the MOSFET will be damaged.

Source for PMOSFET connects to VCC (5V) (it is a source of holes)

Source for NMOSFET connects to GND (0 V) (it is a source of electrons)



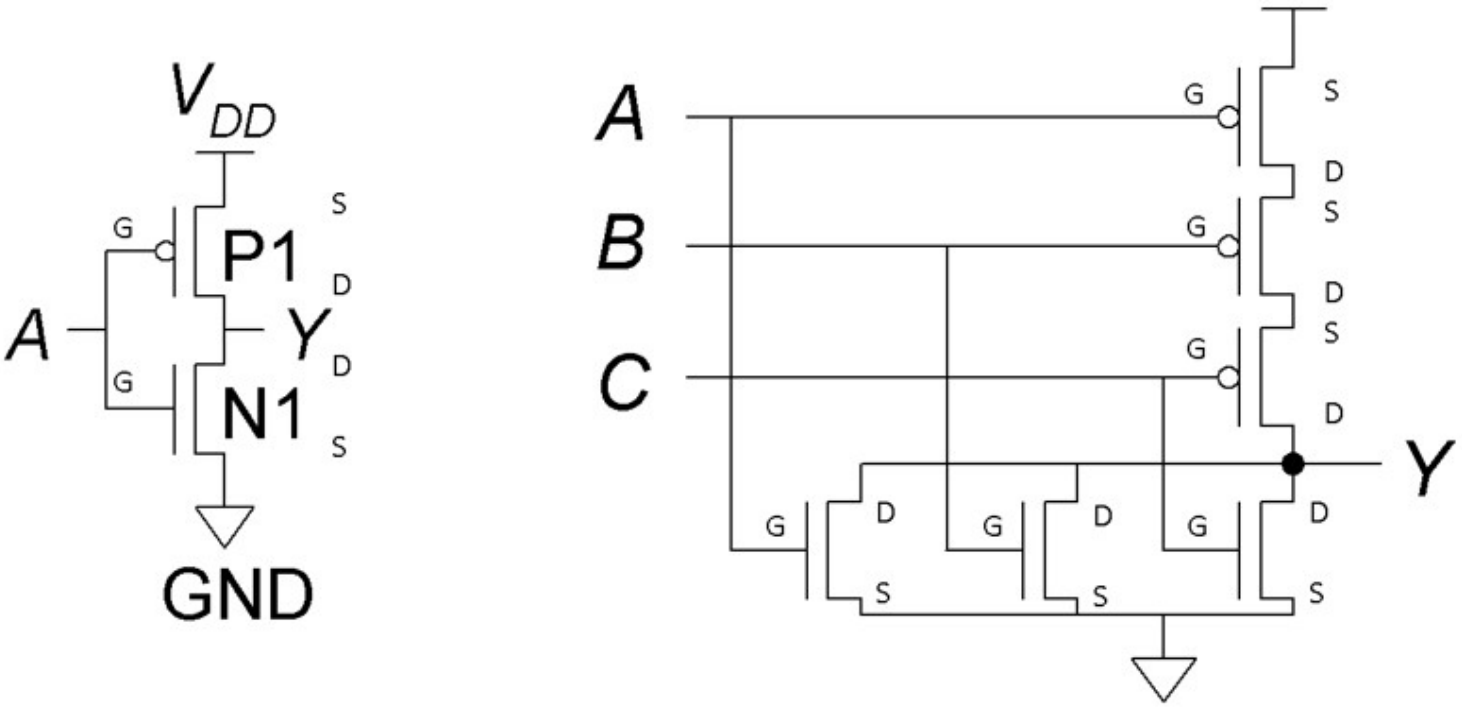
Find the 4 NMOSFETs and 4 PMOSFETs in the foil bag. They are labeled ZVN2106A and ZVP2106A respectively. N = NMOSFET, P = PMOSFET.

Refer to the figure above for pin configuration (same for both, see top view outline).

If “S” and “D” are swapped your transistor will be very hot and may be destroyed.

Connect and test a CMOS inverter on your breadboard.

Connect and test an inverter and three input CMOS NOR gate on your breadboard.



Module 1 task to report in the written Lab Report and demonstrate

If you are born on an odd date, build a three-input CMOS OR gate.

If you are born on an even date, build a three-input CMOS AND gate.

Draw the schematics for your three input CMOS gate using MOSFET transistors.

Connect it on your breadboard and verify the truth table using 3 pushbuttons with LEDs and a LED on the output.

Simulate it with Logisim (see separate instruction).

Take a photo of your working circuit.

Demonstrate this circuit to a Lab Assistant.