Laboration 1

Computer Architectures
for
MSc in Engineering

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Mattias Karlsson
Johan Larsson
Max Niia

2019-09-19

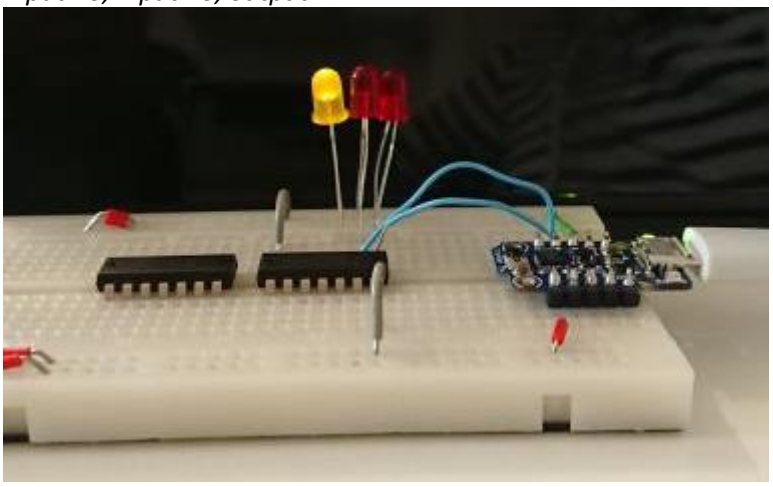
Task 1

The task was to connect a NAND gate and three diodes to verify that the only time the output was low was when both the inputs were high.

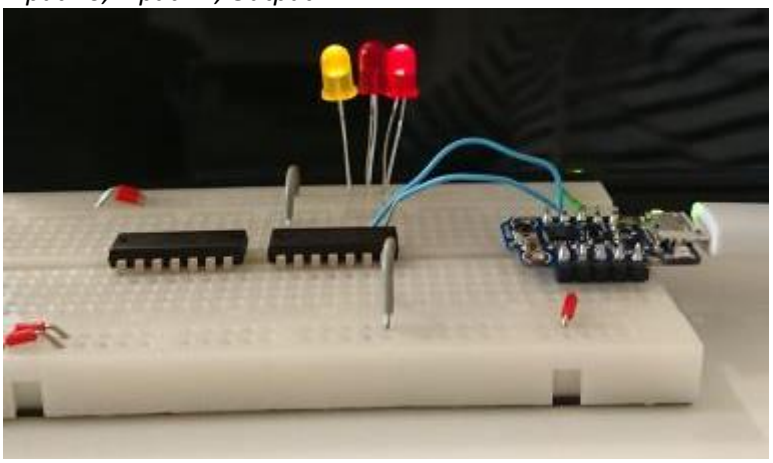
Input 1	Input 2	Output
0	0	1
0	1	1
1	0	1
1	1	0

To successfully verify the truth table above three LEDs has been used, output (yellow) and the two inputs (red). According to the truth table above the only time that the yellow LED was off was when both the red were on.

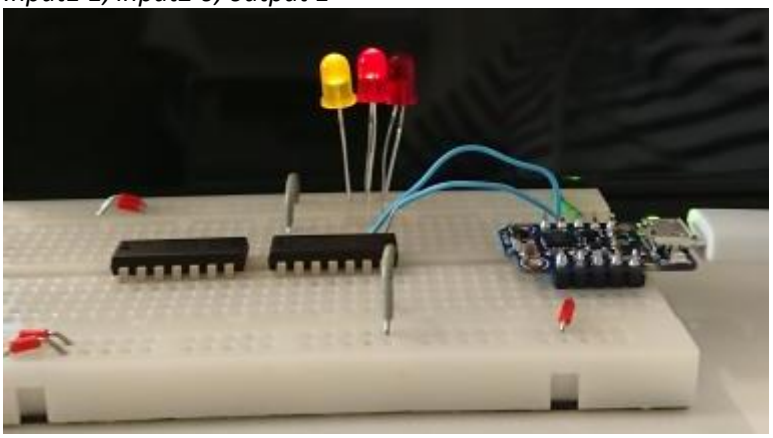
Input1 0, Input2 0, 0utput 1



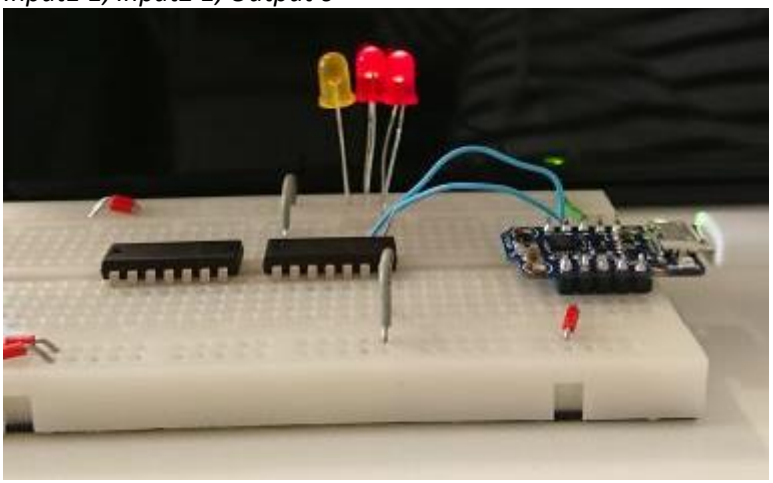
Input1 0, Input2 1, Output 1



Input1 1, input2 0, output 1



Input1 1, Input2 1, Output 0

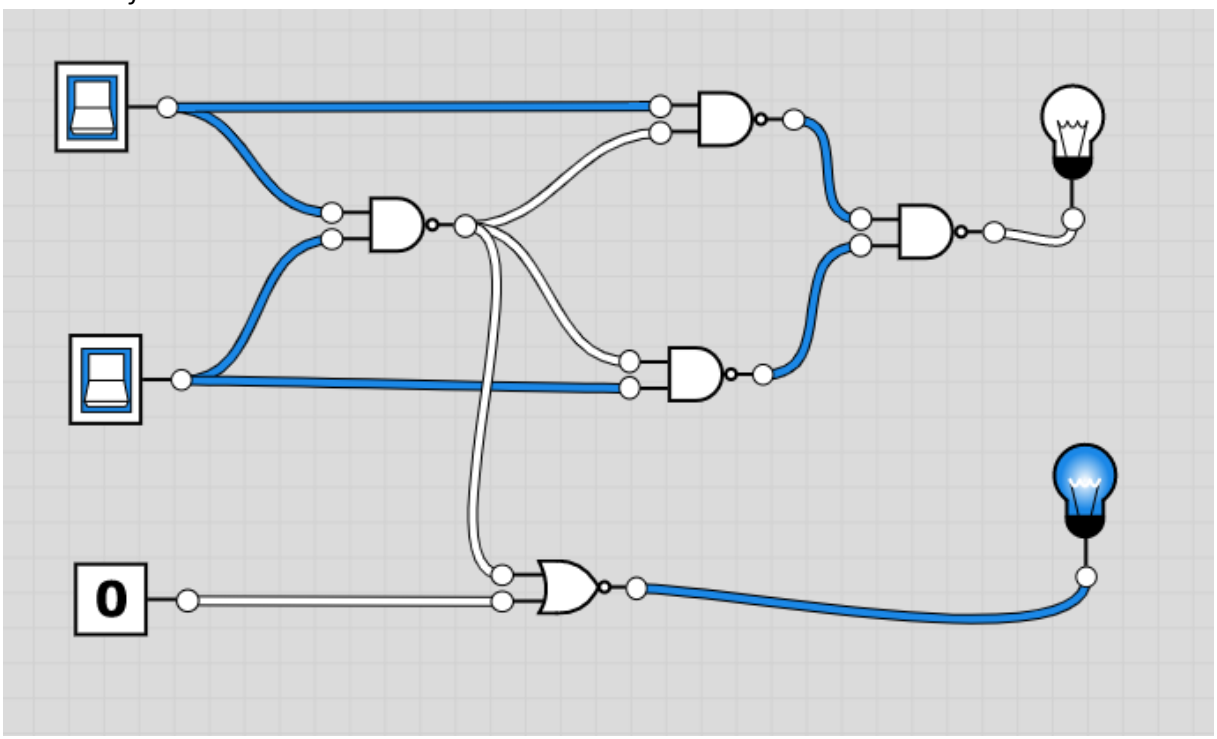


As seen in the pictures above the circuit does what it is supposed to.

Task 2

Problem solved is how to create a ‘Half-adder’ using four NAND-gates and one NOR-gate.

Schedule of the circuit

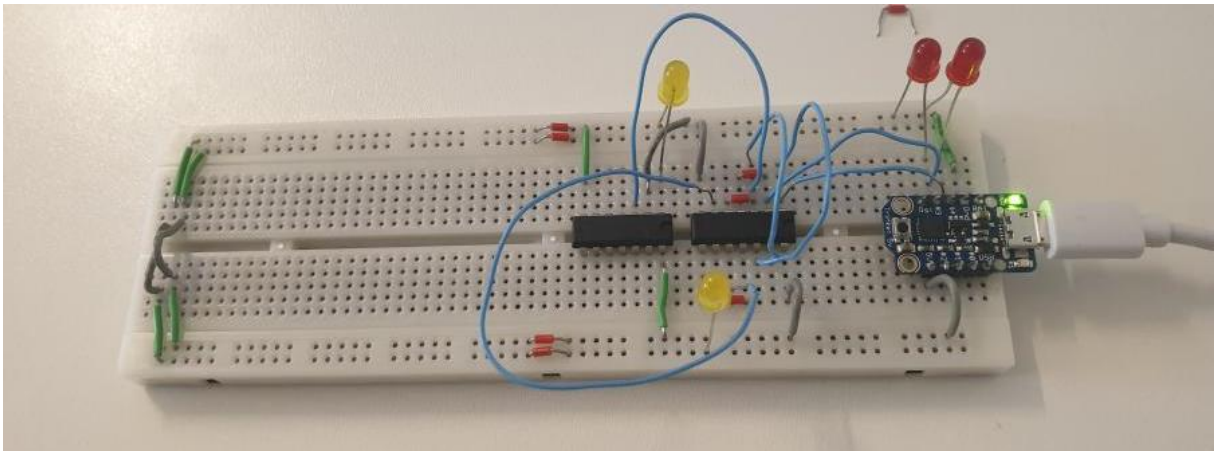


Truth table to match against

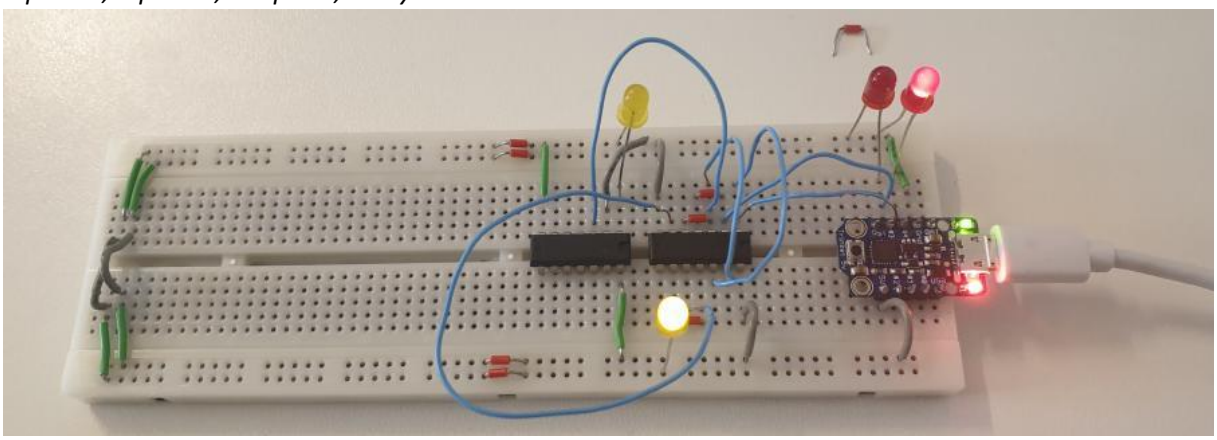
Input 1	Input 2	Output	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

In the pictures the carry is the top yellow LED, the result (output) is the bottom yellow and the two inputs are the two red LEDs.

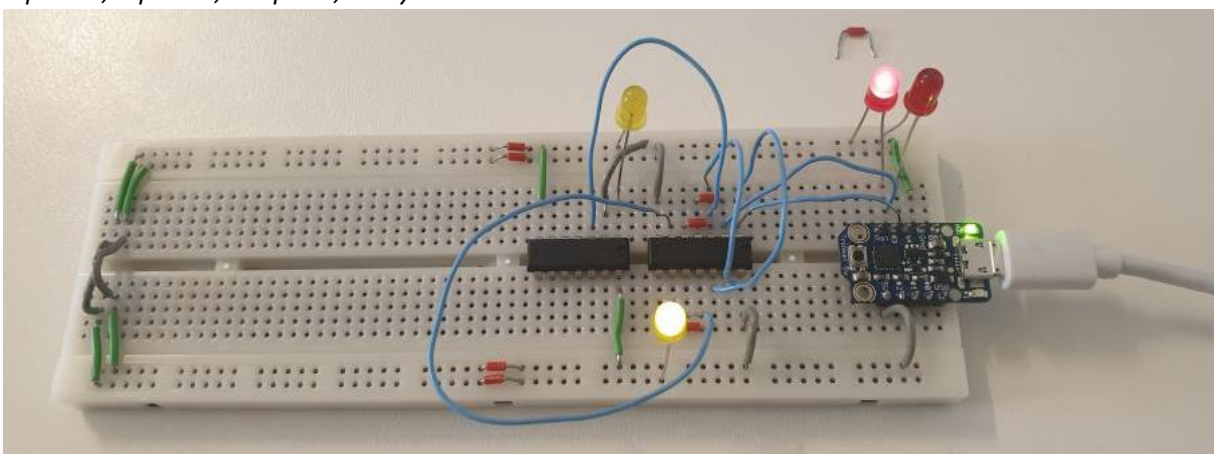
Input1 0, Input2 0, Output 0, Carry 0



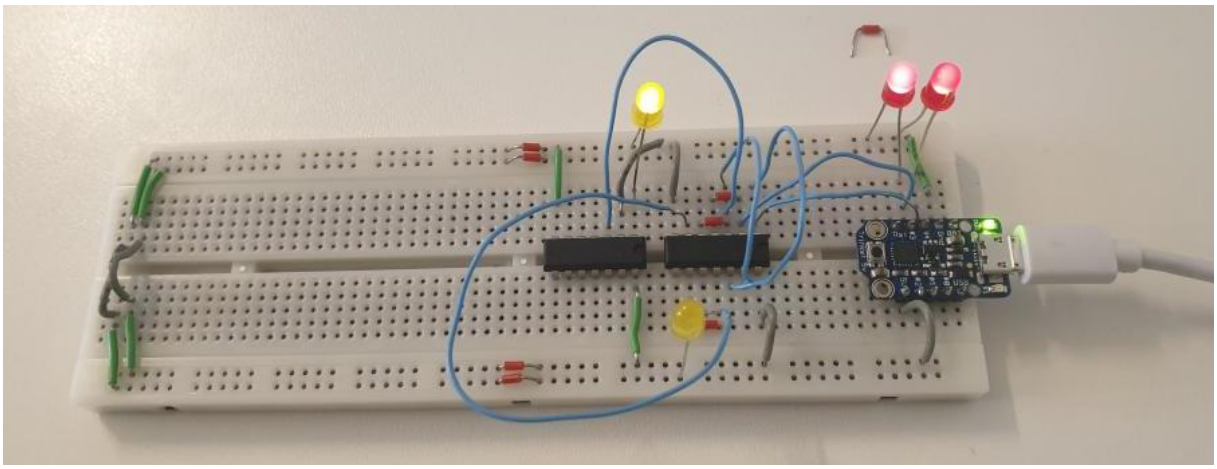
Input1 0, Input2 1, Output 1, Carry 0



Input1 1, Input2 0, Output 1, Carry 0



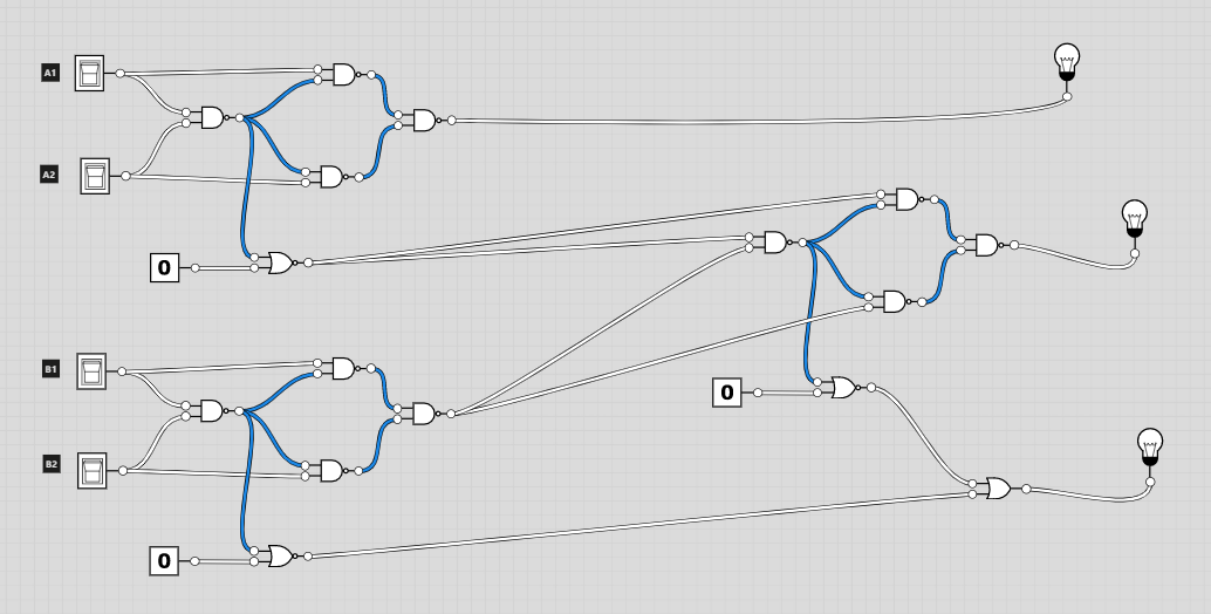
Input1 1, Input2 1, Output 0, Carry 1



Task 3

This will present the solution of how to build a Full-Adder circuit using 12 NAND-gats and 6 NOR-gates.

Schedule of the circuit

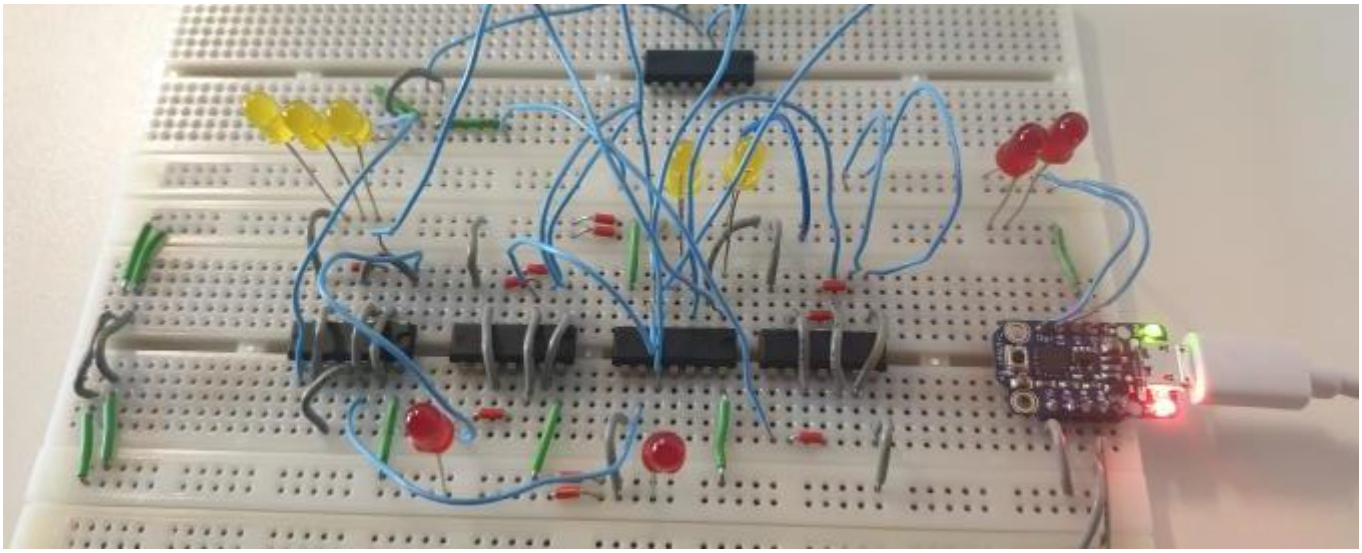


Truth table of said Full-adder.

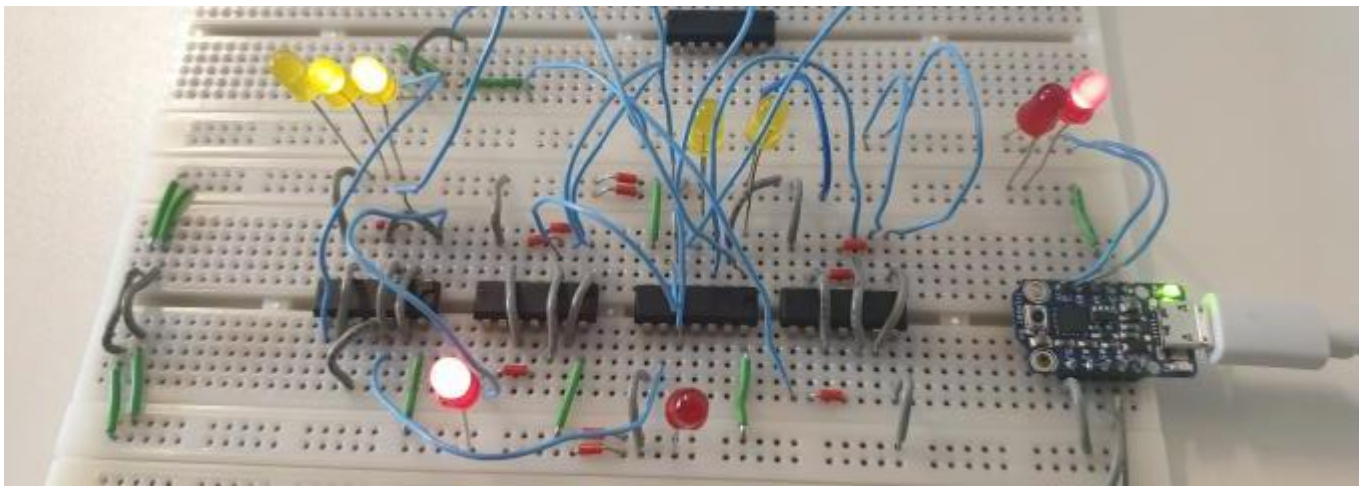
A1 (2^0)	IA2 (2^0)	B1 (2^1)	IB2 (2^1)	Output A (2^0)	Output B (2^1)	Carry (2^2)
0	0	0	0	0	0	0
0	0	0	1	0	1	0
0	0	1	0	0	1	0
0	0	1	1	0	0	1
0	1	0	0	1	0	0
0	1	0	1	1	1	0
0	1	1	0	1	0	1
0	1	1	1	1	0	1
1	0	0	0	1	0	0
1	0	0	1	1	1	0
1	0	1	0	1	1	0
1	0	1	1	1	0	1
1	1	0	0	0	1	0
1	1	0	1	0	0	1
1	1	1	0	0	0	1
1	1	1	1	0	1	1

To ease up on workload we didn't verify all possible combinations, we used the same inputs as lab 1 and 2 for this one. The possible combinations were therefore (1, 0, 1, 0), (0, 1, 0 1) and (1, 1, 1, 1) and (0, 0, 0, 0) which has been highlighted in the table above.
The output will be in vector notation (X, Y, Z) where X denotes the value of 2^0, Y the value of 2^1 and Z is the value of 2^2.
The output are the the yellow LEDs located at the top left of each picture.

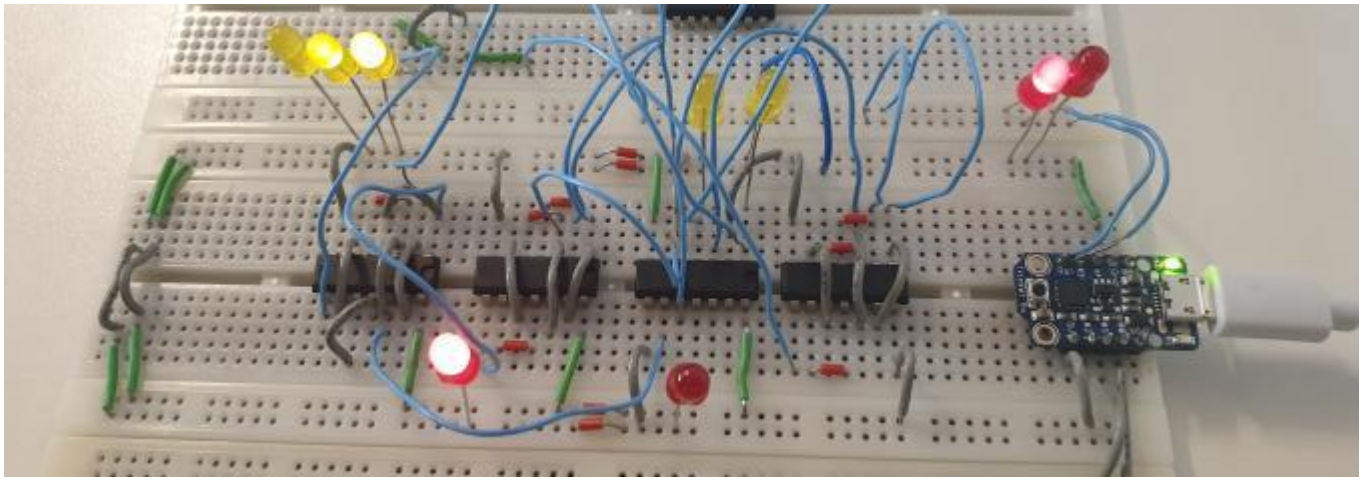
A1 0, A2 0, B1 0, B2 0, Output (0, 0, 0)



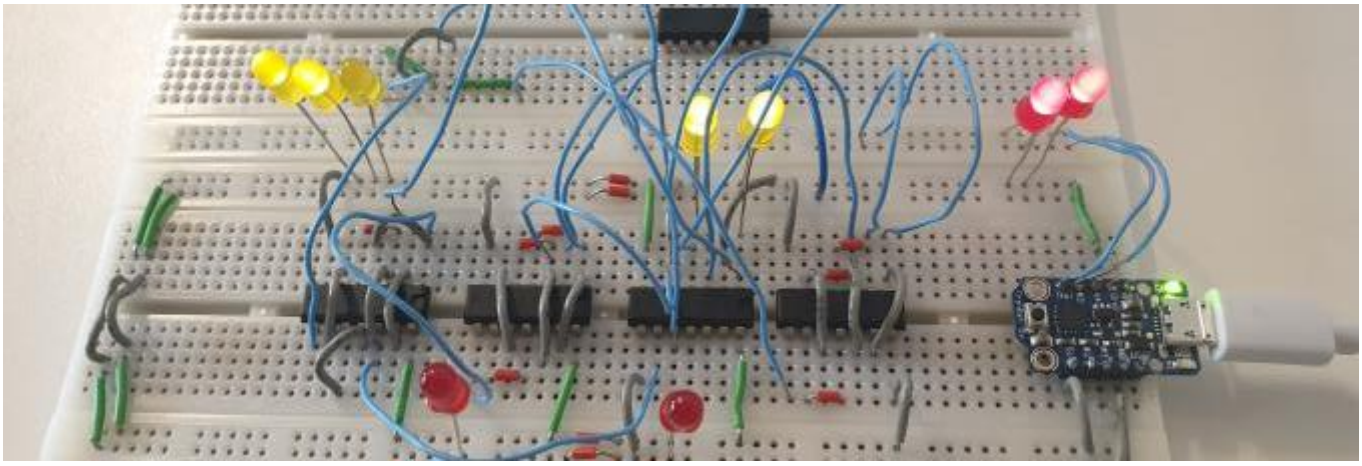
A1 0, A2 1, B1 0, B2 1, Output (0, 1, 1)



A1 1, A2 0, B1 1, B2 0, Output (0, 1, 1)



A1 1, A2 1, B1 1, B2 1, Output (1, 1, 0)



Code

The following was used in the Arduino IDE for task 1, 2 & 3:

```
#define a0 3
#define b0 4

void setup() {
                pinMode(a0, OUTPUT);
                pinMode(b0, OUTPUT);
}

void setHigh(){
                digitalWrite(a0, HIGH);
                digitalWrite(b0, HIGH);
                delay(1000);
}

void setLow(){
                digitalWrite(a0, LOW);
                digitalWrite(b0, LOW);
                delay(1000);
}

void setDif1(){
                digitalWrite(a0, HIGH);
                digitalWrite(b0, LOW);
                delay(1000);
}

void setDIf2){
                digitalWrite(a0, LOW);
                digitalWrite(b0, HIGH);
                delay(1000);
}

void loop(){
                setHigh();
                setLow();
                setDif1();
                setDif2();
}
```