Linnéuniversitetet
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2DT901 – Lab assignment 2: Digital circuits

Goal for this lab:

- Learn to read and interpret logic circuit diagrams.
- Learn to use a simulation software to simulate logic circuits.
- Gain some experience in using digital ICs to implement logic functions.
- Learn to use Karnaugh maps to simplify logic expressions.
- Gain some experience with basic logic circuits, like adders, multiplexors and latches (memory elements).

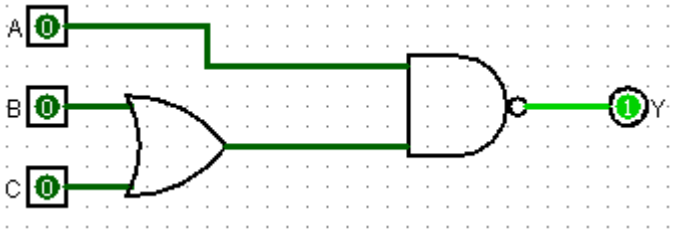
Presentation rules

1) You have to submit a report for assignment, with the LNU template.
2) You have to submit a file, either in *.docx* or *.pdf* format.
3) You are allowed to use this file to make you report, or you can use a new one. In the case you use a new file, make sure to refer to the exercises you are answering. In the case of a new file, you still have to use the LNU template.
4) The file you submit **must be renamed** as follows: <2DT901_goup_name_assignment2 >. Example: 2DT901_group2_assignment2.pdf.
5) Deadline is **8 May 2022**.
6) To pass the assignment, you must pass all the 7 tasks.
7) You have to make a short video in the presentation of task 7. In the video, you need to show that you have made a functional circuit and what happens when you set S=1, S back to 0, R=1 and R back to 0. You can insert a link to the video in the report. If you don't want to make a video, you can show your working digital circuit to the lab assistant instead.

Tasks

Task 1

The diagram below shows a simple combinational circuit.



a. Make a truth table for the circuit.
b. Write a Boolean (logical) expression that describes the function.
c. Use ICs from the 7400 family to create the circuit physically, on a breadboard.

Task 2

A logic function is described by the Boolean expression $\overline{A \cdot \overline{B} + C}$

a. Make a truth table that describes this function.
b. Draw a diagram of a digital circuit that implements the function.

Task 3

A logic function is described by the truth table below.

A	B	C	**Y**
0	0	0	**1**
0	0	1	**1**
0	1	0	**0**
0	1	1	**0**
1	0	0	**0**
1	0	1	**1**
1	1	0	**0**
1	1	1	**1**

a) Write a logic (Boolean) function that describes the function as a sum of products.
b) Use a Karnaugh map to find the simplest expression for the same logical function.

Task 4

A	B	C	D	Y
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

a) Draw a Karnaugh map to represent this logic function.

b) Use the Karnaugh map to find the simplest Boolean expression for the circuit.

c) Draw a logic diagram to implement the function, and verify that the circuit gives the correct truth table.

Task 5

An important digital component is the multiplexor, sometimes called a multiplexer or mux.

a. Read about multiplexors in the book Patterson&Hennessy and on Wikipedia. Write a short text (using your own words) that describe multiplexors.

b. Make a Truth Table describing a 2-to-1-mux.

c. Implement a 2-to-1-mux by using logic gates.

d. Find an application where a mux is used and explain why a mux is required in that application.

Task 6

In this task, you will design a 2-bit adder by using digital gates.

a. Make a truth table that describes a 2-bit adder.

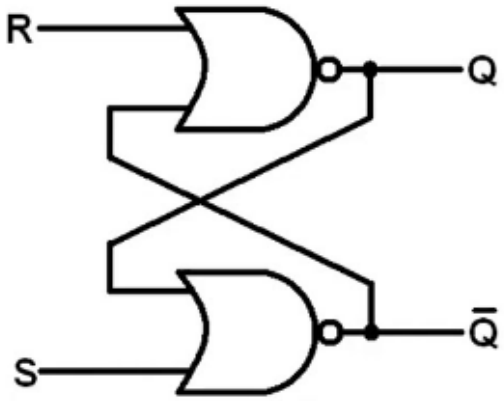
b. Draw a logic diagram (with logical gates) that implements the 2-bit adder.

c. Implement the logic diagram in DigiSim and show with a simulation that the circuit works properly.

Task 7

The logic diagram shows a simple sequential circuit called a SR latch, which is a simple memory element.

a) Build the circuit on a breadboard by using an IC from the 7400 family with NOR gates. Connect the outputs Q and $\overline{Q}$ to LEDs.
b) Set the input S to 1. What happens?
c) Set the input S to 0. What happens?
d) Set the input R to 1. What happens?



To present this task, you need to make a short video to show that it works properly, or show your working circuit to the lab assistant.