USTHB FI 2023-2024
1st Year Computer Science.
Module: STRM1

SERIE N°3

Exercise 1 :

A 7-segment display works with 7 leds, noted as follows: A led is lit when it is at '1'. We want to create a logic circuit with 4 inputs and 7 outputs to display the decimal digits of the BCD code. The one-digit BCD code is applied to the input and a Boolean function is assigned to each segment.

1. Calculate the 7 Boolean functions.
2. Create the circuit that controls the lighting of the leds using logic gates.

Exercise 2 :

Create the following 3-bit transcoders: a) Binary – Gray.

b) Gray-binary.

Exercise 3 :

We want to realize a two-bit comparator. It has two inputs (on two bits) A_1A_0 , B_1B_0 and three outputs (E: Equal, L: Lower and S:Superior)

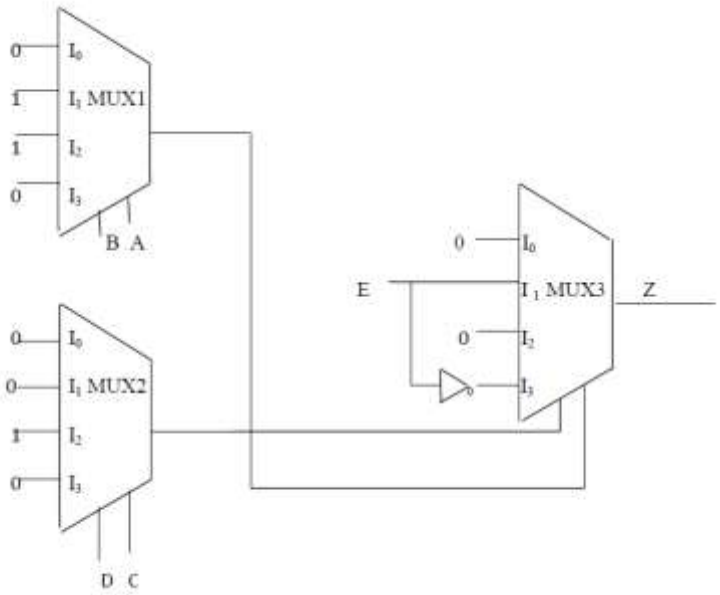
- E =1 if $A_1A_0 = B_1B_0$
- L=1 if $A_1A_0 < B_1B_0$
- S=1 if $A_1A_0 > B_1B_0$

1. Give the truth table of the circuit.
2. Simplify the logical equation by using Karnaugh's map.
3. Perform the function E using NOR gates.
4. Perform the function L using NAND gates.
5. Perform the function S using a MUX 4*1 and logic gates.
6. Perform the function E with a DEC 2*4 and a Mux 4*1.

Exercise 4 :

Consider the montage shown in the figure below, which consists of three MUX-1, MUX-2, and MUX-3 multiplexers, each with 4 inputs.

1. Give the logical expression of Z as a function of A, B, C, D and E.
2. Create the Z circuit with exclusive OR gates.
3. We want to reduce the number of MUXs to a single MUX 8*1, create the corresponding circuit. Logic gates can be used if necessary.



Exercise 5 :

We want to create the circuit that controls the quality of bricks in a factory. We carry out a quality control according to four criteria, weight A and 3 dimensions (length B, width C and height D). By adopting the logic: 0 for incorrect and 1 for correct, we can classify the bricks into three categories:

- **Quality X:** Weight A and at least two dimensions are correct.
- **Quality Y :** -The weight A alone is incorrect.
  - The weight A being correct, at least two dimensions are incorrect.
- **Quality Z :** The weight A is incorrect, one or more dimensions are incorrect.

1. Draw up the truth table of the circuit (A is the most significant variable). Give simplified expressions for X, Y, and Z using Karnaugh-Maps. Draw the circuit of X with only NAND gates.
2. Realize Y with a DEC3*8 and logic gates.
3. Realize Y with a minimum of MUX 4*1.

Exercise 6 :

We want to create a circuit that prevents the wheels of a car from locking when braking. For that, we need the speed of each of the front wheels. It is encoded in 4 bits as follows:

- **A, B** : for left wheel speed;
- **C, D** : for right wheel speed.

The circuit to be studied generates two braking outputs $\mathbf{F_l}$ for the left wheel and $\mathbf{F_r}$ for the right wheel according to the following operation:

- ✓ If the speed of the two wheels is the same, the two outputs $\mathbf{F_l}$ and F_r are at 0.
- ✓ If the speed of the left wheel is greater than that of the right wheel, the left wheel is braked ($\mathbf{F_l} = 1$; $\mathbf{F_r} = 0$).
- ✓ If the speed of the left wheel is lower than that of the right wheel, the right wheel is braked ($\mathbf{F_l} = 0$; $\mathbf{F_r} = 1$).

1. Establish the truth table.
2. Using the Karnaugh method, give the simplified disjunctive functions of $\mathbf{F_l}$ and $\mathbf{F_r}$.
3. Create the Fg circuit using NAND gates only.
4. Create Fg with a DEC 3*8 and logic gates.
5. Create Fd using MUX 4*1.