Tutorial Series 2
MACHINE STRUCTURE

Exercise 1:

Provide the associated functions (**F**irst and **S**econd **C**anonical **F**orms) for each Karnaugh map:

1)

C \ AB	00	01	11	10
0			1	1
1		1	1	

2)

CD \ AB	00	01	11	10
00		1		1
01	1	1	1	1
11	1	1	1	1
10		1		1

Exercise 2:

Simplify with Karnaugh Map the logical functions represented by the following tables:

1)

C \ AB	00	01	11	10
0	1			1
1	1	1		1

2)

CD \ AB	00	01	11	10
00			1	1
01				
11	1			1
10	1		1	1

3)

CD \ AB	00	01	11	10
00		1		1
01				
11	1	1		
10				1

4)

CD \ AB	00	01	11	10
00	1	1	1	1
01	1	1		1
11	1	1	1	1
10	1	1	1	1

5)

CD \ AB	00	01	11	10
00	1		1	1
01	1			1
11				
10	1		1	1

6)

CD \ AB	00	01	11	10
00	1	1	1	
01	1	1		1
11	1	1		1
10	1	1	1	

Exercise 3:

1- Provide the simplified notation (decimal form) of the following Boolean equations:

$F_1(X,Y,Z) = X+\bar{X}.\bar{Z}$

$F_2(A,B,C)=A.B + A.\bar{B}.C$

2- Provide the simplified notations (two notations) of **F** associated with the following Karnaugh map:

CD \ AB	00	01	11	10
00		1		
01				
11	1			1
10	1		1	1

Exercise 4: (Logic circuit synthesis)

1- Simplify $F(A,B,C,D)=\sum(1,2,3,5,6,7,8,10,12,13)$
2- Draw the associated circuit.

Exercise 5: (Logic circuit synthesis)

A hot beverage vending machine offers the following possible drinks to customers:

- Short sweetened coffee
- Short unsweetened coffee
- Long-sweetened coffee
- Long unsweetened coffee
- Long sweetened coffee with milk
- Long unsweetened coffee with milk
- Sweetened milk
- Unsweetened milk

The vending machine orders are:

- short coffee = **a**
- long coffee = **b**
- sugar = **s**
- milk = **m**

Question: Provide the synthesis of the associated circuit.

Exercise 6: (Logic circuit synthesis)

Three switches, $\mathbf{S_1}$, $\mathbf{S_2}$, and $\mathbf{S_3}$, control the startup of a system with two motors, $\mathbf{M_1}$ and $\mathbf{M_2}$.

a- If one or more switches are activated, motor $\mathbf{M_1}$ starts.
b- If at least two switches are activated, motor $\mathbf{M_2}$ starts.

Question: Provide the synthesis of the associated circuit.

Exercise 7:

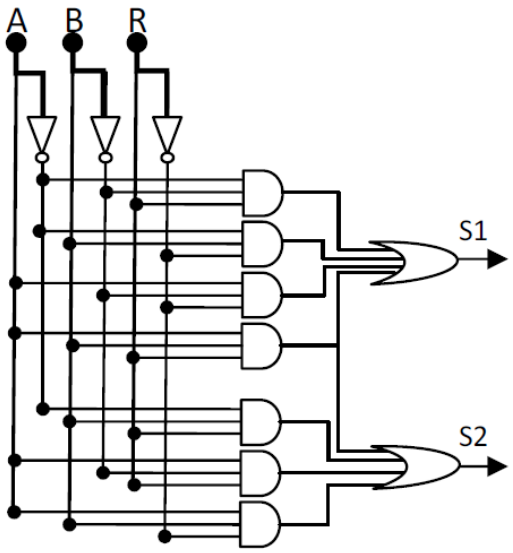
Let **G** be a Boolean function such that:

G= (x.y.z) + (x+y)

1- Draw the circuit associated with G.
2- Use NOT, AND, and OR gates to express G, and draw the associated circuit for G.

Exercise 8: (Analysis of a logic circuit)

Consider the following flowchart:



The analysis of this circuit involves answering these questions:

1- Determine the functions of the circuit (S_1 and S_2).
2- Simplify the equations S_1 and S_2 (using only AND, OR, and NOT).
3- Reuse AND, OR, NOT, XOR, and XNOR gates to obtain the equivalent circuit with fewer logic gates.
4- Draw the obtained circuit.

Exercise 9:

Provide the logic circuits of a half binary subtractor and a full subtractor.

Exercise 10:

Find the combinational circuit that converts binary (3 bits) to Gray code.