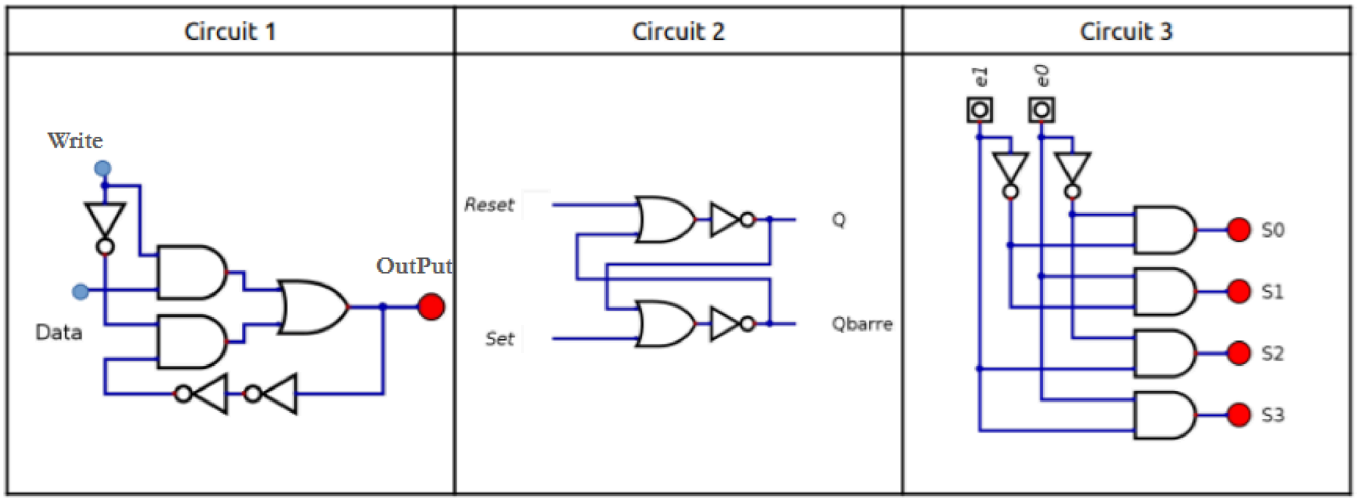
Combinational Logic

Exercise 1:

1- Create a logic circuit to check whether a four-digit (a,b,c and d) binary number is prime.

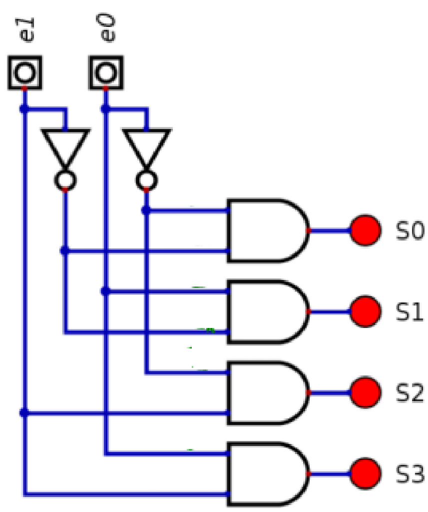
2- Identify the two primary categories of existing logical circuits?

3- Indicate if the circuits below are CLCs? If so, why? If not, substantiate your response with appropriate justification?



4- Clarify the difference between 'analysis' and 'synthesis' in the context of a logic circuit.

5- Analyse the logical circuit:



Exercise 2: Propose a design for an overflow detection circuit, with the principal objective of ascertaining the occurrence of overflow subsequent to a computational process involving two variables, A and B. This design should carefully take into consideration the sign of both A and B, along with the resultant sign, R, emanating from the computation between A and B.

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Exercise 3:

1- Construct an adder circuit for two 2-bit words, $A(a_0,a_1)$ and $B(b_0,b_1)$.

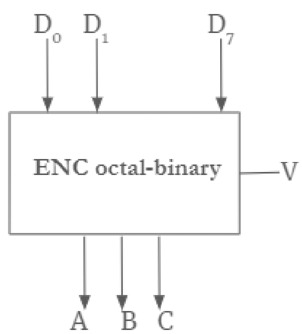
2- Assuming the circuit includes a third anterior retaining input, C_{i-1}, create a logigram for a full adder designed to sum two 8-bit numbers using the previously mentioned circuit.

Exercise 4: Consider the block diagram of an octal-to-binary encoder in the following figure, where V represents a circuit validation input.

1- Draw the truth table connecting the inputs and outputs of this circuit.

2- Provide the output expressions.

3- Create the logigram for this circuit.



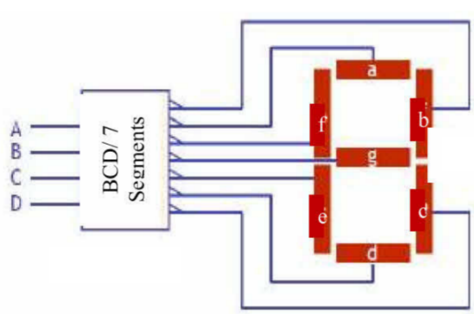
Exercise 5: 7-segment displays are a type of display commonly found in digital display circuits, such as watches, calculators, … etc. Characters are displayed by turning on or off segments, of which there are seven. The segments are most often designated by the letters: a, b, c, d, e, f, g.

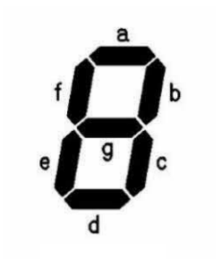
We aim to design a circuit that decodes BCD code into 7-segment code. In other words, this circuit will take a BCD number as input and activate the corresponding segments on the 7-segment display to display that number.

1- Construct the truth table

2- Simplify using Karnaugh maps, then deduce the simplified logical expressions for outputs.

3- Establish the logigram.





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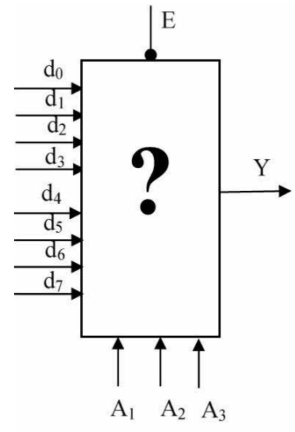
Exercise 6: Consider the switching circuit represented by the following figure .



1- What is the name of this circuit, and what roles do each of these inputs and outputs serve?

2- Create a truth table and provide the logical expression for its output.

3- Illustrate the logic diagram of this circuit.

Let F be a function with three variables defined by the following expression: ***F(x,y,z) = Σ(1, 3, 5, 7).***

4- Implement this function using the circuit.

5- Design an equivalent circuit using a 4x1 Multiplexer (MUX).

Exercise 7: Consider the symbolic diagram of a demultiplexer represented by the following figure:

1- Why does the circuit in this form not work correctly? Propose a solution and draw up the new circuit.

2- Draw up the truth table for this circuit and deduce the output expressions.

3- Create the demultiplexer logic diagram.

4- Utilize the demultiplexer to execute the logic function

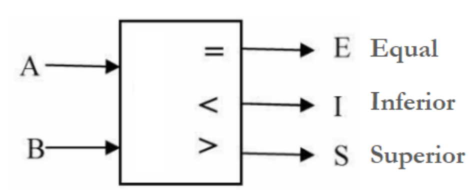
F_1(a, b, c, d)=(0, 2, 4, 6, 8, 10, 13, 14, 15).

5- Repeat the same procedure for F_2(a, b, c, d) = (1, 2, 3, 5, 7).

NB: Consider the MSBgfdw as the variable A2.

Exercise 8: Let A and B be two two-bit binary numbers, where A and B are represented as $A=(a_1a_0)$ and $B= (b_1b_0)$.We aim to design the comparator circuit depicted in the following figure.

1- Draw the logic diagram of the comparator using ports with two inputs.



Exercise 9: Three electrical switches, I_1, I_2, and I_3, regulate the activation of two motors, M_1 and M_2, based on the following conditions:

- Motor M_1 should only start when at least two switches are closed (I_i=1).
- As soon as one or more switches are activated, the motor M2 must start.

1- Create the logic diagrams for M_1 and M_2 using only NAND gates.

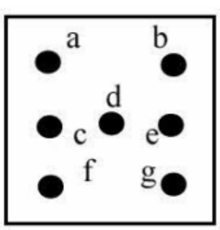
2- Repeat question 1 using only NOR gates.

Exercise 10: Consider an electronic dice, depicted in the figure below (figure a), which consists of 7 LED diodes.

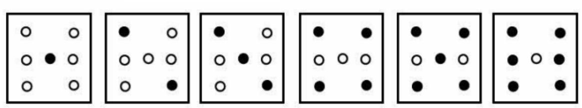
We aim to design the control logic circuit for illuminating these diodes using 3 inputs in binary code (x, y, z) and 7 outputs (a, b, c, d, e, f, g) connected to the diodes (figure b). The various combinations for displaying numbers on the die are illustrated in figure b. For instance, to display the number 2, diodes a and g must be illuminated. Note that for input combinations 0 (000) and 7 (111), no diode should be lit.

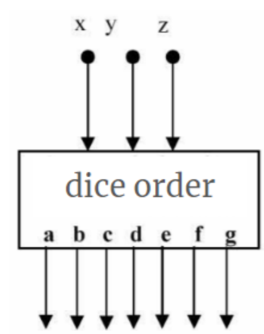
1- Create the operational truth table for the control circuit.

2- Provide simplified expressions for each output, and generate the corresponding flowchart using only NAND gates.



(figure a)


(figure b)



(figure c)