Sétif 1 University
Faculty of Sciences
Common Core Mathematics and Computer Science

2nd semester (year 2023/24)
Machine Structures 2 course
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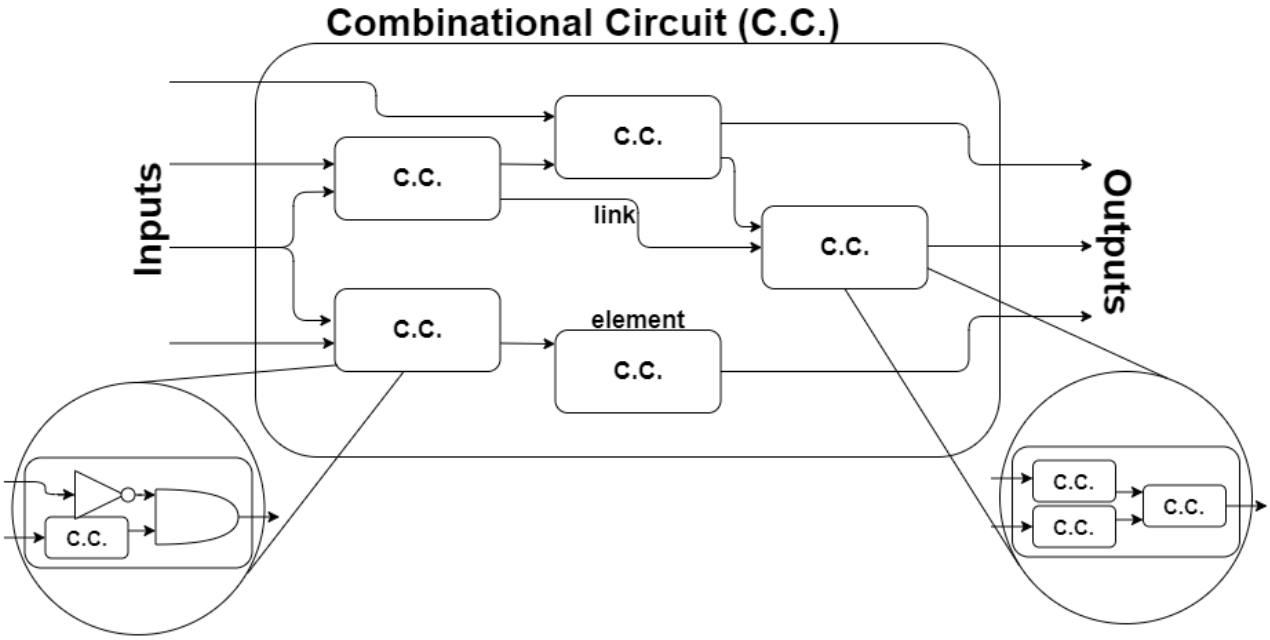
Problem set 0 (introductory concepts)

Exercise 01 :

1) Give the definition of logic gates.
2) Draw a table listing the logic gates information including symbol, truth table, and description. The gates liste contains: NOT, AND, OR, NAND, NOR, XOR, XNOR, buffer, tristate buffer.
3) Draw the symbol and the truth table of an AND3 gate. What does the number 3 in the gate name mean ?
4) Give the definition of *fan-out* characteristic of a logic gate.

Exercise 02 :

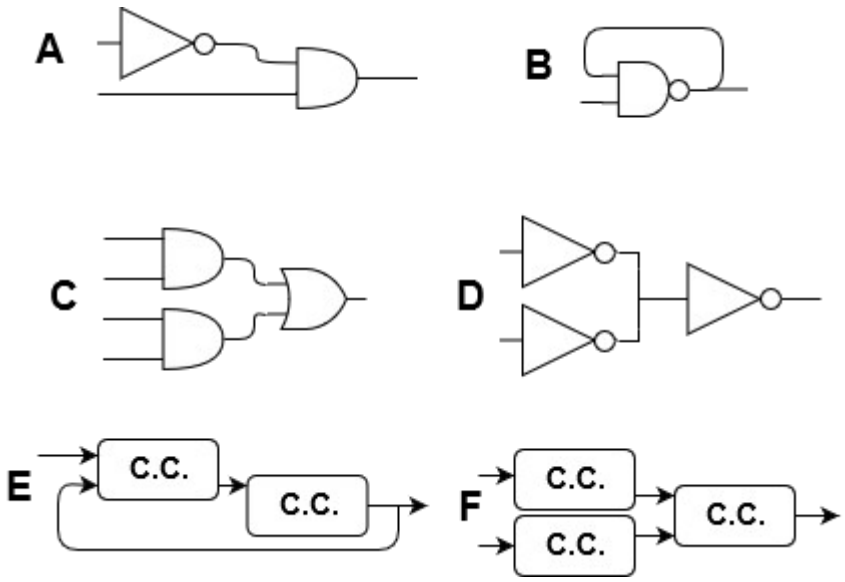
The formal definition of a combinational circuit specify that a combinational circuit is a **graph** composed of several **elements** interconnected to each other by oriented **links**. Each element recursively represents a combinational circuit itself composed by other elements within it. The basic non-composable elementary circuits are logic gates. The following figure demonstrates this configuration :



The combinational circuit by definition must follow the 5 following rules:

- Each element must be either a combinational circuit or a logic gate.
- The combinational circuit has *n* inputs and *m* outputs of discrete (binary) values, it processes the inputs in such a way that for each input combination there is only one single and unique output combination. Mathematically speaking, it represents a logical function (or binary function).
- The links are electrical wires carrying logic values (0 = 0 volts or 1 = 5 volts).
- A link can have several destination points (this is the fan-out) but can only have only one start point.
- Whatever the path taken by a signal from the input to the output of the circuit, it should in any case, cross the same element twice in its path. In other words, there is no cycle in the circuit.

Question : According to these definitions, analyze the following circuits and determine whether they are valid combinational circuits or not, and explain why?



Exercise 03 :

The *specification* (operational description) of a combinational circuit is often formally provided by two main tools; the truth table and/or logical functions. From the logic functions listed below, draw the schematic and the truth table of each corresponding combinational circuit.

1) $F(A,B) = A\cdot\overline{B} + \overline{A}\cdot B$
2) $F(A,B,C) = (A+B+C)\cdot(A+B+\overline{C})+A\cdot B$
3) $F_1(A,B,C) = \overline{A}\cdot B\cdot\overline{C} + A\cdot B\cdot\overline{C} + A\cdot\overline{B}\cdot C$
   $F_2(A,B,C) = \overline{A}\cdot\overline{B} + \overline{A+B+C}$
   $F_3(A,B,C) = (A\oplus B)\cdot(B\otimes C)$