Demorgan's Theorem

First Theorem - Complement of sum is equal to product of its individual complements.
~(A+B) = ~A~B

Second Theorem - Complement of product is equal to sum of its individual complements.
~(AB) = ~A + ~B

Logic Gate

A gate is a digital circuit which operates on one or more signals and produces a single output. Gates are digital circuits because the input and output signals are denoted by either 1(high voltage) or 0(low voltage).Three type of gates are as under:

1. AND gate 2. OR gate 3. NOT gate

Principal of Duality

In Boolean algebras the duality Principle can be is obtained by interchanging AND and OR operators

and replacing 0's by 1's and 1's by 0's. Compare the identities on the left side with the identities on the

Right .Example : X.Y+Z' = (X'+Y').Z

Contingency

A compound proposition is called contingency if and only if it is neither a tautology nor a contradiction.

It contains both T (True) and F (False) in last column of its truth table.

Tautology

A compound proposition is called tautology if and only if it is true for all possible truth values of its propositional variables.

It contains only T (Truth) in last column of its truth table.

Contradiction

A compound proposition is called contradiction if and only if it is false for all possible truth values of its propositional variables.

It contains only F (False) in last column of its truth table.

Flip Flop

Flip Flop is a device which is used to store 1 bit information i.e. 1 or 0.

If it is used to store 1 bit then it is SET and if it is storing 0 bit then it is reset.

VHDL

The **VHSIC (Very High Speed Integrated Circuit Program) Hardware Description Language** (**VHDL**) is a hardware description language (HDL) that can model the behavior and structure of digital systems at multiple levels of abstraction, ranging from the system level down to that of logic gates, for design entry, documentation, and verification purposes.

K-Map

A Karnaugh map (K-map) is a pictorial method used to minimize Boolean expressions without having to use Boolean algebra theorems

Basic Theorem of Boolean Algebra

T1 : Properties of 0

(a) 0 + A = A

(b) 0 A = 0

T2 : Properties of 1

(a) 1 + A = 1

(b) 1 A = A

T3 : Commutative Law

(a) A + B = B + A

(b) A B = B A

T4 : Associate Law

(a) (A + B) + C = A + (B + C)

(b) (A B) C = A (B C)

T5 : Distributive Law

(a) A (B + C) = A B + A C

(b) A + (B C) = (A + B) (A + C)

(c) A+A'B = A+B

T6 : Indempotence (Identity) Law

(a) A + A = A

(b) A A = A

T7 : Absorption (Redundance) Law

(a) A + A B = A

(b) A (A + B) = A

T8 : Complementary Law

(a) X+X'=1

(b) X.X'=0

T9 : Involution

(a) x'' = x

T10 : De Morgan's Theorem

(a) (X+Y)'=X'.Y'

(b) (X.Y)'=X'+Y'

Truth table is a table that contains all possible values of logical variables/statements in a Boolean expression.No. of possible combination = 2n, where n=number of variables used in a Boolean expression.

AND operator

It performs logical multiplication and denoted by (.) dot.

X Y X.Y

0 0 0

0 1 0

1 0 0

1 1 1

OR operator

It performs logical addition and denoted by (+) plus.

X Y X+Y

0 0 0

0 1 1

1 0 1

1 1 1

If the output of Boolean expression is always True or 1 is called **Tautology**. If the output of Boolean expression is always False or 0 is called **Fallacy.**

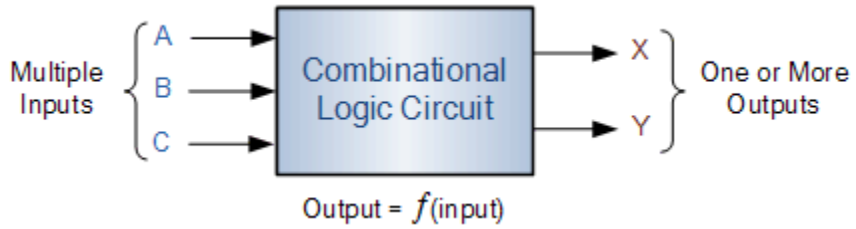
Combinational Logic Circuits

Combinational Logic Circuits are memoryless digital logic circuits whose output at any instant in time depends only on the combination of its inputs

Unlike Sequential Logic Circuits whose outputs are dependant on both their present inputs and their previous output state giving them some form of Memory. The outputs of **Combinational Logic Circuits** are only determined by the logical function of their current input state, logic “0” or logic “1”, at any given instant in time.

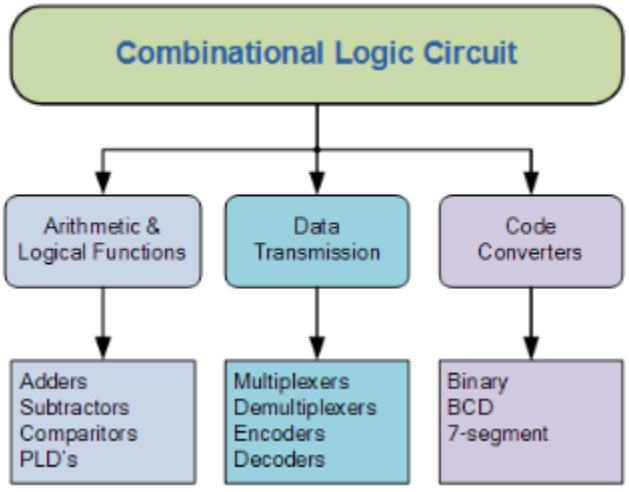
So if one of its inputs condition changes state, from 0-1 or 1-0, so too will the resulting output as by default combinational logic circuits have “no memory”, “timing” or “feedback loops” within their design.

Combinational Logic



Combinational Logic Circuits are made up from basic logic NAND, NOR or NOT gates that are “combined” or connected together to produce more complicated switching circuits. These logic gates are the building blocks of combinational logic circuits. An example of a combinational circuit is a decoder, which converts the binary code data present at its input into a number of different output lines, one at a time producing an equivalent decimal code at its output.

Classification of Combinational Logic



Multiplexer (data Selectors)

• Definition : A multiplexers (MUX) is a device that allows digital information from several sources to be routed onto a single line for transmission over that line to a common destination.

• Several data input lines

• Some select line (less than the no. of input lines)

• Single output line

• If there are n data input lines and m select lines, then 2^m = n

Demultiplexer (Data Distributor)

• Definition : A DEMULTIPLEXER (DEMUX) basically reverses the multiplexing function. It takes data from one line and distributes them to a given number of output lines. For this reason, the demultiplexers is also known as a data distributor.

• Single data input lines

• Some select line (less than the no. of output lines)

• Several output line

• If there are n data output lines and m select lines, then 2^m = n

SEQUENTIAL LOGIC CIRCUITS

Made up of combinational circuits and memory elements. These memory elements are devices capable of

storing ONE-BIT information.Output depend on latest input and previous state.

Examples of sequential circuits are flip flops,counters, shift registers

Sequential circuits are of two types:

1.**SYNCHRONOUS CIRCUITS**: In synchronous sequential circuits, the state of the device changes only at discrete times in response to a clock Pulse.

Synchronous circuits employs a synchronizing signal called clock (a periodic train of pulses; 0s and 1s)A clock determines when computational activities occur Other signals determines what changes will occur,i.e.determining the output from the inputs whenever clock ticks.The storage elements (memory) used in clocked sequential circuits are called flip-flops. Each flip-flop can store one bit of information 0,1

A circuit may use many flip-flops; together they define the circuit state. Flip-Flops (memory/state) update only with the clock

7	a, Flip-flop always have a clock signal	latche doesn't have a clock signal
8	Flip-flop can be build from Latches	Latches can be build from gates
9	ex:D Flip-flop, JK Flip-flop	ex:SR Latch, D Latch

SNO	Flip-flop	Latch
1	Flip-flop is a bistable device i.e., it has two stable states that are represented as 0 and 1.	Latch is also a bistable device whose states are also represented as 0 and 1.
2	It checks the inputs but changes the output only at times defined by the clock signal or any other control signal.	It checks the inputs continuously and responds to the changes in inputs immediately.
3	It is a edge triggered device.	It is a level triggered device.
4	Gates like NOR, NOT, AND, NAND are building blocks of flip flops.	These are also made up of gates.
5	They are classified into asynchronous or synchronous flipflops.	There is no such classification in latches.
6	It forms the building blocks of many sequential circuits like counters.	These can be used for the designing of sequential circuits

2.**ASYNCHRONOUS CIRCUITS**: Asynchronous circuit is not synchronized by a

clock signal; the outputs of the circuit change directly in response to changes in Inputs.

Canonical form of Boolean Expression (Standard form)

In standard SOP and POS each term of Boolean expression must contain all the literals (with and without bar) that has been used in Boolean expression. If the above condition is satisfied by the Boolean expression, that expression is called Canonical form of Boolean expression. In Boolean expression AB+AC

the literal C is mission in the 1st term AB and B is mission in 2nd term AC. That is why AB+AC is not a Canonical SOP.

Minterm and Maxterm

Individual term of **Canonical Sum of Products(SOP)** is called Minterm. In otherwords minterm is a product of all the literals (with or withoutbar) within the Boolean expression.

Individual term of **Canonical Products of Sum(POS)** is called Maxterm. In otherwords maxterm is a sum of all the literals (with orwithout bar) within the Boolean expression.

Purpose of the Index

Minterms and Maxterms are designated with an index The index number corresponds to a binary pattern The index for the minterm or maxterm, expressed as a binary number, is used to determine whether the variable is shown in the true or complemented form

For Minterms:

‘1’ means the variable is “Not Complemented” and

‘0’ means the variable is “Complemented”.

For Maxterms:

‘0’ means the variable is “Not Complemented” and

‘1’ means the variable is “Complemented”.

Two method can by applied to reduce the Boolean expression –

i) Algebraic (The different Boolean rules and theorems are used to simplify the Boolean expression in this method.)

ii)Using Karnaugh Map (K-Map).

DECODER

• A decoder is a combinational circuit.

• A decoder accepts a set of inputs that represents a binary number and activates only that output corresponding to the input number. All other outputs remain inactive.

• Fig. 1 shows the block diagram of decoder with ‘N’ inputs and ‘M’ outputs.

• There are 2N possible input combinations, for each of these input combination only one output will be HIGH (active) all other outputs are LOW

• Some decoder have one or more ENABLE (E) inputs that are used to control the operation of decoder.

2x4,3x8 decoders

ENCODER

• An Encoder is a combinational logic circuit.

• It performs the inverse operation of Decoder.

• The opposite process of decoding is known as Encoding.

• An Encoder converts an active input signal into a coded output signal.

• Block diagram of Encoder is shown in Fig.10. It has ‘M’ inputs and ‘N’ outputs.

• An Encoder has ‘M’ input lines, only one of which is activated at a given time, and produces an N-bit output code, depending on which input is activated.

Encoders are used to translate the rotary or linear motion into a digital signal.

• The difference between Decoder and Encoder is that Decoder has Binary Code as an input while Encoder has Binary Code as an output.

• Encoder is an Electronics device that converts the analog signal to digital

signal such as BCD Code.

• **Types of Encoders**

i. Priority Encoder (As the name indicates, the priority is given to inputs line. If two or more input lines are high at the same time i.e 1 at the same time, then the input line with high priority shall be considered.)

ii. Decimal to BCD Encoder

iii. Octal to Binary Encoder

iv. Hexadecimal to Binary Encoder