Logic design

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First stage

(Lecture 10)

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Chapter Four

-A combinational circuit-

A combinational circuit is the digital logic circuit in which the output depends on the combination of inputs at that point of time with total disregard to the past state of the inputs.

Combinational circuits can be made using various logic gates, such as AND gates, OR gates, and NOT gates.

Types of Combinational Circuits

There are three main types of combinational circuits: decoders, encoders, and multiplexers.

1. Decoders are combinational circuits that convert binary code into a form that can be read by a human. For example, a decoder might take a four-bit binary number and convert it into a seven-segment display.
2. Encoders are combinational circuits that convert information from one form to another. For example, an encoder might take a seven-segment display and convert it into a four-bit binary number.
3. Multiplexers are combinational circuits that select one of several input signals and send it to the output. For example, a multiplexer might take four input signals and send only one of them to the output.

The design procedure for asynchronous sequential circuits is similar in many respects to that developed for synchronous circuits.
The aim of the design is to produce hazard-free next state equations and output functions. The steps in the design procedure are summarized below:

1. *Problem definition*.
2. *Basic state table and internal state diagram*.
3. *Reduction of the basic state table*.
4. *State assignment*.
5. *Equations for the state variables*.

Types of combinational circuits:-

1- Half Adder

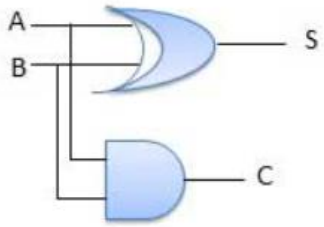
Half adder is a combinational logic circuit with two inputs and two outputs. The half adder circuit is designed to add two single bit binary number A and B. It is the basic building block for addition of two single bit numbers. This circuit has two outputs carry and sum.

Block diagram

Truth Table

Inputs		Output
A	B	S C
0	0	0 0
0	1	1 0
1	0	1 0
1	1	0 1

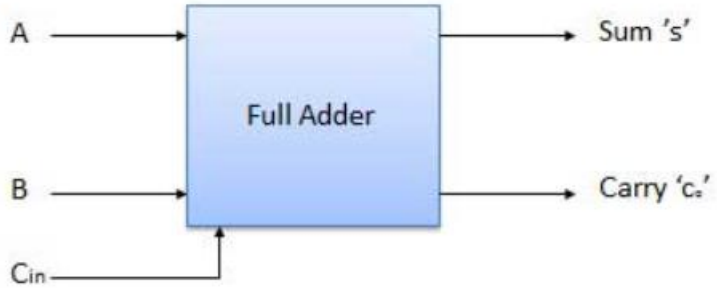
Circuit Diagram



2- Full Adder

Full adder is developed to overcome the drawback of Half Adder circuit. It can add two one-bit numbers A and B, and carry c. The full adder is a three input and two output combinational circuit.

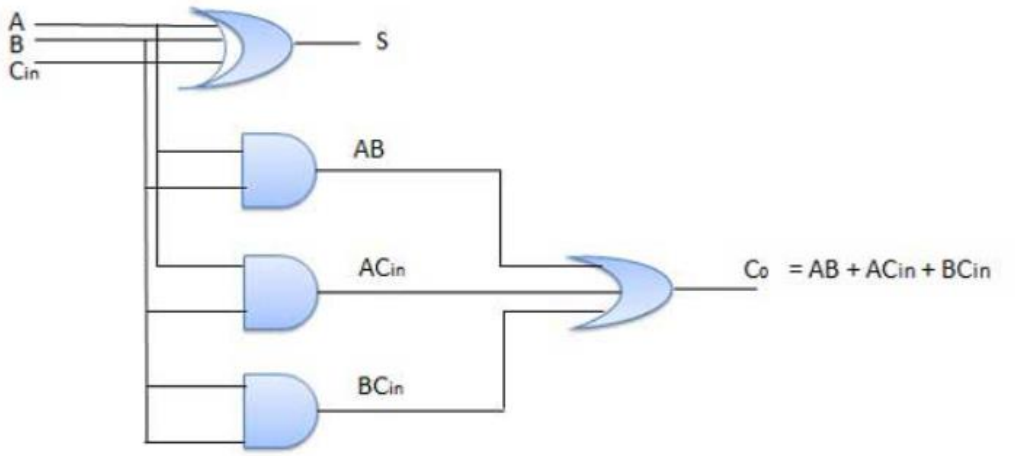
Block diagram



Truth Table

Inputs			Output	
A	B	Cin	S	Co
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Circuit Diagram



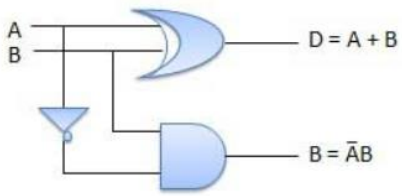
3- Half Subtractor

Half subtractor is a combination circuit with two inputs and two outputs (difference and borrow). It produces the difference between the two binary bits at the input and also produces an output (Borrow) to indicate if a 1 has been borrowed. In the subtraction (A-B), A is called as Minuend bit and B is called as Subtrahend bit.

Truth Table

Inputs		Output	
A	B	(A – B)	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Circuit Diagram



4- Full Subtractors

The disadvantage of a half subtractor is overcome by full subtractor. The full subtractor is a combinational circuit with three inputs A,B,C and two output D and C'. A is the 'minuend', B is 'subtrahend', C is the 'borrow' produced by the previous stage, D is the difference output and C' is the borrow output.

Truth Table

Inputs			Output	
A	B	C	(A-B-C)	C'
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Circuit Diagram