AKTU B.Tech II-Year

GATEWAY CLASSES

EC & EC Allied

DSD : Digital System Design

Gateway Classes

Unit-2 Lec- 3

Today's target

- Serial and parallel adders
- BCD adder
- PYQ



Avinash Sir

UNIT-2 : Combinational circuits:

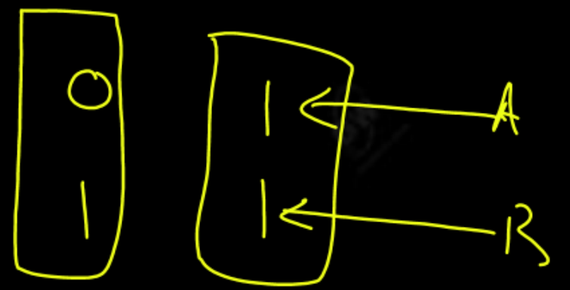
- Analysis and Design of combinational circuits
- MSI devices like comparators, multiplexers, demultiplexers, encoder, decoder,
- circuit realization using Multiplexers and decoders, half and full adders, subtractors, serial and parallel adders, BCD adder, barrel shifter and ALU.

Gateway Classes

Parallel Adder

A parallel adder is a digital circuit used to add two binary numbers simultaneously (in parallel). A parallel adder adds all the bits of two binary numbers at the same time using multiple full adders connected in parallel.

- Each bit of the numbers is added by a separate full adder.
- Carries generated from each stage are propagated to the next higher stage.
- Thus, it is much faster than a serial adder.

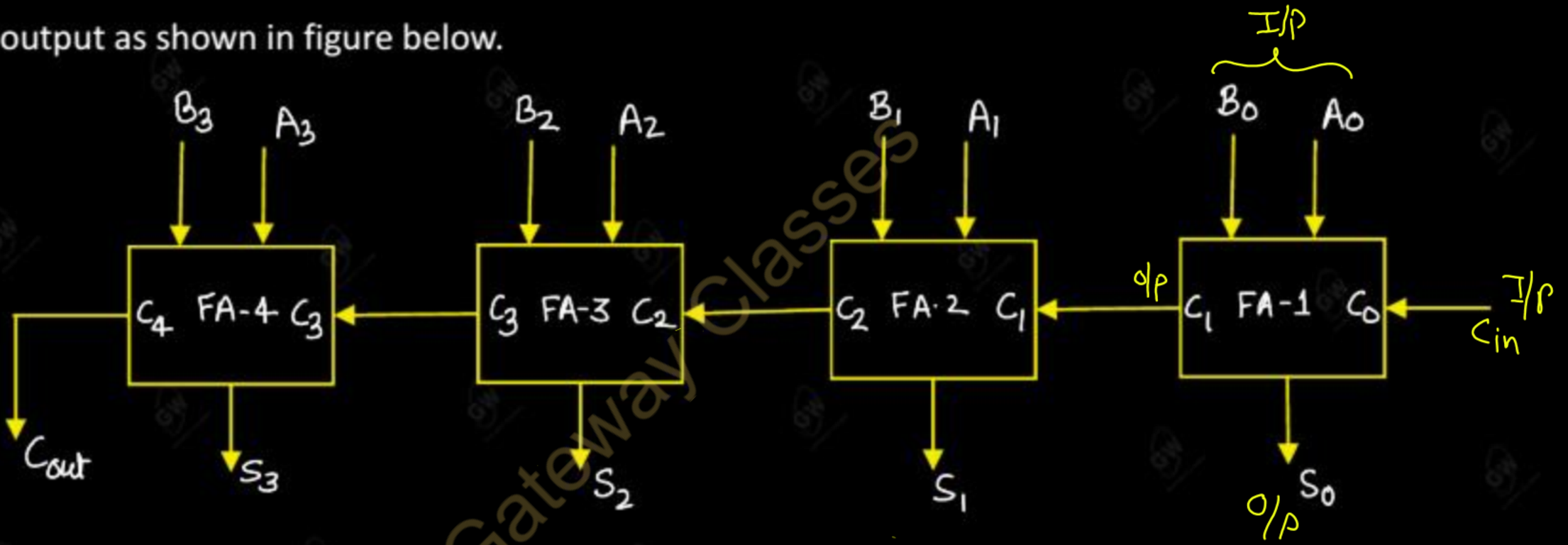


Gateway Classes

4-bit binary adder

Final o/p = C_{out} S_3 S_2 S_1 S_0

The 4-bit binary adder using full adder circuits is capable of adding two 4-bit numbers resulting in a 4-bit sum and a carry output as shown in figure below.



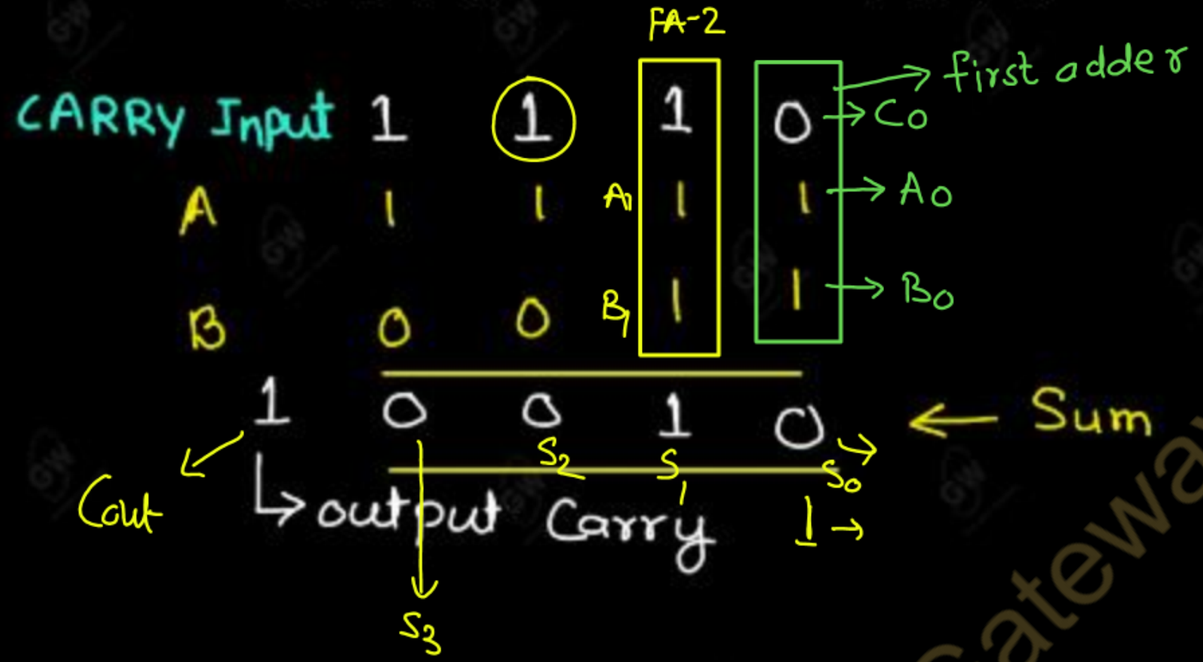
- Use 4 full adders in cascade.
- Carry-out of each stage is connected to carry-in of next stage.

Gateway Classes

4-bit binary adder

Let the 4-bit words to be added be represented by,

$A_3 A_2 A_1 A_0 = 1\ 1\ 1\ 1$ and $B_3 B_2 B_1 B_0 = 0\ 0\ 1\ 1$.

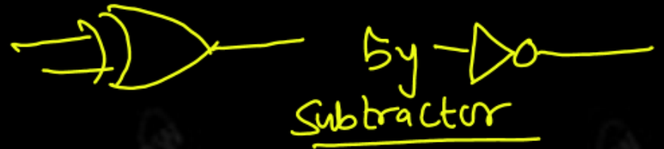


Gateway Classes

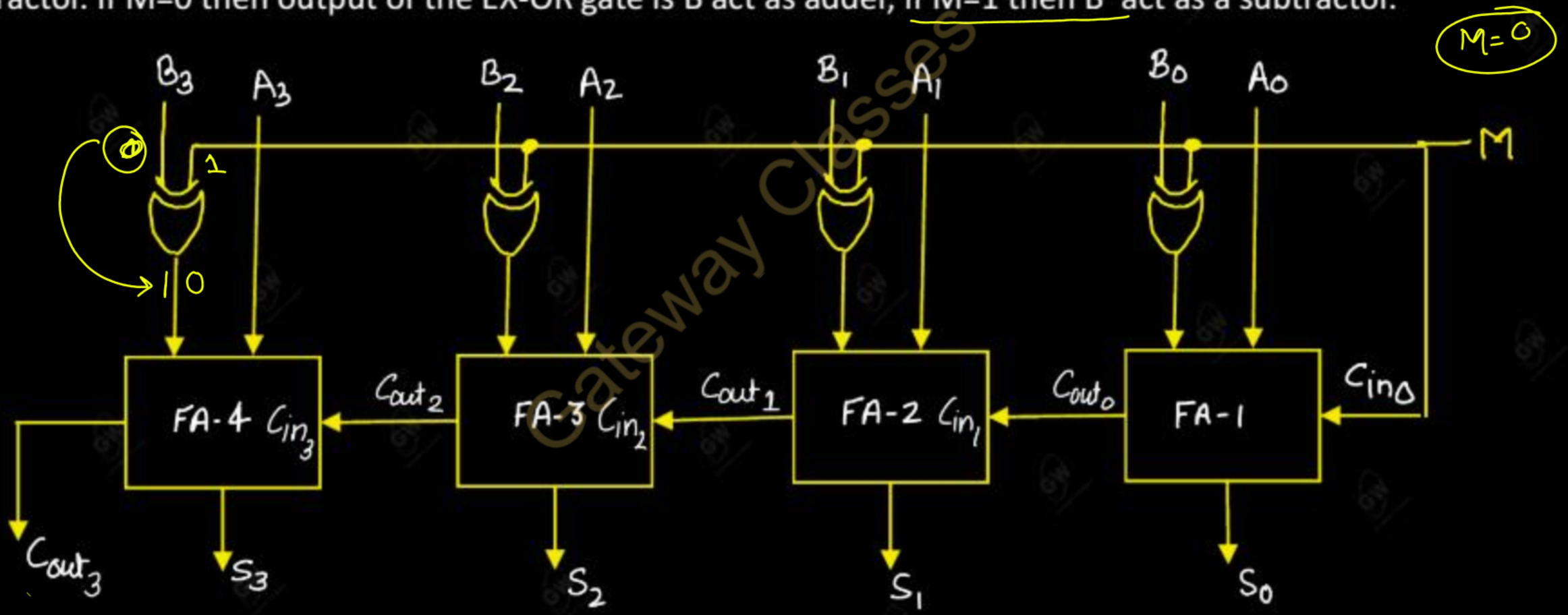
Advantages

- Very fast compared to serial adders (all bits processed simultaneously).
- Simple design using only full adders.
- Widely used in CPUs and ALUs.

Parallel binary Adder – Subtractor

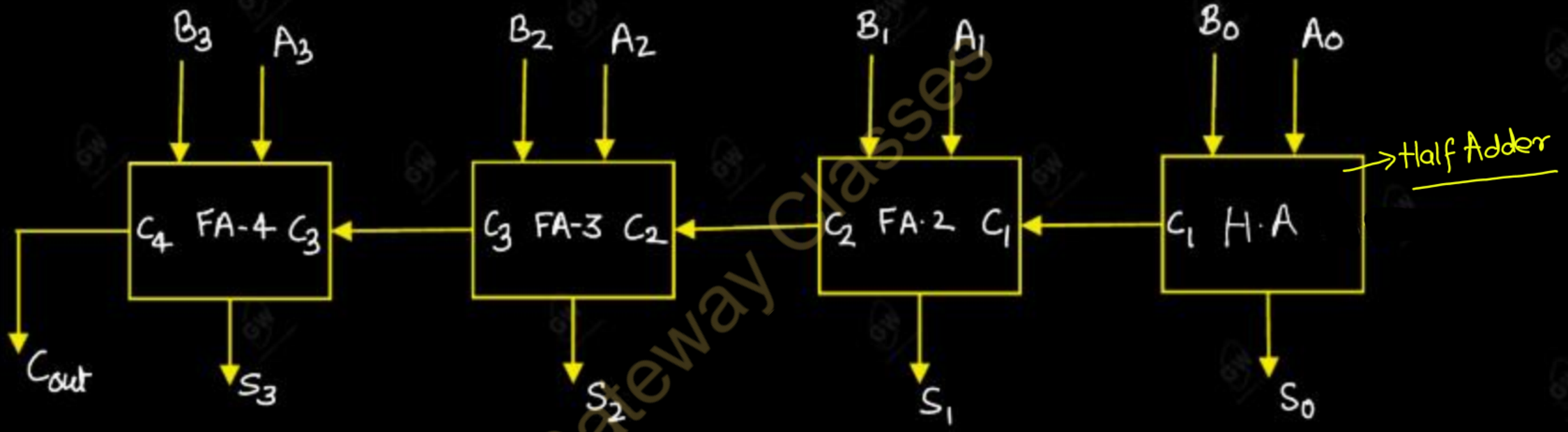


The addition and subtraction operations can be perform using a common adder circuit, where a EX-OR gate is connected in the second input along with the mode selection bit M. if M=0 the circuit act as a adder, M=1 then subtractor. If M=0 then output of the EX-OR gate is B act as adder, if M=1 then B' act as a subtractor.



Gateway Classes

Ex. Design a 4-bit adder using three full adder and one half adder.



Gateway Classes

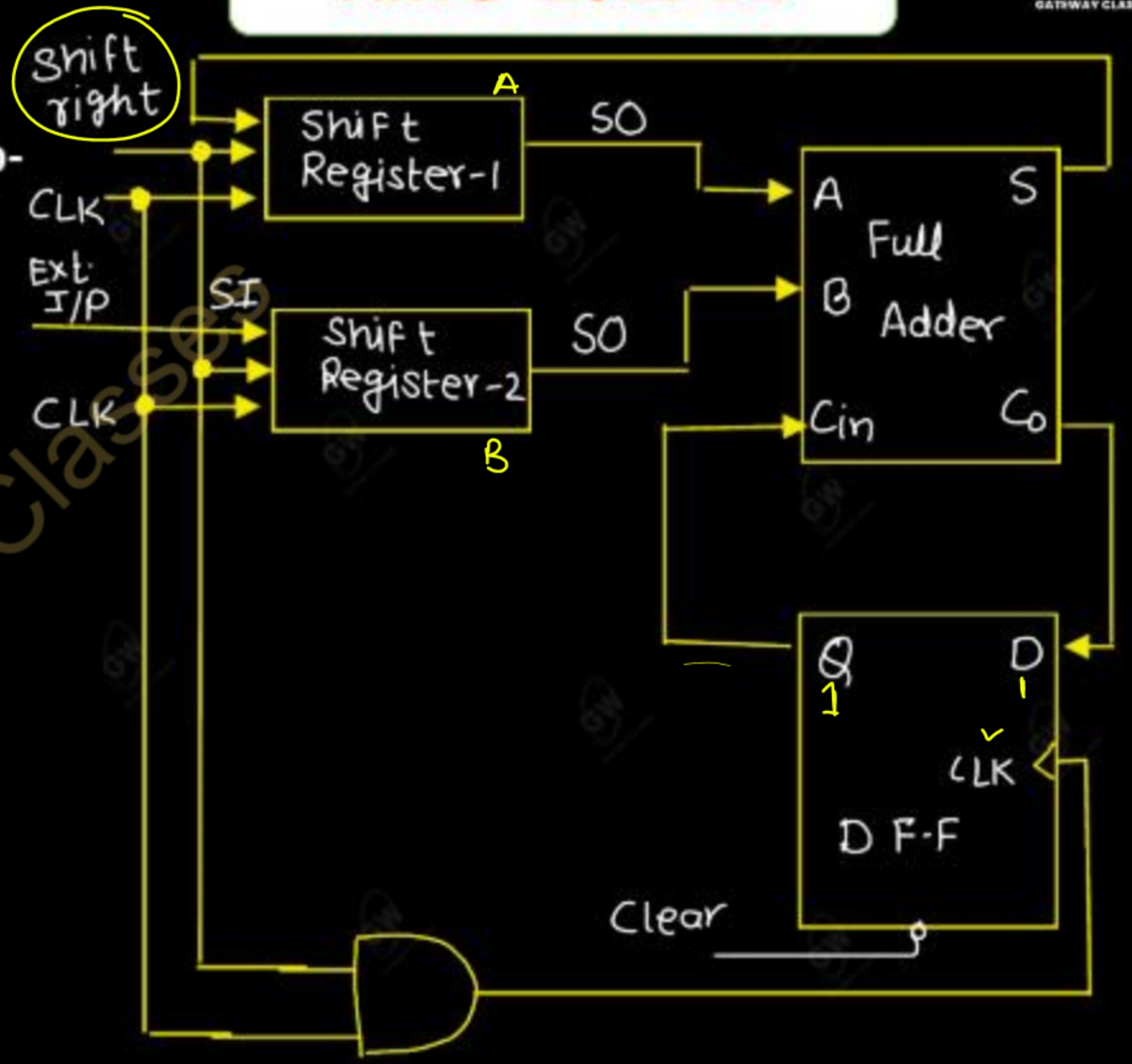
Addition Perform →

Serial Adder

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1. Definition and Circuit

- Uses two shift registers, one full adder, one D flip-flop, and an AND gate.
- The serial outputs of the registers feed into the full adder.
- The sum goes back into one register, and the carry is stored in the D flip-flop.
- Clock pulses (through the AND gate) control shifting and addition.



Gateway Classes

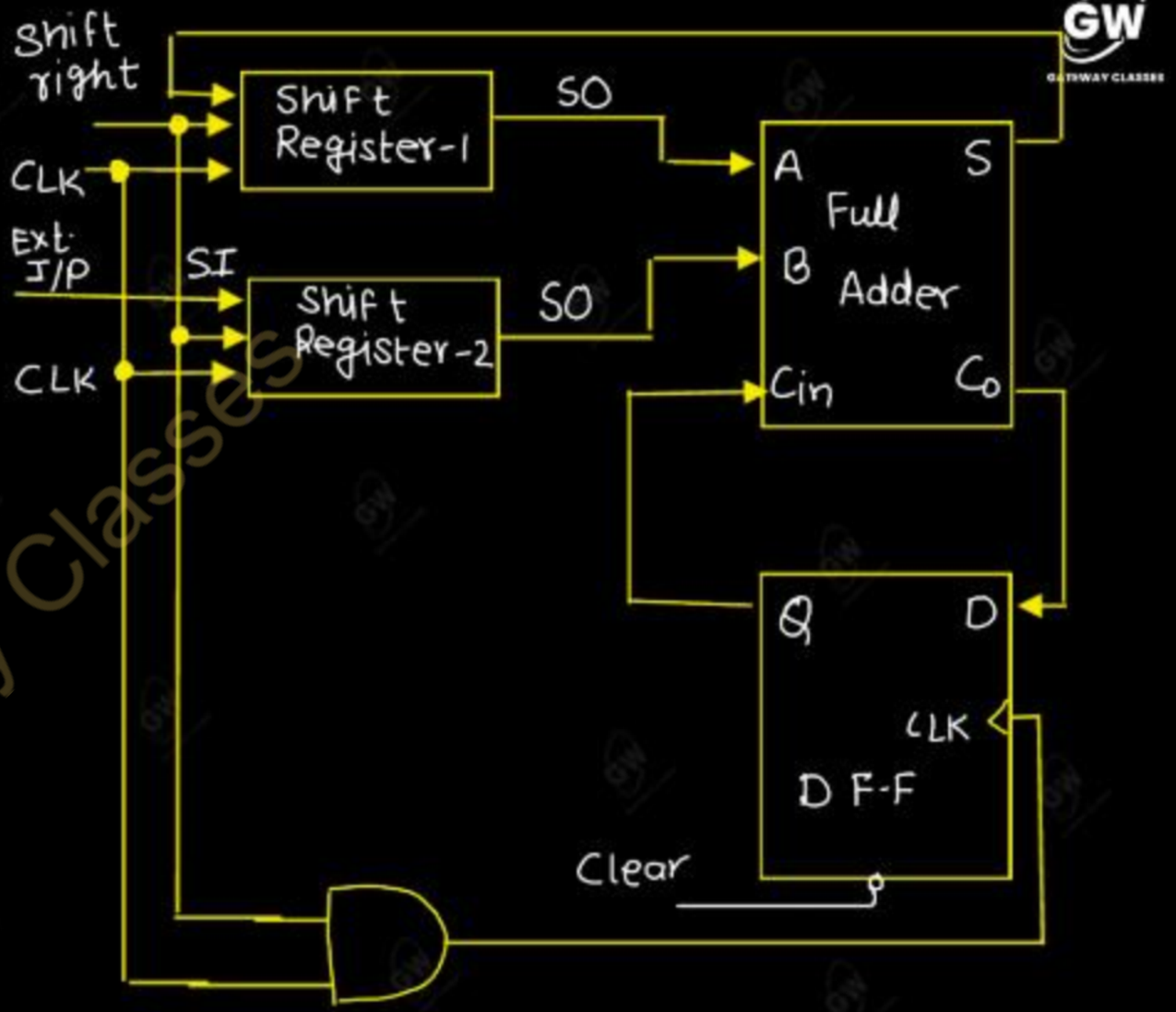
Serial Adder

2. Working Operation

Initially, the D flip-flop is cleared so Q= 0 and C_{in} = 0.

At each clock pulse:

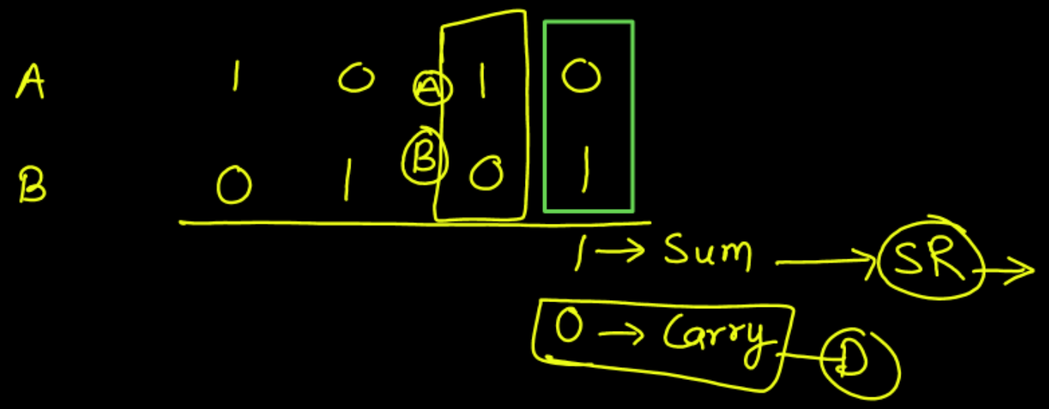
- The least significant bits (LSBs) from both registers are added.
- The full adder produces sum (S) and carry (Cout). Carry is stored in the D flip-flop for the next stage.
- Both registers shift right → next bits move to the output.
- This repeats until all bits are added.

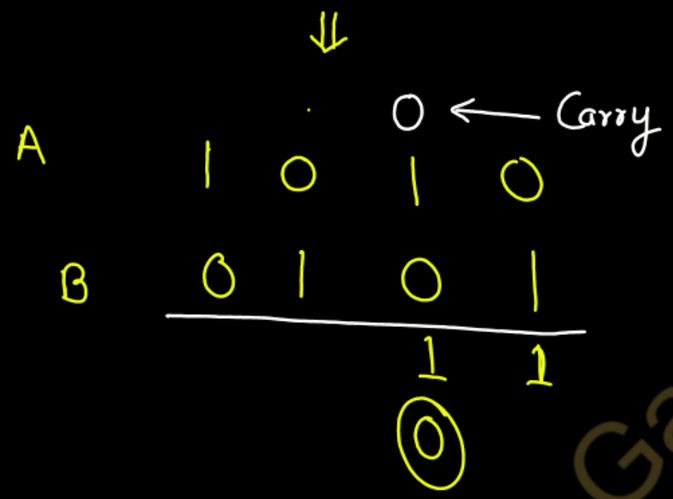


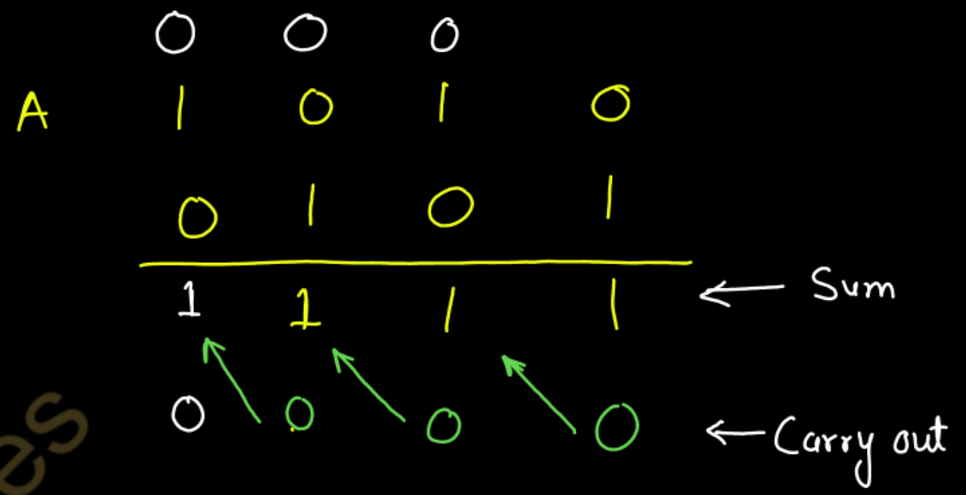
Gateway Classes

Example:-

Let







Gateway Classes

Serial Adder

3. Advantages

- Adds one pair of bits at a time (step-by-step).Needs only $n-1$ clock cycles to finish addition.
- Addition continues as long as shift control is enabled.
- Output sum is obtained in serial form.

4. Drawbacks

- Slow – takes more time compared to parallel adder.
- Circuit is more complex.
- Requires more components.
- Output is in serial form, so complete result is not available at once.

Gateway Classes

BCD Adder

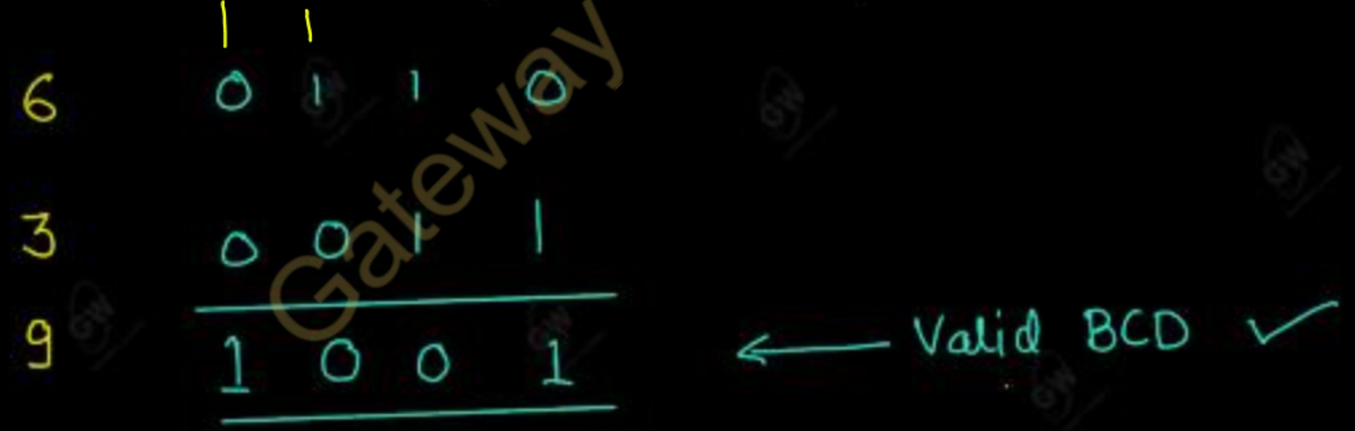


- In digital system, the decimal number is represented in the form of binary coded decimal (BCD).
- The ten digit (0-9) decimal numbers are represented by the binary digits.
- The circuit which add the two BCD number is called BCD adder. The BCD cannot be greater than 9.

There are three different cases in BCD Addition

(i) Sum is less than or equal to 9 with carry 0

Consider the addition of two BCD numbers 6 and 3, The addition is performed as normal binary addition



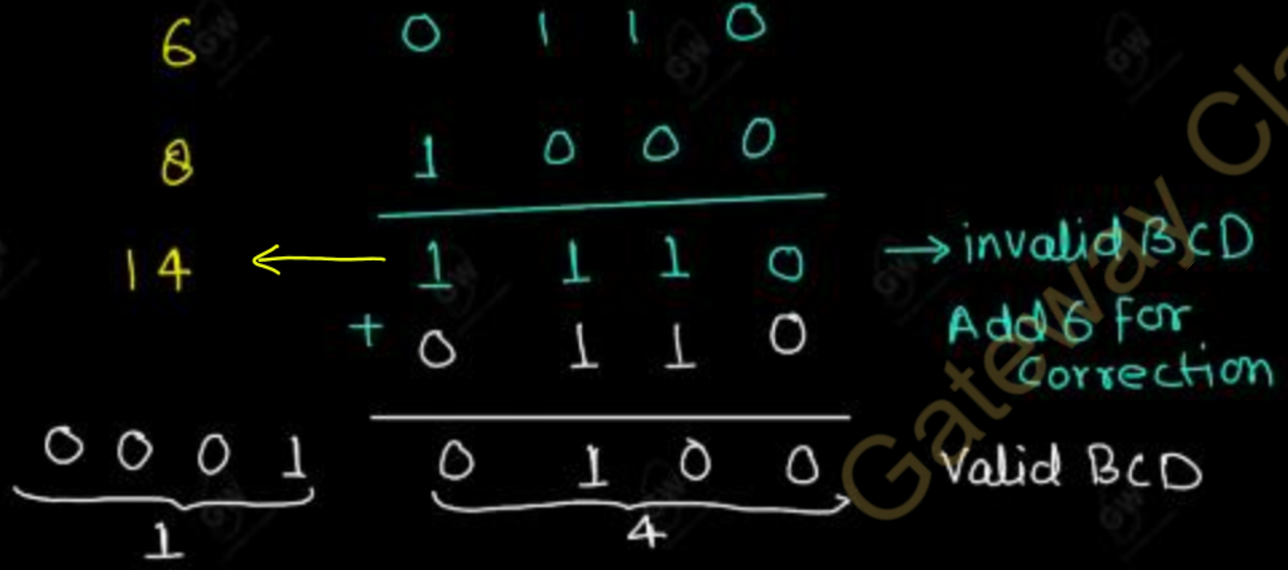
Gateway Classes

BCD Adder

1 4
0001 0100

ii) Sum is greater than 9 with carry 0

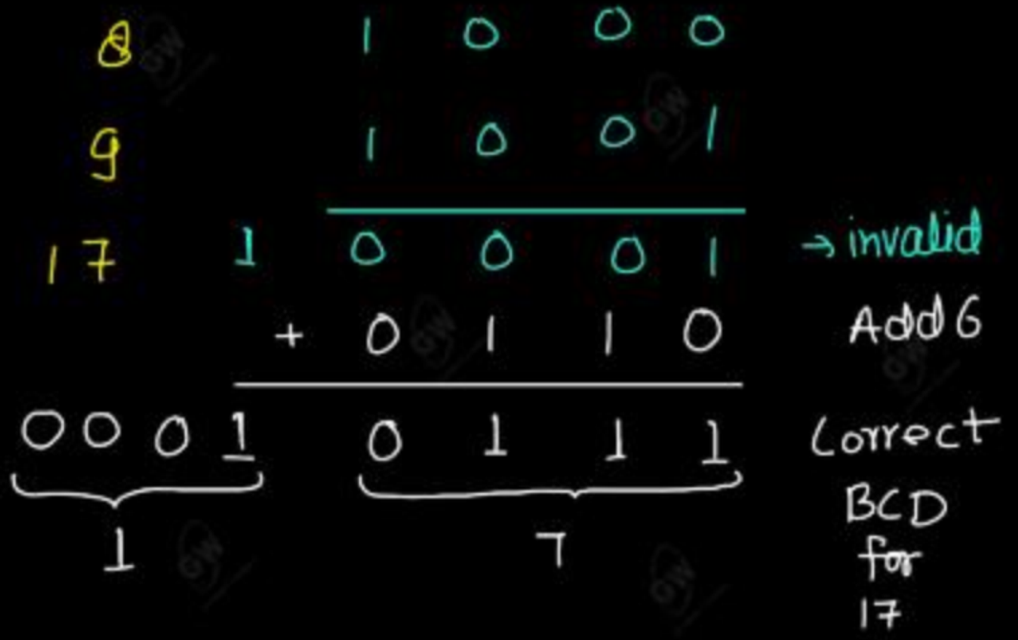
consider the number 6 and 8 in BCD. The sum is invalid BCD number, Add the sum with correction number 6



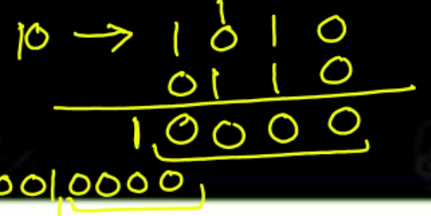
After addition of 6 carry is produced into the second decimal position.

iii) Sum equals 9 or less with carry 1

Consider the addition of 8 and 9 in BCD. The result 0001 0001 is valid BCD number but it is incorrect. Add 6 to get correct number.



Gateway Classes



The procedure for BCD addition is

1. Add two BCD numbers using ordinary binary addition.

2. If four bit sum is less than or equal to ~~zero~~ 9, then correction is not required.

3. If the four bit sum is greater than 9 or if carry is generated then add 0110.

Implementation of BCD Adder

We require 4-bit binary adder for initial addition, Logic circuit to detect sum greater than 9, and second 4 bit binary adder to add 0110.

The following truth table is used to design a circuit for the sum, which is greater than 9

Why 6?

- Because 10 (decimal) = 1010_2, and we want to "roll over" into the next decimal digit.
- Adding 6 shifts invalid results (1010 to 1111) into the next valid BCD range.
- This also generates a carry for the next decimal place.

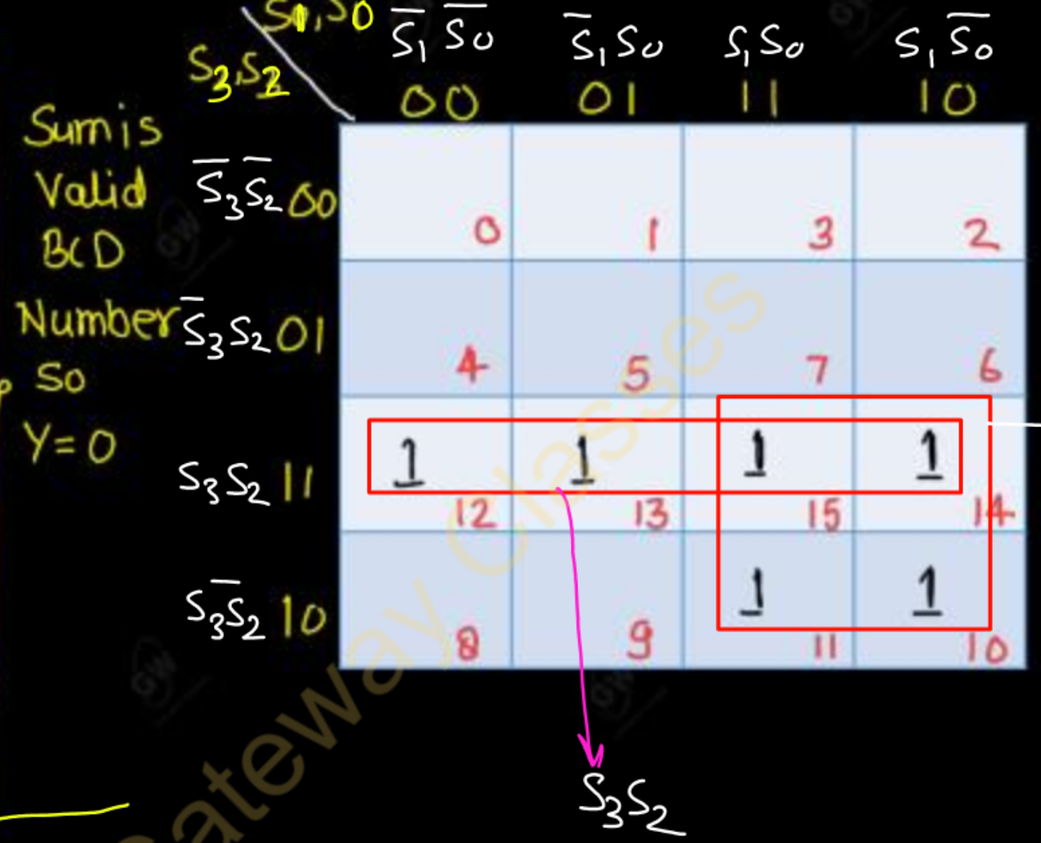
Gateway Classes

	Input				output
	S3	S2	S1	S0	Y
0	0	0	0	0	0
1	0	0	0	1	0
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	0
5	0	1	0	1	0
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	1
11	1	0	1	1	1
12	1	1	0	0	1
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	1

Sum is Valid BCD Number so Y=0

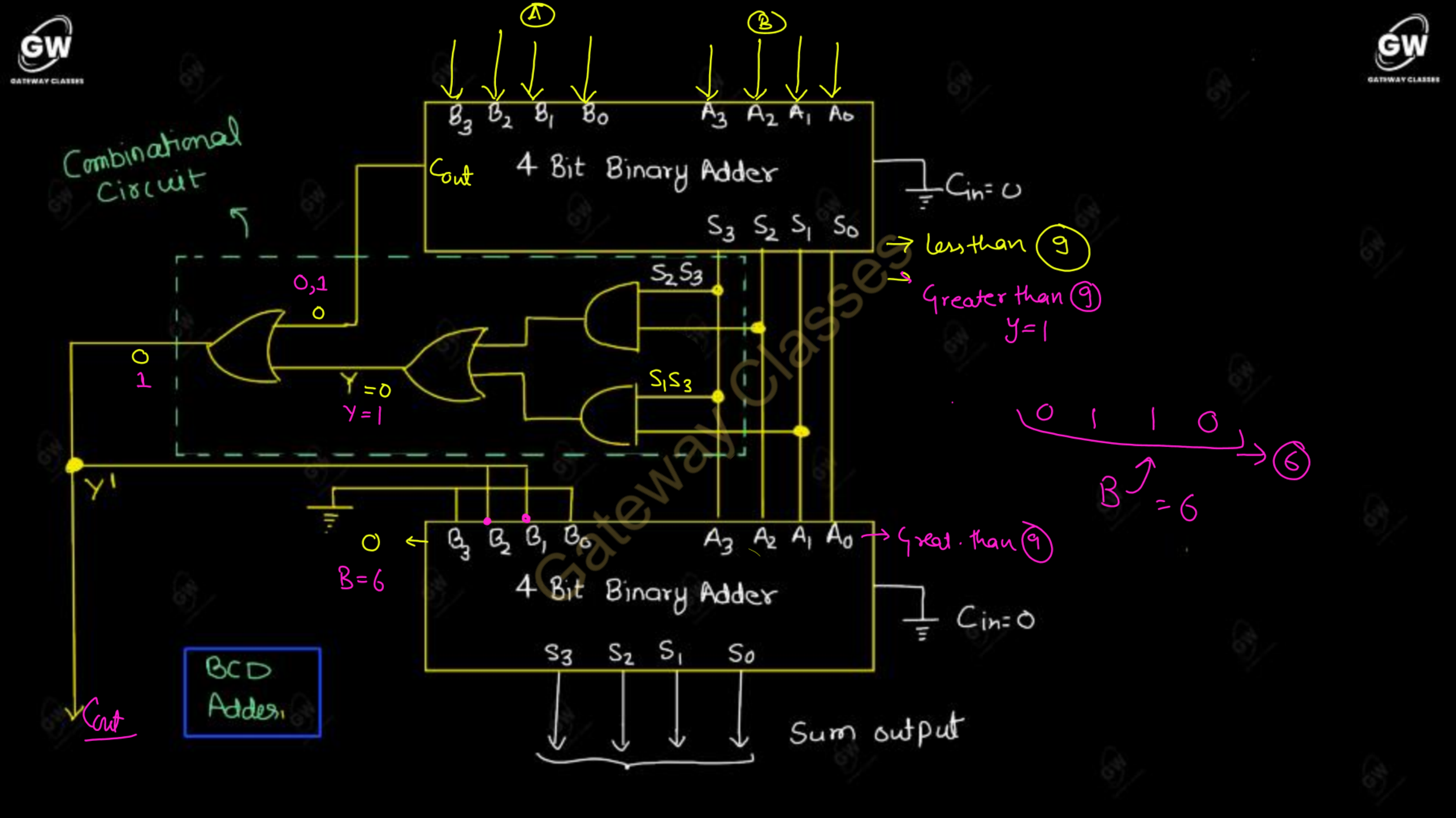
Sum is invalid BCD number Therefor Y=1

K-Map



$$Y = S_3S_2 + S_3S_1$$

Gateway Classes


A
B
B_3 B_2 B_1 B_0
A_3 A_2 A_1 A_0
4 Bit Binary Adder
Cout
C_{in} = 0
S_3 S_2 S_1 S_0
Combinational Circuit
0,1
0
0
1
Y = 0
Y = 1
S_2S_3
S_1S_3
Y1
less than 9
Greater than 9
Y = 1
0 1 1 0
6
B = 6
0
B = 6
Great. than 9
4 Bit Binary Adder
C_{in} = 0
S_3 S_2 S_1 S_0
Sum output
BCD Adder
Cout
Gateway Classes

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Thank You

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